TECHNICAL MEMORANDUM

DATE May 15, 2015 **PROJECT No.** 12-1111-0088-02

TO Mr. Tim Sorochinsky, P.Eng.
AECOM

CC

FROM Mehdi Mostakhdemi, P.Eng. and Lisa Coyne, P.Eng. **EMAIL** mmostakhdemi@golder.com; lcoyne@golder.com

SUPPLEMENTARY PRELIMINARY FOUNDATION INVESTIGATION
BLACK CREEK BRIDGE REPLACEMENT
STRUCTURE SITE NOS. 34-128/1 AND 34-128/2
QUEEN ELIZABETH WAY (QEW), FORT ERIE, REGIONAL MUNICIPALITY OF NIAGARA
G.W.P. 2177-08-00

Golder Associates Ltd. (Golder) was retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide preliminary foundation engineering services for the replacement/rehabilitation of seven structures (Seventh Street, Lyons Creek, Tee Creek and Black Creek) on the Queen Elizabeth Way (QEW) highway in the Regional Municipality of Niagara, Ontario.

This technical memorandum presents the results of a supplementary investigation at the site of the Black Creek bridges to identify the bedrock characteristics including depth to bedrock, bedrock composition, rock mass quality and unconfined compression strength in the vicinity of the proposed north abutment for the QEW NBL bridge. This memorandum is a supplement to and should be read in conjunction with Golder's Report No. 12-1111-0088-2 titled "Preliminary Foundation Investigation and Design Report, Black Creek Bridge Replacement, Structure Site Nos. 34-128/1 and 34-128/2, Queen Elizabeth Way, Fort Erie, Regional Municipality of Niagara, G.W.P. 2177-08-00", dated January 8, 2015.

INVESTIGATION PROCEDURES

Golder previously carried out a subsurface investigation in June 2013 at which time four boreholes (Boreholes 13-11 to 13-14) were advanced in accordance with the requirements of the Terms of Reference for the foundation engineering services, to practical auger refusal at depths between 6.7 m and 8.6 m below the QEW pavement grade. The subsurface conditions encountered during the 2013 investigation are presented in the above-noted Preliminary Foundation Investigation and Design Report.

A supplementary investigation was conducted on May 12 and May 13, 2015 during which time Borehole 15-01 was advanced through the left lane of the northbound QEW, behind the north (compass northeast) abutment, using a truck-mounted Diedrich D120 drill rig supplied and operated by Altech Drilling and Investigation Services of Elmira, Ontario.

The borehole was advanced through the overburden using 108 mm inside diameter hollow stem augers. Soil samples were obtained between depths of 6.1 m and 9.3 m at 1.5 m intervals of depth using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586, Standard Test Method for Standard Penetration Test). Approximately 3 m of NQ-size bedrock coring was conducted below this depth to the borehole termination depth of about 12.2 m.

The borehole location (referenced to the MTM NAD83 co-ordinate system), the ground surface elevation (referenced to Geodetic datum) and the drilled depth are presented below. This borehole has been added to Drawing 1 – Rev. 1, following the text of this memorandum, and the revised Drawing 1 supercedes the version included in the Preliminary Foundation Investigation and Design Report dated January 8, 2015.

Structure	Foundation Element	Borehole No.	Location (MTM NAD83)		Ground Surface Elevation (m)	Borehole Depth (m)
			Northing (m)	Easting (m)		
Toronto (North) Bound	North (Northeast) Abutment	15-01	4,758,299.2	343,782.6	175.8	12.2

SUBSURFACE CONDITIONS

The stratigraphic boundaries shown on the borehole and drillhole records and on the interpreted stratigraphic section on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations. The interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

In summary, the subsoil conditions (below a depth of 6.1 m) encountered in Borehole 15-01 are consistent with the conditions encountered in the 2013 borehole investigation, consisting of a deposit of very stiff to hard sandy clayey silt till overlying a deposit of very dense silty sand and gravel till, which is underlain by dolomitic shale of the Salina formation. A more detailed description of the soils and bedrock encountered in Borehole 15-01 is provided below.

Sandy Clayey Silt Till

Sandy clayey silt till was encountered at a depth of about 6.1 m (Elevation 169.7 m) when sampling of the overburden commenced; this deposit extended to a depth of 7.2 m (Elevation 168.6 m).

One Standard Penetration Test (SPT) 'N'-value of 30 blows per 0.3 m of penetration was measured within the cohesive till deposit, indicating a hard consistency.

Silty Sand and Gravel Till

A 1.9 m thick deposit of silty sand and gravel till was encountered below the clayey silt till and extended to a depth of 9.3 m (Elevation 166.6 m). The sand and gravel till deposit contains trace quantities of clay.

One SPT 'N'-value of 84 blows per 0.3 m of penetration was measured within the silty sand and gravel till, indicating a very dense relative density. An SPT 'N'-value of 100 blows per 0.1 m of penetration was measured at the base of this deposit, but is considered representative of the underlying bedrock.

Dolomitic Shale Bedrock

Bedrock was encountered below the silty sand and gravel till at a depth of about 9.3 m (Elevation 166.6 m).

Based on the cored bedrock samples, the bedrock generally consists of dolomitic shale of the Salina formation. The core samples are described as slightly weathered, laminated to thinly bedded, white to grey, and weak to medium strong, with gypsum nodules.

The Rock Quality Designation (RQD) values measured on the core samples are typically between about 0 per cent and 27 per cent; however, these low RQD values are considered to be attributable to the bedding planes within the laminated to thinly bedded shale formation, and do not necessarily reflect a rock mass of very poor to poor quality. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of the core samples are typically between 96 per cent and 100 per cent and between 38 percent and 77 per cent, respectively.

An unconfined compressive strength (UCS) test carried out on a selected sample of the bedrock measured about 15.7 MPa, as summarised on Table 1 following the text of this memorandum. Photographs of one bedrock core sample before and after UCS testing are shown on Figure 1 following the text of this memorandum.

CLOSURE

This memorandum was prepared by Mr. Mehdi Mostakhdemi, P.Eng. Ms. Lisa Coyne, P.Eng., a Principal and Designated MTO Foundations Contact for Golder, conducted an independent review of this memorandum.

Mehdi Mostakhdemi, M.Sc., P.Eng.
Geotechnical Engineer

Lisa Coyne, P.Eng.
Senior Geotechnical Engineer, Principal

MM/LCC/jl
y:\active\2012 projects\1111 geotechnical\12-1111-0088 - urs - 5 structure replacement - qew\07- report\2 - black creek\4 - technical memo\final\12-1111-0088 mem 2015may15 black creek suplementary investigation.docx

Attachments:

- Drawing 1 Black Creek Bridges – Borehole Locations and Soil Strata
- Lists of Abbreviations and Symbols
- Lithological and Geotechnical Rock Description Terminology
- Record of Borehole Sheet 15-01
- Record of Drillhole Sheet 15-01
- Figure 1 Unconfined Compression Test
- Table 1 Unconfined Compression Test

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
WP No. 2177-08-00

SHEET
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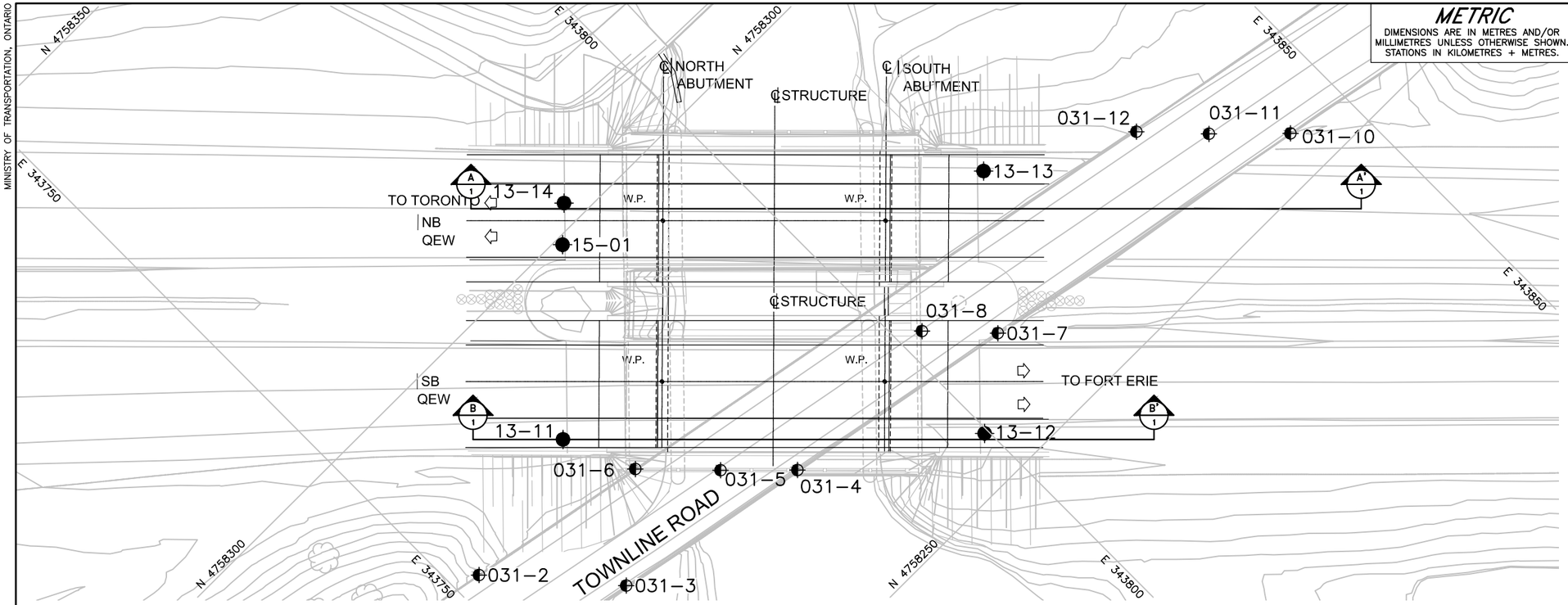
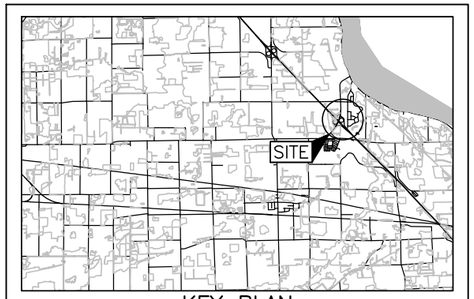
BLACK CREEK BRIDGES
QUEEN ELIZABETH WAY
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates



PLAN
SCALE
5 0 5 10 m

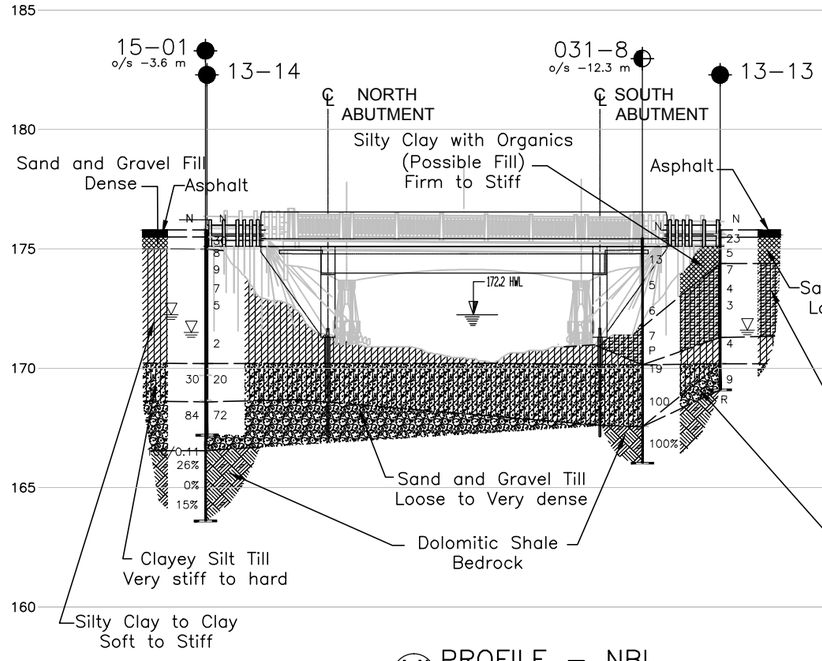


LEGEND

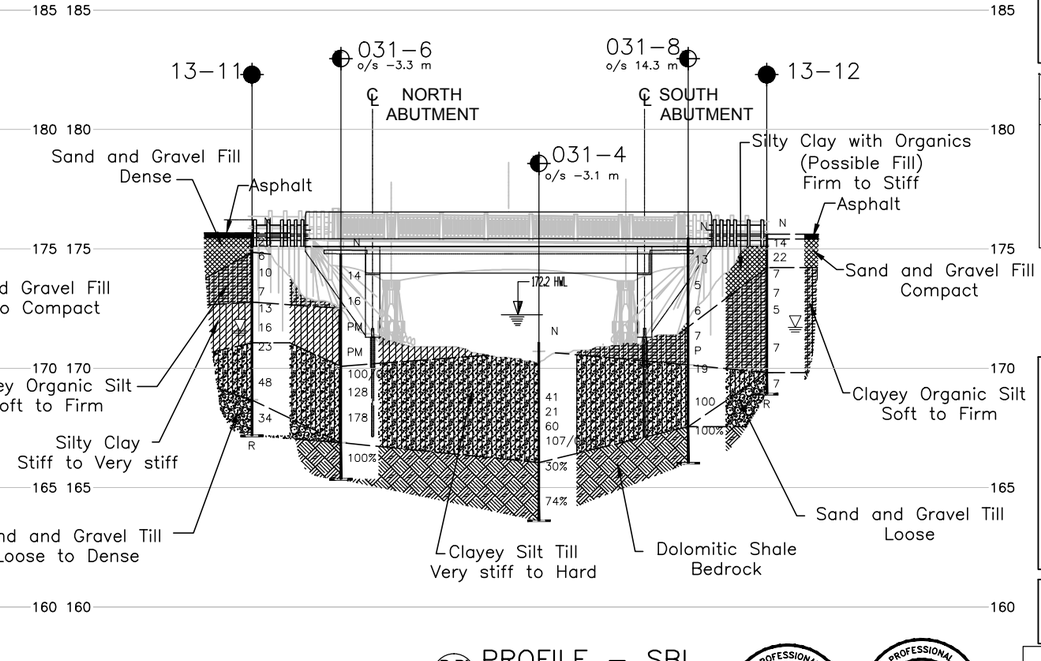
- Borehole – Current Investigation
- Borehole – (Geocres No. 30L14-031) – Location is approximate
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- 0% — Recovery of rock core
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
13-11	175.7	4758285.1	343768.6
13-12	175.6	4758255.1	343799.6
13-13	175.8	4758274.2	343818.4
13-14	175.8	4758302.1	343785.7
15-01	175.8	4758299.2	343782.6



A-A' 1 PROFILE – NBL
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE



B-B' 1 PROFILE – SBL
HORIZONTAL SCALE
5 0 5 10 m
2.5 0 2.5 5 m
VERTICAL SCALE

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 design configuration as shown elsewhere in the Preliminary Design Report.

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

The complete Preliminary 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 URS, drawing file nos. X-Base-All.dwg and X-Contours.dwg, received July 30, 2013 an GA and Profile file No. Draft_Black Creek_GA.dwg, received October 9, 2013.

NO.	DATE	BY	REVISION
1	5/15/15	MM	BOREHOLE 15-01 WAS ADDED

LICENSED PROFESSIONAL ENGINEER L.C. COYNE May 15, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M.MOSTAKHDEMI 100185447 May 15, 2015 PROVINCE OF ONTARIO

Geocres No. 30L14-57

HWY. QEW	PROJECT NO. 12-1111-0088		DIST. CENTRAL
SUBM'D. MM	CHKD. LCC	DATE: 12/22/2014	SITE: 34-128
DRAWN: JFC	CHKD. LCC	APPD. JMAC	DWG. 1

PLOT DATE: May 15, 2015
FILENAME: T:\Projects\2012\12-1111-0088 (URS, Various Structure Replacement, QEW)\-Da- Black Creek\12111008850601.dwg

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:

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

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index / Relative Density	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency

	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

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

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan\phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

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
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

Golder Associates

RECORD OF BOREHOLE No 15-01

SHEET 1 OF 1

METRIC

PROJECT 12-1111-0088

W.P. 2177-08-00 LOCATION N 4758299.2 ;E 343782.6 ORIGINATED BY OS

DIST Central HWY QEW BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers and NQ Core Barrel COMPILED BY JFC

DATUM Geodetic DATE May 12 and 13, 2015 CHECKED BY MM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.8	GROUND SURFACE										
0.0	Augered to a depth of 6.1 m										
169.7											
6.1	Sandy CLAYEY SILT, some gravel (TILL) Very stiff to hard Brown Wet		1	SS	30						
168.6											
7.2	SILTY SAND and GRAVEL,trace clay (TILL)		2	SS	84						
166.6			3	SS	100/0.1						
9.3	DOLOMITIC SHALE (BEDROCK) Bedrock cored between depths of 9.25 m and 12.2 m. Refer to Record of Drillhole 15-01 for bedrock coring details.		1	RC	REC 100%						RQD = 26%
			2	RC	REC 100%						RQD = 0%
			3	RC	REC 96%						RQD = 15%
163.6											
12.2	END OF BOREHOLE NOTES: 1. Water was noted inside hollow stem auger at a depth of 5.1 m below ground surface (Elev. 170.7 m) completion of drilling. 2. Borehole backfilled with portland cement grout upon completion.										

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

PROJECT: 12-1111-0088

RECORD OF DRILLHOLE: 15-01

SHEET 1 OF 1

LOCATION: N 4758299.2 ;E 343782.6

DRILLING DATE: May 12 and 13, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D120 Diesel

DRILLING CONTRACTOR: Altech Drilling Investigation Services Ltd.

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.	COLOUR / % RETURN	FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER .25	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.
		Continued from Record of Borehole 15-01		166.6																
10	NQ Core Barrel May 12 and 13, 2015	Slightly weathered, fine to medium grained, laminated to thinly bedded, weak to medium strong, white to grey DOLOMITIC SHALE, with gypsum nodules of (SALINA FORMATION)		9.3	1		100													
11					2		100													
12					3		96													
				163.6																
		END OF DRILLHOLE		12.2																
13																				
14																				
15																				
16																				
17																				
18																				
19																				

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: OS

CHECKED: NS/MM

GTA-RCK 023 T:\PROJECTS\2012\12-1111-0088 (URS, VARIOUS STRUCTURE REPLACEMENT, QEW)\LOG\12-1111-0088.GPJ GAL-GTA.GDT 5/14/15

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE 1

BEFORE COMPRESSION

AFTER COMPRESSION

Date May 13, 2015
Project 12-1111-0088

Golder Associates

Drawn Frank
Chkd. MM

FORM PRODUCED JUNE 1986

Form GA-D-4 (imperial)

TABLE 1 - UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS

ASTM D7012

SAMPLE IDENTIFICATION

PROJECT NUMBER	12-1111-0088	SAMPLE NUMBER	-
PROJECT NAME	Various / 5 Structure Replacement / QEW	SAMPLE DEPTH, m	9.53-9.68
BOREHOLE NUMBER	-	DATE:	05/14/15

TEST CONDITIONS

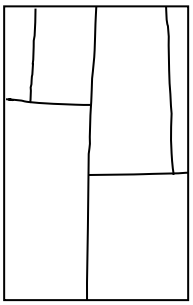
MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.23

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	14.04	WATER CONTENT, (specimen) %	12.11
SAMPLE DIAMETER, cm	6.30	UNIT WEIGHT, kN/m^3	22.98
SAMPLE AREA, cm^2	31.14	DRY UNIT WT., kN/m^3	20.50
SAMPLE VOLUME, cm^3	437.34	SPECIFIC GRAVITY	-
WET WEIGHT, g	1025.20	VOID RATIO	-
DRY WEIGHT, g	914.46		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	15.7

REMARKS:

Checked By: MM

Golder Associates