



FOUNDATION INVESTIGATION REPORT

Highway 127, Station 18+320, Township of Sabina Culvert Replacement Ministry of Transportation, Ontario GWP 5151-13-00

Submitted to:

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18104224-WO#7

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Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	1
3.0 INVESTIGATION PROCEDURES	1
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....	2
4.1 Regional Geology	2
4.2 Subsurface Conditions	3
4.2.1 Asphalt/ Road Structure	3
4.2.2 SILTY SAND (SM) to Sandy GRAVEL (GP) (FILL)	3
4.2.3 SILTY SAND (SM)	4
4.2.4 SAND (SP)	4
4.3 Groundwater Conditions	4
4.4 Analytical Laboratory Testing Results	4
5.0 CLOSURE	5

DRAWINGS

Drawing 1 Borehole Locations and Soil Strata

PHOTOGRAPHS

Photographs 1 to 3

APPENDICES

APPENDIX A Record of Boreholes

Lists of Symbols and Abbreviations

Record of Boreholes 19-1 to 19-3

APPENDIX B Laboratory Test Results

Figure B-1 Grain Size Distribution – SILTY SAND (SM) to SILTY SAND (SM) and GRAVEL (FILL)

Figure B-2 Grain Size Distribution – SILTY SAND (SM)

Figure B-3 Grain Size Distribution – Gravelly SAND (SP) to SAND (SP)

AGAT Analytical Laboratory Test Report

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by D.M. Wills Associates Ltd. (Wills) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services related to the replacement of the culvert under Highway 127 at Station 18+320, approximately 600 m west of the Highway 127 intersection with MacKenzie North Road, in the Township of Sabina. The Key Plan of the general location of this section of Highway 127 and the location of the investigated area are shown on Drawing 1.

The purpose of this exploration is to establish the subsurface conditions at the culvert replacement site by borehole drilling, with laboratory testing carried out on selected soil samples.

The Terms of Reference (TOR) and the scope of services for the foundation investigation are outlined in MTO's Work Order # 7 of Agreement Number 5017-E-0022. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project.

2.0 SITE DESCRIPTION

It should be noted that the orientation (i.e., north, south, east, west) stated in the text of the report is typically referenced to project north and therefore may differ from magnetic north shown on Drawing 1. For the purpose of this report, Highway 127 is oriented in a west-east direction with the culvert positioned north-south, perpendicular to the highway. At the culvert location the creek flows in a north-south direction.

The existing culvert consists of a 750 mm diameter, 32 m long Corrugated Steel Pipe (CSP). The culvert inlet (north end) and outlet (south end) inverts are approximately Elevations 427.9 m and 426.6 m, respectively. In general, the topography in the vicinity of the culvert consists of rolling terrain, with Highway 60, traversing through Algonquin Provincial Park, located about 12 km north of the site. At the culvert location, the highway grade is at approximately Elevation 433.0 m and the embankment is approximately 6 m high relative to the culvert invert. There are no indications of embankment or pavement distress in the immediate vicinity of the culvert other than minor surface cracking of the pavement. The conditions at the culvert ends and road surface in the area of the culvert are shown on Photographs 1 to 3.

3.0 INVESTIGATION PROCEDURES

Field work for this subsurface exploration was carried out between August 12 and 14, 2019 during which time three boreholes (Boreholes 19-1 to 19-3) were advanced at the locations shown on Drawing 1. One borehole was advanced through the roadway embankment using a track mounted Mobile B57 drilling rig supplied and operated by Landshark Drilling of Brantford, Ontario. Two boreholes were advanced near the toes of the highway embankment slopes adjacent to the culvert inlet/outlet using a portable tripod drilling rig supplied and operated by Ohlmann Geotechnical Services Inc. of Almonte Ontario. Traffic control was performed in accordance with MTO's Ontario Traffic Control Manual Book 7 – Temporary Conditions.

Borehole 19-1 and 19-2 were advanced with BW casing with wash boring techniques and Borehole 19-3 was advanced using 216 mm outside diameter hollow stem augers. Ohlmann Geotechnical Services supplied a water filled tote for use in the wash boring operations.

In Borehole 19-3, 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 a full weight automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586-18). In Boreholes 19-1 and 19-2, split spoon samples were taken continuously from ground surface using a full weight manual hammer. The groundwater level inside

the augers/casing was observed during the drilling operations. A standpipe piezometer, 19 mm in diameter, was installed in Borehole 19-1 to allow further groundwater level monitoring. A sand filter pack was placed to surround the screen in the piezometer. Above the screen/sand pack, the annulus surrounding the PVC pipe was backfilled to the ground surface with bentonite pellets. The remaining boreholes were backfilled to ground surface in accordance with Ontario Regulation 903. The roadway surface at the borehole drilled through Highway 127 was sealed using cement.

Field work was supervised on a full-time basis by a members of Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes; and examined the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Whitby for further examination and laboratory testing. Index and classification testing consisting of water content determinations, grain size distributions and Atterberg limits was carried out on selected soil samples. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable.

The as-drilled borehole locations were surveyed by a member of Golder's technical staff using a Trimble GPS unit. The MTM NAD83-CSRS CBN v6-2010.0 (Zone 10) northing and easting coordinates, geographical coordinates, ground surface elevations referenced to Geodetic datum, and borehole depths at each borehole location are presented on the borehole records in Appendix A and summarized below.

Borehole Number	MTM NAD 83 Northing (m) (Latitude)	MTM NAD 83 Easting (m) (Longitude)	Ground Surface Elevation (m)	Borehole Depth (m)
19-1	5029829.2 (45.399981)	413429.5 (-78.112448)	426.4	4.3
19-2	5029862.0 (45.400272)	413449.3 (-78.112187)	428.4	4.3
19-3	5029848.0 (45.400147)	413444.2 (-78.112257)	432.9	11.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

According to published information, the site lies within the Algonquin Highlands physiographic region of southern Ontario (Map P.2715, Chapman and Putnam, 1984)¹. The site is located on an esker, which oriented in a north-south direction, with spills to the east and west. Drumlins are present towards the north and east of the site. Surficial geologic mapping in the vicinity of the site indicates glaciofluvial outwash deposits consisting of gravel and sand boarding on till deposits to the east. The glacial till, where encountered, is reportedly to be unsorted and un-stratified glacial sediment predominately consisting of silty sand with a mixture of any or all of clay, gravel, cobble and boulders. The soils encountered at the site were typical deposits generally encountered within the Algonquin Highlands.

¹ Chapman and Putnam, 1984. Physiography of Southern Ontario. Map P.2715

Based on geological mapping the site is underlain by biotite gneisses and migmatites (Map 2544, Ontario Ministry of Northern Development and Mines, Bedrock Geology of Ontario).²

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes, the standpipe piezometer installation details and the summary results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A. The detailed results of geotechnical laboratory testing are contained in Appendix B. The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the Record of Borehole sheets and discussed in Section 4.2 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile shown on Drawing 1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change.

The subsurface conditions will vary between and beyond the borehole locations, however, the factual data presented on the Record of Borehole Sheets governs any interpretation of the site conditions. A summary description of the soil deposits and groundwater conditions encountered in the boreholes is provided below. It should be noted that the interpreted stratigraphy shown on Drawing 1 is a simplification of the subsurface conditions.

4.2.1 Asphalt/ Road Structure

An approximately 75 mm thick layer of asphalt (pavement) was encountered at Borehole 19-3 at Elevation 432.9 m. Underlying the surface asphalt, the borehole penetrated a 265 mm thick layer of granular road base fill.

4.2.2 SILTY SAND (SM) to Sandy GRAVEL (GP) (FILL)

A 1.5 m to 5.3 m thick non-cohesive deposit of fill, generally comprised of silty sand to sandy gravel, trace to some fines, was encountered in all Boreholes at ground surface or beneath the road base fill between Elevations 432.6 m and 426.4 m. Organic inclusions and/or root fragments were observed in Boreholes 19-1 and 19-2 in and extend to depths of 1.5 m below ground surface (mbgs) and 1.2 mbgs, respectively. Cobbles and potentially boulders are inferred to be present within the fill based on rock fragments recovered in Boreholes 19-1 and 19-2 and auger grinding observed during drilling in Borehole 19-3.

The SPT “N”-values measured within the fill deposit generally range from 3 blows to 26 blows per 0.3 m of penetration, indicating a very loose to compact compactness condition. An SPT “N”-value of 52 blows per 0.3 m of penetration and 50 blows for 0.05 m of penetration was measured in Boreholes 19-3 and 19-1, respectively, indicating a very dense compactness condition, however these are not considered representative of the fill and are inferred to be the result of the SPT contacting cobbles and/or boulders within the fill.

Grain size distribution analysis was carried out on two samples of the silty sand fill and the results are presented on Figure B-1 in Appendix B. The in-situ moisture content measured on two samples of the fill deposit is 6 per cent and 25 per cent.

² Ontario Ministry of Northern Development and Mines. Bedrock Geology of Ontario, East-Central Sheet. Map 2544

4.2.3 SILTY SAND (SM)

A 0.6 m and 0.7 m thick deposit of non-cohesive silty sand, some gravel was encountered in Boreholes 19-2 and 19-3 beneath the fill at Elevations 426.6 m and 427.6 m, respectively.

Two SPT “N”-values measured with the silty sand are 28 and 42 blows per 0.3 m of penetration, indicating a compact to dense compactness condition.

A grain size distribution analysis was carried out on one sample of the silty sand deposit and the result is presented on Figure B-2 in Appendix B. The natural moisture content measured on two samples of the silty sand deposit are 11 per cent and 23 per cent.

4.2.4 SAND (SP)

A non-cohesive deposit of sand, trace to some gravel to gravelly sand, trace fines was encountered in all boreholes beneath the fill or silty sand deposit. The surface of the sand deposit was encountered between Elevations 426.9 m and 424.9 m. Cobbles and boulders are inferred to be present within the sand deposit based on rocks fragments recovered from the samples in Boreholes 19-1 and 19-2 and auger grinding observed during drilling in Borehole 19-3. The sand deposit was not fully penetrated in Boreholes 19-1 to 19-3 after exploring the deposit for depths between 1.9 m and 5.3 m.

The SPT “N”-values measured within the sand deposit range from 3 blows to 54 blows per 0.3 m of penetration, indicating a very loose to very dense compactness condition. SPT “N”-values of 83 blows for 0.23 m of penetration and 50 blows for 0.13 m of penetration were measured in Boreholes 19-2 and 19-3, respectively, however these are inferred to be the result of the SPT contacting cobbles and possibly boulders within the sand deposit.

Grain size distribution analysis was carried out on four samples of the sand to gravelly sand deposit and the results are presented on Figure B-4 in Appendix B. Atterberg limits tests was carried out on one sand sample of the deposit and returned a non-plastic result. The natural moisture content measured on six samples of the deposit range from 11 per cent to 30 per cent.

4.3 Groundwater Conditions

In general, the groundwater level observed in Boreholes 19-1 and 19-2 upon completion of drilling are not considered representative of the conditions observed on site due to the introduction of water during wash boring. The groundwater level in Borehole 19-3 upon completion of drilling was measured at 5.8 m below ground surface and Borehole 19-2 was dry. The groundwater level measured in the standpipe piezometer on August 24, 2019 is summarized below.

Borehole No.	Ground Surface Elevation (m)	Groundwater Level Below Ground Surface (m) in Piezometer	Groundwater Level Elevation (m)
19-1	426.4	1.7	424.7

4.4 Analytical Laboratory Testing Results

Analytical testing was carried out on a soil sample recovered at the bottom of the embankment fill in Borehole 19-3. The soil sample was submitted to AGAT Laboratories of Mississauga, Ontario for testing a suite of parameters

associated with potential corrosion to steel and deterioration of concrete. The analytical laboratory test results are summarized below, and the detailed analytical laboratory test report is included in Appendix B.

Borehole No.	Sample No.	Depth (m)	Parameters				
			Resistivity (ohm-cm)	Electrical Conductivity (mS/cm)	Soluble Sulphate (SO ₄) Content (µg/g)	Chloride (Cl) Content (µg/g)	pH
19-3	4	4.6-5.2	2,390	0.419	8	24	8.51

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Michael Bentley. This Foundation Investigation Report was prepared by Mr. Michael Bentley, and Ms. Sarah E. M. Poot, P.Eng. provided a technical review of the report. Mr. Jorge Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant for Golder, conducted an independent quality control review of this report.

Signature Page

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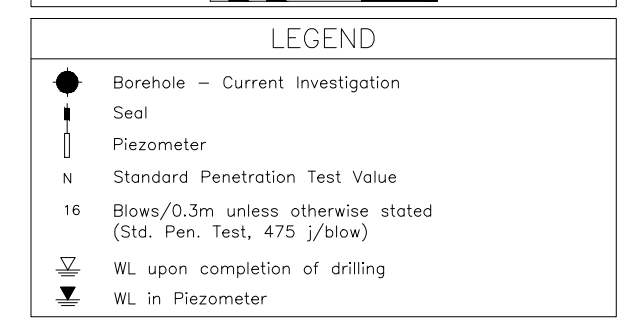
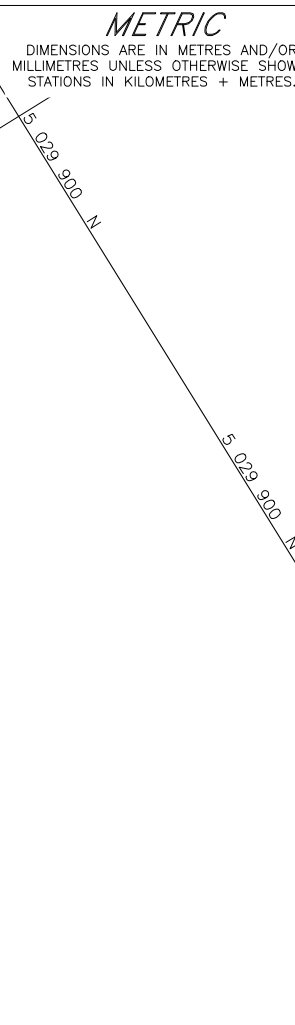


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MJB/SEMP/JMAC/ljv

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NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

REFERENCE

Base plans provided in digital format by D.M. Willis Associates Ltd., file no. wp52651301a.dwg, received September 18, 2019.

	-	-	-	-
NO.	DATE	BY	REVISION	
Geocres No. 31E-408				
HWY. 127			PROJECT NO. 18104224-7	DIST. .
SUBM'D. MJB		CHKD. MJB	DATE: 11/26/2019	SITE:
DRAWN: DD		CHKD. SEMP	APPD. JMAG	DWG. 1



Photograph 1: Culvert Outlet, South End (August 2019)



Photograph 2: Culvert Inlet, North End (August 2019)



Photograph 3: Highway 127 Facing East Towards Culvert Area (August 2019)

APPENDIX A

Record of Boreholes and Drillholes

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
SAND	Coarse	2.00 to 4.75	(10) to (4)
	Medium	0.425 to 2.00	(40) to (10)
	Fine	0.075 to 0.425	(200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (i.e., SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (i.e., some sand)
≤ 10	trace (i.e., trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An 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 (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); 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

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, 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
GS	specific gravity
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 (FV)	field vane (LV-laboratory vane test)
Y	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	➤ 50

3. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

* 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 $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

PROJECT 18104224-7		RECORD OF BOREHOLE No 19-1				SHEET 1 OF 1		METRIC									
G.W.P. 5265-13-01		LOCATION N 5029829.2; E 413429.5 MTM NAD 83 ZONE 10 (LAT. 45.399981; LONG. -78.112448)				ORIGINATED BY MJB											
DIST _____ HWY 127		BOREHOLE TYPE Portable Equipment, BW Casing with Wash Boring				COMPILED BY MJB											
DATUM Geodetic		DATE August 12 and 13, 2019				CHECKED BY SEMP											
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			SHEAR STRENGTH kPa									
426.4	GROUND SURFACE							20	40	60	80	100					
0.0	SAND (SP), some gravel, trace to some fines, rootlets, organic inclusions, some cobbles (FILL) Loose to compact Dark brown to brown Wet		1	SS	6												
			2	SS	22												
424.9	- Rock fragments recovered from wash boring between depths of 1.2 m and 1.4 m - No recovery from Sample 3 Gravelly SAND (SP) to SAND (SP), some gravel, trace fines Compact Brown Wet - No recovery from Sample 5 - Possible cobble at 3.1 m depth		3	SS	50/0.05												
1.5			4	SS	14												
			5	SS	15												
			6	SS	12												
			7	SS	25												
422.1	END OF BOREHOLE																
4.3	NOTES: 1. Water measured at a depth of 0.3 m below ground surface (Elev. 426.1 m) upon completion of drilling (Elev. 424.7 m). 2. Water level measured in piezometer at a depth of 1.7 m below ground surface (Elev. 424.7 m), August 24, 2019. 3. NP-Non-plastic.																

PROJECT		18104224-7		RECORD OF BOREHOLE No 19-2		SHEET 1 OF 1		METRIC								
G.W.P.		5265-13-01		LOCATION		N 5029862.0; E 413449.3 MTM NAD 83 ZONE 10 (LAT. 45.400272; LONG. -78.112187)		ORIGINATED BY								
DIST		HWY 127		BOREHOLE TYPE		Portable Equipment, BW Casing with Wash Boring		COMPILED BY								
DATUM		Geodetic		DATE		August 13 and 14, 2019		CHECKED BY								
								SEMP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _p	W	W _L		
428.4	GROUND SURFACE															
0.0	Sandy GRAVEL (GP), root fragments (FILL)		1	SS	4											
427.8	Loose Brown Wet		2	SS	3											
0.6	- Rock fragments recovered from wash boring between depths of 0.4 m and 1.5 m															
427.2	SILTY SAND (SM), trace gravel, organic inclusions (FILL)		3	SS	26											
1.2	Very loose Dark brown Wet		4	SS	28											
426.6	SAND (SP) and gravel, some fines, some cobbles (FILL)		5	SS	83/0.23											
1.8	Compact Brown															
426.0	SILTY SAND (SM)		6	SS	37											
2.4	Compact Brown Wet															
424.1	SAND (SP), some gravel, trace to some fines, some cobbles		7	SS	39											
4.3	Dense to very dense Brown Wet															
	- Rock fragments recovered from wash boring between depths of 3.0 m and 3.7 m															
	END OF BOREHOLE															
NOTES: 1. Borehole dry upon completion of drilling. 2. Borehole caved to a depth of 2.1 m below ground surface (Elev. 426.3 m) upon completion of drilling.																

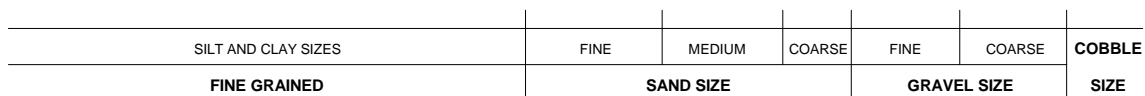
PROJECT 18104224-7		RECORD OF BOREHOLE No 19-3				SHEET 1 OF 1		METRIC									
G.W.P. 5265-13-01		LOCATION N 5029848.0; E 413444.2 MTM NAD 83 ZONE 10 (LAT. 45.400147; LONG. -78.112257)				ORIGINATED BY MJB											
DIST _____ HWY 127		BOREHOLE TYPE 216 mm O.D. Hollow Stem Augers				COMPILED BY MJB											
DATUM Geodetic		DATE August 14, 2019				CHECKED BY SEMP											
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			SHEAR STRENGTH kPa									WATER CONTENT (%)
432.9	GROUND SURFACE							20	40	60	80	100					
0.0	Asphalt (75 mm)																
0.3	SAND and gravel (SW) (FILL)																
	SILTY SAND (SM) and gravel (FILL)																
	Very dense to compact																
	Brown																
	Moist																
	- Auger grinding between depths of 0.3 m and 3.8 m		1	SS	52												41 42 15 2
	- Low recovery in Sample 2		2	SS	23												
			3	SS	11												
	- Auger grinding between depths of 4.6 m and 5.3 m		4	SS	11												
427.6																	
5.3	SILTY SAND (SM), some gravel, oxidation staining		5	SS	42												20 60 18 2
426.9	Dense																
	Brown																
	Moist		6	SS	50/0.13												
6.0	SAND (SP), some to trace gravel, trace fines, oxidation staining																
	Loose to very dense																
	Brown		7	SS	11												
	Moist to wet																
	- Auger grinding between depths of 7.6 m and 8.4 m		8	SS	9												16 77 6 1
			9	SS	8												
			10	SS	6												
			11	SS	3												3 92 5 0
			12	SS	54												
421.6																	
11.3	END OF BOREHOLE																
	NOTES:																
	1. Water measured in open borehole at a depth of 5.8 m below ground surface (Elev. 427.1 m) upon completion of drilling.																
	2. Borehole caved to a depth of 6.0 m below ground surface upon completion of drilling.																

GTA-MTO 001 S:\CLIENTS\MTOWHY_127\02_DATA\GINT\HWY_127.GPJ GAL-GTA.GDT 11/28/19

APPENDIX B

Laboratory Test Results

FIGURE B-1



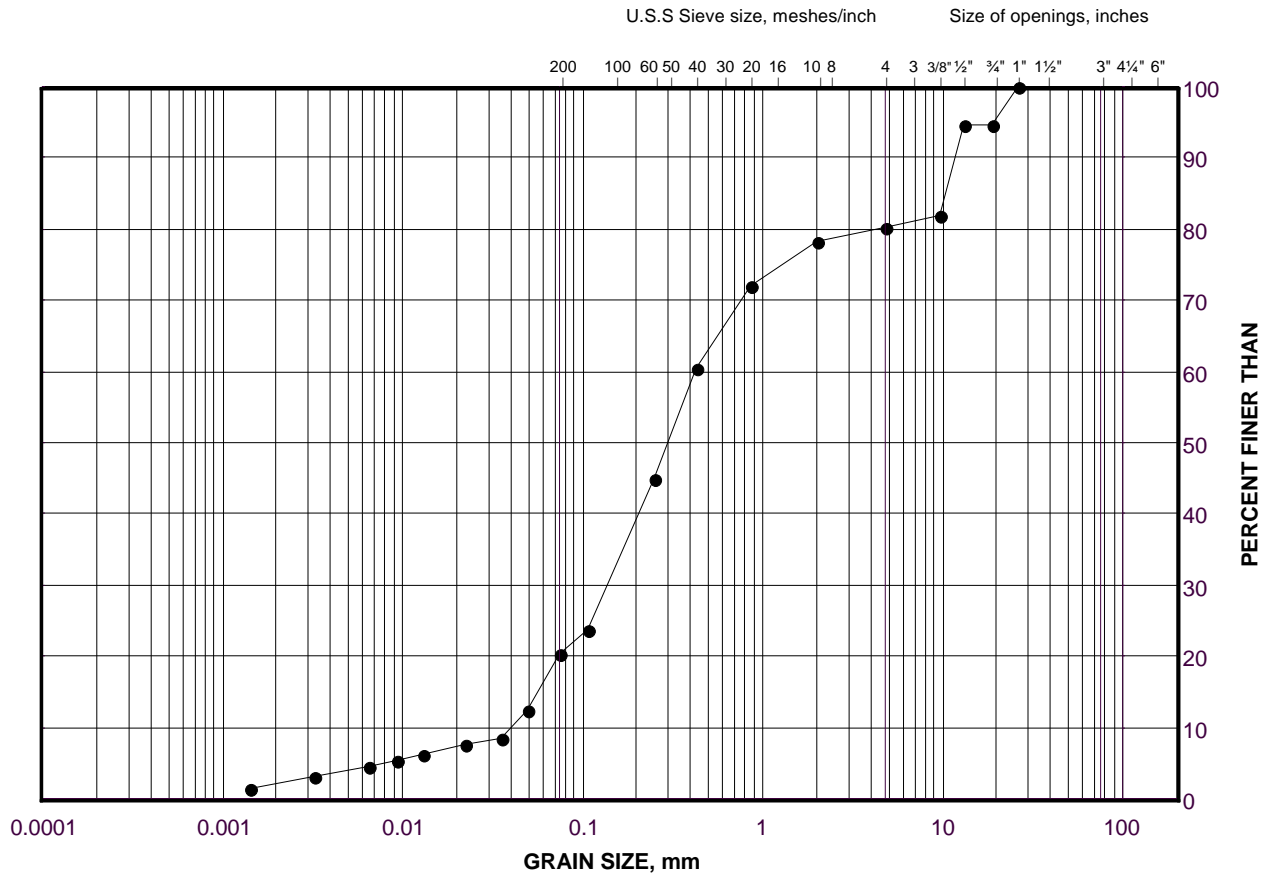
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	19-3	1	431.1
■	19-2	2	427.5

Date: 08-Oct-19

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE B-2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	19-3	5	427.3

Project Number: 18104224

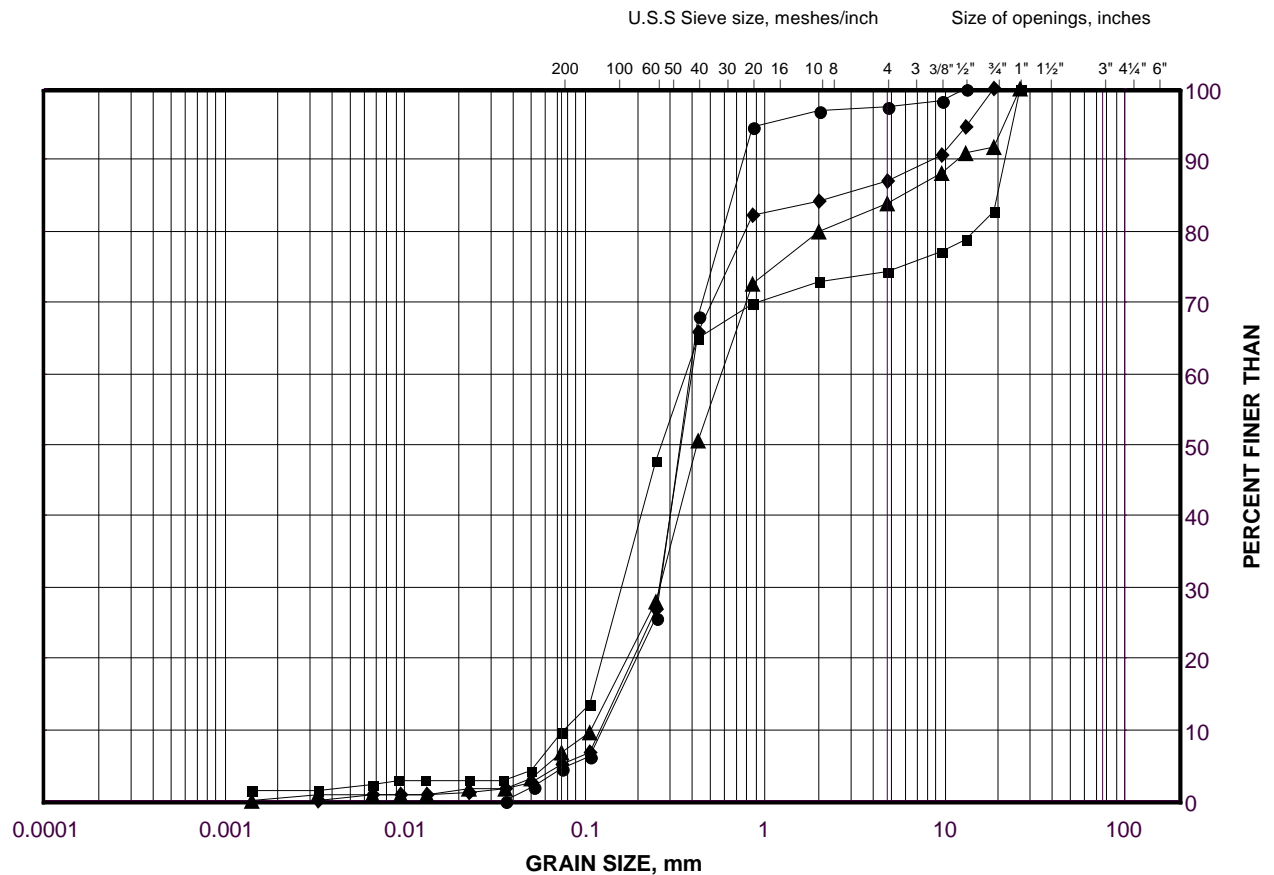
Checked By: MJB

Golder Associates

Date: 08-Oct-19

GRAIN SIZE DISTRIBUTION SAND (SP)

FIGURE B-3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	19-3	11	422.7
■	19-1	4	424.3
◆	19-1	6	423.0
▲	19-3	8	425.0

Project Number: 18104224

Checked By: MJB

Golder Associates

Date: 08-Oct-19

**CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727**

ATTENTION TO: Mike Cleverdon

PROJECT: 18104224

AGAT WORK ORDER: 19T509895

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: Sep 05, 2019

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

***NOTES**

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T509895

PROJECT: 18104224

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

SAMPLING SITE: Hwy 127

ATTENTION TO: Mike Cleverdon

SAMPLED BY: MJB

Corrosivity Package

DATE RECEIVED: 2019-08-26

DATE REPORTED: 2019-09-05

SAMPLE DESCRIPTION: 19-3 Sa4
SAMPLE TYPE: Soil
DATE SAMPLED: 2019-08-14
G / S RDL 472797

Parameter	Unit	G / S	RDL	472797
Chloride (2:1)	µg/g		2	24
Sulphate (2:1)	µg/g		2	8
pH (2:1)	pH Units		NA	8.51
Electrical Conductivity (2:1)	mS/cm		0.005	0.419
Resistivity (2:1) (Calculated)	ohm.cm		1	2390
Redox Potential 1	mV		NA	35.4
Redox Potential 2	mV		NA	44
Redox Potential 3	mV		NA	39.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

472797 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.

PI note: Redox Potential is not an accredited parameter.

Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Divine Basily

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 18104224

SAMPLING SITE: Hwy 127

AGAT WORK ORDER: 19T509895

ATTENTION TO: Mike Cleverdon

SAMPLED BY: MJB

Soil Analysis

RPT Date: Sep 05, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Corrosivity Package

Chloride (2:1)	472797	472797	24	24	0.0%	< 2	102%	80%	120%	106%	80%	120%	111%	70%	130%
Sulphate (2:1)	472797	472797	8	8	NA	< 2	97%	80%	120%	109%	80%	120%	114%	70%	130%
pH (2:1)	472797	472797	8.51	8.49	0.2%	NA	100%	90%	110%						
Electrical Conductivity (2:1)	472797	472797	0.419	0.410	2.2%	< 0.005	99%	90%	110%						
Redox Potential 1	1					NA	97%	90%	110%						

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:

AGAT QUALITY ASSURANCE REPORT (V1)

Page 3 of 5

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

Results relate only to the items tested. Results apply to samples as received.



Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 18104224

SAMPLING SITE: Hwy 127

AGAT WORK ORDER: 19T509895

ATTENTION TO: Mike Cleverdon

SAMPLED BY: MJB

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B, SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE



golder.com