REPORT

November 27, 2014

FOUNDATION INVESTIGATION REPORT

BIQUETTE CREEK CULVERT AT STA 13+350
HIGHWAY 17 REHABILITATION BETWEEN WARREN AND VERNER
FROM HIGHWAY 539 EASTERLY TO 0.2 KM EAST
OF WEST JUNCTION OF HIGHWAY 64
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 300-98-00

Submitted to:
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Table of Contents

PART A

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH), on behalf of the Ministry of Transportation, Ontario (MTO), to provide foundation engineering services for the replacement of the Highway 17 Biquette Creek culvert at STA 13+350 in the Town of Verner in the Municipality of West Nipissing, Ontario. The Key Plan showing the general location of this section of Highway 17 and the location of the investigated area are shown on Drawing 1. The purpose of this investigation is to establish the subsurface conditions at the location of the culvert by borehole drilling, in situ testing and laboratory testing on selected soil samples.

2.0 SITE DESCRIPTION

The Biquette Creek culvert is located on Highway 17 in the Town of Verner immediately west of the west junction with Highway 64. In general, the topography in the area of the overall project limits consists of flat terrain with commercial and residential properties. The existing highway grade is at about Elevation 210 m with Biquette Creek crossing under the embankment about 10 m below the existing highway grade. The side slopes of the existing embankment are inclined at about 2 Horizontal to 1 Vertical (2H:1V) and the embankment side slopes are vegetated with grass and small trees/shrubs. The existing culvert consists of twin 1.1 m diameter Corrugated Steel Pipes (CSP), 59 m long.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the investigation was carried out between November 27 and December 3, 2013, and between February 12 and 24, 2014, during which time a total of seven boreholes were advanced at the approximate locations shown on Drawing 1:

- four boreholes for the culvert alignment (Boreholes BI-1, BI-2, BI-5/5a and BI-6);
- one borehole for the proposed roadway protection (Borehole BI-3); and
- two boreholes for the proposed cofferdam (Boreholes BI-4 and BI-7).

Boreholes BI-1 to BI-3, located on the existing highway embankment, were advanced to depths between 15.8 m and 21.9 m below ground surface using a truck-mounted CME 55 drill rig outfitted with 108 mm inside diameter continuous flight hollow-stem augers and 'NW' casing with wash boring techniques, supplied and operated by Landcore Drilling Inc. of Sudbury, Ontario. Boreholes BI-4 to BI-7, located at or beyond the existing toe of slope, were advanced to a depth of 14.3 m below ground/ice surface using wash boring methods with portable equipment using NQ casing, supplied and operated by George Downing Estate Drilling Ltd. of Grenville-Sur-La-Rouge, Quebec. Borehole BI-5a was advanced adjacent to Borehole BI-5 to obtain Shelby Tube samples and to complete additional field vane testing. A Dynamic Cone Penetration Test (DCPT) was advanced adjacent to Boreholes BI-2 and BI-4 to BI-6 to depths between 15.2 m and 21.9 m below ground surface.

Soil samples were obtained at intervals of depths of about 0.75 m and 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler driven by an automatic hammer at Boreholes BI-1 to BI-3 and a manual hammer at

Boreholes BI-4 to BI-7, and performed in accordance with Standard Penetration Test (SPT) procedure (ASTM D1586). Selected samples of the cohesive soils were obtained using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using MTO Standard 'N' size vanes. 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 in Appendix A. All boreholes were backfilled with bentonite upon completion of drilling in accordance with Ontario Reg. 903 (as amended).

The fieldwork was supervised throughout by members of our technical staff, who located the boreholes, arranged for the clearance of underground services, 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 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, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing are presented on the Record of Borehole sheets in Appendix A and are also included in Appendix B.

A sample of the creek water was obtained on March 10, 2014, using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of parameters. The results of the analytical testing are summarized in Table B1 in Appendix B, together with the detailed analytical laboratory test results.

The as-drilled borehole locations and ground surface elevations were measured and surveyed by members of our technical staff, referenced to the marked stations and offsets on the highway or the ends of the culvert, as applicable. The MTM NAD 83 northing and easting coordinates, ground surface elevations referenced to Geodetic datum and borehole depth at each borehole are presented on the Record of Borehole sheets in Appendix A and are summarized below.

Borehole	Borehole Location		Ground Surface Elevation (m)	Borehole/DCPT Depth Below Ground/Ice Surface (m)
	Northing	Easting		
BI-1	5141606.9	256900.7	210.4	18.9
BI-2	5141600.0	256890.8	210.4	21.9/21.9
BI-3	5141612.0	256878.7	210.5	15.8
BI-4	5141633.4	256911.5	201.4	14.3/15.2
BI-5	5141631.0	256897.4	201.7	14.3/15.2
BI-5a	5141629.9	256897.0	201.7	8.2
BI-6	5141575.9	256881.4	201.3	14.3/15.2
BI-7	5141569.5	256888.3	199.4	14.3*

*includes 0.2 m thick layer of ice and 1.3 m column of water

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on terrain mapping (Ontario Geological Survey[1]), the site is located on a glaciolacustrine plain in an area of sand and silt deposits with bedrock knobs/outcrops located to the north and south of the plain.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions, as encountered in the boreholes advanced for this investigation, together with the results of the laboratory tests carried out on selected soil core samples, are given on the Record of Borehole sheets in Appendix A. The results of the in situ tests (i.e., SPT "N"-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. Detailed results of the laboratory testing of the soil samples are provided in Appendix B. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profile and cross-section shown on Drawing 1 are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs and 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 stratigraphy at the site consists of embankment fill (where encountered) or topsoil (where encountered) generally underlain by clayey silt to silty clay, which in turn is underlain by a silt to silt and sand deposit. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Ice/Water

Borehole BI-7 was advanced from the surface of the ice near the outlet to the culvert at Elevation 200.9 m and encountered a 0.2 m thick layer of ice and 1.3 m column of water.

4.2.2 Fill

Boreholes BI-1 to BI-3 penetrated a layer of asphalt 225 mm thick at Elevation 210.4 m and 210.5 m, underlain by a fill deposit comprised of sand and gravel to sand between about 0.5 m and 2.9 m thick, underlain by clayey silt to silt fill between 6.5 m and 7.6 m thick.

The SPT 'N'-values measured within the sand and gravel to sand fill range between 10 blows and 58 blows per 0.3 m of penetration indicating a compact to very dense relative density; and the 'N'-values measured within the clayey silt to silt fill range between 5 blows and 24 blows per 0.3 m of penetration suggesting a firm to very stiff consistency.

[1] Southern Ontario Engineering Geology Terrain Study, 1980. Ontario Geological Survey.

Grain size analyses were carried out on two samples of the sand and gravel to gravely sand fill and the results are presented on Figure B1 in Appendix B. Grain size analyses were carried out on two samples of the clayey silt to silt fill and the results are presented on Figure B2.

Atterberg limits tests were carried out on three samples of the cohesive fill and measured liquid limits ranging from about 21 per cent to 34 per cent, plastic limits ranging from about 17 per cent to 19 per cent, and plasticity indices ranging from about 4 per cent to 15 per cent. The results, which are plotted on a plasticity chart on Figures B3 in Appendix B, indicate that the tested samples of the overall deposit consist of clayey silt of low plasticity to silt of slight plasticity.

The natural moisture content measured on samples of the sand and gravel to sand fill is between 2 per cent and 4 per cent and samples of the clayey silt to silt fill is between 24 per cent and 32 per cent.

4.2.3 Topsoil

Borehole BI-4 encountered a 0.7 m thick layer of silty topsoil from ground surface at Elevation 201.4 m.

One SPT ‘N’-value measured in the deposit is 3 blows per 0.3 m of penetration, suggesting a very loose consistency.

4.2.4 Sandy Silt to Silty Sand

Below the topsoil in Borehole BI-4 and below the water in Borehole BI-7, a deposit of sandy silt to silty sand was encountered at Elevation 200.7 m and 199.4 m, with a thickness of 1.5 m and 0.6 m, respectively.

Three SPT ‘N’-values measured within this deposit are 9 blows and 10 blows per 0.3 m of penetration, indicating a loose to compact relative density.

4.2.5 Clayey Silt to Silty Clay

A deposit of clayey silt to silty clay was encountered below the fill in Boreholes BI-1 to BI-3, from ground surface in Boreholes BI-5 and BI-6 and below the sandy silt to silty sand deposit in Boreholes BI-4 and BI-7. The surface of the deposit was encountered between about Elevations 203.3 m and 198.8 m and the thickness of the deposit is between about 6.6 m and 10.5 m; Borehole BI-3 did not penetrate the deposit after exploring for 8.6 m. Silt laminations were observed within the majority of samples of this deposit. In Borehole BI-6, a 0.3 m layer of silty sand and gravel was encountered at a depth of 2.1 m below ground surface (Elevation 199.2 m).

The SPT ‘N’-values measured within the clayey silt to silty clay deposit range between 2 blows and 8 blows per 0.3 m of penetration. In situ field vane testing measured undrained shear strengths ranging from 38 kPa to greater than 100 kPa, with sensitivities between 2 and 6. The in situ vane test results indicate that the deposit has a firm to very stiff consistency.

Atterberg limits tests were carried out on fourteen samples of the cohesive deposit and measured liquid limits ranging from about 21 per cent to 47 per cent, plastic limits ranging from about 14 per cent to 25 per cent and plasticity indices ranging from about 5 per cent to 24 per cent. The results, which are plotted on a plasticity chart

on Figures B4.1, indicate that the tested samples of the overall deposit consist of clayey silt of low plasticity to silty clay of intermediate plasticity.

Atterberg limits tests were also carried out on one sample of the deposit that was separated into the silt lamina and the clay lamina and the test results are shown on Figure B4.2. The test results on the clay lamina indicate a liquid limit of about 87 per cent, a plastic limit of 27 per cent and a plasticity index of 60 per cent. The silt lamina has a liquid limit of about 23 per cent, a plastic limit of 17 per cent and a plasticity index of 7 per cent. The test results confirm that the 'silty' varves are classified as a silt of slight plasticity and the 'clayey' varves are classified as a clay of high plasticity.

The results of the grain size distribution testing completed on thirteen samples of this deposit, including those on the silt and clay laminae, are shown on Figure B5.

The natural moisture content measured on selected samples of this deposit generally ranges between about 24 per cent and 50 per cent; the moisture content measured on the clay lamina from Borehole BI-5a is 72 per cent.

4.2.6 Silt to Silt and Sand

A deposit of silt to sandy silt to silt and sand, some clay, was encountered below the clayey silt to silty clay deposit in Boreholes BI-1, BI-2 and BI-4 to BI-7. The surface of this deposit was encountered between Elevations 192.6 m and 189.7 m and sampled boreholes did not fully penetrate the deposit after exploring for thicknesses of between approximately 1.1 m and 5.6 m.

The SPT 'N'-values measured within this deposit range between 2 blows and 14 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

Grain size distribution analyses were carried out on nine samples of this deposit and the results are represented on Figure B6.

Atterberg limits tests were carried out on six samples of this deposit: three samples indicate that the material is non-plastic; and three samples measured liquid limits ranging from about 18 per cent to 22 per cent, plastic limits ranging from about 15 per cent to 16 per cent and plasticity indices ranging from about 3 per cent to 6 per cent. The results, which are plotted on a plasticity chart on Figures B7, indicate that the three samples consist of silt of slight plasticity. Atterberg limits testing carried out on the natural moisture content measured on selected samples of this deposit ranges between about 20 per cent and 30 per cent.

4.2.7 Groundwater Conditions

Borehole BI-3 caved at a depth of about 9.8 m below ground surface (Elevation 200.7 m) upon completion of drilling and the borehole was noted to be dry to the cave depth. The unstabilized water level in Boreholes BI-1, BI-2 and BI-4 to BI-6 upon completion of drilling was between Elevation 201.8 m and 200.5 m. The creek ice surface on the south side of the embankment at Borehole BI-7 on February 23, 2014 was Elevation 200.9 m.

Groundwater levels encountered in the boreholes shortly after drilling may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of

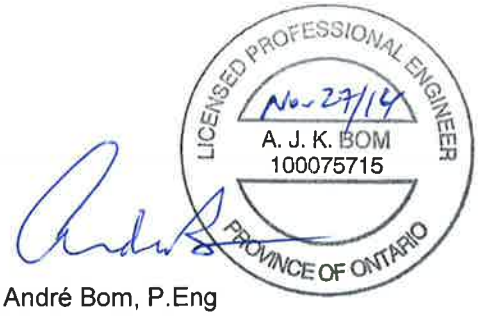
drilling. Groundwater levels are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt.

5.0 CLOSURE

The drilling program was supervised by Mr. Shane Albert and Mr. Mat Riopelle. This report was prepared by Mr. André Bom, P.Eng. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report

Report Signature Page

GOLDER ASSOCIATES LTD.



André Bom, P.Eng
Geotechnical Engineer

Jorge M.A. Costa, P.Eng
Designated MTO Contact, Principal

AB/JMAC/kp

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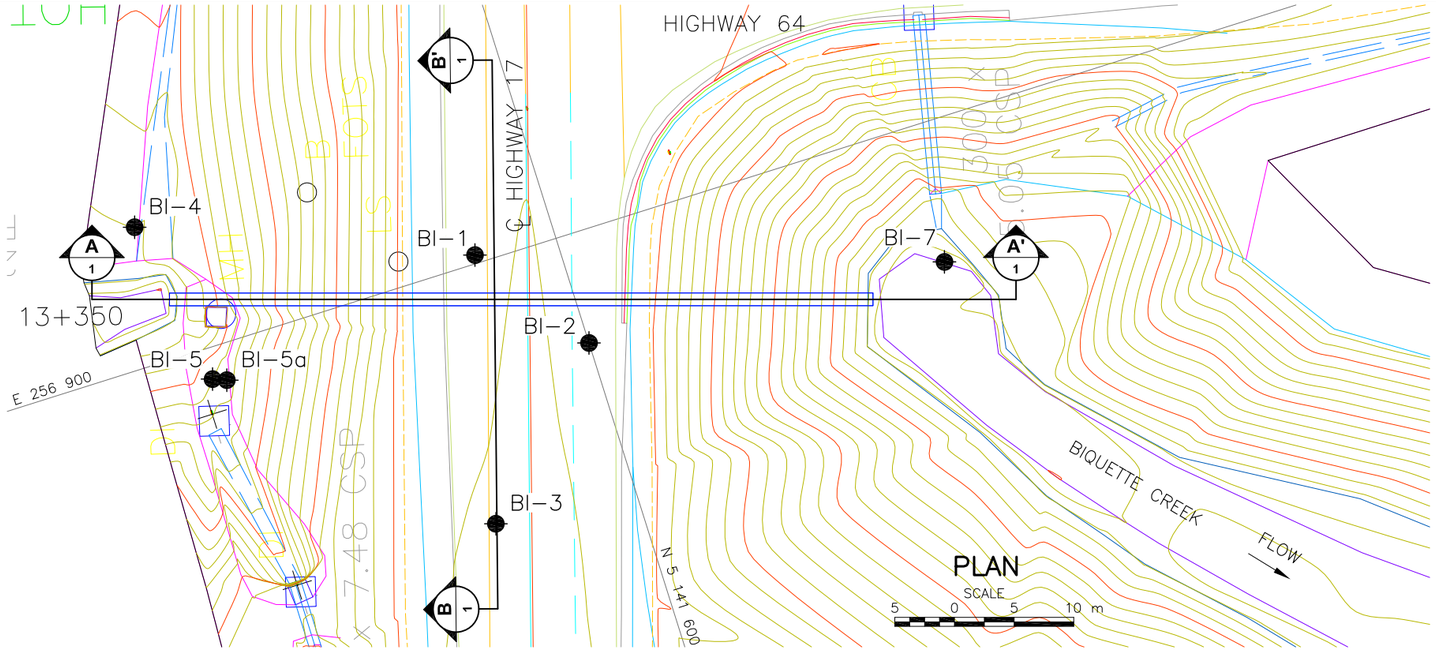
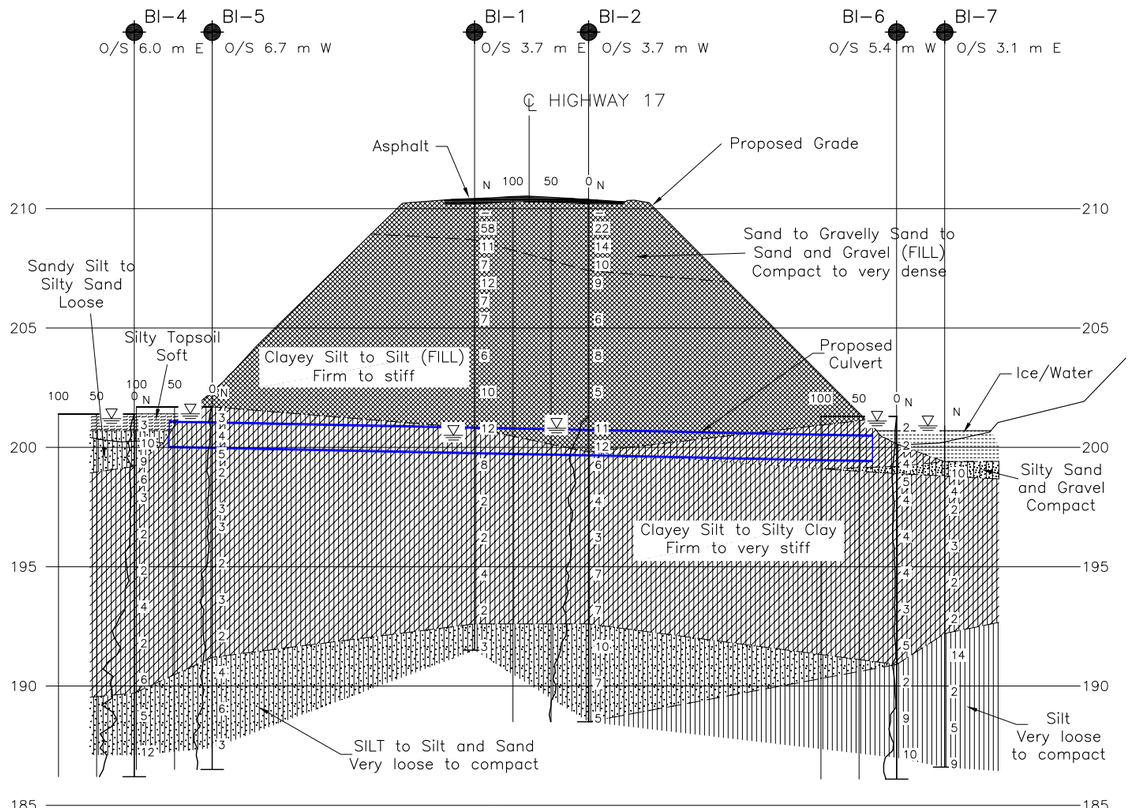
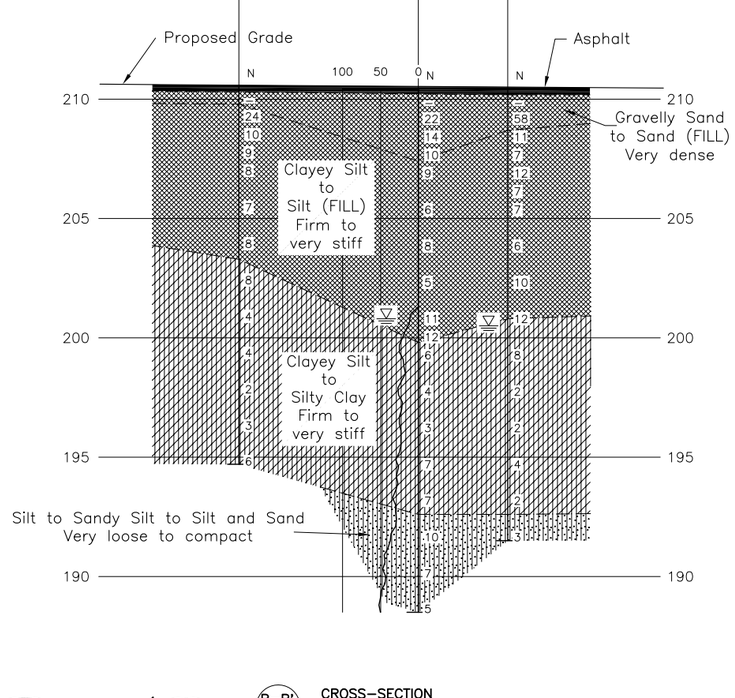
MINISTRY OF TRANSPORTATION, ONTARIO





A–A' 1 CULVERT PROFILE
HIGHWAY 17
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE



B–B' 1 CROSS–SECTION
HIGHWAY 17
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE

LICENCED PROFESSIONAL ENGINEER A.J.K. BOM 100075715 NOV 27, 2014 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA NOV 27, 2014 PROVINCE OF ONTARIO

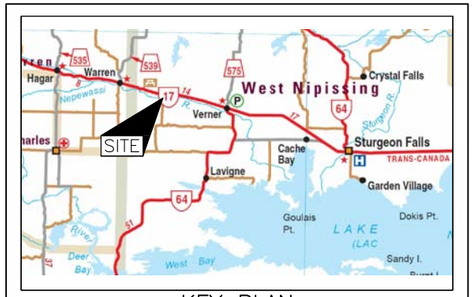
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 300–98–00

SHEET

HIGHWAY 17
BIQUETTE CREEK CULVERT – STA 13+350
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



KEY PLAN
SCALE
8 0 8 km

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
BI–1	210.4	5141606.9	256900.7
BI–2	210.4	5141600.0	256890.8
BI–3	210.5	5141612.0	256878.7
BI–4	201.4	5141633.4	256911.5
BI–5	201.7	5141631.0	256897.4
BI–5a	201.7	5141629.9	256897.0
BI–7	200.9	5141569.5	256888.3

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

The complete Foundation Investigation and Design Report 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

Base plans provided in digital format by Morrison Hershfield, drawing file no. wp3009800a.dwg, received APR 7, 2014 and Biquette Creek Culvert and 11+600 culvert.dwg received on NOV 05, 2014.

NO.	DATE	BY	REVISION

Geocres No. 41I–316

HWY. 17	PROJECT NO. 13–1184–0074		DIST.
SUBM'D. MT	CHKD.	DATE: NOV 2014	SITE: 43–165/C
DRAWN: TB	CHKD. AB	APPD. JMAC	DWG. 1

PLOT DATE: November 26, 2014
FILENAME: \\golder.gds\gal\Sudbury\CAD–GIS\CAD\Projects\2013\13–1184–0074 Warren\13118400744001.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

Golder Associates

RECORD OF BOREHOLE No BI-1

1 OF 2 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
LOCATION N 5141606.9; E 256900.7
ORIGINATED BY SA
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY MT
DATUM GEODETIC
DATE November 27, 2013
CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.4	GROUND SURFACE										
0.0	ASPHALT (225 mm)										
0.2	Gravelly sand to sand, trace silt (FILL) Very dense Brown Moist		1	AS	-		210				
			2	SS	58				○		
208.7							209				
1.7	Clayey silt to silt, occasional organic pockets (FILL) Firm to stiff Brown to grey Moist		3a 3b	SS	11						
			4	SS	7		208		⊢○⊣		0 2 74 24
			5	SS	12		207				
			6	SS	7						
			7	SS	7		206		○		
			8	SS	6		205				
			9	SS	10		204				
			10	SS	12		203				
200.8							202				
9.6	CLAYEY SILT to SILTY CLAY, silt laminations Firm to stiff Grey Wet					▽	201				
			11	SS	8		200		○		
			12	SS	2		199				
			13	SS	2		198		⊢○		0 5 65 30
							197				
							196		○		

Continued Next Page

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

Golder Associates

PROJECT 13-1184-0074

RECORD OF BOREHOLE No BI-1

2 OF 2 **METRIC**

G.W.P. 300-98-00 LOCATION N 5141606.9; E 256900.7 ORIGINATED BY SA

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MT

DATUM GEODETIC DATE November 27, 2013 CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT to SILTY CLAY, silt laminations Firm to stiff Grey Wet		14	SS	4		195		○		
			15	SS	2		194		○		
192.6							193				
17.8	SILT and SAND, some clay Very loose Grey Wet		16	SS	3		192		○	NP	0 38 49 13
191.5											
18.9	END OF BOREHOLE										
	Note: 1. Water level at a depth of 9.9 m below ground surface (Elev. 200.5 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BI-2

1 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141600.0; E 256890.8 | ORIGINATED BY SA

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE November 28 and 29, 2013 | CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
210.4	GROUND SURFACE					
0.0	ASPHALT (225 mm)					
0.2	Sand and gravel to sand, trace to some silt (FILL) Compact Brown Moist		1	AS	-	
			2	SS	22	
			3	SS	14	
			4	SS	10	
207.4						
3.0	Clayey silt to silt, trace to some sand (FILL) Firm to stiff Brown to grey Moist		5	SS	9	
			6	SS	6	
			7	SS	8	
			8	SS	5	
			9	SS	11	▽
			10	SS	12	
199.8						
10.6	CLAYEY SILT, trace to some sand, silt laminations Stiff to very stiff Grey Wet		11	SS	6	
			12	SS	4	
			13	SS	3	

ELEVATION SCALE: 210, 209, 208, 207, 206, 205, 204, 203, 202, 201, 200, 199, 198, 197, 196

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
39	55		(6)

3 (+), 3 (×): Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

>100

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No BI-2

2 OF 2 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
LOCATION N 5141600.0; E 256890.8
ORIGINATED BY SA
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY MT
DATUM GEODETIC
DATE November 28 and 29, 2013
CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT, trace to some sand, silt laminations Stiff to very stiff Grey Wet		14	SS	7		195		○		1 10 64 25
							194				
			15	SS	7				○		
							193				
192.6											
17.8	SILT to SAND, trace to some clay Loose to compact Grey Wet		16	SS	10		192		○		0 60 32 8
							191				
			17	SS	7						
							190				
			18	SS	5		189		○		0 5 79 16
188.5											
21.9	END OF BOREHOLE Note: 1. Water level at a depth of 9.6 m below ground surface (Elev. 200.8 m) upon completion of drilling. 2. Pre-drilled hole to 9.2 m depth immediately adjacent to Borehole BI-2 and advanced DCPT from 9.2 m to 21.9 m.										

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

SUD-MTO 001 13-1184-0074.GPJ GAL-MISS.GDT 19/11/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No BI-3

1 OF 2 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
DIST _____ HWY 17
DATUM GEODETIC

LOCATION N 5141612.0; E 256878.7
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE December 3, 2013

ORIGINATED BY SA
COMPILED BY MT
CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.5	GROUND SURFACE										
0.0	ASPHALT (225 mm)										
0.2	Gravelly sand, some silt (FILL) Brown		1	AS	-		210				23 59 (18)
209.8	Moist										
0.7	Clayey silt to silt, trace sand (FILL) Firm to very stiff Grey Moist		2	SS	24						
			3	SS	10		209				
			4	SS	9		208				
			5	SS	8		207				
			6	SS	7		206				0 3 83 14
			7	SS	8		205				
203.3							204				
7.2	CLAYEY SILT, some sand, silt laminations Stiff to very stiff Grey Wet		8	SS	8		203				
			9	SS	4		202				
			10	SS	4		201	>100			0 5 80 15
			11	SS	2		200	5			0 6 73 21
			12	SS	3		199	6			
							198				
							197				
							196	>100			

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BI-3

2 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141612.0; E 256878.7 | ORIGINATED BY SA

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY MT

DATUM GEODETIC | DATE December 3, 2013 | CHECKED BY AB

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
194.7			13	SS	6		195		○		
15.8	END OF BOREHOLE Note: 1. Borehole caved at 9.8 m (Elev. 200.7 m) upon completion of drilling. Borehole dry to 9.8 m depth.										

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

Golder Associates

RECORD OF BOREHOLE No BI-4

1 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | DIST | HWY 17 | DATUM GEODETIC

LOCATION N 5141633.4; E 256911.5 | BOREHOLE TYPE NW Casing, Wash Boring | DATE February 20, 2014

ORIGINATED BY MR | COMPILED BY MT | CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
201.4	GROUND SURFACE					
0.0	Silty TOPSOIL Very loose Brown		1	SS	3	▽
200.7	Wet					
0.7	Sandy SILT to Silty SAND, trace to some clay Loose Brown to grey Wet		2	SS	10	
			3	SS	9	
199.2						
2.2	Sandy CLAYEY SILT to SILTY CLAY, silt laminations Firm to very stiff Grey Wet		4	SS	6	
			5	SS	3	
			6	SS	2	
			7	SS	2	
			8	SS	4	
			9	SS	2	
			10	SS	6	
189.7						
11.7	SILT and SAND, trace to some clay Loose to compact Grey Wet		11	SS	5	
			12	SS	12	
187.1						
14.3	END OF BOREHOLE					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

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
	0	1	42	57
	0	22	60	18
	0	38	52	10

Continued Next Page

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

SUD-MTO 001 13-1184-0074.GPJ GAL-MISS.GDT 19/11/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No BI-4

2 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141633.4; E 256911.5 | ORIGINATED BY MR

DIST _____ HWY 17 | BOREHOLE TYPE NW Casing, Wash Boring | COMPILED BY MT

DATUM GEODETIC | DATE February 20, 2014 | CHECKED BY AB

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
186.2											
15.2	END OF DCPT Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 201.2 m) upon completion of drilling. 2. DCPT advanced 0.5 m south of Borehole BI-4.										

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

Golder Associates

RECORD OF BOREHOLE No BI-5

1 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141631.0; E 256897.4 | ORIGINATED BY MR
DIST ____ HWY 17 | BOREHOLE TYPE NW Casing, Wash Boring | COMPILED BY MT
DATUM GEODETIC | DATE February 12 and 13, 2014 | CHECKED BY AB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	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
201.7	GROUND SURFACE										
0.0	CLAYEY SILT to SILTY CLAY Firm to very stiff Grey to brown Wet		1	SS	3	▽	201				
			2	SS	4						0 5 71 24
			3	SS	5		200				
	Silt laminations below 2.3 m depth.		4	SS	2		199	2			
							198	>100			
			5	SS	3						
			6	SS	3		197	4			
							196	3			
			7	SS	2						0 2 50 48
							195	3			
								3			
			8	SS	3		194				
							193	4			
								2			
			9	SS	2		192				
191.2								4			
10.5	SILT to SILT and SAND, some clay Very loose to loose Grey Wet							>100			
			10	SS	4		191				0 57 35 8
							190				
			11	SS	6		189				0 13 72 15
							188				
187.4			12	SS	3						
14.3	END OF BOREHOLE						187				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BI-5

2 OF 2 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
LOCATION N 5141631.0; E 256897.4
ORIGINATED BY MR
DIST HWY 17
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY MT
DATUM GEODETIC
DATE February 12 and 13, 2014
CHECKED BY AB

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
186.5											
15.2	END OF DCPT										
	Note:										
	1. Water level at a depth of 0.3 m below ground surface (Elev. 201.4 m) upon completion of drilling.										
	2. DCPT advanced 0.4 m south of Borehole BI-5.										

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

Golder Associates

RECORD OF BOREHOLE No BI-5a

1 OF 1 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141629.9; E 256897.0 | ORIGINATED BY MR

DIST _____ HWY 17 | BOREHOLE TYPE NW Casing, Wash Boring | COMPILED BY MT

DATUM GEODETIC | DATE February 12 and 13, 2014 | CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
201.7	GROUND SURFACE										
0.0	CLAYEY SILT to SILTY CLAY Firm to very stiff Grey to brown Wet						201				
							200				
							199				
	Silt laminations about 2 mm to 5 mm thick, spaced 5 mm to 20 mm apart in Samples 1 and 2.		1	TO	PH				○		0 3 63 34
							198	+ 3			
			2 (s) 2 (c)	TO	PH		197		○ 87 ○		0 2 70 28 0 0 15 85
								+ 3			
							196				
	No recovery in Sample 3.		3	TO	PH						
							195	>100			
	No recovery in Sample 4.		4	TO	PH		194				
193.5											
8.2	END OF BOREHOLE Note: 1. Borehole advanced 1.2 m south of Borehole BI-5.										

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

Golder Associates

RECORD OF BOREHOLE No BI-6

1 OF 2 **METRIC**

PROJECT 13-1184-0074 | G.W.P. 300-98-00 | LOCATION N 5141575.9; E 256881.4 | ORIGINATED BY MR

DIST _____ HWY 17 | BOREHOLE TYPE NW Casing, Wash Boring | COMPILED BY MT

DATUM GEODETIC | DATE February 24, 2014 | CHECKED BY AB

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
201.3	GROUND SURFACE										
0.0	Sandy SILTY CLAY, trace organics Soft Grey Wet		1	SS	2	▽	201				
			2	SS	2					OC=3.5%	0 22 62 16
199.2			3	SS	4		200				
198.9	Silty SAND and GRAVEL Grey										
2.4	Wet SILTY CLAY, trace sand, silt laminations Firm to very stiff Grey Wet		4	SS	5		199				
			5	SS	4		198	2			
			6	SS	4		197				
							196	3	>100		
			7	SS	4		195				0 2 57 41
							194	3			
			8	SS	3		193		>100		
			9	SS	5		192				
190.9							191	4			
10.4	SILT, some clay, some sand Very loose to compact Grey Wet Silty clay laminations encountered below 10.4 m depth.		10	SS	2		190				
			11	SS	9		189				0 13 72 15
187.0			12	SS	10		188				
14.3	END OF BOREHOLE						187				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BI-6

2 OF 2 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
LOCATION N 5141575.9; E 256881.4
ORIGINATED BY MR
DIST HWY 17
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY MT
DATUM GEODETIC
DATE February 24, 2014
CHECKED BY AB

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
186.1											
15.2	END OF DCPT Note: 1. Water level at 0.2 m below ground surface (Elev. 201.1 m) upon completion of drilling. 2. DCPT advanced 0.3 m west of Borehole BI-5.										

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

Golder Associates

RECORD OF BOREHOLE No BI-7

1 OF 1 **METRIC**

PROJECT 13-1184-0074
G.W.P. 300-98-00
LOCATION N 5141569.5; E 256888.3
ORIGINATED BY MR
DIST HWY 17
BOREHOLE TYPE NW Casing, Wash Boring
COMPILED BY MT
DATUM GEODETIC
DATE February 23, 2014
CHECKED BY AB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
200.9	ICE SURFACE										
0.0	ICE										
0.2	WATER										
199.4											
1.5	Silty SAND, trace gravel Compact Grey Wet		1	SS	10						
198.8											
2.1	CLAYEY SILT to SILTY CLAY, trace sand Stiff to very stiff Grey Wet		2	SS	4						
			3	SS	2						
	Silt laminations encountered below 4.6 m depth.		4	SS	3						0 2 60 38
			5	SS	2						
			6	SS	2						
192.2											
8.7	SILT, some clay, trace to some sand Very loose to compact Grey Wet		7	SS	14					NP	0 6 77 17
			8	SS	2						
			9	SS	5					NP	0 5 80 15
			10	SS	9						
186.6											
14.3	END OF BOREHOLE										

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

SUD-MTO 001 13-1184-0074.GPJ GAL-MISS.GDT 19/11/14 DATA INPUT:

APPENDIX B

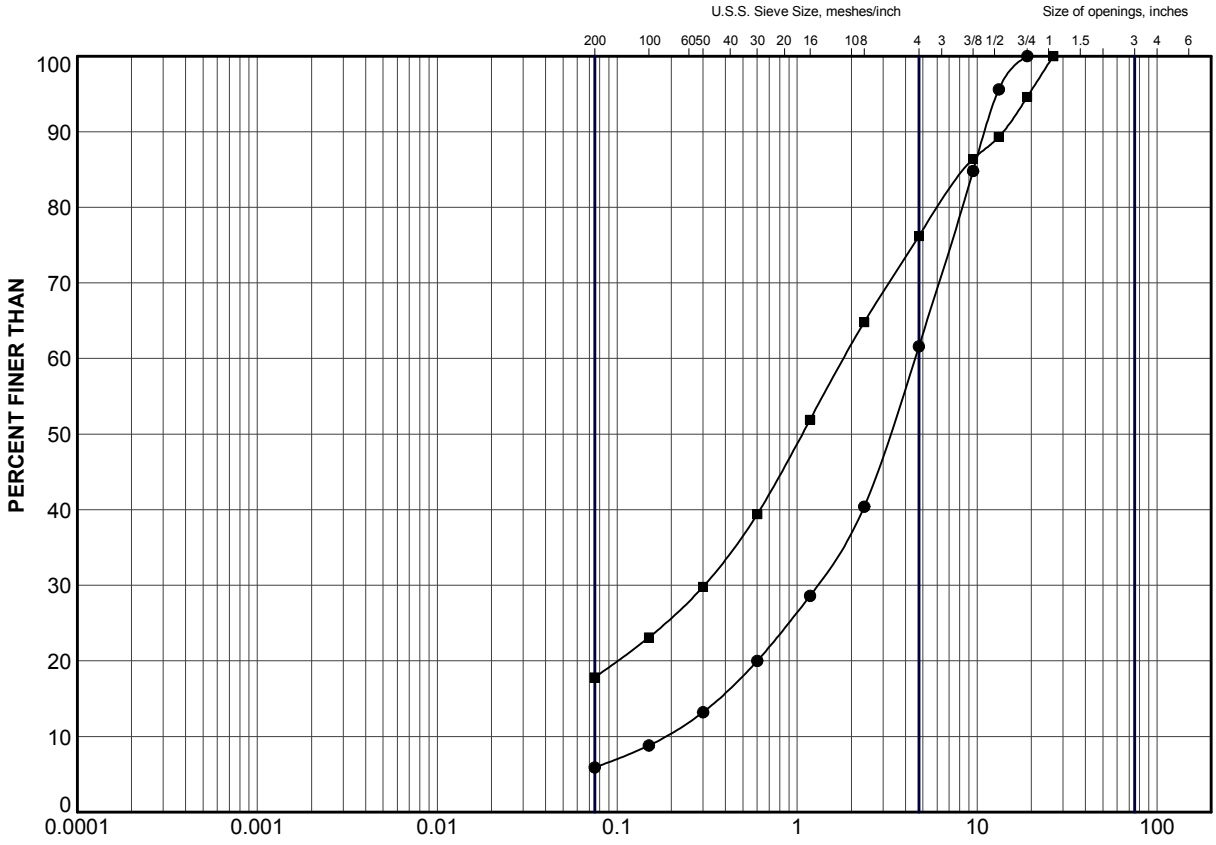
Laboratory Test Results

Table B1 - Summary of Analytical Testing of Biquette Creek Water Sample

Parameter	Units	Reportable Detection Limit	Result
Dissolved Chloride	mg/L	1	5
Dissolved Sulphate	mg/L	1	Not Detected
Conductivity	µohm/cm	1	71
Resistivity	ohm-cm	n/a	14,000
pH	n/a	n/a	6.97

Notes: 1. Sample obtained on March 10, 2014.
2. Analytical testing carried out by Maxxam Analytics.

Checked by: AB



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BI-2	3	208.6
■	BI-3	1	210.1

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

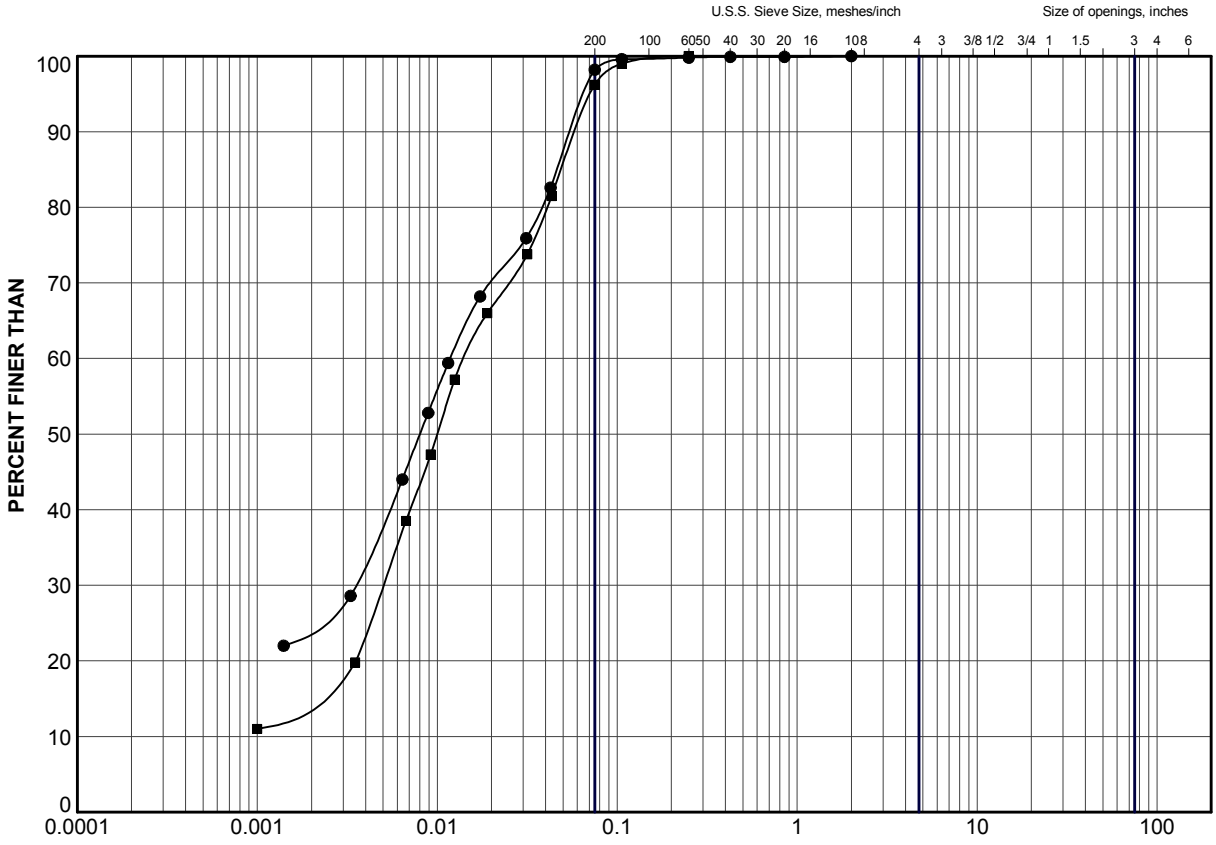
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to GRAVELLY SAND (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE	N/A REV.
CHECK	AB	Jun 2014		
APPR	JMAC	Jun 2014		**FIGURE B1**

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BI-1	4	207.8
■	BI-3	6	205.6

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

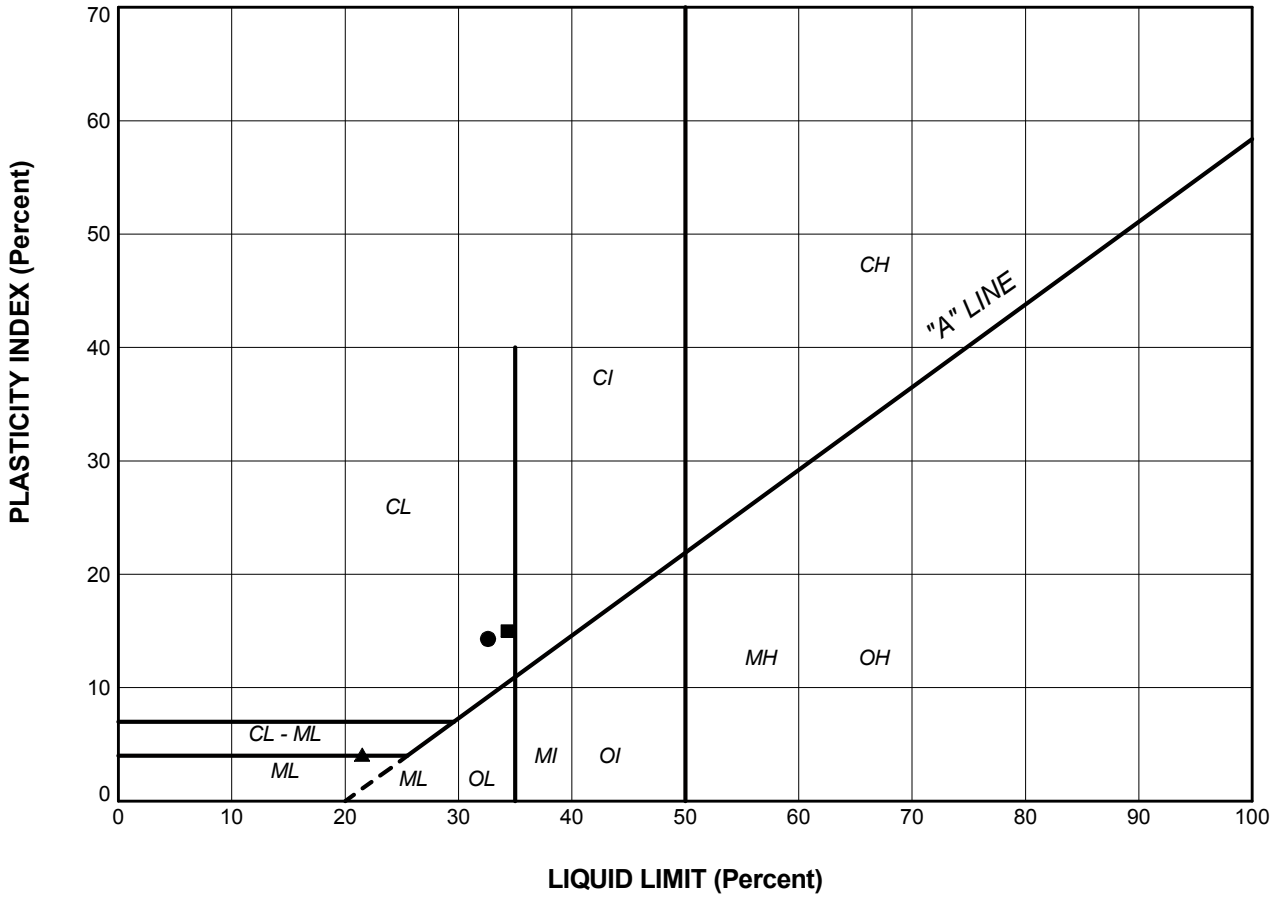
GRAIN SIZE DISTRIBUTION

SILT to CLAYEY SILT (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE N/A	REV.
CHECK	AB	Jun 2014		
APPR	JMAC	Jun 2014	**FIGURE B2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BI-1	4	32.6	18.3	14.3
■	BI-2	8	34.3	19.3	15.0
▲	BI-3	6	21.5	17.4	4.1

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

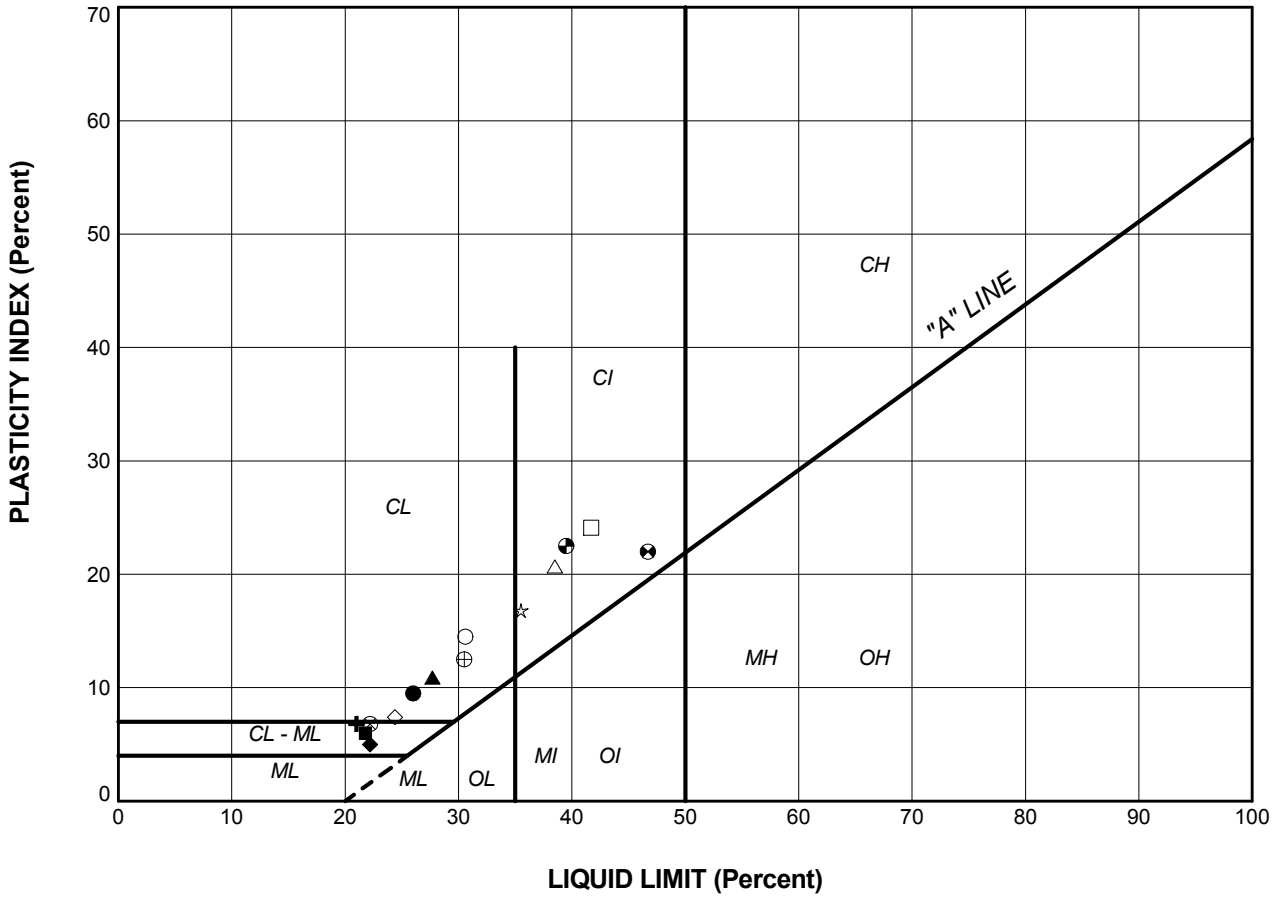
PLASTICITY CHART

SILT to CLAYEY SILT (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE N/A	REV.
CHECK	AB	Jun 2014		
APPR	JMAC	Jun 2014	**FIGURE B3**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BI-1	12	26.0	16.5	9.5
■	BI-2	11	21.8	15.8	6.0
▲	BI-2	13	27.7	16.8	10.9
✚	BI-2	14	21.0	14.2	6.8
◆	BI-3	9	22.2	17.2	5.0
◇	BI-3	10	24.4	17.0	7.4
○	BI-3	12	30.6	16.1	14.5
△	BI-4	7	38.5	17.8	20.7
⊗	BI-4	10	22.2	15.4	6.8
⊕	BI-5	2	30.5	18.0	12.5
□	BI-5	7	41.7	17.6	24.1
◓	BI-6	2	46.7	24.7	22.0
◕	BI-6	7	39.5	17.0	22.5
☆	BI-7	4	35.5	18.7	16.8

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

PLASTICITY CHART

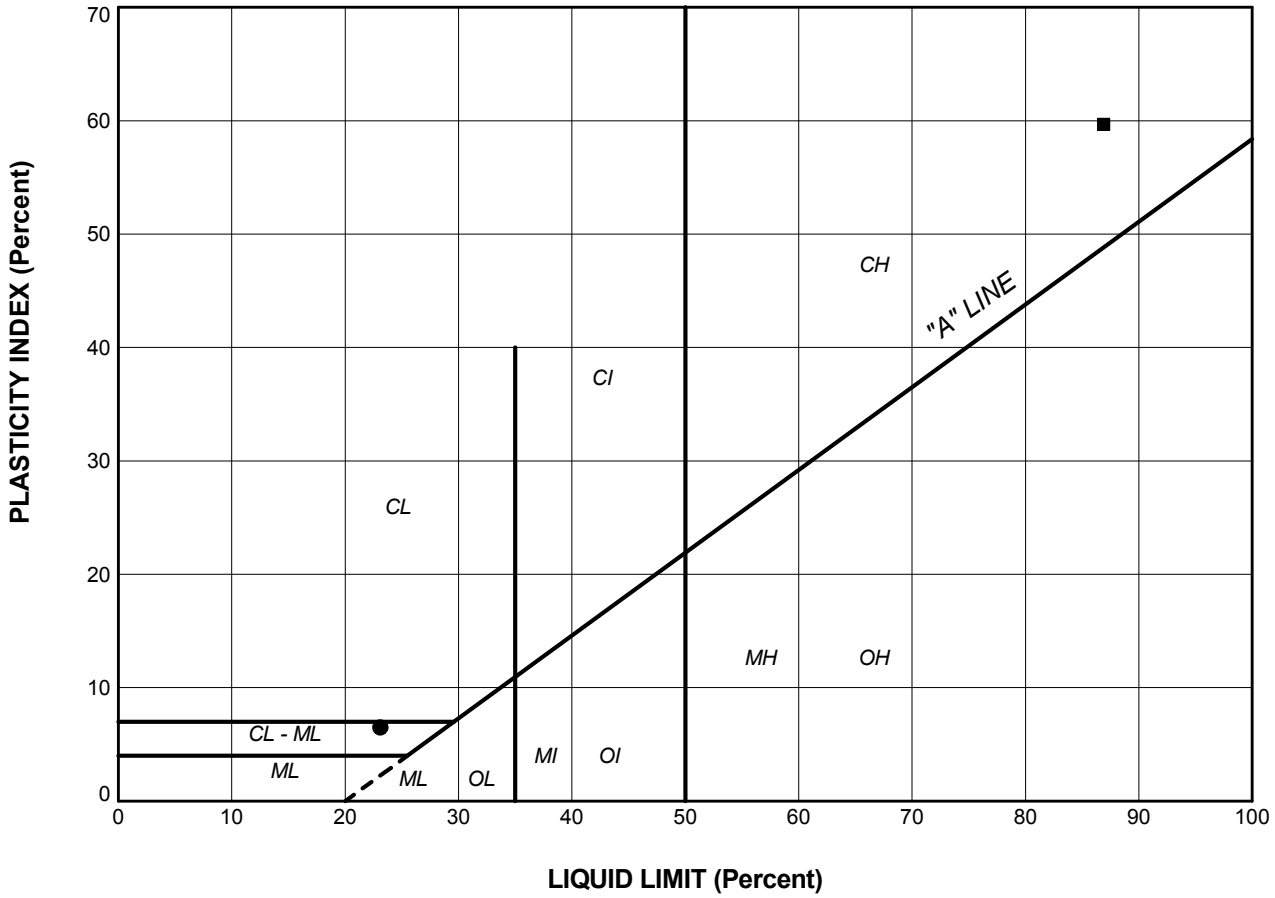
CLAYEY SILT to SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE	N/A
CHECK	AB	Jun 2014	REV.	
APPR	JMAC	Jun 2014		

FIGURE B4.1

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BI-5a	2 (s)	23.1	16.6	6.5
■	BI-5a	2 (c)	86.9	27.2	59.7

Note:
(s) silt lamina
(c) clay lamina

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

PLASTICITY CHART

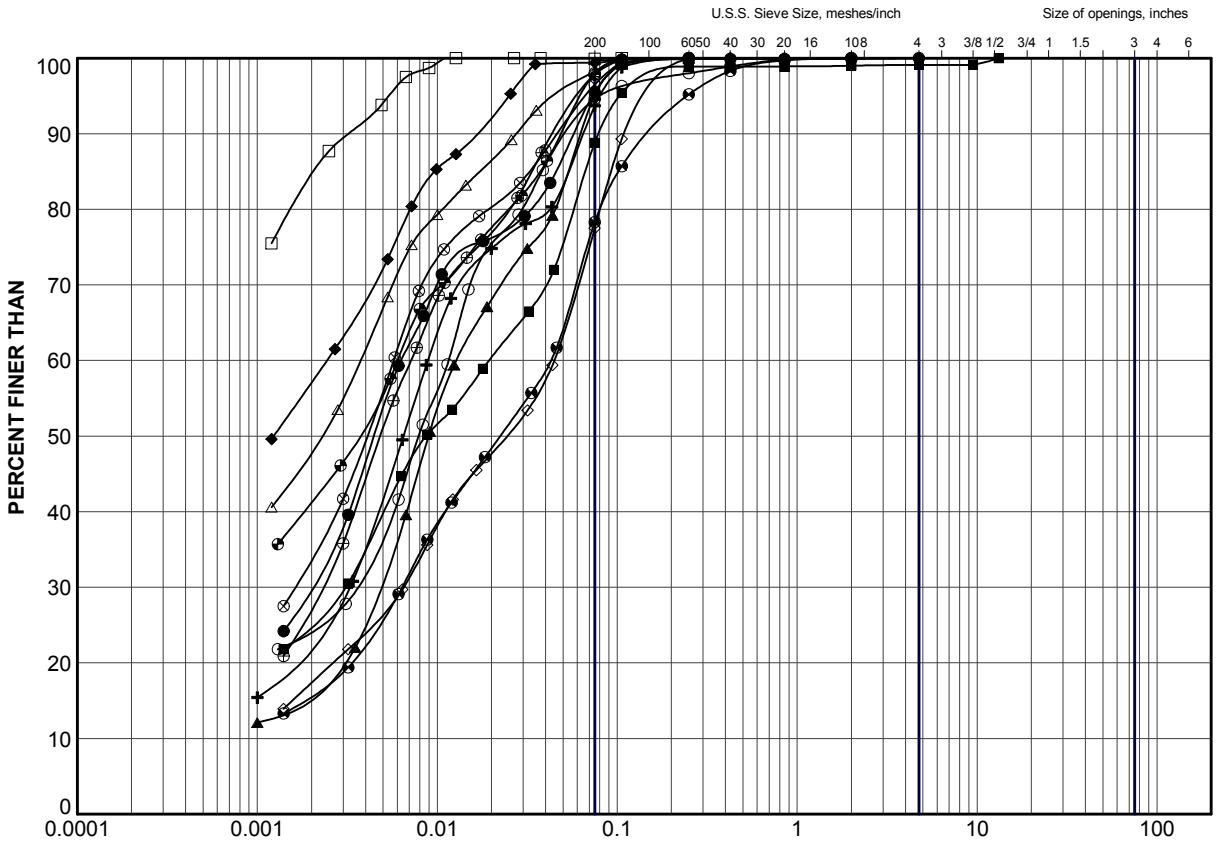
SILT and CLAY LAMINAE

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE N/A	REV.
CHECK	AB	Jun 2014		
APPR	JMAC	Jun 2014		

FIGURE B4.2

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BI-1	12	197.9
■	BI-2	14	194.9
▲	BI-3	9	201.1
✚	BI-3	10	199.5
◆	BI-4	7	195.0
◇	BI-4	10	190.4
○	BI-5	2	200.6
△	BI-5	7	195.3
⊗	BI-5a	1	198.4
⊕	BI-5a	2 (s)	197.0
□	BI-5a	2 (c)	196.9
◓	BI-6	2	200.2
◕	BI-6	7	194.9

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

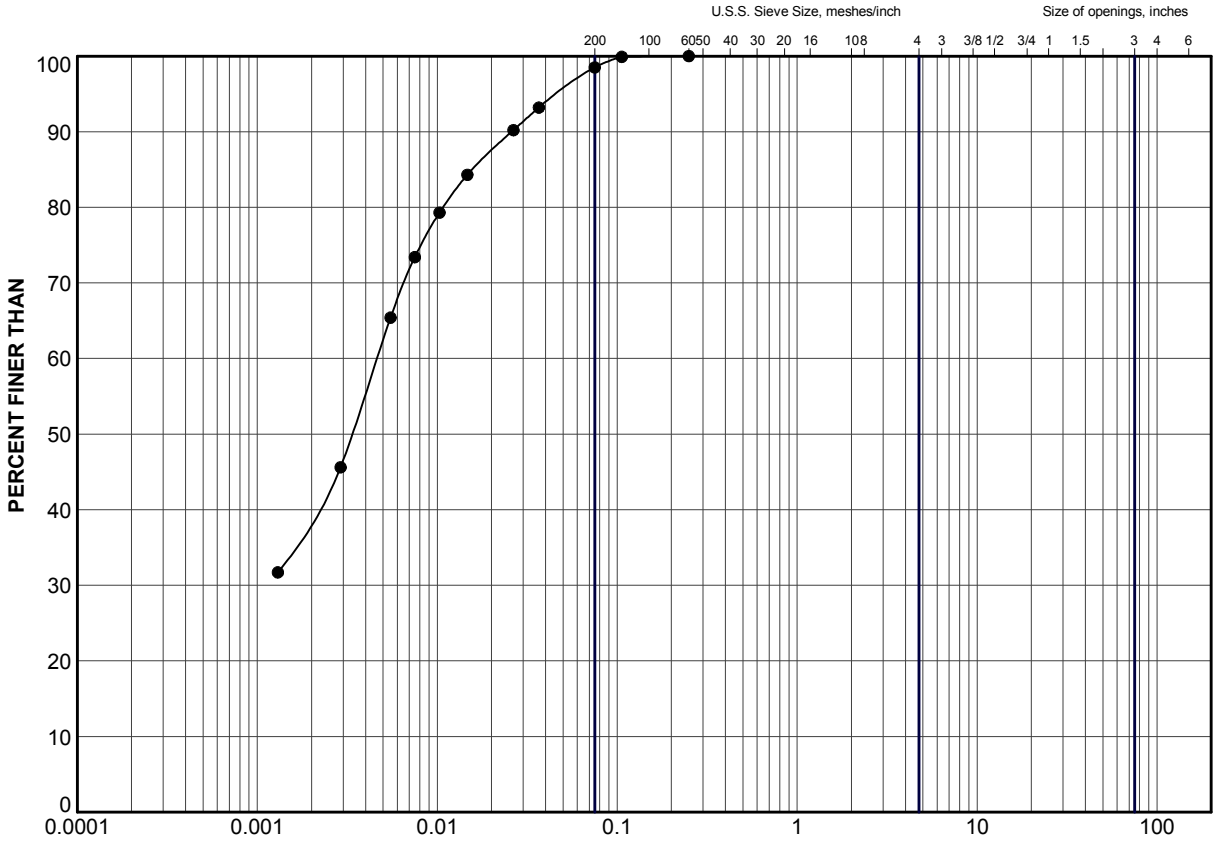
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ	
DRAWN	TB	Jun 2014	SCALE	N/A	REV.
CHECK	AB	Jun 2014			
APPR	JMAC	Jun 2014	**FIGURE B5.1**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BI-7	4	196.0

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

GRAIN SIZE DISTRIBUTION

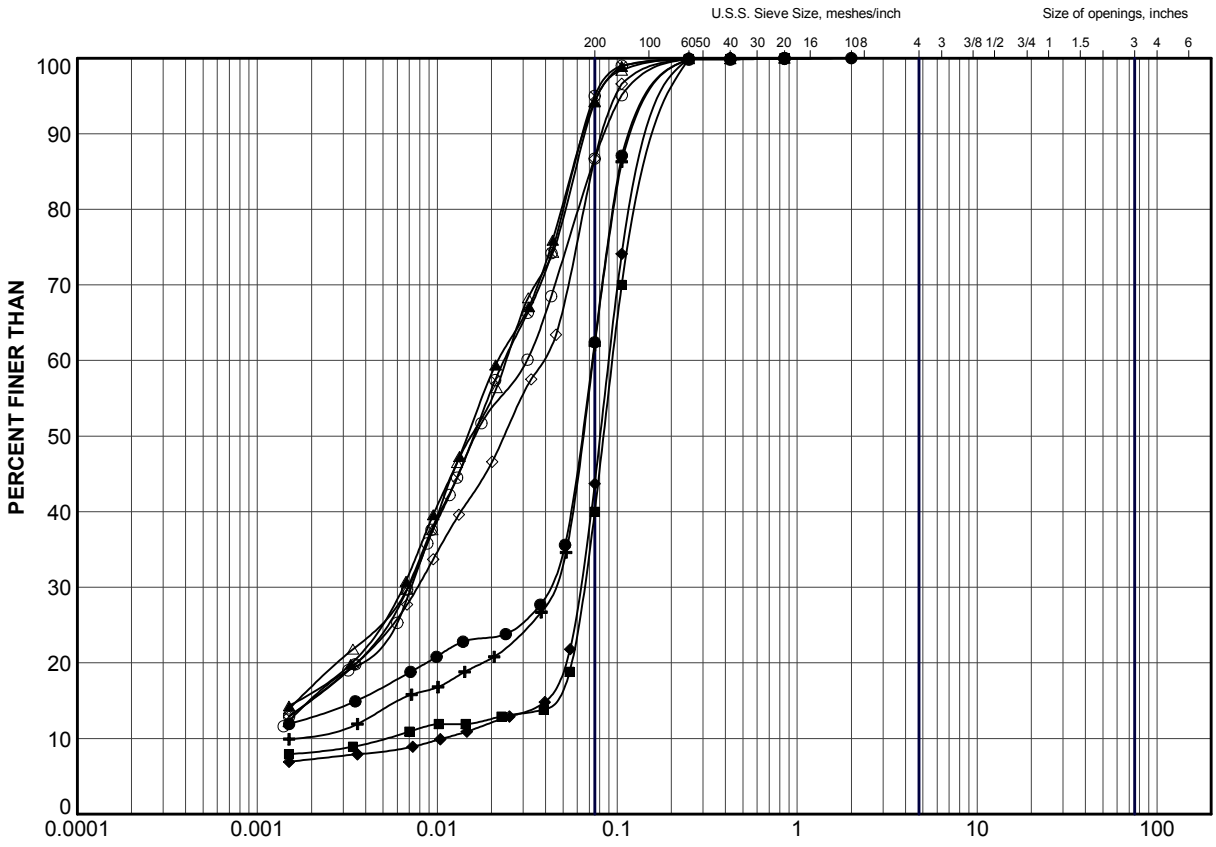
CLAYEY SILT to SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE	N/A
CHECK	AB	Jun 2014	REV.	
APPR	JMAC	Jun 2014		

FIGURE B5.2

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BI-1	16	191.8
■	BI-2	16	191.8
▲	BI-2	18	188.8
✚	BI-4	12	187.4
◆	BI-5	10	190.7
◇	BI-5	11	189.2
○	BI-6	11	188.8
△	BI-7	7	191.5
⊗	BI-7	9	188.4

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

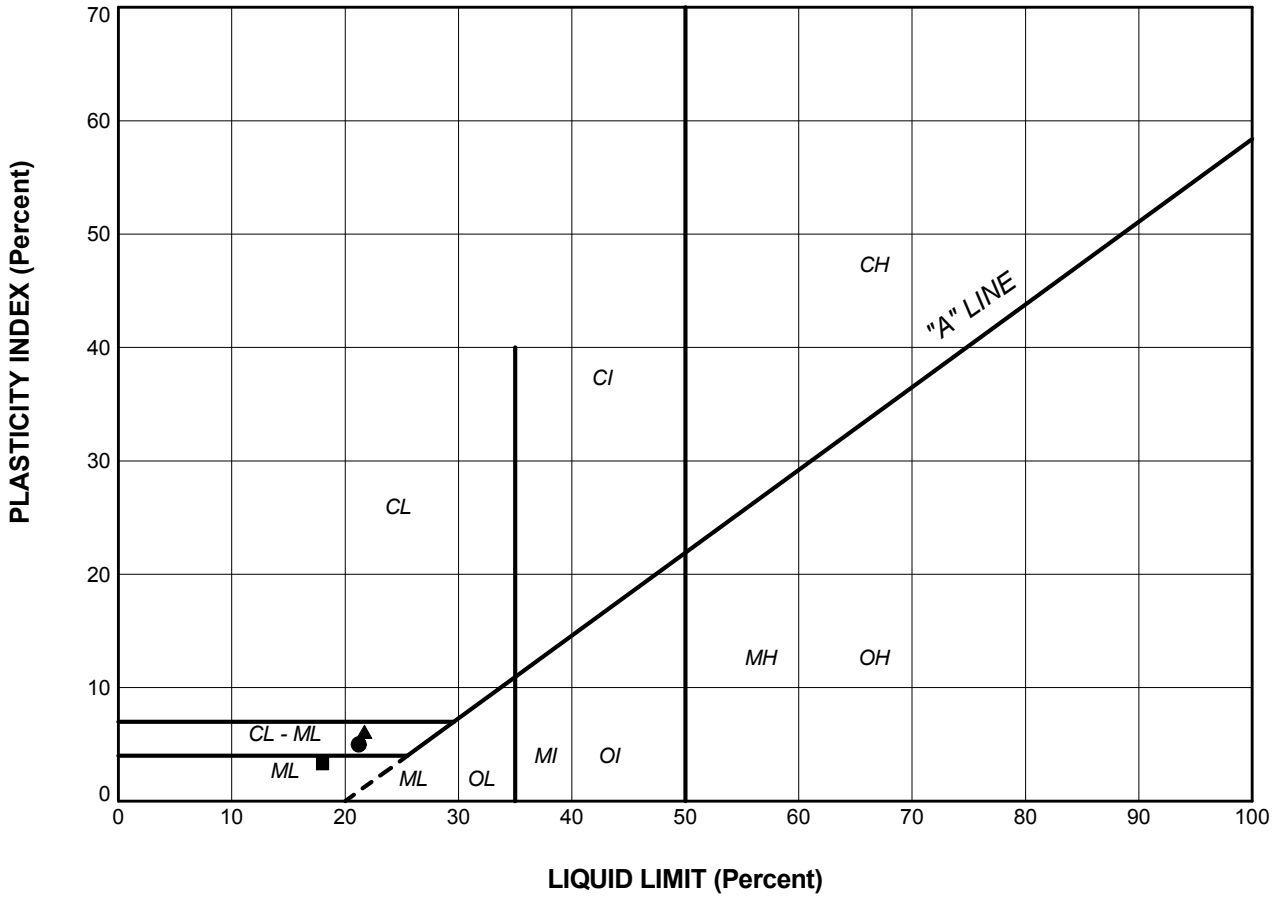
GRAIN SIZE DISTRIBUTION

SILT to SILT and SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ	
DRAWN	TB	Jun 2014	SCALE	N/A	REV.
CHECK	AB	Jun 2014			
APPR	JMAC	Jun 2014	**FIGURE B6**		

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
●	BI-2	18	21.2	16.2	5.0
■	BI-5	11	18.0	14.7	3.3
▲	BI-6	11	21.7	15.6	6.1

PROJECT

HIGHWAY 17
BIQUETTE CREEK CULVERT - STA 13+350

TITLE

PLASTICITY CHART

SILT to SILT and SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	13-1184-0074		FILE No.	13-1184-0074.GPJ
DRAWN	TB	Jun 2014	SCALE N/A	REV.
CHECK	AB	Jun 2014		
APPR	JMAC	Jun 2014	**FIGURE B7**	

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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