



February 10, 2015

## PRELIMINARY FOUNDATION INVESTIGATION REPORT

**UNNAMED CREEK CULVERT, SITE NO. 42-342/C**  
**RESURFACING OF HIGHWAY 11**  
**FROM MUSKOKA ROAD 117 NORTHERLY TO STEPHENSON ROAD 12, 21.9 KM**  
**MINISTRY OF TRANSPORTATION, ONTARIO**  
**GWP 5462-09-00**

**Submitted to:**

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REPORT

**GEOCRES NO.: 31E-342**

**Report Number: 14-1111-0007-2**

**Distribution:**

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UNNAMED CREEK CULVERT SITE NO. 42-342/C**

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# **PART A**

**PRELIMINARY FOUNDATION INVESTIGATION REPORT  
UNNAMED CREEK CULVERT, Site No. 42-342/C  
RESURFACING OF HIGHWAY 11  
FROM MUSKOKA ROAD 117 NORTHERLY TO STEPHENSON ROAD 12  
MINISTRY OF TRANSPORTATION, ONTARIO  
GWP 5462-09-00**



## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the rehabilitation of a structural culvert at Unnamed Creek (Site No. 42-342/C) as part of the rehabilitation of Highway 11 in the Townships of Macaulay and Stephenson between Huntsville and Bracebridge, Ontario. The proposed rehabilitation of Highway 11 extends for 21.9 km, from Muskoka Road 117 northerly to Stephenson Road 12. The structural culvert is located approximately 1.2 km north of the junction of Highway 11 with Stephenson Road 1 at STA 11+209. The general location of the culvert is shown on Drawing 1.

The original Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated June 2011. Golder's proposal for foundation engineering services associated with this culvert is contained in Section 6.8 of AECOM's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated June 26, 2014. The drawings showing the proposed culvert alignments were provided to Golder by AECOM on October 14, 2014.

This report addresses the investigation carried out for the structural culvert at Unnamed Creek, which has been identified as a culvert for rehabilitation. Separate reports will be submitted detailing the foundation investigations for the remaining culverts within the project limits.

The purpose of this investigation is to obtain subsurface information specific to the structural culvert location by methods of borehole drilling, bedrock coring, in situ testing and laboratory testing on selected soil samples and rock core samples. The boreholes for this culvert were located in the field by Golder and were surveyed relative to stakes and/or nail pins installed by exp. Services Inc. (exp.), a professional surveying company retained by AECOM. The culvert location and ground surface elevations at the investigation location were also surveyed in the field by exp.

## **2.0 SITE DESCRIPTION**

The structural culvert at Unnamed Creek is located at approximately STA 11+209 on Highway 11 in the Township of Stephenson, between Muskoka Road 117 and South Mary Lake Road. The existing culvert at this location is a concrete box structure the details of which (width, height, length etc.) are summarized in Table 1, following the text of this report.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely or densely populated treed areas and numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils. The ground surface at the borehole and DCPT locations advanced for the structural culvert investigation, including through the existing Highway 11 embankments, varies between Elevations 303.9 m and 291.7 m, referenced to Geodetic datum.

## **3.0 INVESTIGATION PROCEDURES**

The fieldwork for the investigation associated with the proposed rehabilitation of the Unnamed Creek culvert was carried out between June 18 and 27 as well as on July 9 and 10, 2014, during which periods a total of six (6)



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boreholes and five (5) Dynamic Cone Penetration Tests (DCPTs) were advanced at, or in the immediate vicinity of, the culvert alignment, as summarized in Table 1 and as shown on Drawing A1 in Appendix A.

The field investigation was carried out using truck-mounted CME55 and CME 75 drill rigs supplied and operated by Landcore Drilling of Sudbury, Ontario, as well as portable equipment supplied by and operated by George Downing Estate Drilling Ltd of Grenville-Sur-La-Rouge, Quebec.

The boreholes were advanced through the overburden using 108 mm inside diameter hollow-stem augers, 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 operated by automatic hammers on the drill rigs, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Boreholes advanced by portable equipment generally employed a full-weight hammer lifted manually and dropped from the SPT height. On the drill rigs rock coring was carried out using 'NQ' core barrels beyond auger/casing refusal, where appropriate, and through blast rock fill sections. Coring by portable equipment was carried out using 'BQ' core barrels, through rock fill sections and where bedrock was encountered. All open boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903-Wells (as amended).

The boreholes and DCPTs were advanced to depths generally penetrating about 3 m below the culvert invert, terminating on refusal to further auger, casing and/or split spoon advancement likely on, or in proximity to, the bedrock surface, or upon drilling into probable bedrock. Four boreholes were advanced between approximately 1.2 m to 3.6 m below auger/casing refusal to confirm bedrock.

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.

A sample of the creek water was obtained during the field investigation at the culvert location, 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 A1.

The fieldwork was observed by members 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 samples and rock core. The soil samples and rock core were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury geotechnical laboratory where the samples and core underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO Laboratory Standards and/or ASTM Standards, as appropriate. Classification testing (water content, organic content and grain size distribution) was carried out on selected soil samples. The results of the laboratory testing are provided in Appendix A.

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)<sup>1</sup>. The degree of weathering of the bedrock samples (i.e. fresh to slightly weathered – W1 to W2) and the strength classification of the intact rock mass based on field identification (i.e. strong – R4) are described in accordance with the International Society for Rock Mechanics (ISRM, 1985)<sup>2</sup> standard classification system. A laboratory Unconfined

<sup>1</sup>Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

<sup>2</sup> 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.



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Compression (UC) test was carried out on one core sample of the bedrock and the uniaxial compressive strength (UCS) of the bedrock is described as per Table 3.5 of CFEM (2006)<sup>1</sup>.

Survey stakes and/or nail pins were installed by exp. at selected locations in the area of the culvert prior to the commencement of drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the applicable stakes and/or nail pins 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 applicable survey stakes and/or nail pins installed by exp. The borehole locations given on the Record of Borehole sheets and shown on Drawing A1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and depths drilled are as follows:

Culvert Location	Borehole/DCPT	Location (m)		Ground Surface Elevation (m)	Depth of Borehole/DCPT (m)
		Northing	Easting		
STA 11+209 (Township of Stephenson)	C10-01	5003077.8	319557.2	294.6	5.7
	C10-02	5003084.6	319576.6	302.4	12.0*
	C10-03	5003066.0	319599.8	296.7	3.2
	C10-03A	5003080.0	319599.5	296.6	4.9*
	C10-04	5003085.4	319624.3	303.8	15.9*
	C10-05	5003079.1	319648.9	291.7	3.7*
	C10-DC01	5003084.8	319556.7	294.5	4.6
	C10-DC02A	5003074.6	319576.8	302.4	5.9
	C10-DC02B	5003073.6	319576.7	302.4	5.7
	C10-DC03	5003080.0	319598.9	296.7	3.7
	C10-DC04	5003075.4	319623.9	303.9	7.7

\* Including bedrock coring between 1.2 m and 3.6 m.

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>3</sup>, this section of Highway 11 lies within the physiographic region known as the “Number 11 Strip”, with portions of Highway 11 in contact with the “Georgian Bay Fringe” region. The Number 11 Strip is a narrow belt that extends from Gravenhurst to North Bay and is characterized by deposits of sand, silt and clay, together with more recent swamp deposits between rock knobs and ridges. The bedrock in the area is typically highly deformed gneiss of the Moon River Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province (Geology of Ontario, 1991)<sup>4</sup>.

<sup>3</sup> Chapman, L.J. and D. F. Putnam, 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

<sup>4</sup> Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 2. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.





## **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 rock core samples, are presented on the Record of Borehole and Drillhole sheets and the laboratory test sheets in Appendix A. The stratigraphic boundaries shown on the Record of Borehole and Drillhole sheets are inferred from non-continuous sampling, observations of drilling progress and in situ testing and are approximate. 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.

The stratigraphy at the location of the culvert consists of surficial layers of peat or embankment fill underlain by native non-cohesive soil deposits and bedrock. A detailed description of the subsurface conditions at the structural culvert crossing is provided in the following section 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.

## **4.3 Subsurface Conditions**

The plan and profile along the Unknown Creek culvert centreline showing the borehole locations and interpreted stratigraphy at approximately STA 11+209 in Township of Stephenson is shown on Drawing A1. The height of the embankment at this location is between about 9 m and 11 m and the existing concrete culvert is about 89 m long with dimensions of 3100 mm wide by 1500 mm high. A total of six boreholes and five DCPTs were completed to investigate the subsurface conditions at the culvert location: two boreholes (C10-01 and C10-05) and one companion DCPT (C10-DC01) were advanced near the ends of the culvert; and four boreholes (C10-02, C10-03, C10-03A and C10-04) and four DCPTs (C10-DC02A, C10-DC02B, C10-DC03 and C10-DC04) were advanced through the roadway embankments and near the midpoint of the culvert. In general, the topography in the area of the culvert consists of low-lying areas, bedrock outcrops and treed areas.

### **4.3.1 West Embankment Fill (SBL)**

Embankment fill 3.2 m to 8.8 m thick was encountered in the west embankment. The west embankment fill consists of a deposit of silty sand to sand, trace to some gravel, trace clay and trace organics which was encountered at surface Elevations 302.4 m, 296.7 m and 296.6 m in Boreholes C10-02, C10-03 and C10-03A, respectively, and has a thickness ranging from 3.2 m to 6.2 m. Asphalt mixed with sand and gravel was encountered near the ground surface in Borehole C10-02. A 0.8 m thick layer of rock fill was encountered directly below the silty sand to sand fill in Borehole C10-02 at Elevation 296.2 m and is in turn underlain by a 1.8 m thick layer of sand and gravel in Borehole C10-02 at Elevation 295.14 m.

The SPT 'N'-values measured within the west embankment fill typically range between 9 blows and 34 blows per 0.3 m of penetration in Borehole C10-02 with values of up to 13 blows per 0.13 m, indicating a compact to dense relative density. The SPT 'N'-values measured in Boreholes C10-03 and C10-03A range from 0 blows (weight of hammer) to 11 blows per 0.3 m of penetration indicating a very loose to compact relative density. SPT 'N'-values of 100 blows per 0.13 m of penetration and 100 blows per 0.08 m of penetration were measured at contacts with rock fill and upon borehole refusal at the interface with bedrock.





The natural water content measured on eight sample of the silty sand to sand fill in the west embankment ranges from about 11 per cent to about 31 per cent.

The results of the grain size distribution tests completed on five sample of the silty sand to sand fill are shown on Figure A1 in Appendix A.

#### **4.3.2 East Embankment Fill (NBL)**

Embankment fill 12.6 m thick was encountered in Borehole C10-04 in the east embankment at a surface Elevation 303.8 m. The fill consists of a 2.2 m thick upper layer of sand and gravel, trace silt fill underlain by a 10.4 m thick layer of blast rock encountered at Elevation 301.6 m.

The SPT 'N'-values measured within the sand and gravel fill range between 16 blows and 19 blows per 0.3 m of penetration indicating a compact relative density. SPT 'N'-values measured within the rock fill range from 13 blows to 100 blows per 0.3 m of penetration to 100 blows per 0.05 m of penetration indicating a compact to very dense relative density. Coring methods were required to advance the borehole between the split spoon samples to penetrate through the rock fill.

The natural water content measured on a sample of sand and gravel fill is about 7 per cent.

The result of the grain size distribution test completed on a sample of the sand and gravel fill is shown on Figure A2 in Appendix A.

#### **4.3.3 Peat**

A 0.1 m thick deposit of fibrous peat was encountered in Boreholes C10-01 and C10-05, at ground surface at Elevation 294.6 m and 291.7 m, respectively.

#### **4.3.4 Silty Sand to Sand**

A deposit of grey to brown silty sand to sand, trace organics to silt trace to some clay, trace sand was encountered below the peat layer in Borehole C10-01. The top of the deposit was encountered at Elevation 294.5 m and the thickness of the deposit is 2.1 m.

The SPT 'N'-values measured within the silty sand to sand deposit range between 1 blow and 3 blows per 0.3 m of penetration indicating a very loose relative density.

The natural water content measured on a sample of the silty sand to sand deposit is about 51 per cent. The organic content measured on a sample of this deposit is about 5 per cent.

#### **4.3.5 Silt**

A 2.7 m thick deposit of silt, trace to some clay, trace sand was encountered underlying the silty sand to sand deposit at Elevation 292.4 m.



The SPT 'N'-values measured within the silt deposit range from 20 blows to 30 blows per 0.3 m of penetration indicating a compact relative density.

The natural water content measured on two samples of the silt deposit measured about 25 per cent and 28 per cent.

The result of the grain size distribution test completed on a sample of the silt is shown on Figures A3 in Appendix A.

#### **4.3.6 Silty Sand and Gravel**

A 0.8 m deposit of grey silty sand and gravel was encountered underlying the silt deposit in Borehole C10-01 at Elevation 289.7 m.

The SPT 'N'-values measured within the silty sand and gravel deposit are 29 blows per 0.3 m of penetration and 100 blows per 0.15 m of penetration upon refusal on probable bedrock, indicating a compact to very dense relative density.

The natural water content measured on a sample of the silty sand and gravel deposit is about 10 per cent.

The result of the grain size distribution test completed on a sample of the silty sand and gravel deposit is shown in Figure A4 in Appendix A.

#### **4.3.7 Bedrock / Refusal**

Bedrock was encountered in Boreholes C10-02, C10-03A, C10-04 and C10-05 at between Elevations 293.6 m, and 291.2 m and core samples between 1.2 m and 3.6 m long were obtained. Based on a review of the bedrock core samples, the bedrock consists of fine to coarse grained, fresh, pinkish grey to dark grey gneiss.

The Total Core Recovery (TCR) for the core samples ranges from 93 per cent to 100 per cent and the Solid Core Recovery (SCR) ranges from 0 per cent to 100 per cent. The Rock Quality Designation (RQD) measured on the recovered bedrock core samples in the boreholes range between 0 per cent and 100 per cent, and is generally greater than 52 per cent, indicating the rock is of very poor to excellent quality and generally of fair to good quality, according to Table 3.10 in CFEM (2006)<sup>1</sup>.

On Unconfined Compression (UC) test (ASTM D7012) was carried out on one core sample of the gneiss bedrock obtained in Borehole C10-02 and measured a Uniaxial Compressive Strength (UCS) value of about 76 MPa, as detailed in Table A2. Based on the laboratory UC test, in accordance with Table 3.5 in CFEM (2006)<sup>1</sup>, the gneiss bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa).

Refusal to split-spoon advancement and DCPT penetration was encountered in and adjacent to Boreholes C10-01, C10-02, C10-03, C10-03A and C10-04 at depths ranging from 3.2 m to 12.6 m below ground surface, ranging from Elevations 296.7 m to 288.9 m..



#### **4.3.8 Groundwater Conditions**

The water level was measured in Boreholes C10-01, C10-03, C10-03A and C10-04 upon completion of drilling operations at depths between 1.2 m and 11.6 m below ground surface, ranging from Elevations 295.0 m to 292.2 m. Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

### **5.0 CLOSURE**

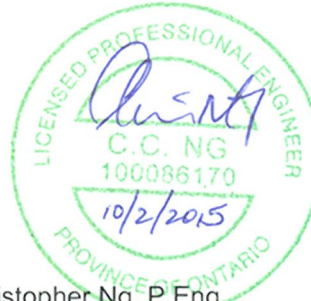
The field personnel supervising the drilling program were Messrs. Indulis Dumpis, Erik Giles and Matthew Thibeault, EIT. This report was prepared by Ms. Madison Kennedy, B.A.Sc. and reviewed by Mr. Christopher Ng, P.Eng. and Associate with Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal with Golder, carried out a quality control review of the report.



## Report Signature Page

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Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4<sup>th</sup> Edition.

Chapman, L.J. and D. F. Putnam, 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.

Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 2. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

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.

ASTM International:

ASTM D1586	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
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ASTM D7012	Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens
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Ontario Water Resources Act:

Ontario Regulation 372/97 Amendment to Ontario Regulation 903



## LIST OF SYMBOLS

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

### I. GENERAL

$\pi$	3.1416
$\ln x$ ,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

### III. SOIL PROPERTIES

<b>(a)</b>	<b>Index Properties</b>
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
e	void ratio
n	porosity
S	degree of saturation

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  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
$C_\alpha$	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
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

### (d) Shear Strength

$\tau_p, \tau_r$	peak and residual shear strength
$\phi'$	effective angle of internal friction
$\delta$	angle of interface friction
$\mu$	coefficient of friction = $\tan \delta$
$c'$	effective cohesion
$c_u, s_u$	undrained shear strength ( $\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
$p'$	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
$q_u$	compressive strength $(\sigma_1 - \sigma_3)$
$S_t$	sensitivity

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
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, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

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

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive Soils

Density Index	N
Relative Density	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 <sub>p</sub>	plastic limit
w <sub>l</sub>	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
D <sub>R</sub>	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 <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

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

### 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



## LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

### WEATHERING 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° 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	



# TABLES



**PRELIMINARY FOUNDATION REPORT - HIGHWAY 11 RESURFACING  
UNNAMED CREEK CULVERT SITE NO. 42-342/C**

**Table 1: Summary of Culvert Details**

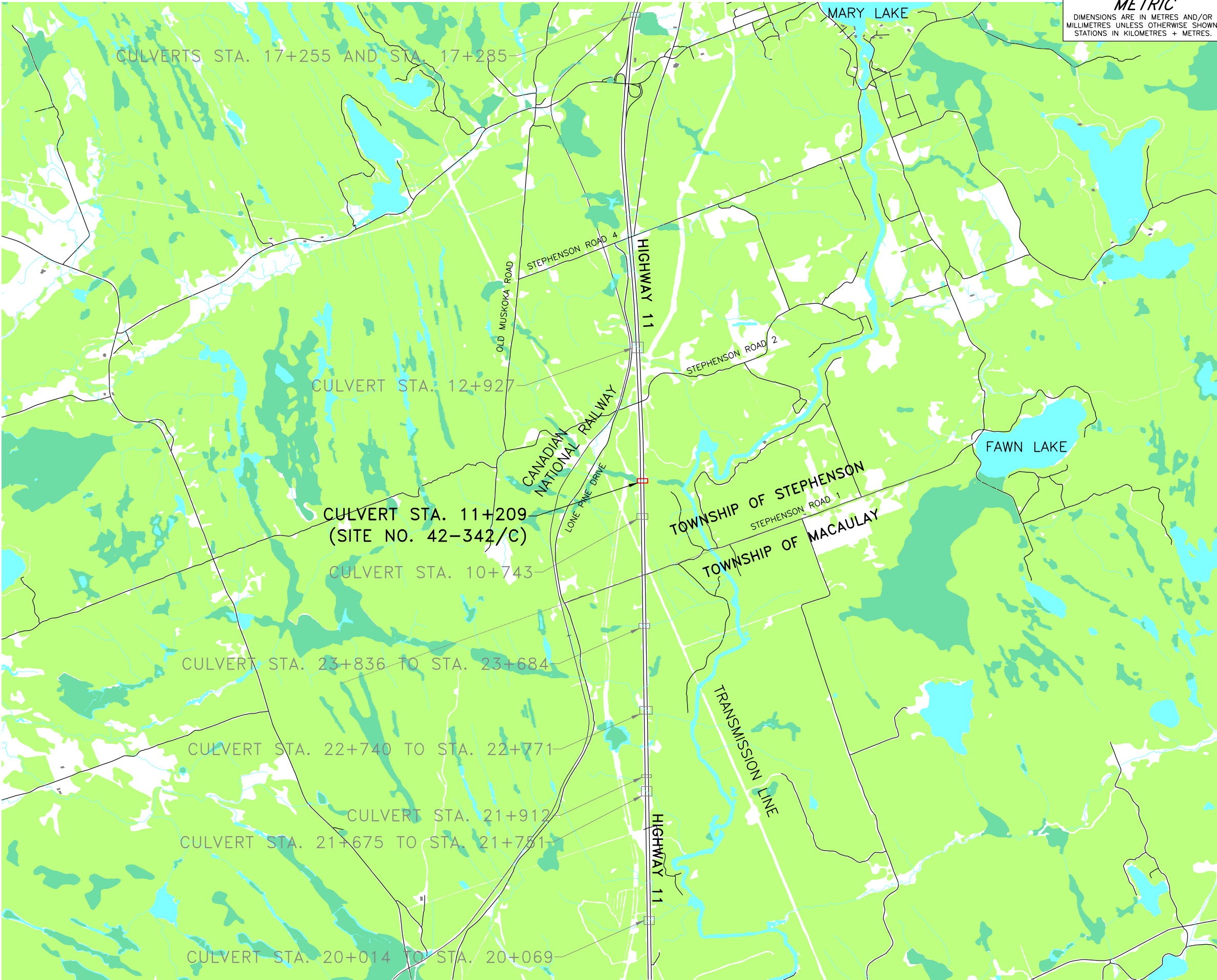
Culvert Location (Township)	Culvert ID	Approximate Height of Embankment <sup>1</sup>	Existing Culvert			Approximate Invert Elevation <sup>2</sup>		Boreholes	Dynamic Cone Penetration Tests	Reference Appendix
			Type	Approximate Dimension	Approximate Length	West End of Culvert	East End of Culvert			
STA 11+209 (Stephenson)	C10	Up to 13 m	Concrete Box	1.5 m high by 3.1 m wide	89 m	294.2 m	290.6 m	6 Boreholes (C10-01, C10-02, C10-03, C10-03A, C10-04 and C10-05)	5 DCPTs (C10-DC01, C10-DC02A, C10-DC02B, C10-DC03 and C10-DC04)	A

Notes:

1. Embankment height is relative to existing ground surface level at the toe of embankment adjacent to the culvert.
2. Culvert invert elevations are estimated based on the top of culvert surveys provided by exp. and culvert dimensions provided by AECOM.



# **DRAWINGS**



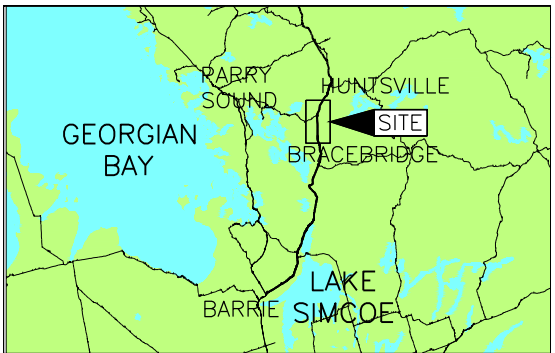
**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. .  
GWP No. 5462-09-00

HIGHWAY 11  
CULVERTS  
INDEX PLAN



SHEET



KEY PLAN  
NOT TO SCALE

CULVERT STA. 11+209  
(SITE NO. 42-342/C)

PLAN  
SCALE  
500 0 500 1000 m

**REFERENCE**  
Base data accessed in digital format from MNR LIO, obtained 2013.

NO.	DATE	BY	REVISION
Geocres No. 31E-342			
HWY. 11	PROJECT NO. 14-1111-0007		DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 11/5/2014	SITE: 42-342/C
DRAWN: MR	CHKD. CN	APPD. JMAC	DWG. 1





# APPENDIX A

Unnamed Creek Culvert at STA 11+209 – Highway 11 – Site No. 42-342/C



PROJECT		14-1111-0007		RECORD OF BOREHOLE No C10-01		SHEET 1 OF 1		METRIC							
G.W.P.		5462-09-00		LOCATION		N 5003077.8 ; E 319557.2		ORIGINATED BY							
DIST		HWY 11		BOREHOLE TYPE		Portable Equipment, Wash Boring		COMPILED BY							
DATUM		Geodetic		DATE		June 19, 2014		CHECKED BY							
								CN							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
294.6	GROUND SURFACE														
294.6	PEAT (Fibrous)		1A	SS	1										
	Silty SAND to SAND, trace organics		1B	SS											
	Very loose		2	SS	2										
	Grey to brown														
	Moist to wet														
292.4			3	SS	3										
292.4	SILT, trace to some clay, trace sand														
	Compact		4	SS	20										
	Grey														
	Wet														
			5	SS	24										
			6	SS	30										
289.7			7A	SS	29										
289.7	Silty SAND and GRAVEL, trace clay		7B	SS											
	Compact to dense														
	Grey														
	Wet		8	SS	100/0.15										
288.9															
288.9	END OF BOREHOLE														
	SPOON REFUSAL														
	(HAMMER BOUNCING)														
	NOTES:														
	1. Water level in open borehole at a depth of 1.2 m below ground surface (Elev. 293.4 m) upon completion of drilling.														
	2. DCPT advanced 1.0 m west of Borehole C10-01.														

PROJECT 14-1111-0007		RECORD OF BOREHOLE No C10-02		SHEET 1 OF 2		METRIC						
G.W.P. 5462-09-00		LOCATION N 5003084.6 ; E 319576.6		ORIGINATED BY ID								
DIST _____ HWY 11		BOREHOLE TYPE CME 55, 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing		COMPILED BY MT								
DATUM Geodetic		DATE June 19, 2014		CHECKED BY CN								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
302.4	GROUND SURFACE											
0.0	Sand, trace to some silt, trace gravel, trace clay (FILL) Compact to dense Brown Moist to wet		1A	SS	10							
			1B									
	Asphalt mixed with sand and gravel encountered from surface to a depth of 0.1 m.		2	SS	10							1 86 11 2
			3	SS	13							
			4	SS	20							0 80 17 3
			5	SS	26							
			6	SS	19							
			7	SS	34							
296.2	Rock fill (FILL)		8	SS	13/0.13							0 87 (13)
295.4	Sand and gravel (FILL) Loose Brown Wet		9	SS	9							
293.6	GNEISS (BEDROCK)		1	RC	REC 100%							RQD = 79%
	Bedrock cored from depths of 8.8 m to 12.0 m.  For bedrock coring details refer to Record of Drillhole C10-02.		2	RC	REC 100%							RQD = 100%
			3	RC	REC 100%							RQD = 100%
290.4	END OF BOREHOLE											
12.0	NOTE:  1. Open borehole dry upon completion of drilling.											

SHEET 2 OF 2

DATUM: Geodetic



DRILLING CONTRACTOR: Landcore Drilling Inc.

CHECKED: CN

PROJECT <u>14-1111-0007</u>		<b>RECORD OF BOREHOLE No C10-03</b>		SHEET 1 OF 1		<b>METRIC</b>												
G.W.P. <u>5462-09-00</u>		LOCATION <u>N 5003066.0 ; E 319599.8</u>		ORIGINATED BY <u>EG</u>														
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>Portable Equipment, Wash Boring</u>		COMPILED BY <u>MT</u>														
DATUM <u>Geodetic</u>		DATE <u>July 9, 2014</u>		CHECKED BY <u>CN</u>														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
296.7	GROUND SURFACE						20	40	60	80	100							
0.0	Sand to silty sand, some gravel, trace clay, trace organics (FILL) Very loose to compact Brown Moist		1	SS	4	▽												
			2	SS	11		296											
			3	SS	WH		295											
			4	SS	1		294											
			5	SS	100/0.13													
293.5	END OF BOREHOLE SPOON REFUSAL																	
3.2	NOTE:  1. Water level in open borehole at a depth of 1.7 m below ground surface (Elev. 295.0 m) upon completion of drilling.																	

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PROJECT 14-1111-0007		<b>RECORD OF BOREHOLE No C10-03A</b>				SHEET 1 OF 2		<b>METRIC</b>									
G.W.P. 5462-09-00		LOCATION N 5003080.0 ; E 319599.5				ORIGINATED BY EG											
DIST _____ HWY 11		BOREHOLE TYPE Portable Equipment, Wash Boring				COMPILED BY MT											
DATUM Geodetic		DATE July 10, 2014				CHECKED BY CN											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
296.6	GROUND SURFACE							20	40	60	80	100					
0.0	Silty sand, trace gravel, trace clay (FILL) Very loose to loose Brown Wet		1	SS	6	▽	296										3 71 24 2
			2	SS	4		295										
			3	SS	3		294										
			4	SS	6		293										
			5	SS	10		292										
292.9	GNEISS (BEDROCK)		6	SS	0000.00		293										
3.7	Bedrock cored from depths of 3.7 m to 4.9 m		1	RC	REC 97%		292										RQD = 69%
291.7	For bedrock coring details refer to Record of Drillhole C10-03A.																
4.9	END OF BOREHOLE																
	NOTE:  1. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 294.3 m) upon completion of drilling.																

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PROJECT: 1411110007

**RECORD OF DRILLHOLE: C10-03A**

SHEET 2 OF 2

LOCATION: N 5003080.0 ;E 319599.5

DRILLING DATE: July 10, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Aluminum Tripod and Cathead/Hitch Pull

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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DEPTH SCALE

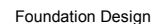
1 : 50



LOGGED: EG

CHECKED: CN

GTA-RCK 023 S:\CLIENTS\MTOWHWY\_11\02\_DATA\GINT\1411110007\GPJ\_GAL-GTA.GDT 11/05/14



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

PROJECT <u>14-1111-0007</u>		<b>RECORD OF BOREHOLE No C10-04</b>				SHEET 2 OF 3		<b>METRIC</b>	
G.W.P. <u>5462-09-00</u>		LOCATION <u>N 5003085.4 ;E 319624.3</u>				ORIGINATED BY <u>EG</u>			
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>CME 75, NW Casing, NQ Coring</u>				COMPILED BY <u>MT</u>			
DATUM <u>Geodetic</u>		DATE <u>June 25, 2014</u>				CHECKED BY <u>CN</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
287.9			3	RC	REC 100%		288										RQD = 100%
15.9	END OF BOREHOLE  NOTE:  1. Water level in open borehole at a depth of 11.6 m below ground surface (Elev. 292.2 m) upon completion of drilling.																

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PROJECT: 1411110007

**RECORD OF DRILLHOLE: C10-04**

SHEET 3 OF 3

LOCATION: N 5003085.4 ;E 319624.3

DRILLING DATE: June 26, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75

DRILLING CONTRACTOR: Landcore Drilling Inc.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR FLUSH % RETURN	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.										DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC -Q AVG	
							RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DIP W/L CORE AXIS				TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K <sub>v</sub> cm/sec	T <sub>v</sub> °C	T <sub>h</sub> °C				
							TOTAL CORE %	SOLID CORE %			B Angle	DIP W/L CORE AXIS	DIP W/L CORE AXIS	DIP W/L CORE AXIS											
							80 60 40 20 0	80 60 40 20 0			80 60 40 20 0	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20											
13	NQ Coring June 26, 2014	Continued from Record of Borehole C10-04		291.2 12.6	1	GREY 100																			
14		Broken core encountered from 12.6 m to 15.0 m depth, likely as a result of drilling operations.		2	GREY 100																				
15		3		GREY 100																					
16		END OF DRILLHOLE		287.9 15.9																					
17																									
18																									
19																									
20																									
21																									
22																									

DEPTH SCALE

1 : 50



LOGGED: EG

CHECKED: CN

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PROJECT		14-1111-0007		RECORD OF BOREHOLE No C10-05		SHEET 1 OF 2		METRIC										
G.W.P.		5462-09-00		LOCATION		N 5003079.1 ; E 319648.9		ORIGINATED BY										
DIST		HWY 11		BOREHOLE TYPE		Portable Equipment		COMPILED BY										
DATUM		Geodetic		DATE		June 25, 2014		CHECKED BY										
								CN										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
291.7	GROUND SURFACE							20	40	60	80	100						
0.0	PEAT (Fibrous)		1	RC	REC 96%													RQD = 28%
	GNEISS (BEDROCK)		2	RC	REC 100%													RQD = 82%
	Bedrock cored from depths of 0.1 m to 3.7 m		3	RC	REC 93%													RQD = 52%
	For bedrock coring details refer to Record of Drillhole C10-05.		4	RC	REC 100%													RQD = 100%
			5	RC	REC 97%													RQD = 93%
288.0	END OF BOREHOLE																	
3.7	NOTE: 1. Water level not recorded.																	



PROJECT: 1411110007

**RECORD OF DRILLHOLE: C10-05**

SHEET 2 OF 2

LOCATION: N 5003079.1 ;E 319648.9

DRILLING DATE: June 25, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Drilling Equipment

DRILLING CONTRACTOR: George Downing Estate Drilling Ltd.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	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.										DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY		Diametral Point Load Index (MPa)	RMC - Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	K <sub>v</sub> cm/sec	K <sub>h</sub> cm/sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
							TOTAL CORE %	SOLID CORE %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							FLUSH	80 85 90 95 100	80 85 90 95 100	80 85 90 95 100	0 1 2 3 4 5	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20	0 5 10 15 20			0 5 10 15 20																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
1	BQ Thin-walled Coring June 25, 2014	Continued from Record of Borehole C10-05  GNEISS Pinkish grey Medium grained Slightly weathered  Highly fractured zone encountered from 0.3 m to 0.4 m depth.		291.6 0.1	1	GREY 100						JN,PL,RO  BR., JN,IR,RO JN,IR,RO																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

DEPTH SCALE

1 : 50



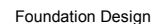
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CHECKED: CN

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PROJECT <u>14-1111-0007</u>		<b>RECORD OF DCPT No C10-DC01</b>		SHEET 1 OF 1		<b>METRIC</b>											
G.W.P. <u>5462-09-00</u>		LOCATION <u>N 5003084.8 ; E 319556.7</u>		ORIGINATED BY <u>MT</u>													
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>MT</u>													
DATUM <u>Geodetic</u>		DATE <u>June 19, 2014</u>		CHECKED BY <u>CN</u>													
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									
294.5	GROUND SURFACE							20	40	60	80	100					
0.0	Dynamic Cone Penetration Test (DCPT)							20	40	60	80	100	10	20	30	kN/m <sup>3</sup>	GR SA SI CL
289.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (72 Blows / 0.30 m) (HAMMER BOUNCING)																
4.6																	

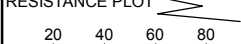
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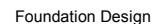
+3, ×3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



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

PROJECT <u>14-1111-0007</u>		<b>RECORD OF DCPT No C10-DC03</b>		SHEET 1 OF 1		<b>METRIC</b>			
G.W.P. <u>5462-09-00</u>		LOCATION <u>N 5003080.0 ; E 319598.9</u>		ORIGINATED BY <u>EG</u>					
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>Portable Equipment, Dynamic Cone Penetration Test</u>		COMPILED BY <u>MT</u>					
DATUM <u>Geodetic</u>		DATE <u>July 9, 2014</u>		CHECKED BY <u>CN</u>					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED WATER CONTENT (%)	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE					
296.7 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)								
293.0 3.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.08 m) (HAMMER BOUNCING)								

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



**PRELIMINARY FOUNDATION REPORT - HIGHWAY 11 RESURFACING  
UNNAMED CREEK CULVERT SITE NO. 42-342/C**

**Table A1: Summary of Analytical Testing of Surface Water**

Culvert Location Highway 11 (Township)	Parameter (Units, Detection Limit)				
	Chloride (mg/L, 1)	Sulfate (mg/L, 1)	Conductivity ( $\mu$ S/cm, 1)	Resistivity ( $\Omega$ -cm)	pH
STA 11+209 (Township of Stephenson)	26	Not Detected	120	8000	6.95

Notes: 1. Samples obtained July 18, 2014  
2. Analytical testing carried out by Maxxam Analytics.

Prepared by: MCK  
Checked by: CN  
Reviewed by: JMAC

**Golder Associates Ltd.**

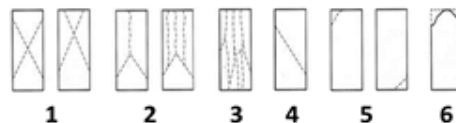
6925 Century Avenue, Suite #100  
Mississauga, Ontario, L5N 7K2  
Telephone: (905) 567-4444  
Fax: (905) 567-6561

**TABLE A2 - Unconfined Compressive Strength**

**PROJECT NO.:** 14-1111-0007  
**JOB NAME:** Unnamed Creek Culvert  
**TYPE OF UNIT:** Bedrock Core

GOLDER LAB NUMBER	G0837
BOREHOLE	C10-02
DATE TESTED	September 5, 2014
DEPTH OF TESTED CORE (m)	10.2
LENGTH AS CUT (mm)	105.0
DIAMETER (mm)	47.5
DENSITY (kg/m3)	2758
UNIAXIAL COMPRESSIVE STRENGTH (MPa)	76.1
TYPE OF FRACTURE	3

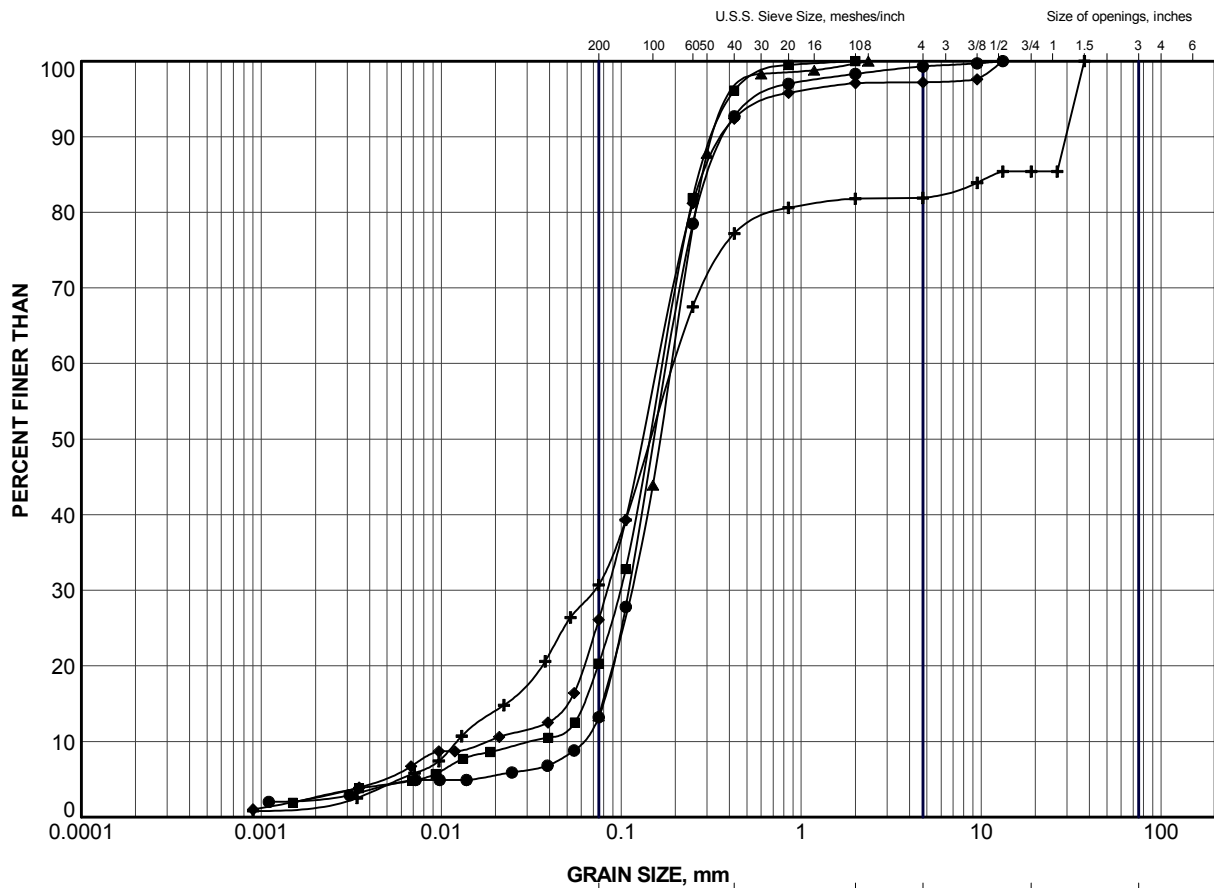
*Type of Fracture*



Tested by: SA

Reviewed by : CN





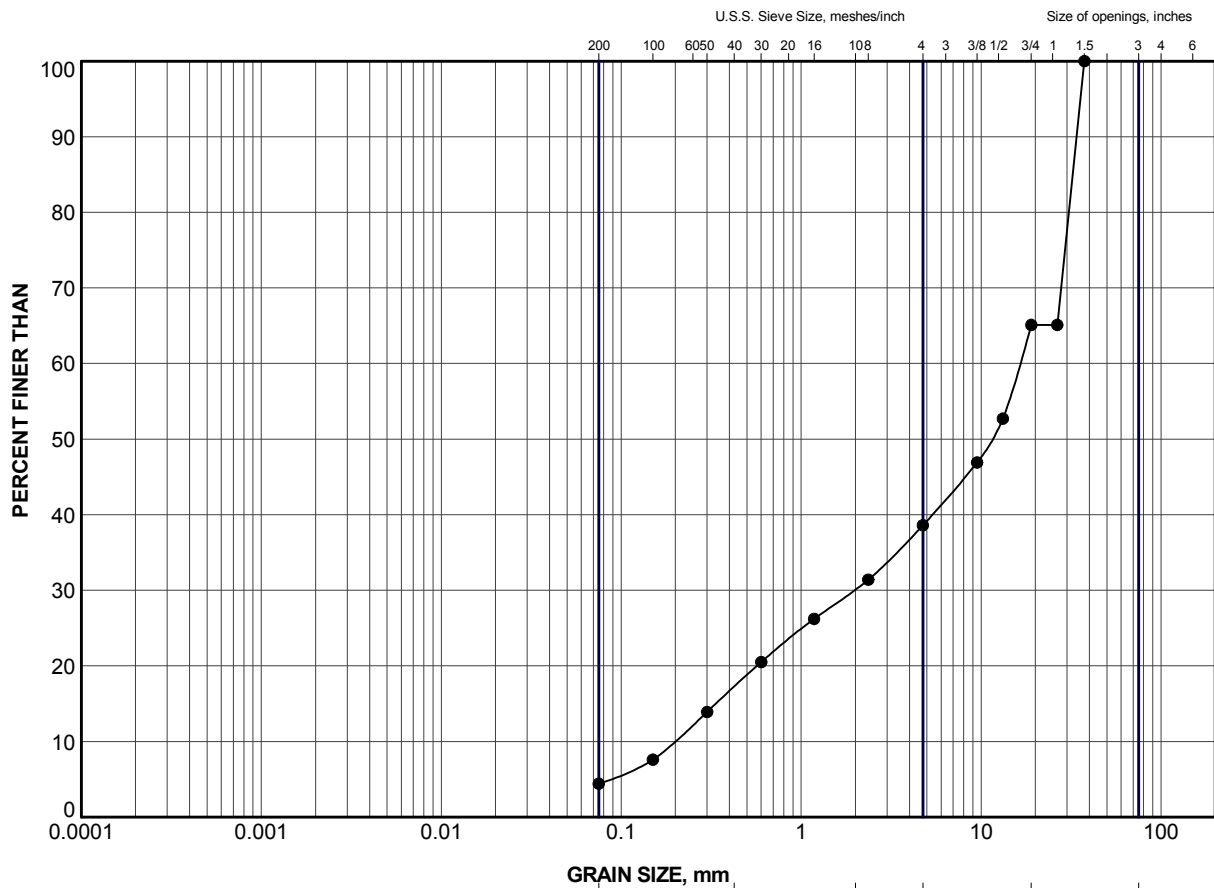
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C10-02	2	301.3
■	C10-02	4	299.8
▲	C10-02	8	296.2
+	C10-03	4	294.1
◆	C10-03A	3	294.8

PROJECT						HIGHWAY 11 RESURFACING UNNAMED CREEK CULVERT SITE NO. 42-342/C					
TITLE						GRAIN SIZE DISTRIBUTION SILTY SAND to SAND (FILL)					
PROJECT No.			14-1111-0007			FILE No.			14-1111-0007.GPJ		
DRAWN	TB	Oct 2014	SCALE	N/A	REV.						
CHECK	MCK	Oct 2014									
APPR	CN	Oct 2014									
						FIGURE A1					





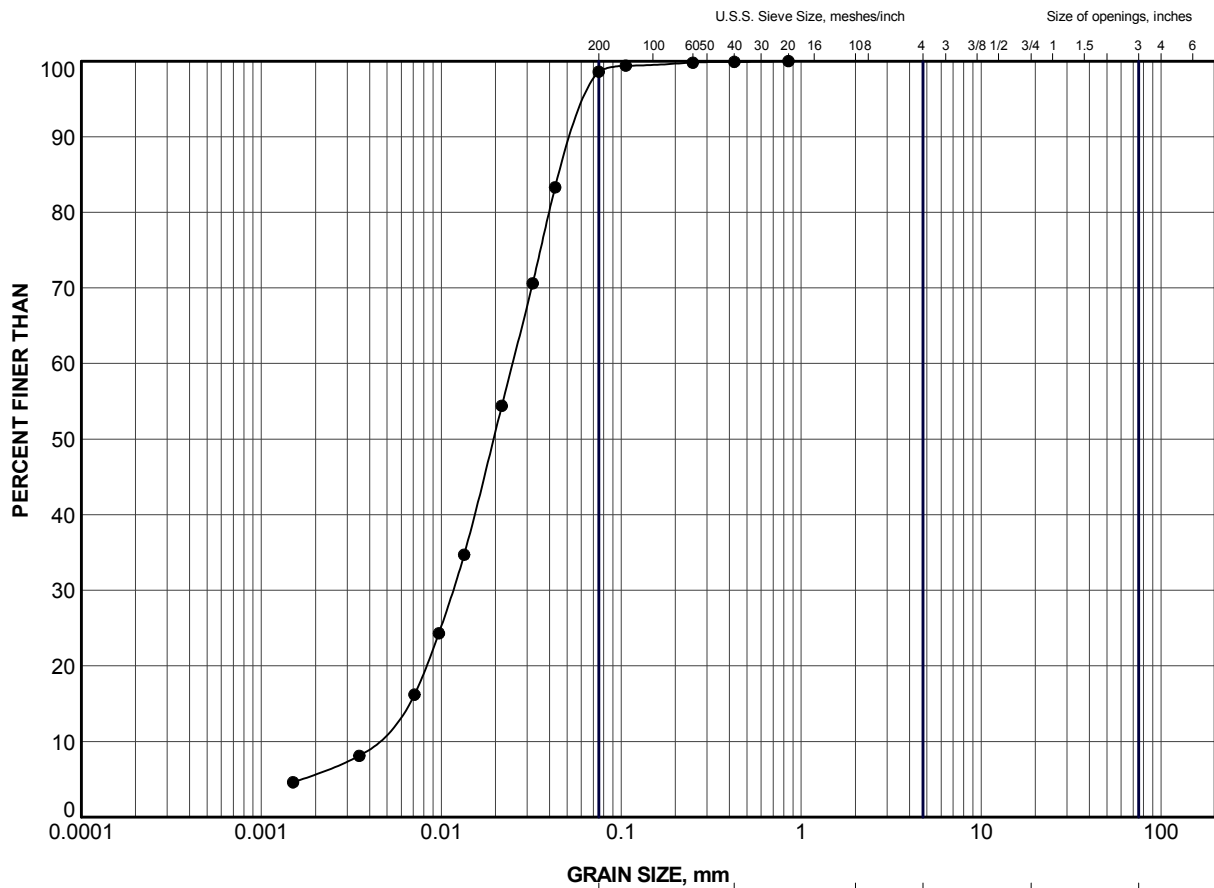
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C10-04	3	302.0

PROJECT						HIGHWAY 11 RESURFACING UNNAMED CREEK CULVERT SITE NO. 42-342/C					
TITLE						GRAIN SIZE DISTRIBUTION SAND and GRAVEL (FILL)					
PROJECT No.			14-1111-0007			FILE No.			14-1111-0007.GPJ		
DRAWN	TB	Oct 2014	SCALE	N/A	REV.						
CHECK	MCK	Oct 2014									
APPR	CN	Oct 2014									
						FIGURE A2					




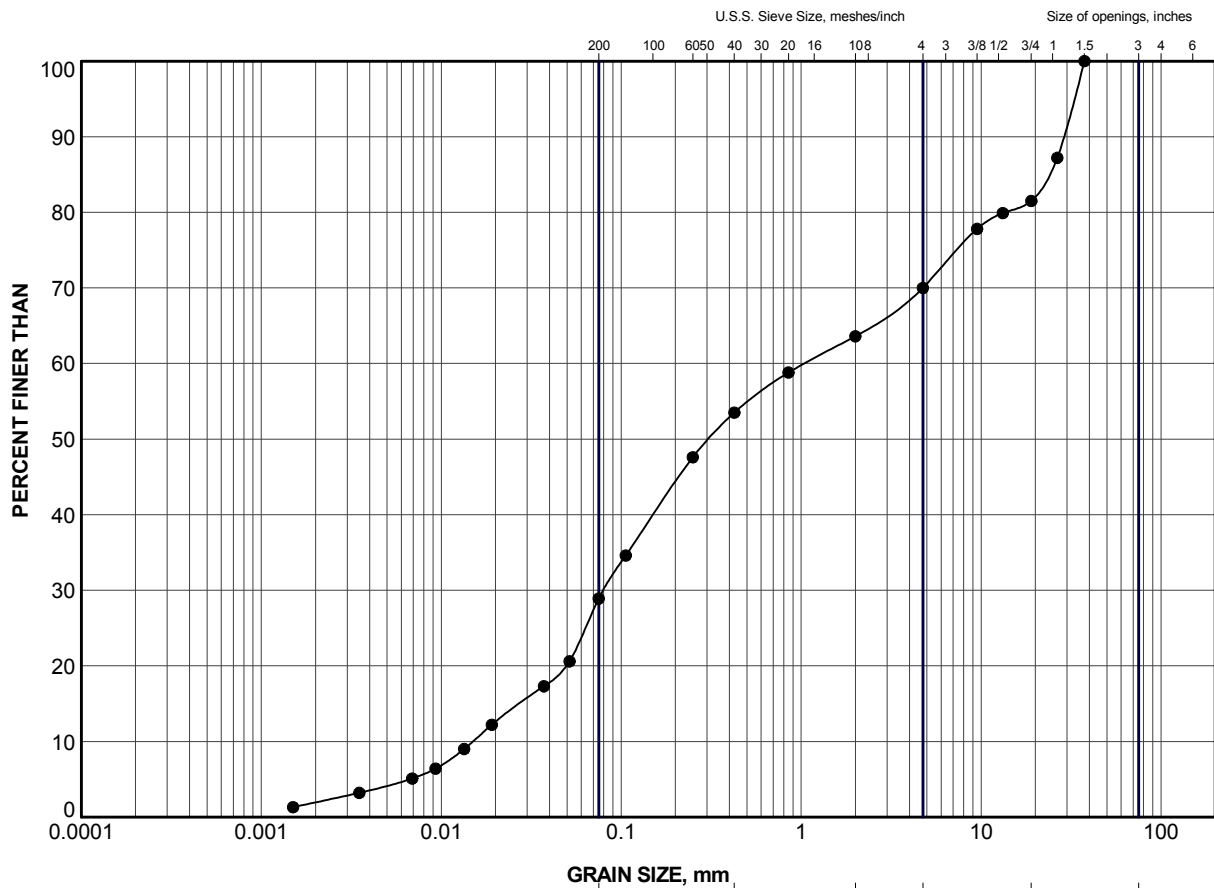


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C10-01	5	291.2

PROJECT						HIGHWAY 11 RESURFACING UNNAMED CREEK CULVERT SITE NO. 42-342/C					
TITLE						GRAIN SIZE DISTRIBUTION SILT					
PROJECT No.			14-1111-0007			FILE No.			14-1111-0007.GPJ		
DRAWN	TB	Oct 2014	SCALE	N/A	REV.						
CHECK	MCK	Oct 2014									
APPR	CN	Oct 2014									
 <b>Golder Associates</b> SUDBURY, ONTARIO			<b>FIGURE A3</b>								



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

#### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C10-01	8	289.1

PROJECT						HIGHWAY 11 RESURFACING UNNAMED CREEK CULVERT SITE NO. 42-342/C					
TITLE						GRAIN SIZE DISTRIBUTION SILTY SAND and GRAVEL					
PROJECT No.			14-1111-0007			FILE No.			14-1111-0007.GPJ		
DRAWN	TB	Oct 2014	SCALE	N/A	REV.						
CHECK	MCK	Oct 2014									
APPR	CN	Oct 2014									
						<b>FIGURE A4</b>					



At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

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