REPORT

November 15, 2013

FOUNDATION INVESTIGATION REPORT

CULVERT AT STATION 13+080 (BC1)
REALIGNMENT OF HIGHWAY 66 AT VIRGINIATOWN FROM 10.6 KM EAST OF HIGHWAY 624 EASTERLY 3.4 KM
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5091-07-00

Submitted to:
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GEOCRES NO.: **32D-13**

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PART A

FOUNDATION INVESTIGATION REPORT

CULVERT AT STATION 13+080 (BC1)

REALIGNMENT OF HIGHWAY 66 AT VIRGINIATOWN

FROM 10.6 KM EAST OF HIGHWAY 624 EASTERLY 3.4 KM

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5091-07-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin Corporation (MRC), a member of MMM Group Limited (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed Culvert BC1 crossing the proposed Highway 66 realignment at Station 13+080. The proposed work is part of the overall Highway 66 realignment from 10.6 km east of Highway 624 easterly 3.4 km. The foundation engineering components within the overall project limits include the engineering of: high fill embankments and embankments over swamps; a deep cut section; as well as a number of culverts. The proposed Culvert BC1 is located about 11.1 km east of Highway 624 within the High Fill area H4. The general location of the proposed Culvert BC1 is shown on the Key Plan on Drawing 1.

This report addresses the investigation carried out for the proposed Culvert BC1 only. Separate reports address the foundation investigations for the remaining culverts, Swamp Crossing/High Fill areas and deep cut section.

The purpose of this investigation is to establish the subsurface conditions along the proposed culvert alignment by methods of borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The centreline of the proposed Highway 66 realignment was staked in the field by MRC and the foundation investigation was carried out at Culvert BC1 as defined in the Terms of Reference. The investigation area is shown in plan on Drawing 1.

2.0 SITE DESCRIPTION

The new Highway 66 alignment is oriented generally in an east-west direction within the Township of McGarry. The proposed culvert will be approximately 45 m long extending across the proposed realigned Highway 66 at about STA 13+080. The land in the area of Culvert BC1 is cleared and is currently used as a corridor for power lines.

In general, the topography in the vicinity of Culvert BC1 consists of native terrain slightly sloping downward towards the south and is covered by sparse to densely populated treed areas, and wet grassy terrain adjacent to the existing Highway 66. The ground surface within the limits of the culvert alignment varies between about Elevation 305 m and 306 m. A detailed description of the subsurface conditions along the culvert alignment is presented in Section 4.0.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The investigation for Culvert BC1 crossing the realigned Highway 66 was carried out between September 8 and 10, 2012, during which time a total of three boreholes were advanced along the proposed culvert alignment. The locations of the boreholes are shown on Drawing 1 and are provided on the Record of Borehole sheets in Appendix A.

The field investigation was carried out using a track-mounted CME-55 drill rig supplied and operated by Landcore Drilling (Landcore) of Sudbury, Ontario. The boreholes were advanced through the overburden using 108 mm inner diameter hollow-stem augers, and/or 'NW' casing with wash boring techniques. In general, soil samples were obtained at intervals of depth of about 0.75 m, 1.5 m and 3.0 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). Samples of the cohesive soils were obtained at selected locations 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 carried out in cohesive soils for assessment of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using MTO Standard 'N' size vanes. Samples of the bedrock were obtained using an 'NQ' size rock core barrel. Two boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The culvert boreholes were advanced to depths ranging between 10.5 m and 16.6 m below existing ground surface, including between 3.4 m and 3.6 m of bedrock coring.

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. A piezometer was installed in Borehole BC1-3 to permit monitoring of the groundwater level at this location. The piezometer consists of a 50 mm diameter PVC pipe with a 1.5 m long slotted screen sealed within the sand and gravel deposit. The borehole annulus surrounding the piezometer screen was backfilled with sand and the remainder of the borehole was backfilled with a bentonite plug and cuttings. The piezometer exhibited artesian conditions and was backfilled with cement grout as required for the conditions and in accordance with the regulations.

The fieldwork was observed by a member of our engineering and 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 and rock core 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, Atterberg limits and grain size distribution) was carried out on selected samples. Strength testing, for uniaxial compression strength (UCS), was carried out on a selected specimen of the rock core. The results of the laboratory testing on samples from the culvert boreholes are included in Appendix B.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 of the Canadian Foundation Engineering Manual (CFEM, 2006)[1]. The degree of weathering of the bedrock samples (i.e. fresh to completely weathered) and the strength classification of the intact rock mass based on field identification (i.e. strong to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM[2]) standard classification system. Classification of the bedrock core samples with respect to strength is based on Table 3.5 of CFEM (2006).

The proposed centreline of the new highway alignment was staked in the field by MRC prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at temporary benchmarks, which were installed by MRC prior to the commencement of fieldwork. The borehole locations given in the Record of Borehole sheets and shown on Drawing 1 are positioned relative to MTM NAD 83 northing and

[1]Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

[2] International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

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		
BC1-1	5333456.8	409598.0	305.0	14.2
BC1-2	5333464.9	409579.7	306.0	10.5
BC1-3	5333449.6	409614.5	305.1	16.6

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

In the Quaternary Period, the Virginiatown area was encompassed by glacial Lakes Barlow and Ojibway. In areas of more turbulent waters in these lakes, coarse grained sediments of sand and gravel were deposited. In the calmer portions of the glacial lakes fine grained sediments consisting primarily of varved clay, were deposited. After Lakes Barlow and Ojibway receded, organic materials were deposited. In the Kirkland Lake area the organic deposits are usually found as fens, bogs and swamps containing varying thicknesses of organics and are often encountered in glaciolacustrine plains (overlying the sand and gravel or clay), along creeks and streams and in bedrock basins(Baker, 1985) [3].

Based on NOEGTS[4] Mapping, the subsoils in the vicinity of the Highway 66 realignment generally consist of till deposited as a ground moraine. A primarily clay/clayey glaciolacustrine deposit is located further than 1 km north of the realignment. The soils along the Highway 66 realignment consist of variable deposits of organic materials, lacustrine sand, silt and clay and till.

Published literature indicates that the site is located in the Abitibi Subprovince of the Superior Province (OGS, 1991)[5]. The Abitibi Subprovince contains rocks of up to 2.75 Ga in age, is about 800 km by 300 km in area and lies within the southern portion of the Superior Province. Bedrock in this subprovince consists primarily of zones of mafic to intermediate metavolcanic rocks and metasedimentary rocks.

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 and bedrock core samples, are presented on the attached Record of Borehole sheets and the soil laboratory test sheets provided in Appendices A and B. The results of the in situ field 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. 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

3 C.L. Baker, 1985. Quaternary Geology of the Kirkland Lake Area, Districts of Cochrane and Timiskaming; Ontario Geological Survey.

4 Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Map Reference Number 32DSW.

5 Ontario Geological Survey, 1991. Geology of Ontario, Special Volume 4, Part 1. Eds P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott, Ministry of Northern Development and Mines, Ontario.

transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations.

The inferred soil stratigraphy based on the result of the boreholes is shown in profile on Drawing 1. The orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north and/or up-chainage (along the proposed Highway 66 alignment). For purposes of this report, Highway 66 is oriented east-west.

In general, the subsurface conditions encountered at the site generally consist of topsoil at the ground surface underlain by a cohesive deposit comprised of a zone of firm to stiff clayey silt and soft to stiff silty clay to clay at depth. Underlying the cohesive deposit is a firm to stiff clayey silt deposit, underlain by a deposit of sandy gravel to sand and gravel, and metasediment bedrock.

Detailed descriptions of the subsurface conditions along the investigated culvert alignment are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit or stratum.

4.2.1 Topsoil

An approximately 0.1 m thick deposit of topsoil was encountered from ground surface in Boreholes BC1-1, BC1-2 and BC1-3, ranging from Elevation 306.0 m to 305.0 m.

4.2.2 Clayey Silt to Clay

A cohesive deposit consisting of an upper zone of clayey silt, a middle zone of silty clay to clay and transitioning to a lower zone of clayey silt was encountered underlying the topsoil in the boreholes. The total thickness of the cohesive deposit is between 3.1 m and 8.9 m and the surface of the deposit was encountered between Elevation 305.9 m and 304.9 m.

The upper zone is 1.3 m thick in Boreholes BC1-2 and BC1-3 and comprises brown clayey silt, some sand, some gravel to gravelly sandy clayey silt, trace organics. The middle zone, encountered in all boreholes, is comprised of brown to grey silty clay to clay, trace gravel, trace sand, and is between 1.8 m and 5.2 m thick. The lower zone is comprised of grey clayey silt in Boreholes BC1-1 and BC1-3 and is between 1.9 m and 3.0 m thick. Silt seams were encountered within the middle zone of the deposit between Elevations 304.9 m and 299.7 m in Borehole BC1-1 and within the middle and lower zones at Elevations 300.5 m, 299.1 m and 297.6 m in Borehole BC1-3. An approximately 25 mm thick sand seams was encountered at about Elevation 303.9 m in Borehole BC1-2.

4.2.2.1 Clayey Silt

The SPT 'N'-values measured within the upper clayey silt portion of the deposit range from 6 blows to 14 blows per 0.3 m of penetration, suggesting a firm to stiff consistency.

The natural water content measured on one sample of the clayey silt portion of the deposit is about 13 per cent.

A grain size distribution test completed on one sample of the upper zone of the clayey silt deposit is shown on Figure B1 in Appendix B.

An Atterberg limits test was carried out on one sample of this portion of the deposit and the measured liquid limit is about 24 per cent, the plastic limit is about 17 per cent and the plasticity index is about 7 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B and indicate the material is classified as a clayey silt of low plasticity.

4.2.2.2 Silty Clay to Clay

The SPT 'N'-values measured within the lower silty clay to clay portion of the deposit range from 0 blows (weight of hammer) to 5 blows per 0.3 m of penetration. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging between 23 kPa and 64 kPa, and the sensitivity is calculated to range between 3 and 5. The field vane tests results indicate that the silty clay to clay portion of the deposit has a soft to stiff consistency.

The natural water content measured on seven samples of this portion of the deposit ranges from about 37 per cent to 72 per cent.

The results of grain size distribution tests completed on four samples of the silty clay to clay portion of the deposit are shown on Figure B3 in Appendix B.

Atterberg limits tests were carried out on six samples of this portion of the deposit and measured liquid limits ranging from about 35 per cent to 64 per cent, plastic limits ranging from about 19 per cent to 27 per cent and plasticity indices ranging from about 17 per cent to 38 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 is classified as a silty clay of intermediate plasticity to clay of high plasticity.

4.2.2.3 Clayey Silt

The SPT 'N'-values measured within the lower clayey silt portion of the deposit range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from 41 kPa to about 91kPa and the sensitivity is calculated to range from 3 to 5. The field vane tests results indicate that this portion of the deposit has a firm to stiff consistency.

The natural water content measured on three selected samples of this portion of the deposit is between about 28 per cent and 34 per cent.

A grain size distribution test completed on one sample of the lower clayey silt portion of this deposit is shown on Figure B1 in Appendix B.

Atterberg limits tests were carried out on two samples of this portion of the deposit and measured liquid limits of about 26 per cent and 30 per cent, plastic limits of about 18 per cent and 19 per cent and plasticity indices of about 7 per cent and 11 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B and indicate the material is classified as a clayey silt of low plasticity.

4.2.3 Sandy Gravel to Sand and Gravel

An approximately 3.6 m to 4.0 m thick deposit of grey to brown, wet sandy gravel to sand and gravel was encountered underlying the clayey silt in Borehole BC1-1 and Borehole BC1-3 and below silty clay to clay in Borehole BC1-2. The surface of the deposit was encountered between depths of 3.2 m and 9.0 m below ground surface (corresponding to between Elevation 302.8 m and 296.1 m) and the bottom of the deposit is defined by the bedrock surface. A zone of cobbles was encountered in Boreholes BC1-1 and BC1-2 at Elevation 294.9 m and Elevation 299.7 m, with thicknesses of 0.2 m and 0.6 m, respectively.

The SPT 'N'-values measured within the sandy gravel to sand and gravel deposit range from 12 blows to 35 blows per 0.3 m of penetration, indicating a compact to dense relative density. Several samples did not penetrate the full sampler depth indicating the presence of very dense material and/or inferred cobbles.

The natural water content measured on three samples of this deposit ranges from about 2 per cent to 19 per cent.

The results of grain size distribution tests completed on three samples of this deposit are shown on Figure B5 in Appendix B.

4.2.4 Bedrock

Bedrock was encountered in all of the boreholes. The depth to the surface of the bedrock in these boreholes ranges from about 6.9 m to 13.0 m below ground surface, corresponding to between about Elevation 299.1 m to Elevation 292.1 m.

Bedrock was cored in all the boreholes for lengths between 3.4 m and 3.6 m. The retrieved bedrock core is described as very fine grained, moderately weathered to fresh, green to grey, metasediment with occasional fractured sheared zones as presented in the Record of Drillhole sheets in Appendix A. Photographs of the retrieved bedrock core samples are shown on Figure B6.

The Total Core Recovery (TCR) measured on all core samples ranges from 98 per cent to 100 per cent. The Solid Core Recovery (SCR) of the rock core samples ranges from 28 per cent to 100 per cent. The Rock Quality Designation (RQD) measured on the core samples ranges from 65 per cent to 100 per cent, indicating a rock mass of fair to excellent quality.

Laboratory Uniaxial Compression Strength (UCS) tests were carried out on selected bedrock core samples from each borehole. The UCS values are presented on the Record of Drillhole sheets in Appendix A and are summarized below, and indicate that the bedrock is strong to very strong.

Borehole	Elevation (m)	UCS (MPa)
BC1-1	293.4	112
BC1-2	296.7	114
BC1-3	290.8	62

4.3 Groundwater Conditions

Groundwater levels were measured in the open boreholes during and upon completion of drilling and a piezometer was installed in Borehole BC1-3, sealed within the sand and gravel deposit to monitor the groundwater level. The groundwater levels measured in the open boreholes and piezometer are presented below.

Borehole	Installation	Time and/or Date	Depth to Groundwater (Below ground surface) (m)	Groundwater Elevation (m)
BC1-1	Open Borehole	September 9, 2012	2.0	303.0
BC1-2	Open Borehole	September 10, 2012	2.1	303.9
BC1-3	Open Borehole	September 10, 2012	1.0	304.1
	Piezometer	November 17, 2012	-1.0 (i.e. above ground surface)	306.1
	Piezometer	May 19, 2013	-1.1 (i.e. above ground surface)	306.2

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. Matt Thibeault, EIT. This report was prepared by Ms. Michelle He and Mr. Matt Thibeault and reviewed by Ms. Sarah Coyne, P.Eng., a senior geotechnical engineer and Associate with Golder. 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

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METRIC

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

CONT No.

GWP No. 5091–07–00

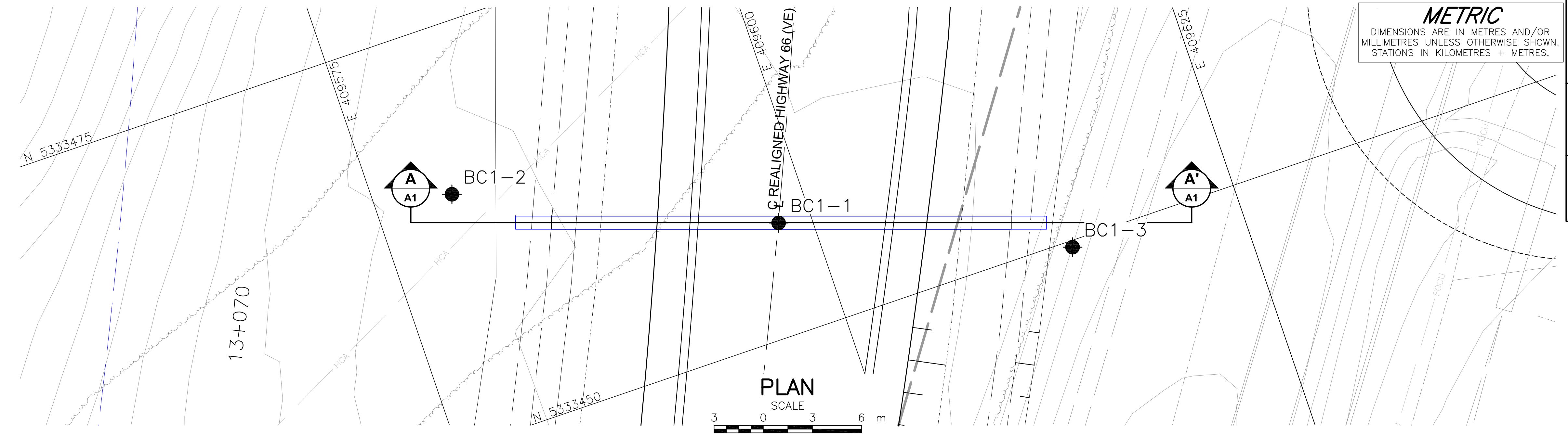
SHEET

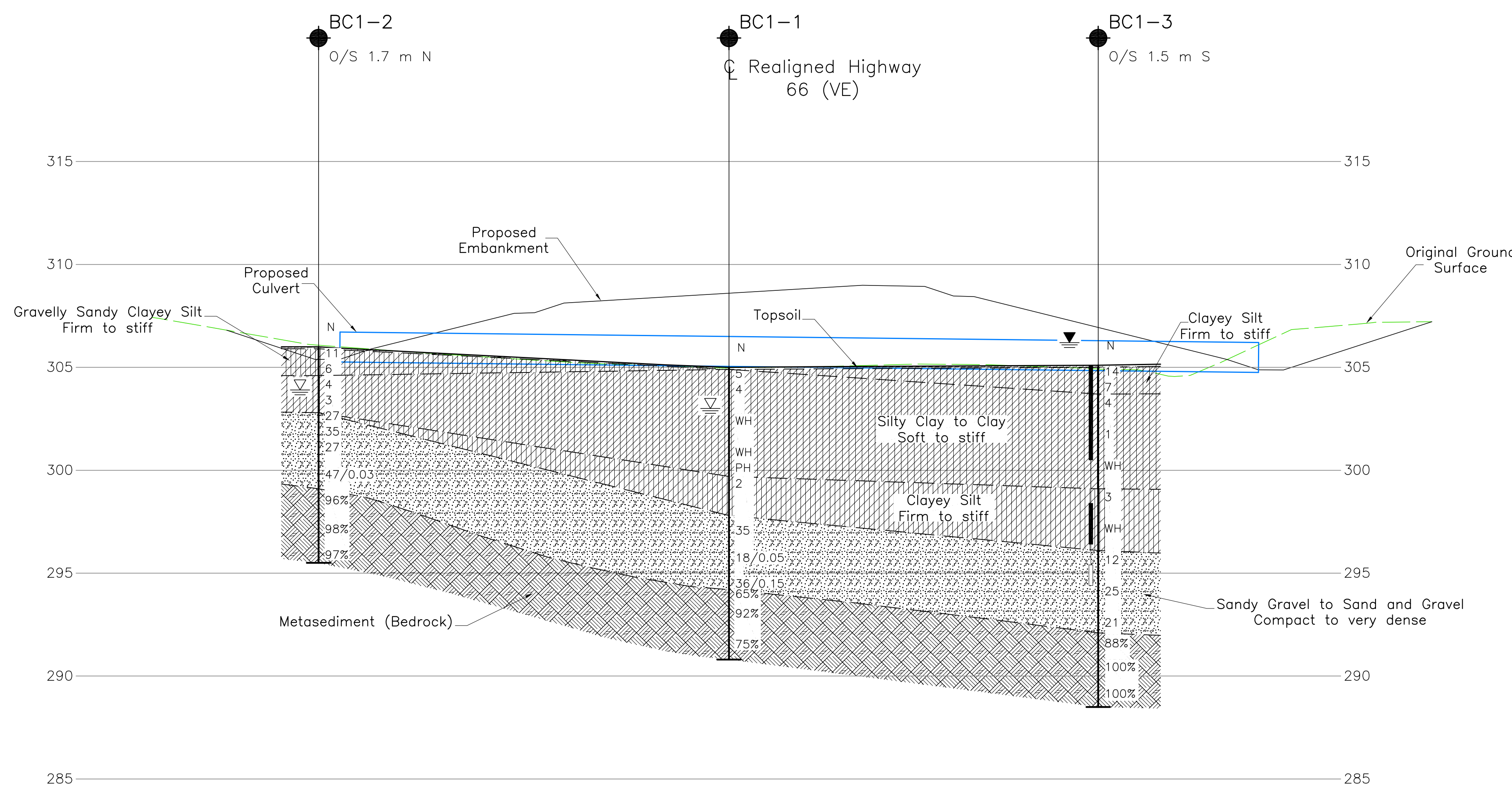
HIGHWAY 66

CULVERT AT STA 13+080

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



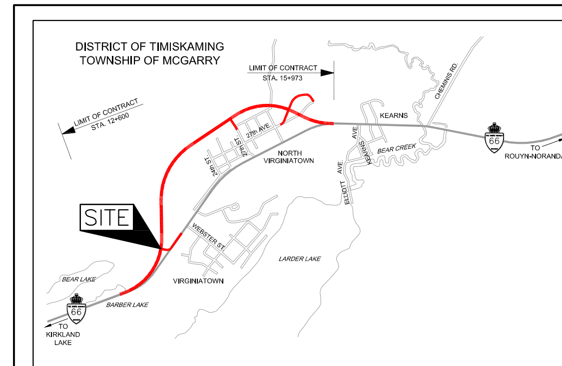


A–A' / A1 CULVERT AT STA 13+080

HIGHWAY 66

HORIZONTAL SCALE 3 0 3 6 m

VERTICAL SCALE 3 0 3 6 m



KEY PLAN

SCALE 700 0 700 m

LEGEND

- Borehole
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL upon completion of drilling
- WL in piezometer, measured on MAY 19, 2013

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BC1–1	305.0	5333456.8	409598.0
BC1–2	306.0	5333464.9	409579.7
BC1–3	305.1	5333449.6	409614.5

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 MMM, drawing file nos. H3211009D16 ROLL PLAN–ULTIMATE and PDR.dwg, received DEC 3, 2012. Keyplan drawing file nos. H3211009G02 received JAN 24, 2013.

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J.M.A. COSTA — LICENSED PROFESSIONAL ENGINEER, PROVINCE OF ONTARIO — NOV 15, 2013

NO.	DATE	BY	REVISION

Geocres No. 32D–13			
HWY. 66	PROJECT NO. 10–1191–0044		DIST.
SUBM'D. MT	CHKD.	DATE: NOV 2013	SITE:
DRAWN: JJL	CHKD. SEMC	APPD. JMAC	DWG. 1

PLOT DATE: November 13, 2013

APPENDIX A

Highway 66 Realignment, Virginiatown— Culvert at STA 13+080 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
σ_1, σ_2, σ_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 $= \sigma'_p / \sigma'_{vo}$

(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

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	**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

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

RECORD OF BOREHOLE No BC1-1

 METRIC

PROJECT 10-1191-0044
G.W.P. 5091-07-00
LOCATION N 5333456.8; E 409598.0
ORIGINATED BY MT
DIST HWY 66
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY MT
DATUM GEODETIC
DATE September 8 and 9, 2012
CHECKED BY SEMC

ELEV DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	FIELD VANE SHEAR (kPa) / SENSITIVITY	WATER CONTENT / LIMITS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.0	GROUND SURFACE						
0.0	TOPSOIL						
0.1	SILTY CLAY to CLAY, Firm to stiff, Grey, Moist to wet	1	SS	5			
		2	SS	4			
					+ (5), + (4)		
		3	SS	WH			
	Silt seams encountered between 0.1 m and 5.3 m depth.				+ (3), + (3)		
		4	SS	WH			0 0 39 61
	Roots and silt pockets encountered at 5.2 m depth in Shelby tube Sample 5.	5	TO	PH			0 0 47 53
299.7 / 5.3	CLAYEY SILT, Stiff, Grey, Wet	6	SS	2			
					+ (4), + (5)		
297.8 / 7.2	Sandy GRAVEL, Dense to very dense, Grey, Wet	7	SS	35			78 22 0 0
		8	SS	18/0.05			
	Cobbles encountered between 10.1 m and 10.3 m depth.	9	SS	36/0.15			
294.2 / 10.8	METASEDIMENT (BEDROCK). Bedrock cored from 10.8 m depth to 14.2 m depth. For coring details see Record of Drillhole BC1-1.	1	RC	REC 100%			RQD = 65%
		2	RC	REC 100%			RQD = 92%
		3	RC	REC 98%			RQD = 75%
290.8 / 14.2							

Groundwater level symbol (▽) shown at approx. elevation 303.1.

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (304 to 291); 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.

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BC1-1

 METRIC

PROJECT 10-1191-0044

G.W.P. 5091-07-00 | LOCATION N 5333456.8; E 409598.0 | ORIGINATED BY MT

DIST ____ HWY 66 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY MT

DATUM GEODETIC | DATE September 8 and 9, 2012 | CHECKED BY SEMC

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 ---										
	END OF BOREHOLE Note: 1. Water level at a depth of 2.0 m below ground surface (Elev. 303.0 m) upon completion of drilling.										

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

SUD_MTO 003 10-1191-0044SUD.GPJ GAL-MISS.GDT 16/08/13 DATA INPUT:

PROJECT: 10-1191-0044

RECORD OF DRILLHOLE: BC1-1

SHEET 1 OF 1

LOCATION: N 5333456.8 ;E 409598.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 9, 2012

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling Inc.

DATUM: GEODETIC

Legend: JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
		REFER TO PREVIOUS PAGE					
11	September 9, 2012; NQ Coring; NW	METASEDIMENT Very strong Fine grained Moderately weathered to fresh Greenish grey	294.2 / 10.8	1	WHITE 100%	JN,IR,Ro JN,IR,Ro	
12				2	GREY / WHITE 100%	JN,IR,Ro	112 MPa
13–14		Sheared zone encountered between 12.7 m and 14.2 m depth.		3	GREY / WHITE 100%	JN,IR,Ro JN,IR,Ro JN,IR,Ro JN,IR,Ro JN,IR,Ro JN,IR,Ro BR	
		END OF DRILLHOLE	290.8 / 14.2				

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

SUD-RCK 10-1191-0044SUD.GPJ GAL-MISS.GDT 16/08/13 DATA INPUT:

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MT

CHECKED: SEMC

Golder Associates

Foundation Design

RECORD OF BOREHOLE No BC1-2

1 OF 1 **METRIC**

PROJECT 10-1191-0044
G.W.P. 5091-07-00
DIST ___ HWY 66
DATUM GEODETIC

LOCATION N 5333464.9; E 409579.7
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE September 9 and 10, 2012

ORIGINATED BY MT
COMPILED BY MT
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
306.0	GROUND SURFACE						
0.0	TOPSOIL	1a	SS	11			
0.1	Gravelly Sandy CLAYEY SILT Firm to stiff Brown Moist	1b				plotted	24 26 33 17
		2	SS	6			
304.6 / 1.4	SILTY CLAY, trace gravel, trace sand Soft Brown Moist Approximately 25 mm thick sand seam encountered at 2.1 m depth.	3	SS	4	∇ (303.9)	plotted	
		4	SS	3			
302.8 / 3.2	Sandy GRAVEL, trace silt, trace clay Compact to dense Grey to brown Wet	5a	SS	27		plotted	4 3 64 29
		5b					
		6	SS	35			
	Approximately 0.4 m thick sand seam encountered at 4.6 m depth.	7a	SS	27		plotted	11 80 7 2
		7b					
		8	SS	47/0.03			
299.1	Cobbles encountered between 6.3 m and 6.9 m depth.						
6.9	METASEDIMENT (BEDROCK) Bedrock cored from 6.9 m depth to 10.5 m depth. For coring details see Record of Drillhole BC1-2.	1	RC	REC 100%			RQD = 96%
		2	RC	REC 100%			RQD = 98%
		3	RC	REC 100%			RQD = 97%
295.5 / 10.5	END OF BOREHOLE Note: 1. Water level at a depth of 2.1 m below ground surface (Elev. 303.9 m) upon completion of drilling.						

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; ELEVATION SCALE (305, 304, 303, 302, 301, 300, 299, 298, 297, 296); 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

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

PROJECT: 10-1191-0044

RECORD OF DRILLHOLE: BC1-2

LOCATION: N 5333464.9 ;E 409579.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 10, 2012

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling Inc.

DATUM: GEODETIC

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR / % RETURN	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
		REFER TO PREVIOUS PAGE						
7	NW Casing	METASEDIMENT Very strong Fine grained Fresh Grey	299.1 6.9	1	GREY 100%	•	VN,PL,RO	
8	NQ Coring, September 10, 2012			2	GREY / WHITE 100%	•	JN,IR,Ro	
9						•	JN,IR,Ro	114 MPa
10			295.5 10.5	3	GREY 100%			
		END OF DRILLHOLE						

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: MT

CHECKED: SEMC

Golder Associates

RECORD OF BOREHOLE No BC1-3

 METRIC

PROJECT 10-1191-0044
G.W.P. 5091-07-00 LOCATION N 5333449.6; E 409614.5 ORIGINATED BY MT
DIST HWY 66 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY MT
DATUM GEODETIC DATE September 10, 2012 CHECKED BY SEMC

ELEV DEPTH (m)	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.1	GROUND SURFACE				
0.0	TOPSOIL				
0.1	CLAYEY SILT, some sand, trace organics Firm to stiff Brown Moist	1	SS	14	
		2	SS	7	
303.7 1.4	CLAY Firm Brown to grey Moist to wet	3	SS	4	0 1 40 59
		4	SS	1	
		5	SS	WH	
	Silt seams encountered between 4.6 m and 6.0 m depth.				
299.1 6.0	CLAYEY SILT Firm Grey Wet	6	SS	3	
	Silt seams encountered between 6.0 m and 7.5 m depth.				
		7	SS	WH	0 2 82 16
296.1 9.0	SAND and GRAVEL, some silt, trace clay Compact Grey Wet	8	SS	12	
		9	SS	25	36 43 17 4
		10	SS	21	
292.1 13.0	METASEDIMENT (BEDROCK) Bedrock cored from 13.0 m depth to 16.6 m depth. For coring details see Record of Drillhole BC1-3.	1	RC	REC 100%	RQD = 88%
		2	RC	REC 100%	RQD = 100%

ELEVATION SCALE: 305 to 291

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

Field vane results (sensitivity): 3, 3 (approx. El. 302.5–302.2); 4, 3 (approx. El. 301.0–300.7); 4, 4 (approx. El. 299.5–299.2); 4, 4 (approx. El. 297.9–297.6); 3 (approx. El. 296.4)

PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L — WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BC1-3

 METRIC

PROJECT 10-1191-0044
G.W.P. 5091-07-00
LOCATION N 5333449.6; E 409614.5
ORIGINATED BY MT
DIST ___ HWY 66
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY MT
DATUM GEODETIC
DATE September 10, 2012
CHECKED BY SEMC

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 + 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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	METASEDIMENT (BEDROCK)		2	RC			290				RQD = 100%
	Bedrock cored from 13.0 m depth to 16.6 m depth. For coring details see Record of Drillhole BC1-3.		3	RC	REC 100%		289				RQD = 100%
288.5 / 16.6	END OF BOREHOLE Note: 1. Water level at a depth of 1.0 m below ground surface (Elev. 304.1 m) upon completion of drilling. 2. Water level in piezometer measured at 1.0 m above ground surface (Elev. 306.1 m) on November 17, 2012 and at 1.1 m above ground surface (Elev. 306.2 m) on May 19, 2013. 3. Piezometer installed within heaving sand and gravel.										

SUD_MTO 003 10-1191-0044SUD.GPJ GAL-MISS.GDT 16/08/13 DATA INPUT:

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

PROJECT: 10-1191-0044

RECORD OF DRILLHOLE: BC1-3

LOCATION: N 5333449.6 ;E 409614.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 10, 2012

DRILL RIG: CME 55

DRILLING CONTRACTOR: Landcore Drilling Inc.

DATUM: GEODETIC

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH COLOUR % RETURN	NOTES / WATER LEVELS / INSTRUMENTATION
		REFER TO PREVIOUS PAGE		292.1			
13	NQ Coring, September 10, 2012	METASEDIMENT Strong Fine grained Fresh Greenish Grey Sheared zone between 13.0 m and 16.6 m depth.		13.0	1	GREY 100%	
14–15					2	GREY 100%	62 MPa
16				288.5	3	GREY 100%	
		END OF DRILLHOLE		16.6			

Column headings also include: RECOVERY (TOTAL CORE %, SOLID CORE %), R.Q.D. %, FRACT. INDEX METRES, DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn), HYDRAULIC CONDUCTIVITY k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}), Diametral Point Load Index (MPa), RMC -Q' AVG.

Depth scale: 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

DEPTH SCALE

1 : 50

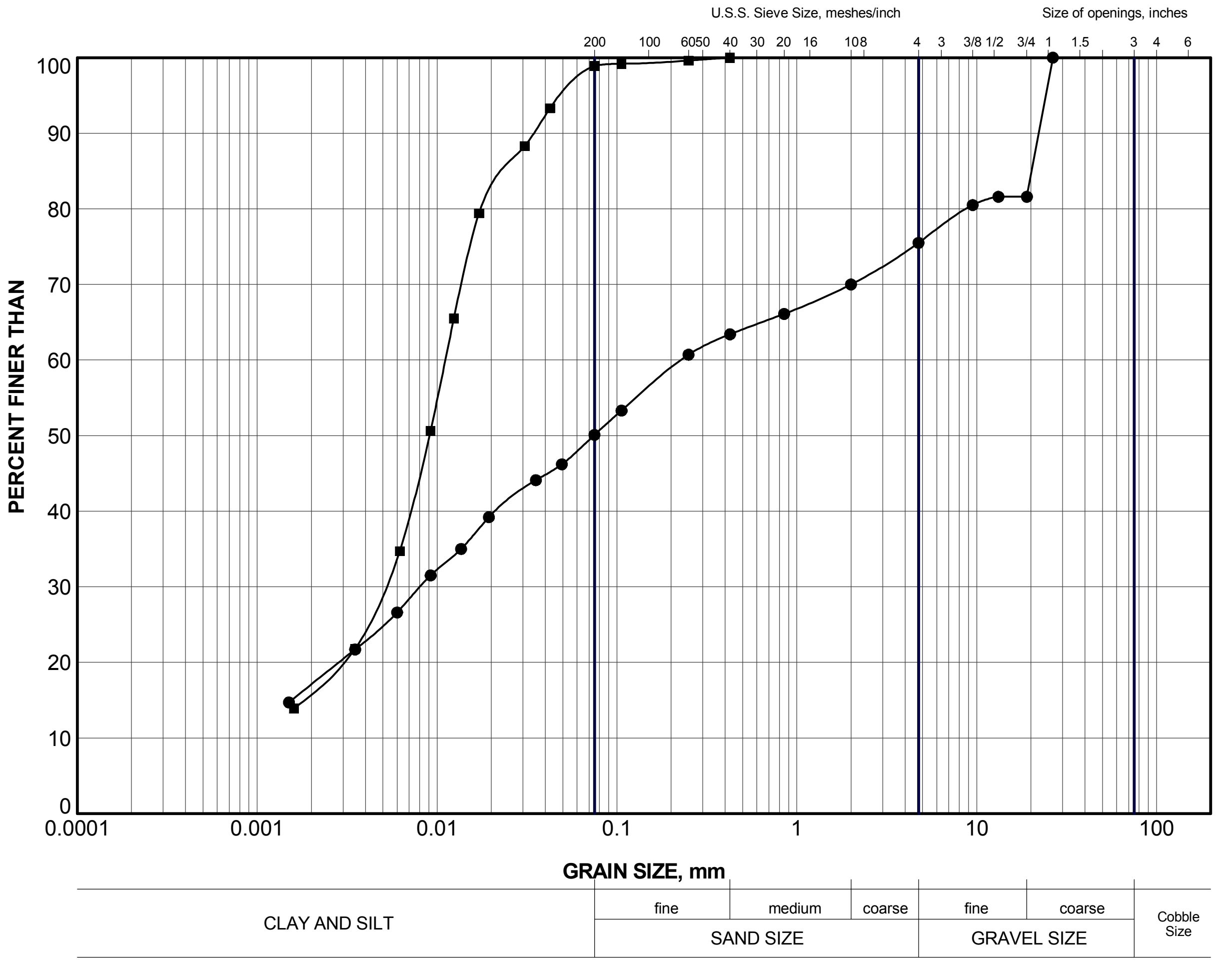
Golder Associates

LOGGED: MT

CHECKED: SEMC

APPENDIX B

Highway 66 Realignment, Virginiatown — Culvert at STA 13+080 Laboratory Tests Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BC1-2	1b	305.7
■	BC1-3	7	297.2

PROJECT

HIGHWAY 66 - CULVERT BC1
STA 13+080

TITLE

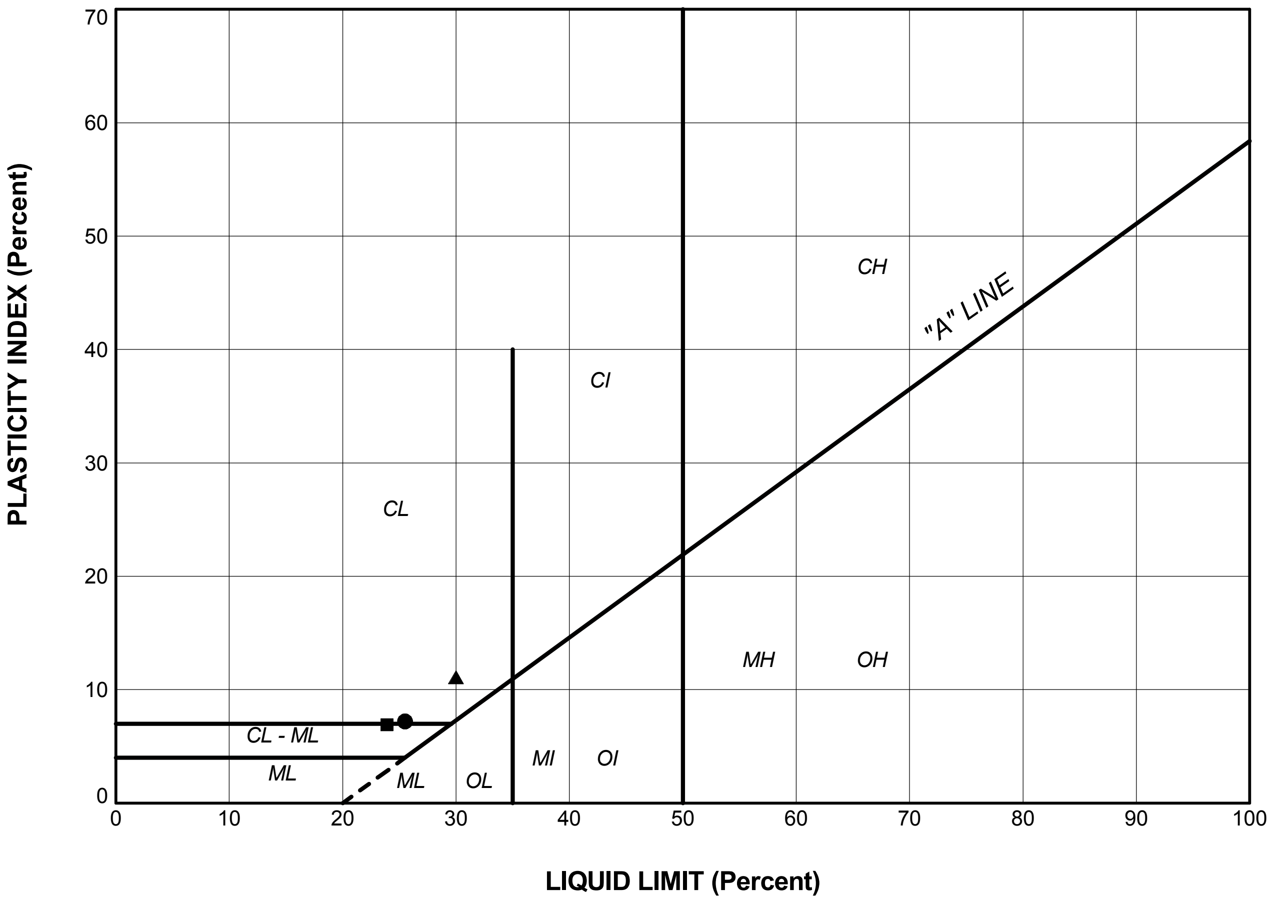
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	10-1191-0044		FILE No.	10-1191-0044C.GPJ
DRAWN	JJL	May 2013	SCALE N/A	REV.
CHECK	SEMC	May 2013	FIGURE B1	
APPR		May 2013		

SUD-MTO GSD GLDR_LDN.GDT



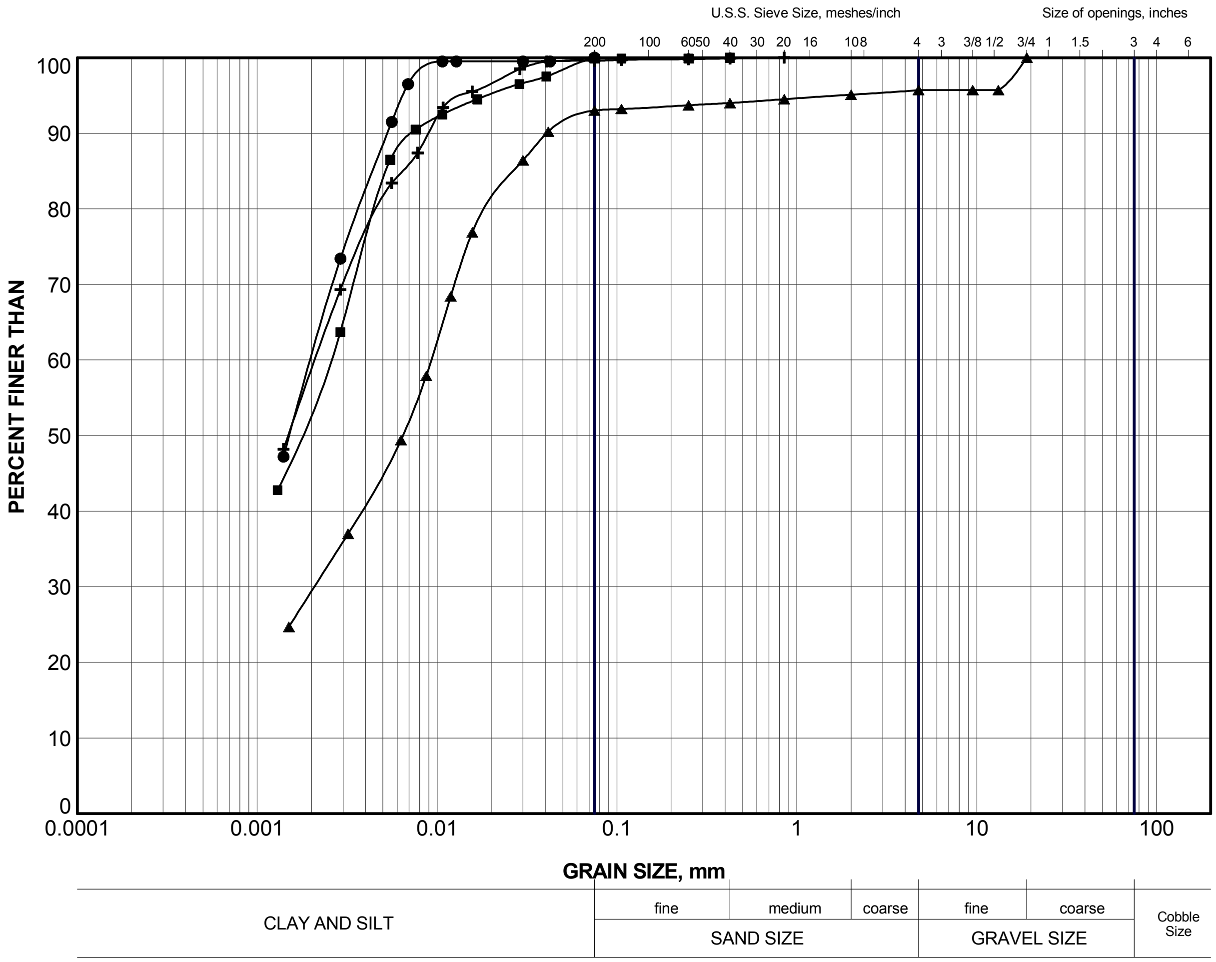
SOIL TYPE	**PLASTICITY**
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	BC1-1	6	25.5	18.3	7.2
■	BC1-2	1b	23.9	17.0	6.9
▲	BC1-3	6	30.0	18.9	11.1

PROJECT	HIGHWAY 66 STA 13+080			
TITLE	**PLASTICITY CHART** CLAYEY SILT			
Golder Associates SUDBURY, ONTARIO	PROJECT No.	10-1191-0044	FILE No.	10-1191-0044C.GPJ
	DRAWN	JJL	May 2013	SCALE N/A REV.
	CHECK	SEMC	May 2013	**FIGURE B2**
	APPR	JMAC	May 2013	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BC1-1	4	300.9
■	BC1-1	5	300.1
▲	BC1-2	5a	302.9
+	BC1-3	3	303.3

PROJECT

HIGHWAY 66 - CULVERT BC1
STA 13+080

TITLE

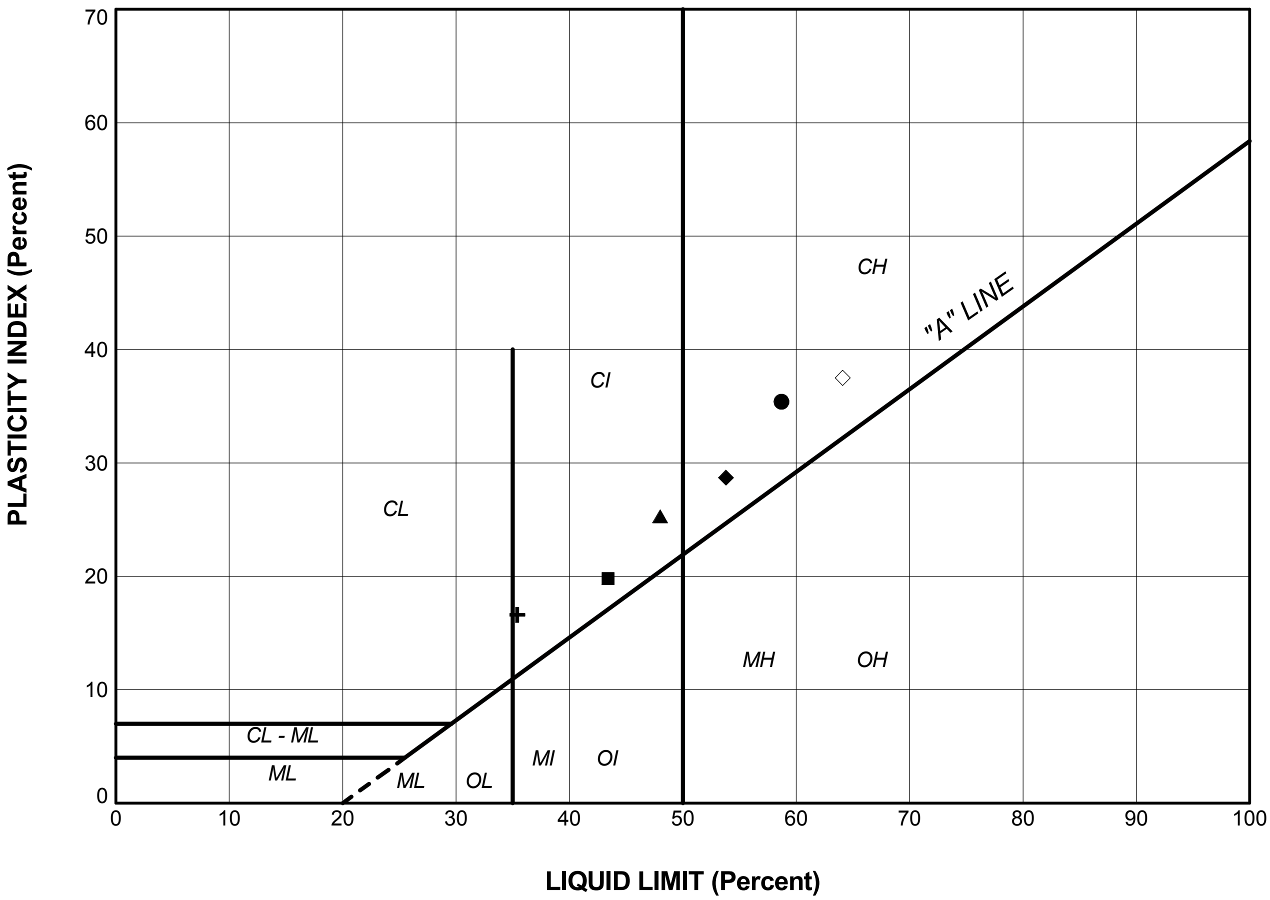
GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAY

PROJECT No.	10-1191-0044		FILE No.	10-1191-0044C.GPJ
DRAWN	JJL	May 2013	SCALE N/A	REV.
CHECK	SEMC	May 2013		
APPR		May 2013	**FIGURE B3**	

Golder Associates
SUDBURY, ONTARIO

SUD-MTO GSD 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
●	BC1-1	4	58.7	23.3	35.4
■	BC1-1	5	43.4	23.6	19.8
▲	BC1-2	3	48.0	22.7	25.3
✚	BC1-2	5a	35.4	18.8	16.6
◆	BC1-3	3	53.8	25.1	28.7
◇	BC1-3	4	64.1	26.6	37.5

PROJECT

HIGHWAY 66 - CULVERT BC1
STA 13+080

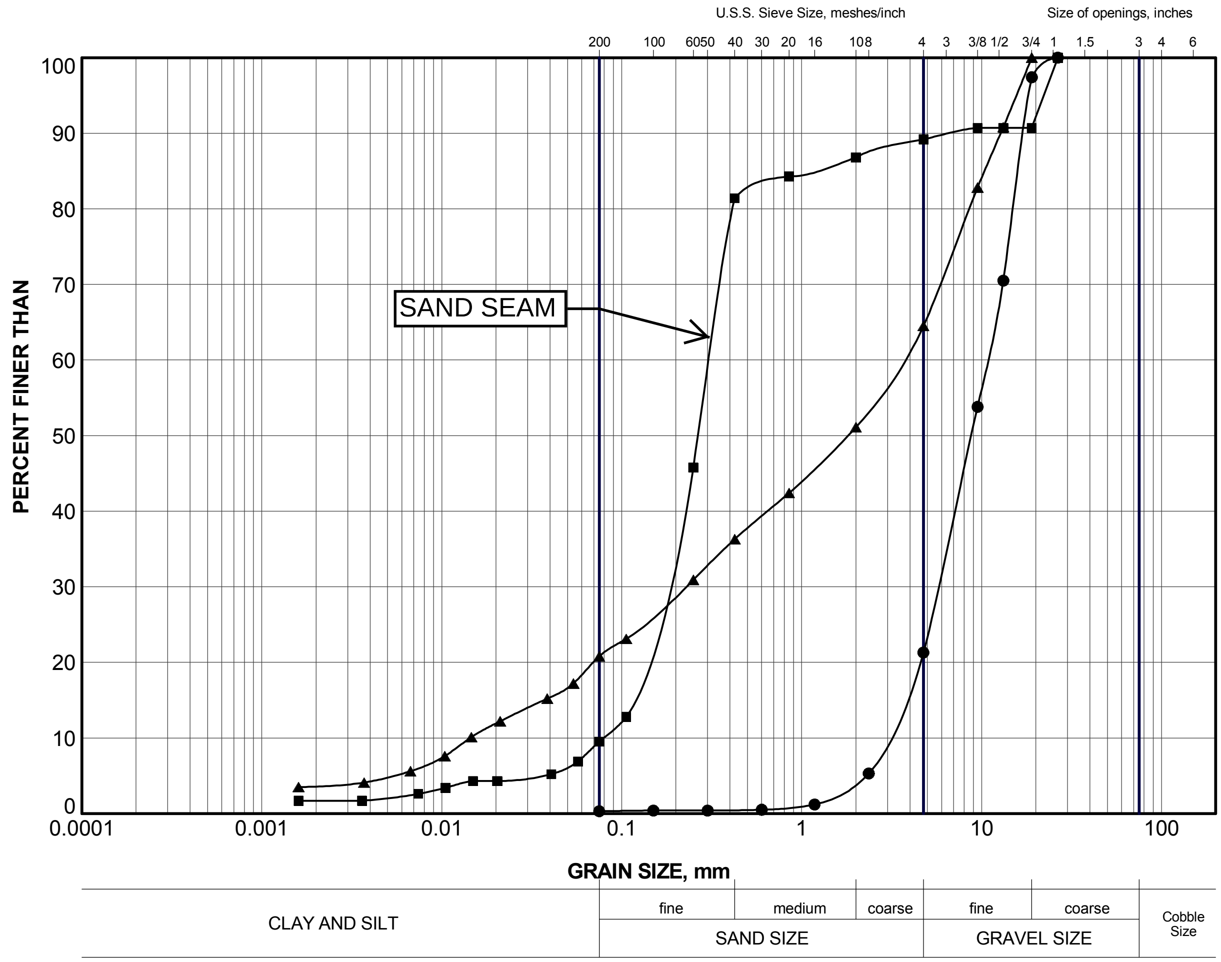
TITLE

PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	10-1191-0044		FILE No.	10-1191-0044C.GPJ
DRAWN	JJL	May 2013	SCALE N/A	REV.
CHECK	SEMC	May 2013		
APPR		May 2013	**FIGURE B4**	

SUD-MTO PL_GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	BC1-1	7	297.1
■	BC1-2	7	301.2
▲	BC1-3	9	294.1

PROJECT

HIGHWAY 66
STA 13+080

TITLE

GRAIN SIZE DISTRIBUTION

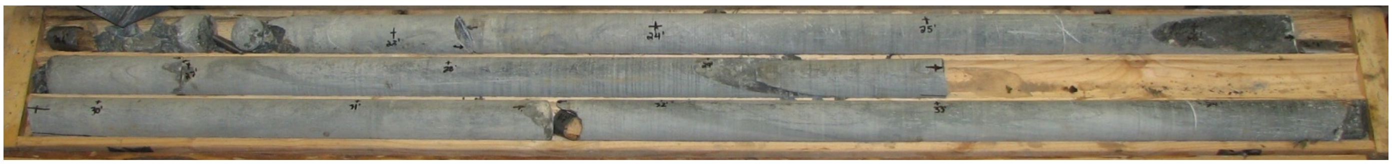
SANDY GRAVEL to SAND AND GRAVEL

Golder Associates
SUDBURY, ONTARIO

PROJECT No.		10-1191-0044	FILE No.	10-1191-0044C.GPJ
DRAWN	JJL	May 2013	SCALE N/A	REV.
CHECK	SEMC	May 2013		
APPR	JMAC	May 2013	FIGURE B5	

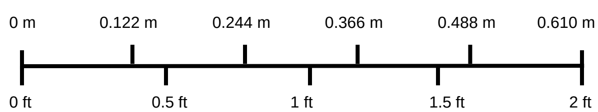
SUD-MTO GSD (NEW) GLDR_LDN.GDT

Borehole BC1-1
Elevation 294.2 m to 290.8 m



Borehole BC1-2
Elevation 299.1 m to 295.5 m

Borehole BC1-3
Elevation 292.1 m to 288.5 m



PROJECT
Highway 66 – Culvert BC1
STA 13+080

TITLE
BEDROCK CORE PHOTOGRAPHS

Golder Associates

PROJECT No.	10-1191-0044		FILE No.	----
DESIGN	MT	Apr 2013	SCALE AS SHOWN	REV.
CADD	--			
CHECK	SEMC	Apr 2013	**FIGURE B6**	
REVIEW	JMAC	Apr 2013		

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