



January 29, 2016

FOUNDATION INVESTIGATION REPORT

**BARRIE-COLLINGWOOD RAILWAY OVERHEAD
STRUCTURE (SITE NO. 30-177/1&2)
HIGHWAY 400 FROM ESSA ROAD TO DUNLOP
STREET WEST
BARRIE, ONTARIO
GWP 2159-11-00**

Submitted to:

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GEOCRES No. 31D-631

Report Number: 1532543-2

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REPORT





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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services to support the detail design for the Barrie-Collingwood Railway (BCR) overhead structure site. This report addresses the foundation investigation completed for the proposed construction of the new BCR overhead structure to carry the Highway 400 northbound lanes over the rail line.

The purpose of this investigation is to establish the subsurface conditions at the location of the proposed overhead structure, approach embankments and wing walls, by means of a limited borehole investigation and geotechnical laboratory testing on selected samples.

Golder has completed the foundation engineering services in accordance with Proposal No. GEOTETOB22161AA, dated March 13, 2015, originally provided to MH by Coffey Geotechnics Inc. (Coffey).

2.0 SITE DESCRIPTION

The existing overhead structure carrying Highway 400 over BCR is located between the Dunlop Street and Essa Road interchanges, in Barrie, Ontario, at the location shown on the Key Plan on the Borehole Location and Soil Strata drawing contained in the Contract Documents. The BCR overhead structure is located approximately 180 m south of the Tiffin Street overpass structure site.

This portion of Highway 400, including the existing BCR overhead structure, was built between 1950 and 1955. The existing structure consists of a 10.5 m long, single-span, concrete rigid frame structure supported on spread footings. The existing overhead structure carries six active lanes of Highway 400 traffic above BCR.

At this location, Highway 400 is constructed on fill / raised embankments. The existing Highway 400 grade is at about Elevation 243 m at the structure, while the ground surface surrounding the rail line is at about Elevation 234.5 m under the bridge. The existing Highway 400 approach embankments are up to about 8.5 m in height.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigation by Others

Coffey completed a preliminary foundation investigation for the BCR overhead structure site comprising two boreholes (Boreholes F5 and F6) in October 2014. The borehole records are provided in Appendix C. The locations of these boreholes are summarized below and are shown on the Borehole Location and Soil Strata drawing contained in the Contract Documents; Borehole F5 was advanced from the existing Highway 400 grade, while Borehole F6 was advanced from the existing rail grade.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
F5	4,914,403.1	288,402.0	243.0	18.9
F6	4,914,429.1	288,399.8	234.6	6.1



The results of this previous investigation are presented in Coffey's Preliminary Foundation Investigation and Design Report (GEOCRES No. 31D-590) dated February 11, 2015.

3.2 Current Investigation

The foundation investigation for the BCR structure site was carried out between June 24 and July 16, 2015, during which time a total of seven boreholes (Boreholes 15-7 to 15-10, HF-3, TRW-1 and P-RW3) were advanced using a track-mounted drill rig, supplied and operated by specialist drilling subcontractors. Two additional boreholes (15-1(BCR) and 15-2(BCR)) were drilled within the Highway 400 SBL at this structure site in November 2015. The locations of these boreholes are shown on the Borehole Location and Soil Strata drawing contained in the Contract Documents.

The boreholes were advanced to depths ranging from 10.1 m to 17.4 m below existing ground surface using hollow stem auger drilling methods. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure. Each of the boreholes was terminated at the previously established depths provided in the Coffey proposal, to avoid penetrating into a trichloroethylene (TCE) plume that is present in the vicinity of the site.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations, and a standpipe piezometer was installed in Boreholes 15-1(BCR) and 15-10 to permit monitoring of the groundwater level at the site. The piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the borehole. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipes was backfilled to the ground surface with bentonite pellets. The piezometer installation details and water level readings are indicated on the record for Boreholes 15-1(BCR) and 15-10 contained in Appendix A. All remaining boreholes were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was supervised on a full-time basis by a member of Golder's staff who observed the drilling, sampling and in situ testing operations, and logged the subsurface conditions encountered in the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests consisting of water contents, Atterberg limits and grain size distributions were carried out on selected soil samples.

The borehole locations were measured relative to site features, and the ground surface elevations were obtained from the digital terrain model provided by MH. The borehole locations, including MTM NAD83 northing and easting coordinates and ground surface elevations referenced to geodetic datum, are summarized below and are shown on the Borehole Location and Soil Strata drawing contained in the Contract Documents.

Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
15-1(BCR)	4,914,393.4	288,377.2	242.0	17.4
15-2(BCR)	4,914,425.5	288,367.3	241.1	17.4
15-7	4,914,422.5	288,388.8	243.1	17.2



Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
15-8	4,914,416.4	288,424.7	234.2	10.1
15-9	4,914,402.9	288,423.0	237.3	14.0
15-10	4,914,439.4	288,392.5	237.8	14.0
HF3	4,914,383.3	288,436.2	238.6	10.1
P-RW3	4,914,460.1	288,390.7	234.3	10.1
T-RW1	4,914,430.8	288,380.2	243.0	12.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 400 lies within the Simcoe Lowlands, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, Third Edition, 1984). The soil deposits are typically interlayered non-cohesive, sands and silt layers, with occasional cohesive clayey silt silty clay layers.

4.2 Subsurface Conditions

The detailed soil and groundwater conditions encountered in the boreholes advanced as part of the current investigation, and the results of in situ and geotechnical laboratory testing, are given on the borehole records contained in Appendix A. The results of geotechnical laboratory testing from Golder's current investigation are also presented on Figures B1A to B4 contained in Appendix B. The borehole records and laboratory test results of the previous investigation (GEOCRES No. 31D-590) are contained in Appendix C.

The stratigraphic boundaries shown on the borehole records, and on the interpreted stratigraphic profiles and cross-sections on the Borehole Location and Soil Strata drawings contained in the Contract Documents are inferred from observations of drilling progress and 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.

In general, the subsoils encountered in the boreholes consist of fill underlain by a deposit of loose to very dense silt to sandy silt to silty sand to sand. Clayey silt layers are present within this non-cohesive deposit. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Asphalt

Approximately 100 mm to 260 mm of asphalt was encountered immediately below the ground surface in Boreholes 15-7, F5 and TRW-1, which were drilled through the existing Highway 400 pavement on the east edge of the Highway 400 northbound lanes.

Approximately 200 mm to 230 mm of asphalt was encountered immediately below the ground surface in Boreholes 15-1(BCR) and 15-2(BCR), which were drilled through the existing Highway 400 pavement along the Highway 400 southbound lanes.



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4.2.2 Fill

All of the boreholes encountered fill materials of variable composition and thickness. As boreholes were advanced from both the Highway 400 embankment level and the rail level, the elevation of the surface of the fill materials varies. The elevations of the surface and base of the fill and the thickness of the fill materials as encountered in the boreholes are summarized below.

Borehole No.	Fill Surface Depth (m)	Fill Surface Elevation (m)	Fill Thickness (m)	Base of Fill Elevation (m)
15-1(BCR)	0.2	241.8	8.2	233.6
15-2(BCR)	0.2	240.9	8.5	232.4
15-7	0.2	242.9	7.0	235.9
15-8	0.0	234.2	3.8	230.4
15-9	0.0	237.3	2.2	235.1
15-10	0.0	237.8	3.0	234.9
F5	0.3	242.7	8.8	233.9
F6	0.0	234.6	1.5	233.1
HF3	0.0	238.6	3.0	235.7
P-RW3	0.0	234.3	4.1	230.2
T-RW1	0.1	242.9	8.6	234.3

The fill materials vary in composition from sand, to silty sand, to sand and silt, to gravelly sand containing trace clay. Rootlets and organics were encountered within the fill in Boreholes 15-8, 15-9, 15-10, T-RW1 and F6 to a maximum depth of approximately 1.5 m below ground surface. The results of grain size distribution tests completed on eight selected samples of the fill from the current investigation are shown on Figures B1A and B1B in Appendix B.

The Standard Penetration Test (SPT) "N"-values measured within the fill range from 1 blow to 64 blows per 0.3 m of penetration, indicating a variable, very loose to very dense relative density.

4.2.3 Sand to Silt

A deposit of sand to silt was encountered below the fill in all boreholes. All boreholes terminated within this non-cohesive deposit, with the exception of Boreholes 15-9 and 15-10 which terminated in an underlying clayey silt deposit or layer. The elevations of the surface and base of the sand to silt deposit and the thickness of this stratum as encountered in the boreholes are summarized below.

Borehole No.	Sand to Silt Surface Depth (m)	Sand to Silt Surface Elevation (m)	Sand to Silt Thickness (m)	Sand to Silt Base Elevation (m)	Description
15-1 (BCR)	8.4	233.6	>9.0	Below 224.6	Silty Sand to Sandy Silt
15-2 (BCR)	8.7	232.4	>8.7	Below 223.7	Sand to Silt
15-7	7.2	235.9	>10.0	Below 225.9	Silty Sand to Sand and Silt



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Borehole No.	Sand to Silt Surface Depth (m)	Sand to Silt Surface Elevation (m)	Sand to Silt Thickness (m)	Sand to Silt Base Elevation (m)	Description
15-8	3.8	230.4	0.7	229.7	Silt
	5.8	228.4	>4.3	Below 224.1	Sandy Silt to Sand
15-9	2.2	235.1	8.0	227.1	Sand to Silt
15-10	3.0	234.9	10.2	224.7	Silt to Sand and Silt
F5	9.1	233.9	>9.8	Below 224.1	Silty Sand to Sandy Silt
F6	1.5	233.1	>4.6	Below 228.5	Silty Sand
HF3	3.0	235.7	1.4	234.3	Silt
	5.8	232.8	>4.3	Below 228.6	Silt and Sand to Sand
P-RW3	4.1	230.2	>6.0	Below 224.2	Sand to Silt
TRW-1	8.7	234.3	>4.1	Below 230.2	Silt to Sand

A clayey silt interlayer was encountered within the sand to silt stratum in Boreholes HF3 and 15-8, at depths of about 4.4 m and 4.5 m, respectively, corresponding to Elevations 234.3 m and 229.7 m. The clayey silt interlayer has a thickness of 1.4 m and 1.3 m in Boreholes HF3 and 15-8, respectively.

The results of the grain size distribution tests completed on 12 selected samples of the non-cohesive deposit are shown on Figures B2A and B2B in Appendix B. In the previous investigation, grain size distribution tests were completed on two selected samples, and the results from these tests are contained in Appendix C.

The SPT "N"-values measured within the sand to silt deposit range from 3 blows to 72 blows per 0.3 m of penetration, indicating a variable, very loose to very dense relative density.

4.2.4 Clayey Silt

A clayey silt deposit was encountered in some boreholes, as follows:

- As an interlayer within the sand to silt deposit in two boreholes (HF3 and 15-8) on the south side of the proposed BCR overhead structure; and
- As a lower unit below the sand to silt deposit, in Boreholes 15-9 and 15-10. These boreholes terminated within the clayey silt deposit, penetrating it for a thickness of 3.8 m and 0.9 m thick, respectively.

The elevation of the surface and base of the deposit and the thickness of the stratum as encountered in the boreholes are summarized below.



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Borehole No.	Clayey Silt Surface Depth (m)	Clayey Silt Surface Elevation (m)	Clayey Silt Thickness (m)	Clayey Silt Base Elevation (m)
15-8	4.5	229.7	1.3	228.4
15-9	10.2	227.1	>3.8	>223.3
15-10	13.1	224.7	>0.9	>223.8
HF3	4.4	234.3	1.4	232.8

The results of the grain size distribution tests completed on two selected samples of the clayey silt deposit are shown on Figure B3 in Appendix B. Atterberg limits tests were conducted on two selected samples and measured plastic limits of 12 and 18 per cent, liquid limits of 17 and 21 per cent, and plasticity indices of about 4 and 6 per cent. These test results, which are plotted on a plasticity chart on Figure B4 in Appendix B, confirm that the deposit consists of clayey silt of low plasticity.

The SPT "N"-values measured within the clayey silt interlayer/deposit range from 8 blows to 21 blows per 0.3 m of penetration, suggesting a stiff to very stiff consistency.

4.3 Groundwater Conditions

The observed water levels in the open boreholes following completion of drilling, and the water levels measured in the installed piezometers, are summarized as follows:

Structure	Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement	Notes
Highway 400 SBL	South Abutment	15-1 (BCR)	242.0	227.9	November 9, 2015	Open Borehole
				229.6	January 7, 2016	Piezometer
	North Abutment	15-2 (BCR)	241.1	228.2	November 8, 2015	Open Borehole
Highway 400 NBL	South Approach	HF3	238.6	235.1	July 16, 2015	Open Borehole
		15-9	237.3	233.5	July 16, 2015	Open Borehole
	South Abutment	15-8	234.2	230.8	July 16, 2015	Open Borehole
	North Abutment	15-7	243.1	230.9	June 24, 2015	Open Borehole
		F6	234.8	230.5	October 31, 2014	Piezometer
				230.4	November 17, 2015	Piezometer



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Structure	Foundation Element	Borehole No.	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement	Notes
	North Approach	15-10	237.8	233.0	October 7, 2015	Piezometer
				232.9	November 6, 2015	Piezometer
		P-RW3	234.3	225.0*	July 6, 2015	Open Borehole
		TRW-1	243.0	Dry	June 25, 2015	Open Borehole

* Wet soils observed in Borehole P-RW3 above this elevation.

The water levels observed in the open boreholes do not represent the stabilized groundwater level at the site. The groundwater levels at the site are expected to fluctuate seasonally in response to changes in precipitation and snow melt, and are expected to be higher during the spring season.

5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Caitlyn Cartwright, E.I.T. and Ms. Nikol Kochmanová, P.Eng., and reviewed by Ms. Lisa Coyne, P.Eng., a Designated MTO Foundations Contact and Principal with Golder.

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CC/NK/LCC/sm

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REFERENCES

Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.



APPENDIX A

Borehole Records from Current Investigation



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
ν	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

(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

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

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



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 cm² 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	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 _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

PROJECT 1532543			RECORD OF BOREHOLE No 15-1 (BCR)			1 OF 2 METRIC						
G.W.P. 2159-11-00			LOCATION N 4914393.4; E 288377.2			ORIGINATED BY DM						
DIST Central HWY 400			BOREHOLE TYPE 203 mm O.D. Hollow Stem Augers			COMPILED BY NK/NLP						
DATUM GEODETIC			DATE November 9, 2015			CHECKED BY LCC						
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
242.0	GROUND SURFACE											
0.0	ASPHALT											
241.5	Sand and gravel, trace silt (FILL) Compact Brown Moist		1	SS	-							
0.5			A									
240.8	Gravelly sand, some silt (FILL) Compact Brown Moist		2	SS	23							
1.2			B									
	Sand, trace to some gravel, trace to some silt (FILL) Loose to dense Brown Moist		3	SS	15							
			4	SS	6							11 78 8 3
			5	SS	6							
			A									
			6	SS	32							
			B									
			7	SS	64							
			8	SS	31							
233.6	SILTY SAND, trace clay, trace fibrous organics Compact to very dense Dark brown to brown Moist to wet		9	SS	31							
8.4												
			10	SS	20							0 74 22 4
			11	SS	70							
230.3	SILT and SAND Dense Light brown Wet											
11.7			12	SS	42							
228.7	SILTY SAND Dense to very dense Light brown to grey Wet											
13.3			13	SS	58							

Continued Next Page

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

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 22/01/16 DATA INPUT:

PROJECT 1532543		RECORD OF BOREHOLE No 15-1 (BCR)				2 OF 2 METRIC											
G.W.P. 2159-11-00		LOCATION N 4914393.4; E 288377.2				ORIGINATED BY DM											
DIST Central HWY 400		BOREHOLE TYPE 203 mm O.D. Hollow Stem Augers				COMPILED BY NK/NLP											
DATUM GEODETIC		DATE November 9, 2015				CHECKED BY LCC											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L 10 20 30					
225.7	SILTY SAND Dense to very dense Light brown to grey Wet		14	SS	36		226										0 67 30 3
16.3	Sandy SILT Compact Grey Wet																
224.6			15	SS	21		225										
17.4	END OF BOREHOLE Notes: 1. Water level in open borehole at a depth of 14.1 m (Elev. 227.9 m) upon completion of drilling. 2. Water level measured in piezometer at 12.4 m (Elev. 229.6 m) on January 7, 2016.																

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 22/01/16 DATA INPUT:

PROJECT 1532543				RECORD OF BOREHOLE No 15-2 (BCR)				1 OF 2 METRIC					
G.W.P. 2159-11-00				LOCATION N 4914425.5; E 288367.3				ORIGINATED BY DM					
DIST Central HWY 400				BOREHOLE TYPE 203 mm O.D. Hollow Stem Augers				COMPILED BY NK/NLP					
DATUM GEODETIC				DATE November 8, 2015				CHECKED BY LCC					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p W W _L			
241.1	GROUND SURFACE												
0.0	ASPHALT		1	AS	-								
	Gravelly sand, trace silt (FILL)		2	AS	-								
	Grey Moist												
0.6	Sand, some gravel, some silt (FILL)		3	SS	28								
	Brown Moist												
	Sand, some silt to silty sand, trace to some gravel, trace clay (FILL)		4	SS	20								
	Compact to dense												
	Brown Moist												
	Clay pockets observed in Sample 4.		5	SS	33								
			6	SS	29								
			7	SS	43								
			8	SS	38								
			9	SS	45								
232.4													
8.7	SILTY SAND to SAND, trace gravel, trace organics to 9.17 m		A	SS	9								
	Loose		10										
	Brown to orange		B										
	Moist												
230.9													
10.2	SANDY SILT, trace to some clay		11	SS	48								
	Dense												
	Light brown												
	Moist to wet		12	SS	36								
227.8													
13.3	SILT, trace to some clay		13	SS	14								
	Compact												
	Light brown												
	Wet												
226.3													
14.8													

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 22/01/16 DATA INPUT:

Continued Next Page

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

PROJECT 1532543		RECORD OF BOREHOLE No 15-2 (BCR)				2 OF 2 METRIC											
G.W.P. 2159-11-00		LOCATION N 4914425.5; E 288367.3				ORIGINATED BY DM											
DIST Central HWY 400		BOREHOLE TYPE 203 mm O.D. Hollow Stem Augers				COMPILED BY NK/NLP											
DATUM GEODETIC		DATE November 8, 2015				CHECKED BY LCC											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
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PROJECT 1532543				RECORD OF BOREHOLE No 15-7				1 OF 2 METRIC						
G.W.P. 2159-11-00				LOCATION N 4914422.5; E 288388.8				ORIGINATED BY AK						
DIST Central HWY 400				BOREHOLE TYPE 200 mm O.D. Hollow Stem Augers				COMPILED BY NLP						
DATUM GEODETIC				DATE June 24, 2015				CHECKED BY LCC						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
243.1	GROUND SURFACE							20 40 60 80 100						
0.0	ASPHALT						243							
0.2	Sand, some gravel, some silt (FILL)		1	SS	35									12 71 17 0
242.4	Dense Brown Moist													
0.7	Gravelly sand, trace silt (FILL)													
241.9	Compact Brown Moist						242							
1.2	Sand, some silt, trace gravel, trace clay (FILL)		2	SS	17									
	Loose to compact Brown Moist						241							
			3	SS	6									
							240							
	Gravelly sand encountered in Sample 4.		4	SS	4									24 67 7 2
			5	SS	4		239							
			6	SS	4		238							
							237							
			7	SS	9		236							
235.9							235							
7.2	Silty SAND, trace gravel Dense to compact Light brown Moist		8	SS	30		234							
	- Oxidation staining below 9.2 m		9	SS	16		233							
232.9							232							
10.2	SAND and SILT, some gravel, trace clay Compact Grey Moist to wet		10	SS	29		231							11 39 47 3
							230							
230.9							229							
12.2	Silty SAND Compact to very dense Grey Moist		11	SS	13									
			12	SS	72									

SUD-MTO 001 1532543.GPJ GAL-MISS GDT 16/10/15 DATA INPUT:

Continued Next Page

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

PROJECT <u>1532543</u>				RECORD OF BOREHOLE No 15-7				2 OF 2 METRIC									
G.W.P. <u>2159-11-00</u>				LOCATION <u>N 4914422.5; E 288388.8</u>				ORIGINATED BY <u>AK</u>									
DIST <u>Central</u> HWY <u>400</u>				BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>NLP</u>									
DATUM <u>GEODETIC</u>				DATE <u>June 24, 2015</u>				CHECKED BY <u>LCC</u>									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
			13	SS	16		228										
							227										
225.9			14	SS	22		226										
17.2	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 12.2 m (Elev. 230.9 m) during drilling operations.																

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

PROJECT <u>1532543</u>		RECORD OF BOREHOLE No 15-8				1 OF 1 METRIC											
G.W.P. <u>2159-11-00</u>		LOCATION <u>N 4914416.4; E 288424.7</u>				ORIGINATED BY <u>AK</u>											
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>NLP</u>											
DATUM <u>GEODETIC</u>		DATE <u>July 16, 2015</u>				CHECKED BY <u>LCC</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
234.2	GROUND SURFACE							20	40	60	80	100					
0.0	Silty sand, trace gravel, organic staining, rootlets and organic inclusions (FILL) Loose to compact Dark brown to brown Moist		1	SS	5	▽	234										
232.9			2	SS	10		233										
1.2	Silty sand (FILL) Compact Light brown Moist to wet		3	SS	23		232										
			4	SS	16		231										
230.4			5	SS	17		230										
3.8	SILT, trace sand, trace clay Loose Light brown Wet		6	SS	8		229										
229.7			7	SS	12		228										
4.5	CLAYEY SILT, trace sand Stiff Light brown Moist		8	SS	42		227										
228.4			9	SS	17		226										
5.8	SAND, some silt, trace clay Dense to compact Grey Wet		10	SS	6		225										
225.6			11	SS	7												
8.5	SANDY SILT, trace clay Loose Grey Wet																
224.1																	
10.1	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 3.4 m (Elev. 230.8 m) during drilling operations.																

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

PROJECT 1532543				RECORD OF BOREHOLE No 15-9				1 OF 2 METRIC									
G.W.P. 2159-11-00				LOCATION N 4914402.9; E 288423.0				ORIGINATED BY AK									
DIST Central HWY 400				BOREHOLE TYPE 200 mm O.D. Hollow Stem Augers				COMPILED BY NLP									
DATUM GEODETIC				DATE July 16, 2015				CHECKED BY LCC									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>									
237.3	GROUND SURFACE																
0.0	Silty sand, trace gravel, organic staining, rootlets (FILL)		1	SS	3	▽	237										
236.6	Very loose Dark brown Moist																
0.7	Sand, trace gravel, trace silt, organic staining (FILL)		2	SS	14		236										
235.8	Compact Brown Moist																
1.5	Silty sand (FILL)	3	SS	5													
235.1	Loose Brown to light brown Moist																
2.2	Silty SAND to SAND, trace to some silt	4	SS	18	235												
	Compact Light brown to grey Moist to wet	5	SS	15	234												
		6	SS	22	233												
		7	SS	17	232												
		8	SS	17	231												
		9	SS	27	230												
		10A	SS	14	228												
227.9	SILT, trace to some sand, trace clay	10B															
9.4	Compact Grey Moist to wet																
227.1	CLAYEY SILT, trace to some sand																
10.2	Stiff to very stiff Grey Moist	11	SS	8	227												
		12	SS	13	226												
		13	SS	21	225												
223.3																	
14.0																	

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

Continued Next Page

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

<div style="display: flex; justify-content: space-between;"> <div>PROJECT <u>1532543</u></div> <div>RECORD OF BOREHOLE No 15-9</div> <div>2 OF 2 METRIC</div> </div>																	
G.W.P. <u>2159-11-00</u>		LOCATION <u>N 4914402.9; E 288423.0</u>		ORIGINATED BY <u>AK</u>													
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>NLP</u>											
DATUM <u>GEODETIC</u>		DATE <u>July 16, 2015</u>				CHECKED BY <u>LCC</u>											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			
	--- CONTINUED FROM PREVIOUS PAGE --- END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 3.8 m (Elev. 233.5 m) during drilling operations.																

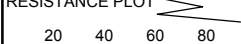
SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

PROJECT 1532543				RECORD OF BOREHOLE No 15-10				1 OF 2 METRIC						
G.W.P. 2159-11-00				LOCATION N 4914439.4; E 288392.5				ORIGINATED BY AK						
DIST Central HWY 400				BOREHOLE TYPE 200 mm O.D. Hollow Stem Augers				COMPILED BY NLP						
DATUM GEODETIC				DATE July 8, 2015				CHECKED BY LCC						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
237.8	GROUND SURFACE													
0.0	Silty sand, trace gravel (FILL) Loose to compact Dark brown to brown, organic staining Moist		1	SS	9									
			2	SS	17									
236.4														
1.5	Sand and silt, trace clay, organic inclusions (FILL) Compact Brown to grey Moist		3	SS	10									
			4	SS	13									0 49 50 1
234.9														
3.0	SILT Loose Grey Moist to wet		5	SS	6									
			6	SS	9									
233.3														
4.5	SAND and SILT, trace clay Compact to loose Grey Moist to wet		7	SS	27									
			8	SS	17									0 53 46 1
			9	SS	12									
			10	SS	8									
			11	SS	6									
226.7														
11.1	SILT, trace clay, trace sand Compact Grey Wet													
			12	SS	14									0 3 94 3
224.7														
13.1	CLAYEY SILT, some sand Very stiff Grey Moist		13	SS	17									
223.8														
14.0														

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

Continued Next Page





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

<div style="display: flex; justify-content: space-between;"> PROJECT <u>1532543</u> RECORD OF BOREHOLE No 15-10 2 OF 2 METRIC </div>																
G.W.P. <u>2159-11-00</u>		LOCATION <u>N 4914439.4; E 288392.5</u>		ORIGINATED BY <u>AK</u>												
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>NLP</u>										
DATUM <u>GEODETIC</u>		DATE <u>July 8, 2015</u>				CHECKED BY <u>LCC</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100 10 20 30								
	--- CONTINUED FROM PREVIOUS PAGE --- END OF BOREHOLE NOTE: 1. Water level in piezometer measured a depth of 4.8 m (Elev. 233.0 m) on October 7, 2015.															

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

PROJECT		1532543		RECORD OF BOREHOLE No HF3		1 OF 1 METRIC	
G.W.P.		2159-11-00		LOCATION		N 4914383.3; E 288436.2	
DIST		Central HWY 400		BOREHOLE TYPE		200 mm O.D. Hollow Stem Augers	
DATUM		GEODETIC		DATE		July 16, 2015	
						ORIGINATED BY AK	
						COMPILED BY NLP	
						CHECKED BY LCC	
SOIL PROFILE				SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
							20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100 PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p — W — W _L WATER CONTENT (%)
238.6	GROUND SURFACE						
0.0	Silty sand, trace gravel, organic staining, rootlets (FILL)		1	SS	5		238
237.9	Loose Dark brown Moist						
0.7	Silt and sand, trace clay (FILL)		2	SS	9		237
	Loose Brown Moist						
236.5			3	SS	9		
2.1	Sandy silt (FILL) Compact Brown Moist		4	SS	13		236
235.7							
3.0	SILT, some sand, trace gravel Compact Light brown to grey Moist to wet		5	SS	12		235
234.3			6	SS	16		
4.4	CLAYEY SILT Stiff Light brown Moist		7	SS	13		234
232.8							233
5.8	SAND and SILT to SAND, trace clay Compact Grey Wet		8	SS	22		232
							231
			9	SS	19		230
			10	SS	12		
			11	SS	14		229
228.6							
10.1	END OF BOREHOLE						
NOTES:							
1. Water level in open borehole at a depth of 3.5 m (Elev. 235.1 m) during drilling operations.							
2. Borehole caved to 7.6 m (Elev. 231.0 m) after removal of augers.							

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

PROJECT <u>1532543</u>		RECORD OF BOREHOLE No P-RW3				1 OF 1 METRIC								
G.W.P. <u>2159-11-00</u>		LOCATION <u>N 4914460.1; E 288390.7</u>				ORIGINATED BY <u>AK</u>								
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>AC</u>								
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2015</u>				CHECKED BY <u>SEMP</u>								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
234.3	GROUND SURFACE							20 40 60 80 100						
0.0	Sand, trace gravel, trace silt (FILL) Loose to compact Dark brown to brown Moist		1	SS	6		234							
			2	SS	10		233							
			3	SS	5		232							
232.1	Silt and sand to silt, trace clay (FILL) Very loose to compact Grey Moist		4	SS	13		232							0 41 58 1
2.2			5	SS	2		231							
			6A	SS	10		230							
230.2	SAND, trace to some silt Compact to loose Brown to grey Moist to wet		6B				230							
4.1			7	SS	15		229							
			8	SS	7		228							
227.1	SILT, some sand, trace clay Very loose to compact Grey Wet		9	SS	3		227							
7.2			10	SS	13		226							
			11	SS	9		225							0 12 87 1
224.2	END OF BOREHOLE													
10.1	NOTE: 1. Water level in open borehole at a depth of 9.3 m (Elev. 225.0 m) during drilling operations.													

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:

PROJECT <u>1532543</u>		RECORD OF BOREHOLE No TRW-1				1 OF 1 METRIC											
G.W.P. <u>2159-11-00</u>		LOCATION <u>N 4914430.8; E 288380.2</u>				ORIGINATED BY <u>DM</u>											
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>200 mm O.D. Hollow Stem Augers</u>				COMPILED BY <u>AC</u>											
DATUM <u>GEODETIC</u>		DATE <u>June 24-25, 2015</u>				CHECKED BY <u>SEMP</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
243.0	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT																
	Sand, some gravel, trace silt (FILL) Brown Moist																
242.2																	
0.9	Silty sand, trace clay, trace to some gravel (FILL) Compact to dense Brown Moist -Minor organic staining at 1.5 m		1	AS	-		242										
			2	SS	26		241										
			3	SS	25		240										
			4	SS	24		239										
			5	SS	21		238										
			6	SS	35		237										
			7A	SS	40		236										
236.4	Trace organics at depth of 6.6 m		7B	SS	40		235										
6.6	Sand, trace silt, trace gravel (FILL) Dense Light brown Moist		8A	SS	31		234										
			8B	SS	31		233										
			8C	SS	31		232										
234.3							231										
8.7	SAND, trace silt Compact Brown Moist		9	SS	25												
232.8																	
10.2	Silty SAND Compact Light brown Moist -Becoming wet below a depth of 10.8 m		10A	SS	18												
			10B	SS	18												
			10C	SS	18												
231.3																	
11.7	SILT, trace clay, trace sand, slight plasticity Loose Brown Wet		11	SS	9												
230.2																	
12.8	END OF BOREHOLE																
	NOTES: 1. Borehole dry upon completion of drilling. 2. Hole caved to a depth of 11.6 m (Elev. 231.4 m) upon removal of augers.																

SUD-MTO 001 1532543.GPJ GAL-MISS.GDT 16/10/15 DATA INPUT:



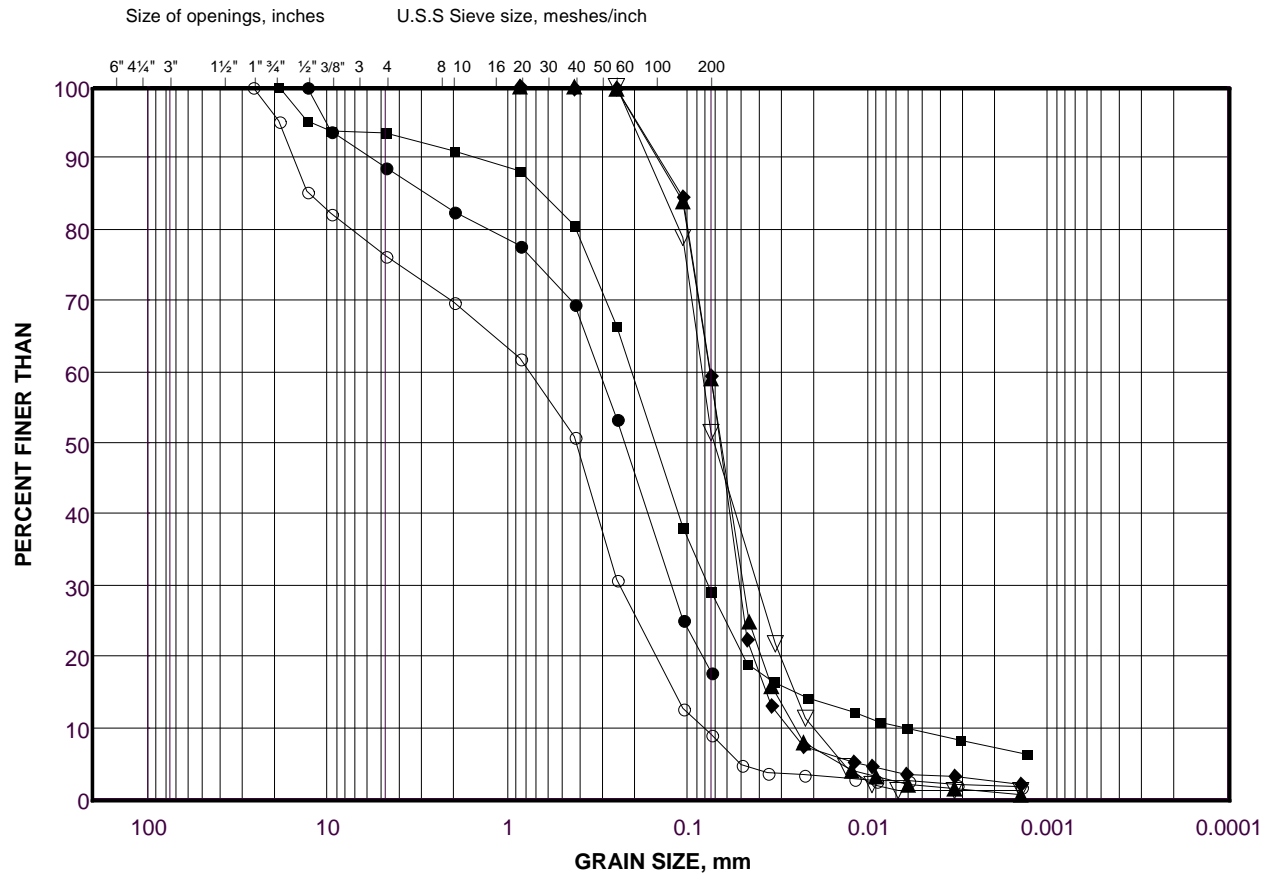
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sand and Silt to Sand Fill

FIGURE B1A



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	15-7	1	242.4
■	TRW-1	2	241.2
◆	HF3	3	236.8
▲	P-RW3	4	231.7
▽	15-10	4	235.2
○	15-7	4	239.7

Project Number: 1532543

Checked By: _____ LCC

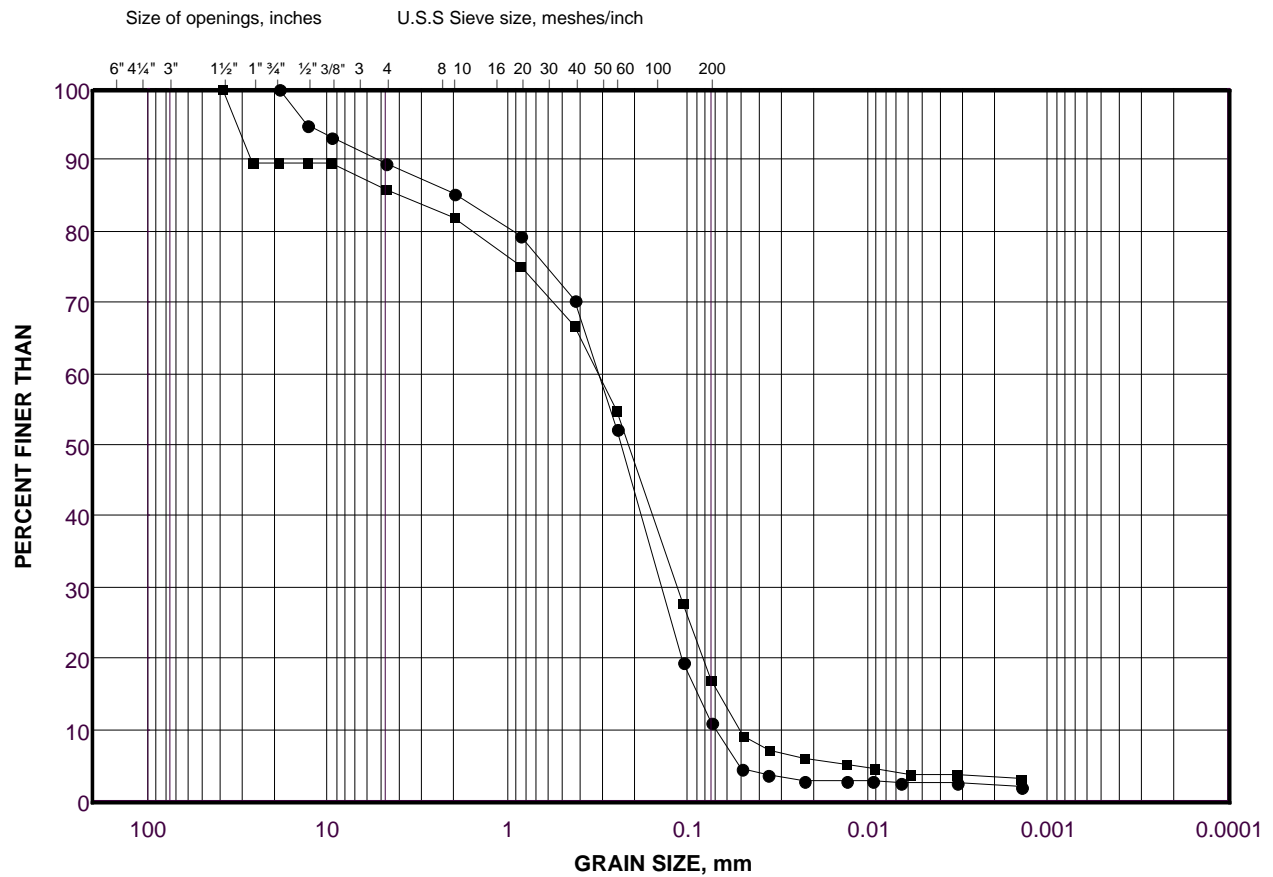
Golder Associates

Date: 14-Oct-15

GRAIN SIZE DISTRIBUTION

Sand and Silt to Sand Fill

FIGURE B1B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	15-1 (BCR)	4	239.4
■	15-2 (BCR)	8	234.7

Project Number: 1532543

Checked By: LCC

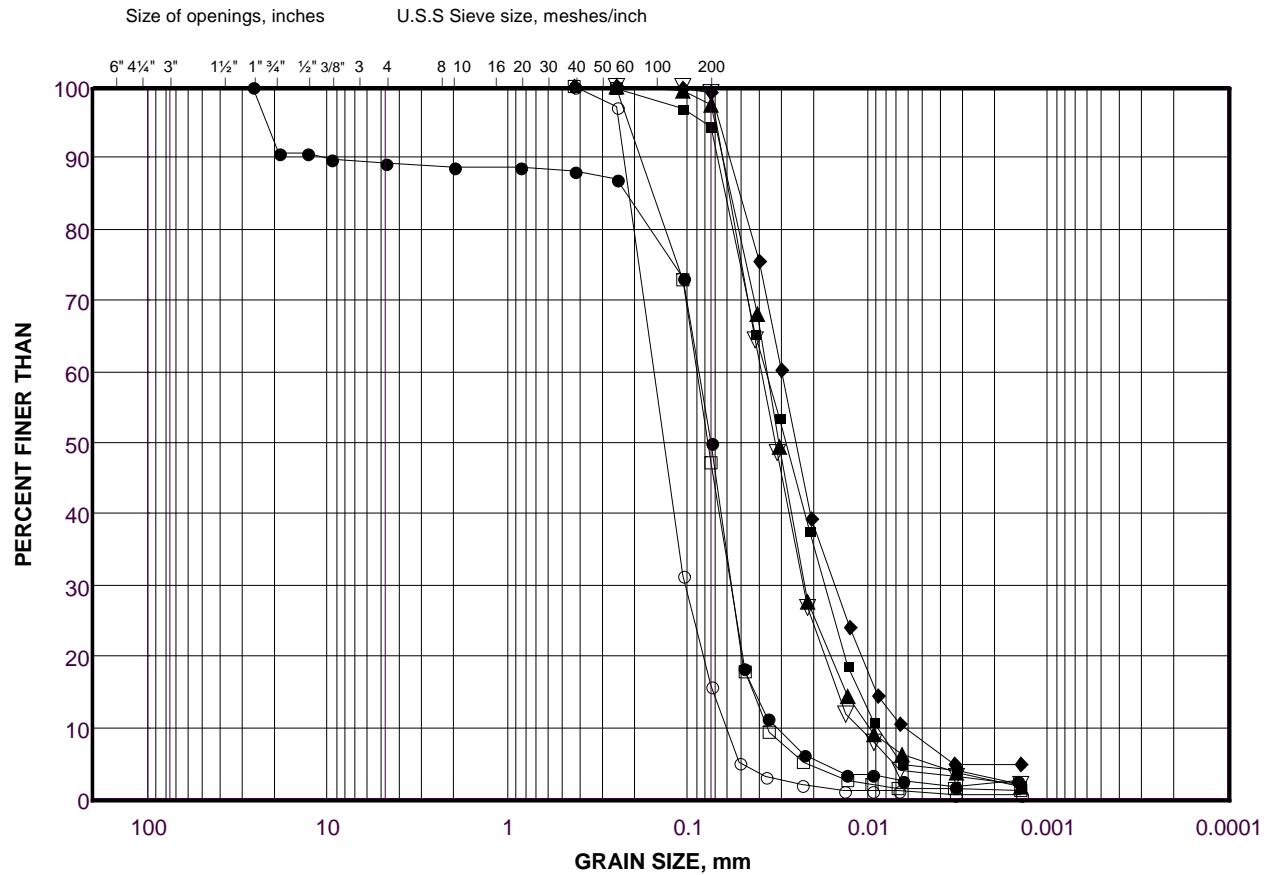
Golder Associates

Date: 29-Jan-16

GRAIN SIZE DISTRIBUTION

Silt to Sand

FIGURE B2A



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	15-7	10	232.2
■	15-9	10B	227.9
◆	TRW-1	11	230.5
▲	15-10	12	225.3
▽	15-8	6	230.1
○	15-8	8	227.8
□	15-10	8	231.4

Project Number: 1532543

Checked By: LCC

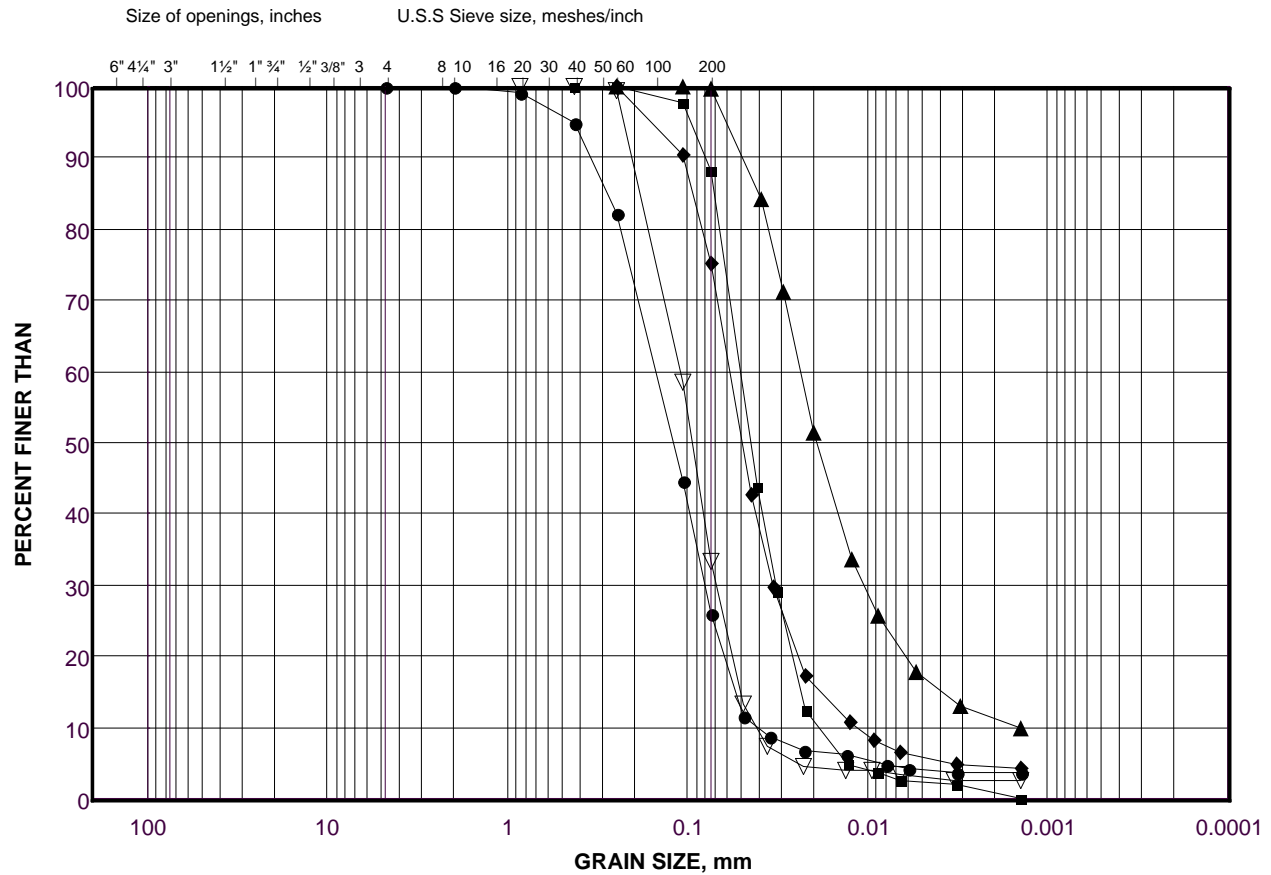
Golder Associates

Date: 14-Oct-15

GRAIN SIZE DISTRIBUTION

Silt to Sand

FIGURE B2B



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	15-1 (BCR)	10	232.60
■	P-RW3	10	225.2
◆	15-2 (BCR)	12	228.6
▲	15-2 (BCR)	13	227.1
▽	15-1 (BCR)	14	226.5

Project Number: 1532543

Checked By: LCC

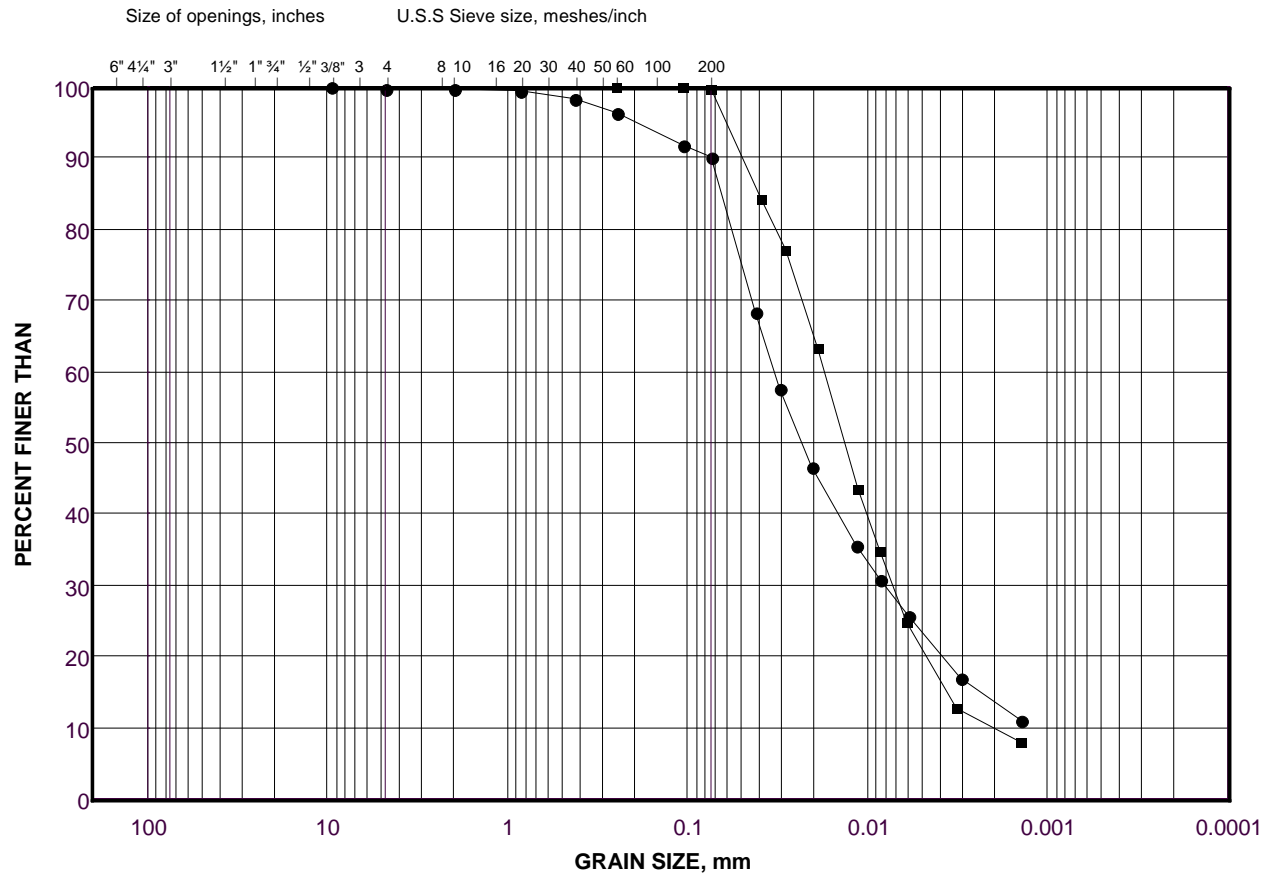
Golder Associates

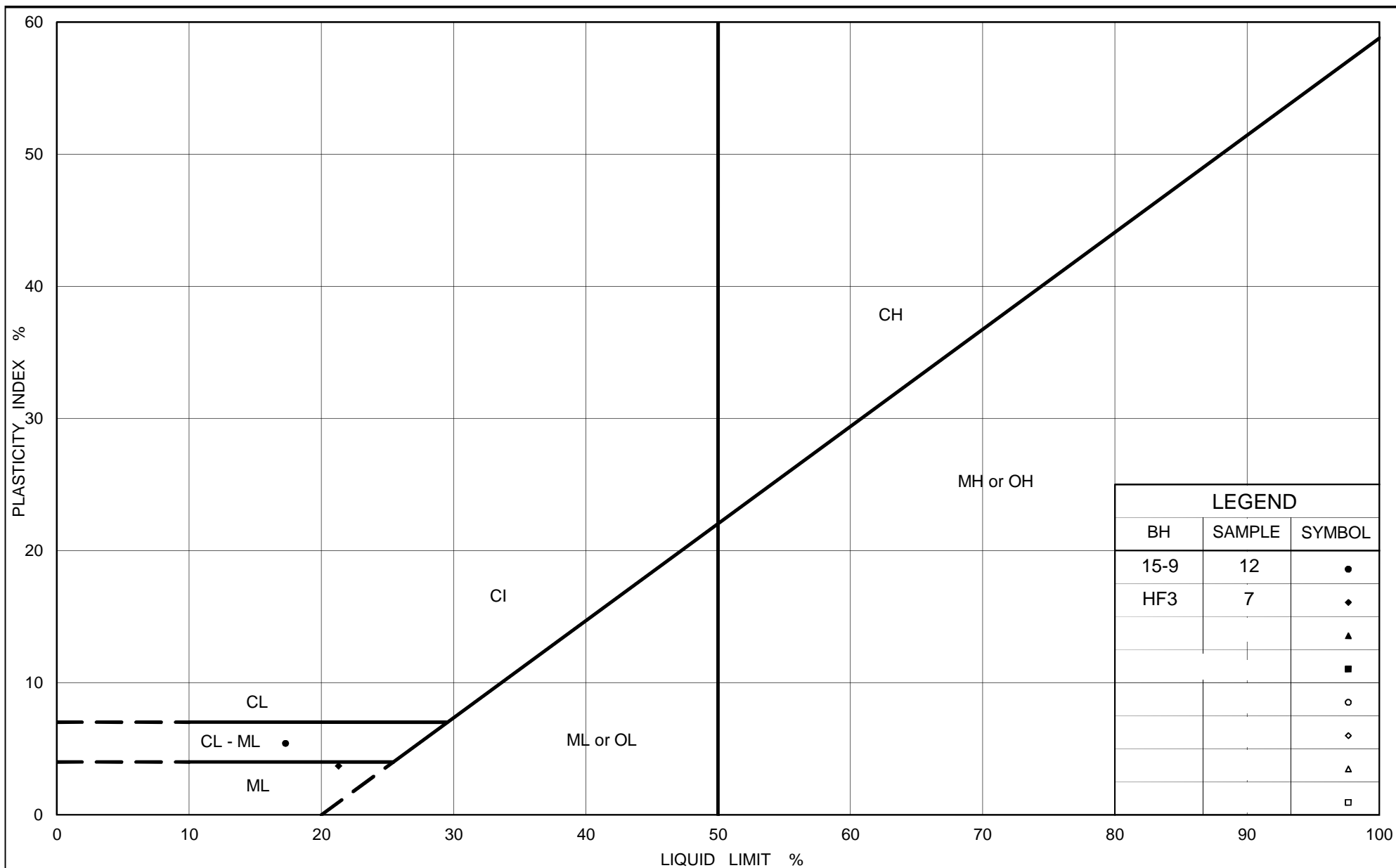
Date: 20-Jan-16

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE B3





PLASTICITY CHART Clayey Silt

Figure No. B4

Project No. 1532543

Checked By: LCC



APPENDIX C

Borehole Records from Previous Investigation (GEOCRES No. 31D-590)

GEOTETO22181AA: Hwy 400/ Tiffin Street

RECORD OF BOREHOLE No BH F5

1 OF 2

METRIC

GWP 2074-11-00 LOCATION 29+533, 11.9 m Rt C/L (N 4814403.1, E288402) ORIGINATED BY LG
 DIST HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MP
 DATUM Geodetic DATE 21/10/2014 CHECKED BY SH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)				
								20 40 60 80 100				
								20 40 60 80 100				
243.0	GROUND SURFACE											
242.9	280 mm ASPHALT											
0.3	PAVEMENT GRANULAR FILL: 0.2 m thick Sand and Gravel 0.4 m thick Sand, some gravel		1	SS	35							
242.1	FILL: Silty Sand trace to some gravel brown to grey, loose to dense, moist to wet		2	SS	17							
0.6												
			3	SS	9							
			4	SS	8							
			5	SS	3							
			6	SS	6							
			7	SS	15							
			8	SS	13							
			9	SS	15							
			10	SS	18							
233.9			11	SS	12							
9.1												
			12	SS	27							
			13	SS	9							
			14	SS	17							
228.0												

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15 10 5 10 (%) STRAIN AT FAILURE

GEOTETO22181AA: Hwy 400/ Tiffin Street

RECORD OF BOREHOLE No BH F5

2 OF 2

METRIC

GWP 2074-11-00 LOCATION 29+533, 11.9 m R/L (N 4914403.1, E288402) ORIGINATED BY LG
 DIST HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MP
 DATUM Geodetic DATE 21/10/2014 CHECKED BY SH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
228.0 15.0	SILTY SAND TO SANDY SILT brown to grey, loose to compact moist to wet		15	SS	23		228										GR SA SI CL added bentonite (quick gel) for further drilling
							227										
			16	SS	17		226										
							225										
224.1 18.9			17	SS	8												
	End of Borehole Cave-in @ 13.7 m																

+³, X³: Numbers refer to Sensitivity 20 15 10 5 0 (% STRAIN AT FAILURE)

GEOTETO822181AA; Hwy 400/ Tiffin Street

RECORD OF BOREHOLE No BH F6

1 OF 1

METRIC

GWP 2074-11-00 LOCATION 29+554, 26.8 m Rt C/L (N 4914429.1, E288399.8) ORIGINATED BY LG
DIST HWY 400 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MP
DATUM Geodetic DATE 03/10/2014 CHECKED BY SH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
FLY DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE		WATER CONTENT (%) w _p w w _L				
234.8 0.0	GROUND SURFACE						20 40 60 80 100							
	FILL: Silty Sand trace gravel, trace rootlet brown, moist		1	SS	1							○		
			2	SS	4							○		
233.1 1.5	SILTY SAND brown, compact to dense moist to wet		3	SS	25							○		0 53 (47)
			4	SS	15							○		
			5	SS	6							○		wet spoon
	silt, loose trace clay layer		6	SS	8							○		0 2 90 8
			7	SS	17							○		
			8	SS	34							○		
228.5 6.1	End of Borehole Water level @ 3.9 m (not stabilized)* upon completion. Piezometer installed to 6.1 m. Piezometer water level records : Oct. 31, 2014 4.1 m (El. 230.5 m)													

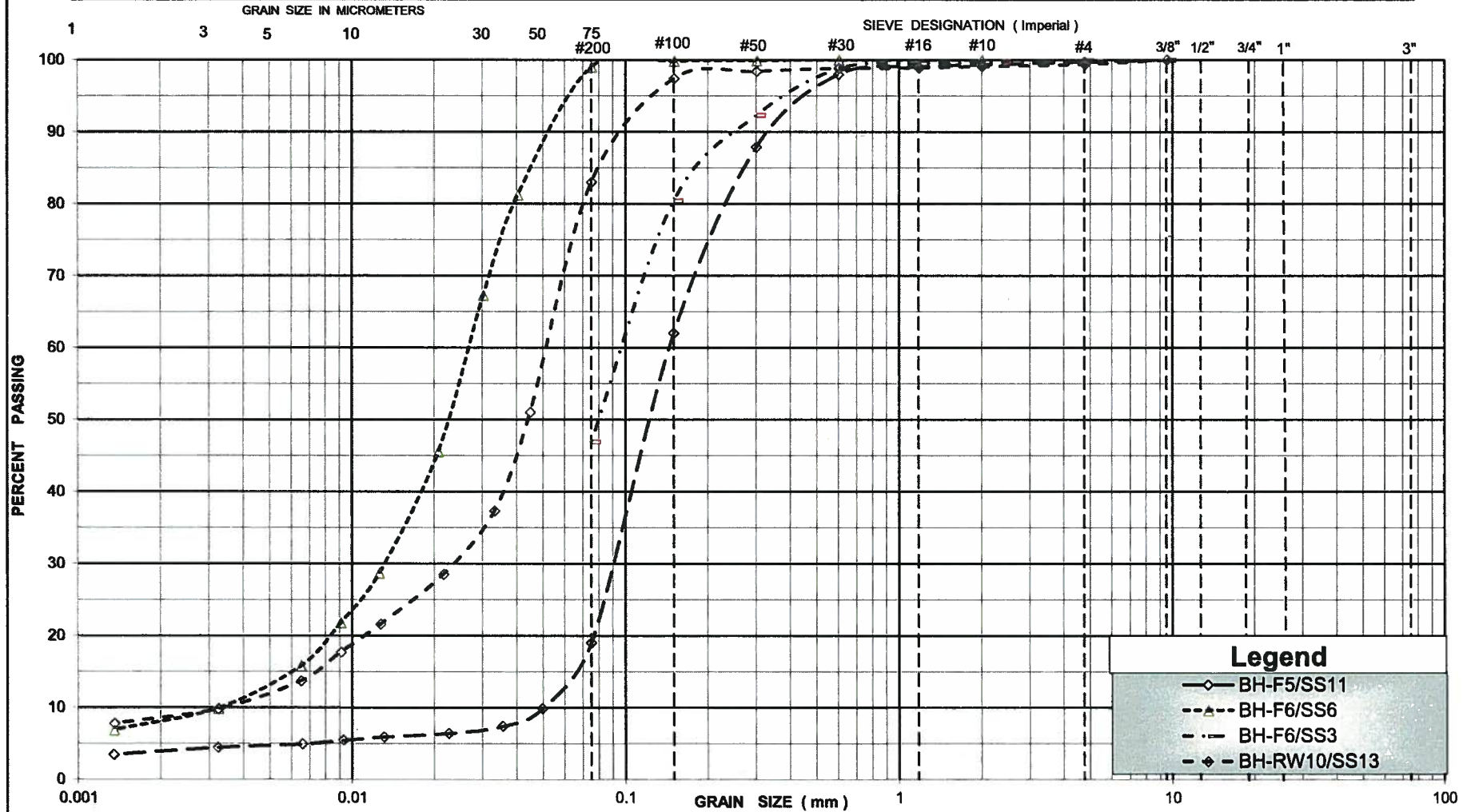
+³.X³: Numbers refer to
Sensitivity

20
15-5
10 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

LS 702/ ASTM D 422

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Legend

- ◇— BH-F5/SS11
- - -△- - BH-F6/SS6
- · - BH-F6/SS3
- ◆ - BH-RW10/SS13



GRAIN SIZE DISTRIBUTION
Sandy Silt to Silty Sand and Silt to Sand & Silt

FIGURE NO. : B-2

PROJECT NO.: GEOTETO22161AA

DATE : NOV 19, 2014

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