REPORT

November 9, 2018

FOUNDATION INVESTIGATION REPORT

STRUCTURAL BUNDLE - 11 STRUCTURES ON HIGHWAYS 129, 532 AND 556
HIGHWAY 532 - ATKINSON CREEK CULVERT NO. 1 REPLACEMENT, 9.7 KM NORTH OF HIGHWAY 556 (SITE NO. 38S-290C)
LAT. 46.817536° ; LONG. -84.089595°
GAUDETTE TOWNSHIP, ALGOMA DISTRICT, ONTARIO
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5378-11-00 ; WP 5261-13-02

Submitted to:
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Report No.: 1670846 ; GEOCRES No. 41K-110
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Golder Associates

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PART A

FOUNDATION INVESTIGATION REPORT
STRUCTURAL BUNDLE – 11 STRUCTURES ON HIGHWAYS 129, 532 AND 556
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the replacement of a culvert on Highway 532 (Site No. 38S-290C) in the Gaudette Township, Algoma District, Ontario.

The purpose of the field investigation is to establish the subsurface conditions at the location of the proposed replacement culvert by methods of borehole drilling, in-situ testing and laboratory testing on selected soil samples.

This report summarizes the factual results of field and laboratory work (including field investigation procedures, borehole stratigraphy, and geotechnical and analytical laboratory test results) as well as a description of the interpreted soil and groundwater conditions at the Atkinson Creek culvert site.

The Terms of Reference and Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal dated May 2016 (Agreement No. 5016-E-0029). Golder's proposal for foundation engineering services is contained in Section 17.8 of AECOM's Technical Proposal for this assignment.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Project Description

The existing culvert at the site conveys the Atkinson Creek under Highway 532 in a northeast to southwest direction. The culvert was constructed in 1978 and there are no records of the culvert being rehabilitated since that time. It is understood that the existing culvert underwent a structural assessment in 2015 and was identified as being in fair structural condition with minor deterioration of several elements, and more significant deterioration of the structural steel coatings. The culvert is to be replaced with a new reinforced concrete box culvert.

2.2 Site Description

The site of the proposed culvert replacement is located about 9.7 km north of Highway 556 in the Gaudette Township, Algoma District, Ontario.

The existing culvert consists of a single cell, Structural Plate Corrugated Steel Pipe (SPCSP) culvert with an approximately 3.67 m diameter and measuring about 30.9 m in length. The culvert is shown on Drawing 1.

The Atkinson Creek at the location of the culvert is between approximately 6 m and 7 m wide and flows in a generally northeast to southwest direction where it crosses below Highway 532. The downstream end of the Atkinson Creek flows into the Achigan Creek about 260 m southwest of the culvert. The Achigan Creek in turn flows into the Goulais River about 5.6 km south of the culvert (i.e., immediately south of Searchmont).

Highway 532 at the location of the culvert consists of an approximately 5.5 m high earth fill embankment that carries one lane of traffic in each direction. Although the highway is oriented in a generally northwest to southeast direction at the culvert, for the purposes of this report the highway is defined as running in a north-south direction. The travelled portion of the highway consists of an asphalt surface which is at approximately Elevation 251.6 m in the vicinity of the existing culvert.

Entrances to residential dwellings are located on the east side of Highway 532, approximately 80 m south and 105 m north of the culvert, as well as on the west side of Highway 532, approximately 90 m north of the culvert. Overhead electrical transmission lines run along the highway on the east side of Highway 532 (i.e., immediately west of the inlet).

The topography of the area in the immediate vicinity of the culvert is relatively flat to undulating, particularly on the west side of Highway 532, given that the site is located within the Achigan Creek valley. However, the natural ground surface rises significantly further east and west of the culvert – an indicator of the high relief and rugged topography in this area. The natural ground surface in the immediate vicinity of the inlets and outlets of the existing culvert varies between about Elevations 246.5 m and 248.0 m. The site is relatively heavily vegetated with grasses and shrubs, as well as deciduous and coniferous trees.

3.0 FIELD INVESTIGATION PROCEDURES

The fieldwork at the site of the existing culvert was carried out on September 6 and 8, 2017, during which time three boreholes (designated as Boreholes ACC2-01 to ACC2-03) were advanced near the existing culvert. Boreholes ACC2-01 and ACC2-03 were advanced near the outlet and inlet of the existing culvert, respectively. Borehole ACC2-02 was advanced through the Highway 532 embankment on the northbound lane (south of the existing culvert).

The subsurface soil conditions encountered in the boreholes are shown in detail on the Records of Boreholes in Appendix A. Lists of abbreviations and symbols are also provided in Appendix A to assist in the interpretation of the borehole records. The locations of the as-drilled boreholes are shown in plan on Drawing 1.

The boreholes were advanced using portable drilling equipment and a drill rig. Boreholes ACC2-01 and ACC2-03 were advanced using portable drilling equipment set up on land near the inlet and outlet of the existing culvert. The portable drilling equipment was supplied and operated by Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario. These two boreholes were advanced through the overburden using 'BW' casing with wash boring techniques. Borehole ACC2-02 was advanced using a CME-75 truck-mounted drill rig supplied and operated by Landcore Drilling Inc. of Chelmsford, Ontario. This borehole was advanced using 210 mm outer diameter, continuous-flight, hollow-stem augers; however, rock coring using a 'NQ' double-tube rock core barrel was used to penetrate through a gravelly fill layer with cobbles encountered below the embankment fill.

In the two boreholes advanced near the inlet and outlet of the existing culvert, the soil samples were generally obtained continuously immediately below the existing ground surface followed by sampling at intervals of depth of about 1.5 m; while in the borehole advanced on Highway 532, the soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m. All soil samples were collected using a 50 mm outer diameter, split-spoon sampler driven by a manual hammer (within Boreholes ACC2-01 and ACC2-03 advanced using the portable drilling equipment) or an automatic hammer (within Borehole ACC2-02 advanced using the truck-mounted drill rig) in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*). Field vane shear tests were carried out in the cohesive soils for assessment of undrained shear strengths (ASTM D2573, *Standard Test Method for Field Vane Shear Strength Test in Cohesive Soil*) using the MTO Standard 'N'-size vane in the borehole advanced with the drill rig, and 'B'-size vane in the smaller diameter boreholes advanced by portable equipment. Dynamic Cone Penetration Tests (DCPTs) were also carried out in all boreholes following the soil sampling operation.

The boreholes, including the DCPTs, were advanced to depths ranging between about 12.8 m and 19.2 m below existing ground surface.

All three boreholes were backfilled upon completion of drilling in accordance with Ontario Regulation 903 (Wells) (as amended).

Prior to commencement of field work, Golder arranged for the clearance of underground utilities/services. The field work was observed on a full-time basis by a member of Golder's engineering staff who monitored the drilling and sampling operations, and logged the boreholes in the field. The soil samples were transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual/tactile examination and geotechnical laboratory testing.

Geotechnical index testing (i.e., water content, organic content, Atterberg limits and grain size distribution) was carried out on selected soil samples. The results of the geotechnical laboratory testing are summarized on the borehole records in Appendix A and the results of the geotechnical testing are provided in Appendix B. All of the laboratory tests were carried out in accordance with MTO Laboratory and/or ASTM Standards, as appropriate.

A soil sample was also collected from Boreholes ACC2-03 (advanced near the inlet of the existing culvert) for corrosivity testing. The selected soil sample was submitted, under chain-of-custody procedures, to Maxxam Analytics of Mississauga, Ontario (a Standards Council of Canada accredited laboratory) for analysis of a suite of corrosivity parameters including pH, sulphate, sulphide, chloride and resistivity/conductivity.

Temporary benchmarks were established and surveyed near the existing Atkinson Creek culvert by Callon Dietz Inc. prior to the drilling crews mobilizing to site. Upon completion of drilling operations, borehole offsets and corresponding ground surface elevation differences were recorded and tied-in to the surveyed benchmark locations to determine the as-drilled borehole locations and ground surface elevations. The borehole survey information, including northing and easting coordinates (presented in the MTM NAD83 Zone 13 and latitude/longitude coordinate systems) and the ground surface elevations (referenced to Geodetic datum), are provided on the borehole records in Appendix A, presented on Drawing 1, and summarized below.

Borehole No.	Approximate Location	Coordinates (MTM NAD83 Zone 13)		Ground Surface Elevation	Borehole Depth [3]
		Northing (Latitude)	Easting (Longitude)		
ACC2-01 [1]	Outlet of existing culvert; west of Highway 532	5186427.3 m (46.817360°)	297960.3 m (-84.089639°)	247.8 m	12.8 m
ACC2-02 [2]	Northbound lane of Highway 532; south of existing culvert	5186446.5 m (46.817533°)	297968.1 m (-84.089537°)	251.6 m	19.2 m
ACC2-03 [1]	Inlet of existing culvert; east of Highway 532	5186463.0 m (46.817681°)	297966.3 m (-84.089561°)	248.0 m	13.1 m

Notes:
1. Boreholes ACC2-01 and ACC2-03 were advanced using portable drilling equipment set up on land near the outlet and inlet of the existing culvert.
2. Borehole ACC2-02 was advanced using a truck-mounted drill rig through the Highway 532 embankment.
3. The borehole depth includes the DCPT carried out at the bottom of each open borehole.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)[1] mapping, the Atkinson Creek culvert site is located at the edge of a valley train consisting primarily of gravelly and sandy soils which "are mainly confined to the larger river valleys and usually occur as flat, terraced landforms" (McQuay, 1980). The granular deposits are variable in thickness and are generally underlain by varved silt and clay to glacial till and bedrock. The valley train is bordered by bedrock knobs.

Based on geological mapping developed by the Ontario Ministry of Northern Development and Mines (MNDM)[2], the site is underlain by bedrock from the gneissic tonalite suite of rocks comprised of tonalite to granodiorite (foliated to gneissic) with minor supracrustal inclusions.

4.2 Overview of Local Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes advanced at this site, together with the results of the in-situ and geotechnical/analytical laboratory testing, are presented on the Records of Boreholes (provided in Appendix A) and the laboratory test figures/sheets (provided in Appendices B and C). The results of the in-situ field tests (i.e., SPT 'N'-values and field vane undrained shear strengths) as presented on the borehole records are uncorrected, and the 'N'-values are based on SPT sampling procedures carried out with a manual hammer at the locations of Boreholes ACC2-01 to ACC2-03 and an automatic hammer at the location of Borehole ACC2-02.

The stratigraphic boundaries shown on the borehole records and on the soil strata profile (i.e., Drawing 1) are inferred from observations of drilling progress, generally non-continuous sampling, and in-situ testing and therefore, represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the Atkinson Creek culvert site consist of a granular embankment fill (associated with Highway 532) or a surficial granular deposit comprised of sandy silt to silt and sand underlain by an extensive deposit of clayey silt. The cohesive deposit is underlain by a deposit of silt.

Detailed descriptions of the subsurface conditions encountered in the boreholes at this site are provided in the following subsections.

4.2.1 Asphalt

An approximately 130 mm thick layer of asphalt was encountered in Borehole ACC2-02 which was advanced through the Highway 532 embankment on the northbound lane (south of the existing culvert). The top of the asphalt layer is at about Elevation 251.6 m.

4.2.2 Sand to Gravelly Sand to Sand and Gravel to Gravel (Fill)

An approximately 5.5 m thick layer of granular fill associated with the Highway 532 embankment was encountered below the layer of asphalt in Borehole ACC2-02. The embankment fill is comprised predominantly of sand, trace

1 Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41KNE, Study Number 91.

2 Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2544.

to some gravel, trace to some silt to gravelly sand, trace to some silt, but becomes coarser at a depth of about 3.7 m below existing ground surface, where it is comprised of sand and gravel to gravel, trace to some silt with cobbles and rock fragments. An approximately 1.2 m thick layer of granular fill comprised of gravelly sand, some silt, trace clay was also encountered immediately at the ground surface in Borehole ACC2-01 which was advanced near the outlet of the existing culvert and next to the toe of the highway embankment. The top of the granular fill layer encountered in Boreholes ACC2-01 and ACC2-02 is at about Elevation 247.8 m and Elevation 251.5 m, respectively.

The SPT 'N'-values measured within the upper portion of the embankment fill range from 9 blows to 14 blows per 0.3 m of penetration, indicating a loose to compact state of compactness. A SPT 'N'-value measured within the gravel portion of the fill is 36 blows per 0.3 m of penetration, indicating a dense state of compactness. A SPT 'N'-value measured within the sand and gravel portion of the fill (i.e., at the base of the fill) is 12 blows per 0.3 m of penetration, indicating a compact state of compactness. However, the latter SPT 'N'-value is likely unrepresentative of the material's state of compactness as a result of coring immediately above the split-spoon sample. Two SPT 'N'-values measured within the granular fill encountered at the ground surface in Borehole ACC2-01 are 8 blows per 0.3 m of penetration, indicating a loose state of compactness.

The water content measured on two samples of the sand to gravelly sand portion of the embankment fill is approximately 6% and 7%. The water content measured on the gravel portion of the embankment fill is approximately 2%. The water content measured on sample of the granular fill recovered near the outlet of the existing culvert is approximately 17%.

The results of a grain size distribution tests carried out on two samples of the granular fill are shown on Figure B1 in Appendix B.

A consolidated drained direct shear test was also carried out on samples of the sand to gravelly sand fill recovered from Borehole ACC2-02. The results are presented on Figure B2.

4.2.3 Sandy Silt to Silt and Sand

A deposit of organic silt and sand was encountered below the surficial layer of fill in Borehole ACC2-01 advanced near the outlet of the existing culvert, and a deposit of sandy silt to silt and sand was encountered immediately at the ground surface in Borehole ACC2-03 advanced near the inlet of the existing culvert. The deposit contains rootlets, wood fragments, and organics. The top of this deposit in Borehole ACC2-01 is at about Elevation 246.6 m and its thickness is about 1.9 m; while in Borehole ACC2-03, the top of this deposit is at about Elevation 248.0 m and its overall thickness is about 2.2 m.

The SPT 'N'-values measured within this deposit range between 0 blows (i.e., designated as "WH" on the borehole record, which indicates that the split-spoon sampler was penetrated for 0.3 m under the self-weight of the hammer) and 4 blows per 0.3 m of penetration, indicating a very loose and loose state of compactness.

The water content measured on three samples of the silt and sand portion of the deposit ranges between approximately 37% and 60%. An organic content test carried out on a sample recovered from Borehole ACC2-01 is 5.8% (by weight).

The results of grain size distribution tests carried out on two samples of the silt and sand portion of the deposit are shown on Figure B3 in Appendix B.

An Atterberg limits test carried out on a sample of the silt and sand deposit recovered from Borehole ACC2-01 measured a liquid limit of about 30%, a plastic limit of about 26%, and a corresponding plasticity index of about 4%. The results of this Atterberg limits test are shown on the plasticity chart on Figure B4 in Appendix B, and indicate that the material is classified as an organic silt of slight plasticity. An Atterberg limits test was also carried out on a sample of the silt and sand deposit recovered from Borehole ACC2-03 and the results indicate that the material is non-plastic.

4.2.4 Clayey Sit

An extensive cohesive deposit comprised of clayey silt, trace to some sand, was encountered below the silt and sand deposit in Boreholes ACC2-01 and ACC2-03 and below the sand and gravel fill in Borehole ACC2-02. The top of the cohesive deposit ranges between about Elevations 246.0 m and 244.8 m and its thickness ranges from about 7.1 m to 9.2 m.

The SPT 'N'-values measured within the clayey silt deposit range between 1 blow and 8 blows per 0.3 m of penetration. In-situ vane tests carried out within this deposit in Boreholes ACC2-02 and ACC2-03 measured (uncorrected) undrained shear strength ranging from about 46 kPa to greater than 96 kPa. The measured undrained shear strengths below the Highway 532 embankment are generally greater than 96 kPa, while the measured undrained shear strength range between about 46 kPa and 75 kPa near the inlet of the existing culvert. An in-situ vane test was also attempted at a depth of about 5.2 m below ground surface in the borehole advanced near the outlet of the existing culvert; however, it was not possible to turn the vane, indicative of the material's very stiff to hard consistency. The sensitivity (defined as the quotient between the undisturbed shear strength and the remoulded shear strength) ranges between about 2 and 11, but typically varies from 2 to 7. The in-situ field vanes tests results indicate that the deposit has a predominantly firm to very stiff consistency.

The water content measured on nine samples of this deposit ranges between about 33% and 50%, and on average is about 39%.

The results of grain size distribution tests carried out on six samples of the clayey silt deposit are shown on Figure B5 in Appendix B.

Atterberg limits tests were carried out on seven samples of the clayey silt deposit. The tests measured liquid limits between about 24% and 30%, plastic limits between about 18% and 21%, and plasticity indices between about 4% and 10%. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B6 in Appendix B and indicate that the material can be classified as a clayey silt of low plasticity.

4.2.5 Silt

A deposit of silt, trace to some sand, was encountered below the clayey silt deposit in all boreholes. The top of this deposit ranges between about Elevations 237.8 m and 236.8 m. The thickness of the sampled portion of the silt deposit is greater than 1.1 m; all of the boreholes were terminated within the silt deposit. DCPTs were also carried out at the bottom of each open borehole (i.e., below the last collected soil sample). The DCPTs were terminated at elevations ranging between about 235.2 m and 232.4 m. The blow counts at these elevations generally range between 20 blows and 60 blows per 0.3 m of penetration.

The SPT 'N'-values measured within the silt deposit range between 10 blows and 17 blows per 0.3 m of penetration, indicating a loose to compact state of compactness.

The water content measured on two samples of the silt deposit recovered from Boreholes ACC2-02 and ACC2-03 is approximately 28% and 31%, respectively.

4.3 Groundwater Conditions

The water level was measured at a depth of about 0.7 m (corresponding to Elevation 247.1 m) and 3.5 m (corresponding to Elevation 244.5 m) below existing ground surface upon removal of drilling casing in Boreholes ACC2-01 and ACC2-03 (advanced near the outlet and inlet of the existing culvert), respectively. The water levels are not necessarily considered representative of the groundwater level at the site due to introduction of drilling water to accommodate wash boring techniques. The water level measured inside the hollow-stem augers in Borehole ACC2-02 (advanced through the Highway 532 embankment) was measured upon completion of drilling at a depth of about 4.3 m below existing ground surface, corresponding to Elevation 247.3 m. Drilling water was also introduced at depth of about 4.4 m to core through a layer of cobbles and the measured water level may not be indicative of the groundwater level at the site.

Given the presence of the Atkinson Creek, the groundwater level is anticipated to be at or near the creek surface. The water level surveyed at the surface of the Atkinson Creek in June 2017 was at approximately Elevation 247.0 m, which is similar to the higher water levels described above.

The water level in the creek and the degree of saturation of the embankment fill (or the potential presence of a perched water table within the fill) is subject to seasonal fluctuations and precipitation events. Water levels in the creek and within the fill are expected to be higher during wet seasons and sustained periods of precipitation.

4.4 Analytical Testing of Soil

A soil sample was selected from Borehole ACC2-03 (advanced near the inlet of the existing culvert) and submitted to Maxxam Analytics Ontario for corrosivity testing. The analytical laboratory test results are provided on the Certificates of Analysis presented in Appendix C, and summarized below.

Borehole Designation	Sample No.	Average Approx. Sample Depth (m)	Average Approx. Sample Elevation (m)	Material Type	Resistivity (ohm·cm)	Conductivity (µohm/cm)	pH	Chloride (Cl) Content (ppm or µg/g)	Sulphate (SO_4) Content (ppm or µg/g)
ACC2-03 [1,2]	SA 2	0.9	247.1	Silt and Sand	4,100	246	5.1	130	22

Notes:
1. The borehole designation on the Certificates of Analysis was erroneously labelled as “ACCS-03”.
2. It is noted that corrosivity test results associated with soil samples recovered from boreholes that were advanced at other sites associated with this project are also presented on the Certificates of Analysis.

Sulphide concentration was also measured on the soil sample referenced above and is approximately 1.06 µg/g.

5.0 CLOSURE

The field work for this investigation was supervised by Ms. Amelia Jewison, B.A.Sc., and Ms. Katelyn Nero, B.A.Sc. The Foundation Investigation Report was prepared by Mr. Tomasz Zalucki, P.Eng., a geotechnical engineer with Golder. Ms. Lisa C. Coyne, P.Eng., a MTO Foundations Designated Contact and Principal of Golder, conducted an independent quality control review of the report.

Report Signature Page

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MTO Foundations Designated Contact, Principal

TZ/JPD/LCC/tz

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https://golderassociates.sharepoint.com/sites/14262g/deliverables/04-final fidr/atkinson creek culvert no. 1/1670846-09a-rpt-rev0-atkinson creek culvert no. 1 fir-20181109.docx

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McQuay, D.F. 1980. Sault Ste. Marie Area (NTS 41K/NE), District of Algoma; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 91, 21p. Accompanied by Maps 5012 and 5013, Scale 1:100000.

Ontario Ministry of Natural Resources and Forestry. Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 41KNE, Study Number 91.

Ontario Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2544.

ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

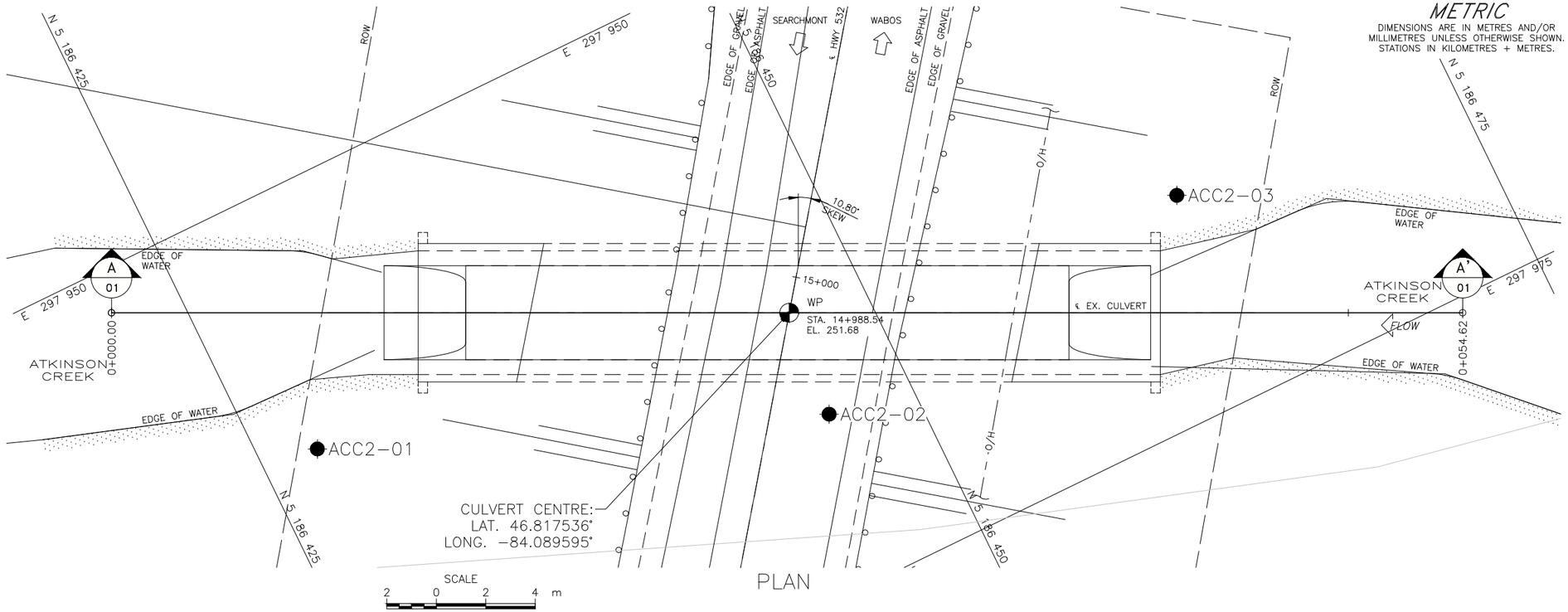
ASTM D2573 Standard Test Method for Field Vane Shear Strength Test in Cohesive Soil

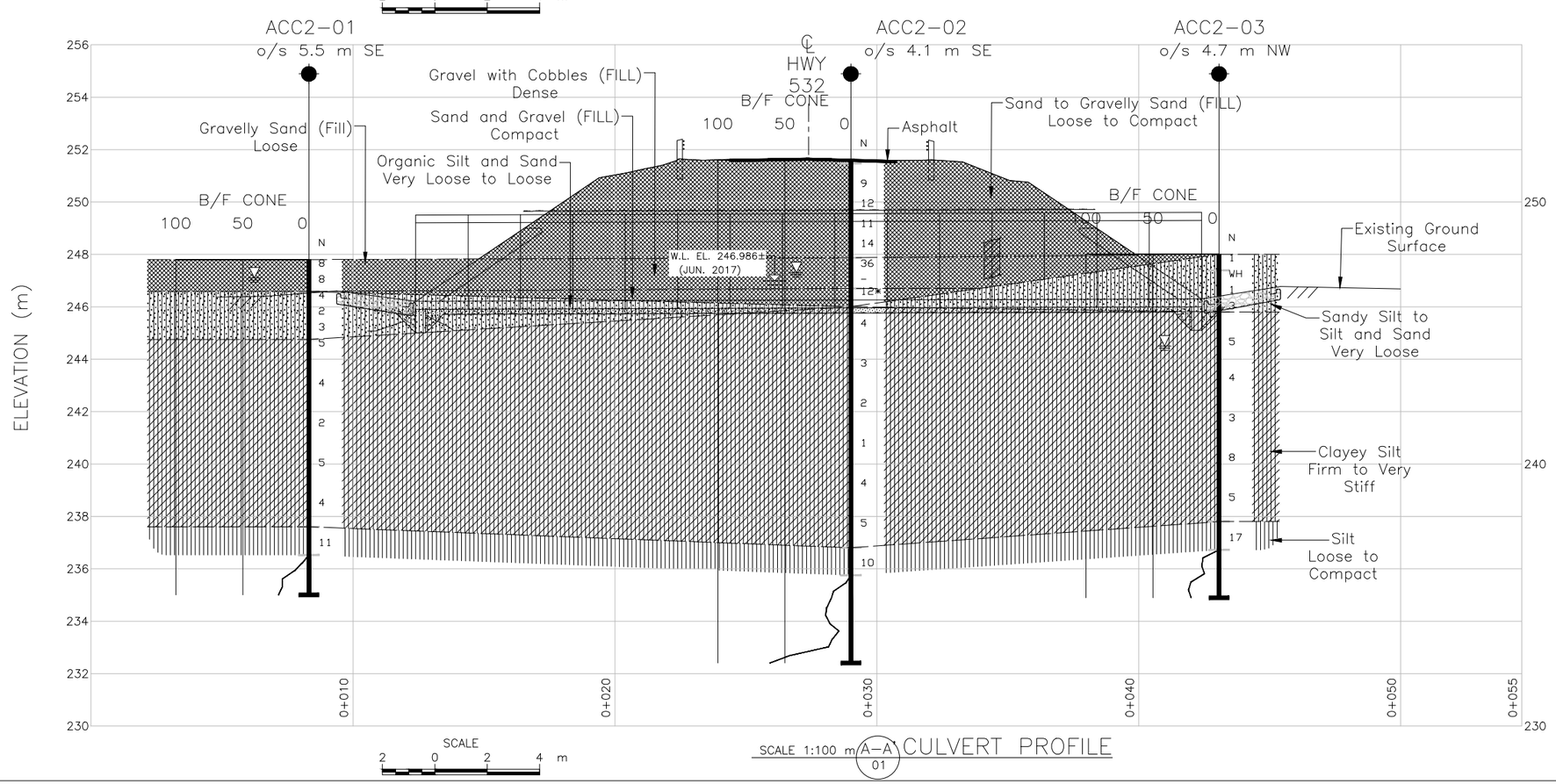
Ontario Regulations:

R.R.O 1990, Regulation 903 Wells, under Ontario Water Resources Act, R.S.O. 1990, c. O.40

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO





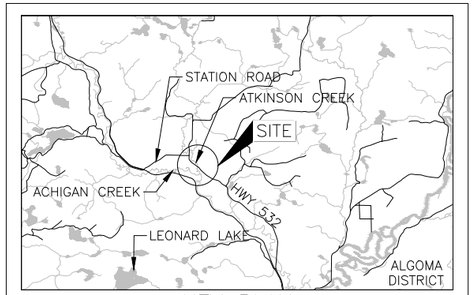
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5261-13-02

SHEET

HIGHWAY 532
ATKINSON CREEK CULVERT NO. 1
BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



KEY PLAN
SCALE

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 13)

No.	ELEVATION	NORTHING	EASTING
ACC2-01	247.8	5186427.3	297960.3
ACC2-02	251.6	5186446.5	297968.1
ACC2-03	248.0	5186463.0	297966.3

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LICENSED PROFESSIONAL ENGINEER L.C. COYNE Nov. 09, 2018 PROVINCE OF ONTARIO

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 AECOM, drawing file no. "60546679-P60.dwg", received June 7, 2018.

NO.	DATE	BY	REVISION

Geocres No. 41K-110

HWY. 532	PROJECT NO. 1670846		DIST. ALGOMA
SUBM'D. AK	CHKD. TZ	DATE: 11/8/2018	SITE: 38S-2900
DRAWN: SMD	CHKD. LCC	APPD. LCC	DWG. 01

PLOT DATE: November 8, 2018
FILENAME: S:\Clients\MTO\Sault_Ste_Marie\99_PROJ\1670846_Hwys_129_532_556\40_PROD\0007_AtkinsonCreek\1670846-0007-BC-0001.dwg

APPENDIX A

Borehole Records

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 δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

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

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

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

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

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

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness Condition	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

GOLDER

RECORD OF BOREHOLE No ACC2-01 SHEET 1 OF 2 METRIC

PROJECT 1670846
W.P. 5261-13-03
DIST ALGOMA HWY 556
DATUM Geodetic
LOCATION N 5186427.3; E 297960.3 MTM NAD 83 ZONE 13 (LAT. 46.817360; LONG. -84.089639)
BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing
DATE September 6, 2017
ORIGINATED BY KN
COMPILED BY SE
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
247.8	GROUND SURFACE										
0.0	Gravelly sand, some silt, trace clay (FILL) Loose Brown Moist		1	SS	8	▽	247		○		24 56 19 1
			2	SS	8						
246.6											
1.2	ORGANIC SILT and SAND, trace clay, trace rootlets, wood fragments and organics Very loose to loose Brown Moist to wet		3	SS	4		246				
			4	SS	2				H ○		0 52 45 3
			5	SS	3		245		○	OC=5.8%	
244.8											
3.1	CLAYEY SILT, trace to some sand Firm to very stiff Grey Wet		6	SS	5		244		○		
			7	SS	4		243				
	- Unable to turn a vane at a depth of about 5.2 m						242				
			8	SS	2				H ○		0 7 77 16
							241				
			9	SS	5		240				
							239				
			10	SS	4				H ○		0 4 87 9
237.6							238				
10.2	SILT, trace to some sand Compact Grey Wet		11	SS	11		237				
236.5											
11.3	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)						236				
235.0											
12.8	END OF DCPT						235				

NOTES:

1. Borehole ACC2-01 was advanced near the outlet of the existing Atkinson Creek Culvert (West side of Highway 532).

Continued Next Page

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 11/8/18

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACC2-01 SHEET 2 OF 2 METRIC

W.P. 5261-13-03 LOCATION N 5186427.3; E 297960.3 MTM NAD 83 ZONE 13 (LAT. 46.817360; LONG. -84.089639) ORIGINATED BY KN

DIST ALGOMA HWY 556 BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing COMPILED BY SE

DATUM Geodetic DATE September 6, 2017 CHECKED BY TZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	2. Borehole caved to a depth of about 7.9 m below existing ground surface (Elev. 239.9 m) upon removal of casing. 3. Water level measured at a depth of about 0.7 m below exisitng ground surface (Elev. 247.1 m) upon removal of casing.										

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 11/8/18

GOLDER

RECORD OF BOREHOLE No ACC2-02 SHEET 1 OF 2 METRIC

PROJECT 1670846
W.P. 5261-13-03
DIST ALGOMA HWY 556
DATUM Geodetic

LOCATION N 5186446.5; E 297968.1 MTM NAD 83 ZONE 13 (LAT. 46.817533; LONG. -84.089537)
BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; NQ Coring
DATE September 8, 2018

ORIGINATED BY AJ
COMPILED BY AK
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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
251.6	GROUND SURFACE						251				
0.0	ASPHALT (130 mm)										
0.1	Sand, trace to some gravel, trace to some silt to gravelly sand, trace to some silt (FILL) Loose to compact Brown Moist		1	SS	9						
			2	SS	12		250		○		
			3	SS	11		249		○		10 81 9 0
			4	SS	14						
247.9							248				
3.7	Gravel, trace to some sand, with cobbles and rock fragments (FILL) Dense Grey, black and red Wet		5	SS	36	▽			○		
246.7			-	RC	-		247				
4.9	Sand and gravel (FILL) Compact Grey, black and red Wet		6	SS	12*						
246.0							246				
5.6	CLAYEY SILT, trace to some sand Stiff to very stiff Grey Wet		7	SS	4				H ○		0 6 87 7
			8	SS	3		244		○		
			9	SS	2		243	>96 +	H ○		
			10	SS	1		242	+ 11			
			11	SS	4		241	>96 +	H ○		0 13 80 7
			12	SS	5		240				
236.8							239	>96 +			
14.8							238				
							237				

Continued Next Page

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

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GOLDER

RECORD OF BOREHOLE No ACC2-02 SHEET 2 OF 2 METRIC

PROJECT 1670846
W.P. 5261-13-03
DIST ALGOMA HWY 556
DATUM Geodetic

LOCATION N 5186446.5; E 297968.1 MTM NAD 83 ZONE 13 (LAT. 46.817533; LONG. -84.089537) ORIGINATED BY AJ
BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers; NQ Coring COMPILED BY AK
DATE September 8, 2018 CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
235.8	SILT, trace to some sand Loose to compact Grey Wet		13	SS	10		236 235 234 233				
15.9 232.4	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)										
19.2	END OF DCPT NOTES: 1. Borehole ACC2-02 was advanced on the northbound lane of Highway 532 to the south of the existing Atkinson Creek Culvert. 2. Water level measured at a depth of about 4.3 m below existing ground surface (Elev. 247.3 m) inside the augers upon completion of drilling. 3. Borehole caved to a depth of about 2.7 m below existing ground surface (Elev. 248.9 m) upon removal of augers. * The SPT 'N'-value is likely unrepresentative of the material's state of compactness as a result of coring immediatly above the split-spoon sample.										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100
WATER CONTENT (%): 20 40 60

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 11/8/18

GOLDER

RECORD OF BOREHOLE No ACC2-03 SHEET 1 OF 2 METRIC

PROJECT 1670846
W.P. 5261-13-03
DIST ALGOMA HWY 556
DATUM Geodetic
LOCATION N 5186463.0; E 297966.3 MTM NAD 83 ZONE 13 (LAT. 46.817681; LONG. -84.089561)
BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing
DATE September 6, 2017
ORIGINATED BY KN
COMPILED BY AK
CHECKED BY TZ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.0	GROUND SURFACE										
0.0 / 247.4	Sandy SILT, trace clay, trace organics Very loose Brown Moist		1	SS	1		247				
0.6	SILT and SAND, trace to some clay, trace rootlets, wood fragments and organics Very loose Brown Moist to wet		2	SS	WH						
			3	SS	1					Non-Plastic	0 46 49 5
245.8			4A 4B	SS	3		246				
2.2	CLAYEY SILT, trace to some sand Firm to very stiff Grey Wet										
			5	SS	5	▽	245				
			6	SS	4		244				0 5 84 11
			7	SS	3		243				
			8	SS	8		242				0 8 84 8
			9	SS	5		241				
237.8							240				
10.2	SILT, trace to some sand Compact Grey Wet		10	SS	17		239				
236.7							238				
11.3	END OF BOREHOLE Dynamic Core Penetration Test (DCPT)						237				
234.9							236				
13.1	END OF DCPT NOTES: 1. Borehole ACC2-03 was advanced near the inlet of the existing Atkinson Creek Culvert (East side of Highway 532).						235				

Continued Next Page

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 11/8/18

GOLDER

PROJECT 1670846

RECORD OF BOREHOLE No ACC2-03 SHEET 2 OF 2 METRIC

W.P. 5261-13-03 LOCATION N 5186463.0; E 297966.3 MTM NAD 83 ZONE 13 (LAT. 46.817681; LONG. -84.089561) ORIGINATED BY KN

DIST ALGOMA HWY 556 BOREHOLE TYPE Portable Equipment - Wash Boring; BW Casing COMPILED BY AK

DATUM Geodetic DATE September 6, 2017 CHECKED BY TZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	2. Borehole caved to a depth of about 9.1 m below existing ground surface (Elev. 238.9 m) upon removal of casing. 3. Water level measured at a depth of about 3.5 m below ground surface (Elev. 244.5 m) upon removal of casing.										

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

GTA-MTO 001 \\GOLDER.GDS\GAL\MISSISSAUGA\SIM\CLIENTS\MTO\SAULT_STE_MARIE\02_DATA\GINT\SAULT_STE_MARIE.GPJ GAL-GTA.GDT 11/8/18

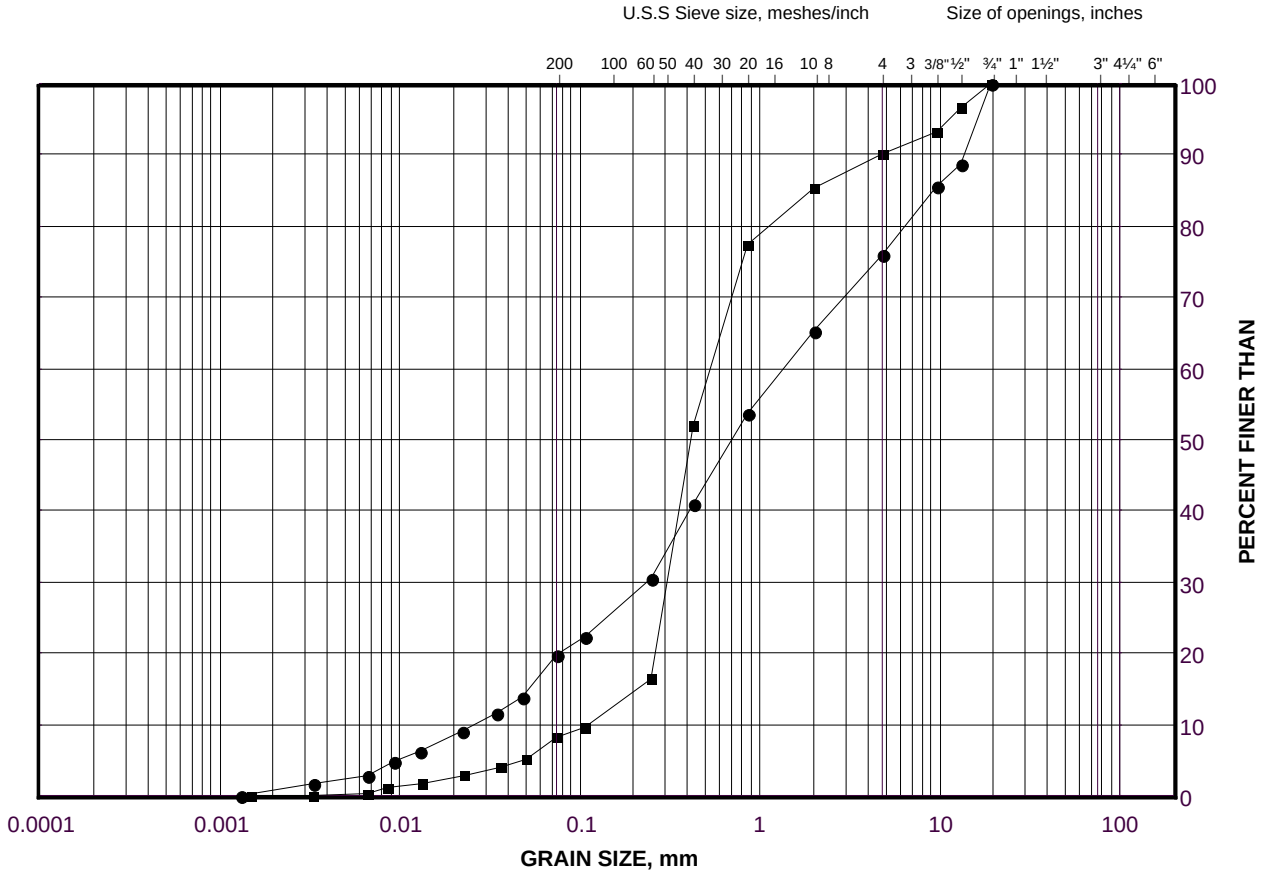
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sand to Gravelly Sand (Fill)

FIGURE B1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACC2-01	1	247.5
■	ACC2-02	3	249.0

Project Number: 1670846

Checked By: TZ

Golder Associates

Date: 03-Jul-18

CONSOLIDATED DRAINED DIRECT SHEAR TEST SHEET 1 OF 3			FIGURE B2A
TEST STAGE	A	B	C
BOREHOLE NUMBER		ACC2-02	
SAMPLE		1,2,4	
SAMPLE DEPTH, (m)		-	
SAMPLE HEIGHT, (mm)	27.40	27.20	27.50
SAMPLE LENGTH, (mm)	60.00	60.00	60.00
WATER CONTENT, BEFORE TEST, (%)	7.41	7.41	7.41
NORMAL (CONSOLIDATION) STRESS, (kPa)	25	50	100
WATER CONTENT, AFTER TEST, (%)	17.20	16.26	15.31
DISPLACEMENT RATE, mm/min	0.024	0.024	0.024
TIME TO FAILURE, hours	0.9	3.9	4.0
PEAK SHEAR STRESS[1], (kPa)	22.9	50.1	98.1
HORIZONTAL DISPLACEMENT AT PEAK, (mm)	1.3	5.6	5.7
DRY DENSITY, initial, Mg/m^3	1.731	1.763	1.734
WET DENSITY, initial, Mg/m^3	1.859	1.894	1.862

TEST NOTES:

[1] In the absence of a peak, the shear stress reported is at 10% of relative horizontal displacement (ASTM D3080).

[3] Specimens compacted to a target density of 1.87 g/cm^3 at 7% moisture content; achieved 99% compaction.

[4] Direct Shear Tests carried out under submerged conditions.

Date: 7/25/2018 Prepared By: LH

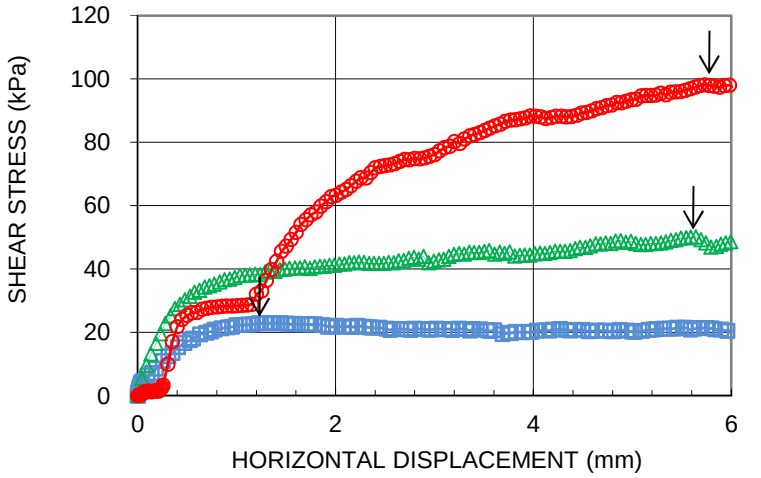
Project No. 1670846 **Golder Associates Ltd.** Checked By: TZ

CONSOLIDATED DRAINED DIRECT SHEAR TEST
SHEET 2 OF 3

FIGURE B2B

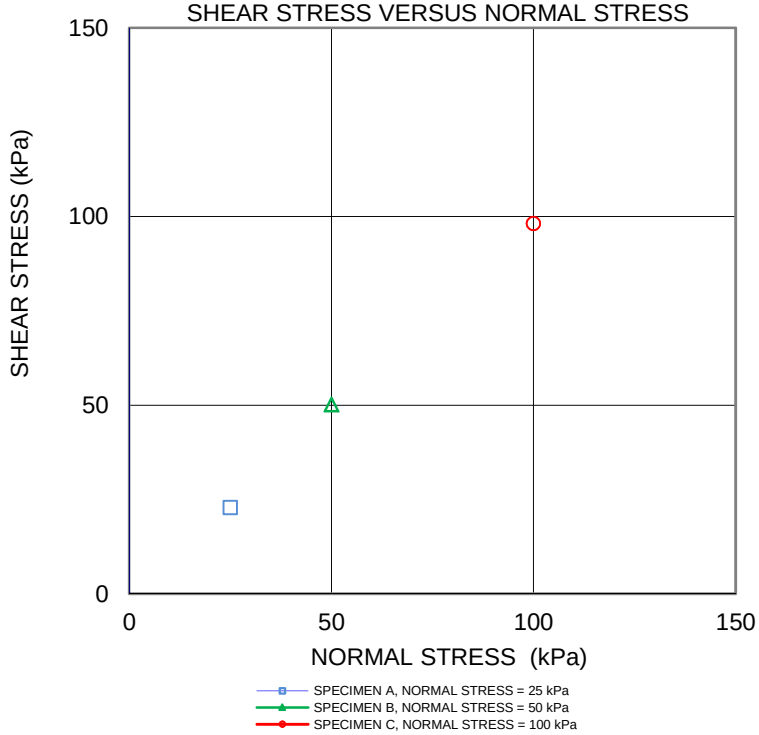
BH ACC2-02 SA 1,2,4

SHEAR STRESS VERSUS HORIZONTAL DISPLACEMENT



BH ACC2-02 SA 1,2,4

SHEAR STRESS VERSUS NORMAL STRESS



Date: 7/25/2018

Project No. 1670846

Golder Associates Ltd.

Prepared By: LH

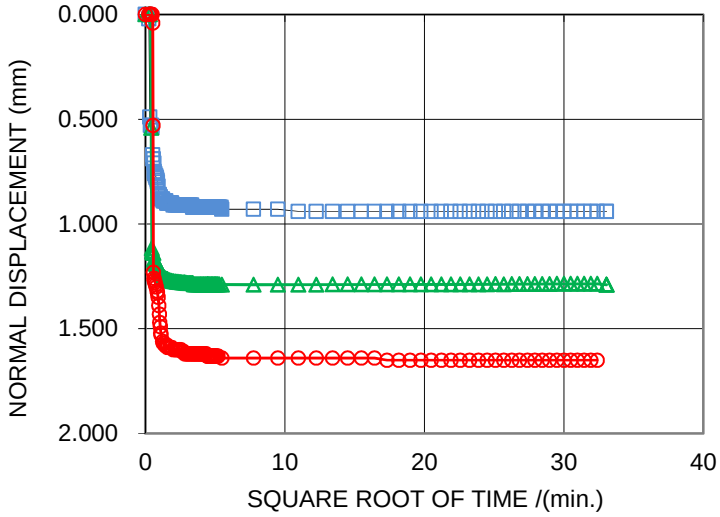
Checked By: TZ

CONSOLIDATED DRAINED DIRECT SHEAR TEST
SHEET 3 OF 3

FIGURE B2C

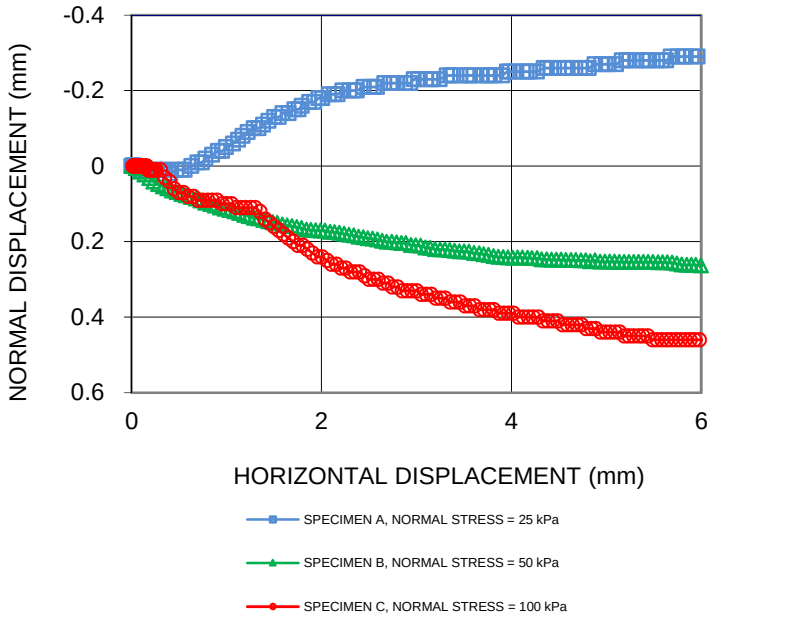
BH ACC2-02 SA 1,2,4

NORMAL DISPLACEMENT VERSUS SQUARE ROOT OF TIME



BH ACC2-02 SA 1,2,4

NORMAL DISPLACEMENT VERSUS HORIZONTAL DISPLACEMENT



Date: 7/25/2018
Project No. 1670846

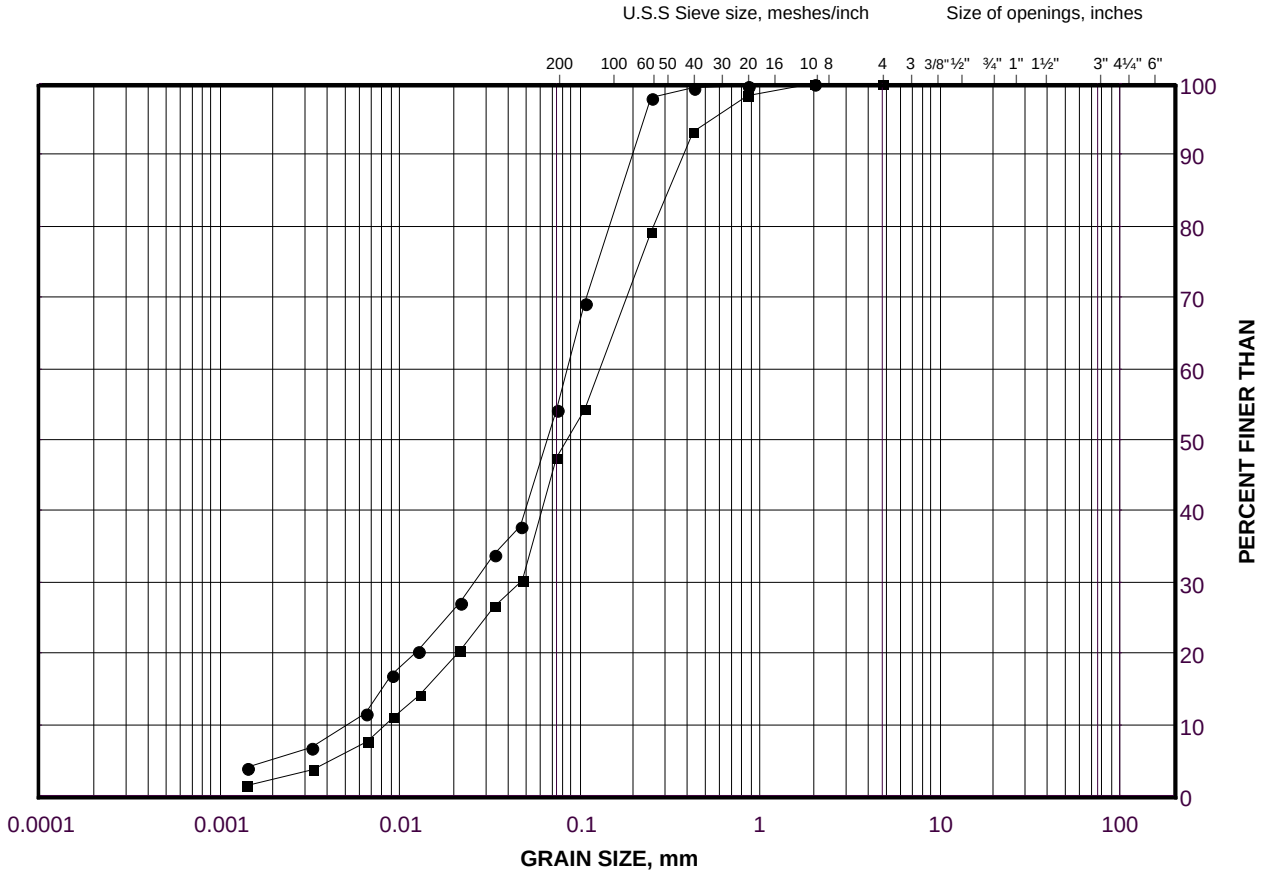
Golder Associates Ltd.

Prepared By: LH
Checked By: TZ

GRAIN SIZE DISTRIBUTION

Silt and Sand to Organic Silt and Sand

FIGURE B3



LEGEND

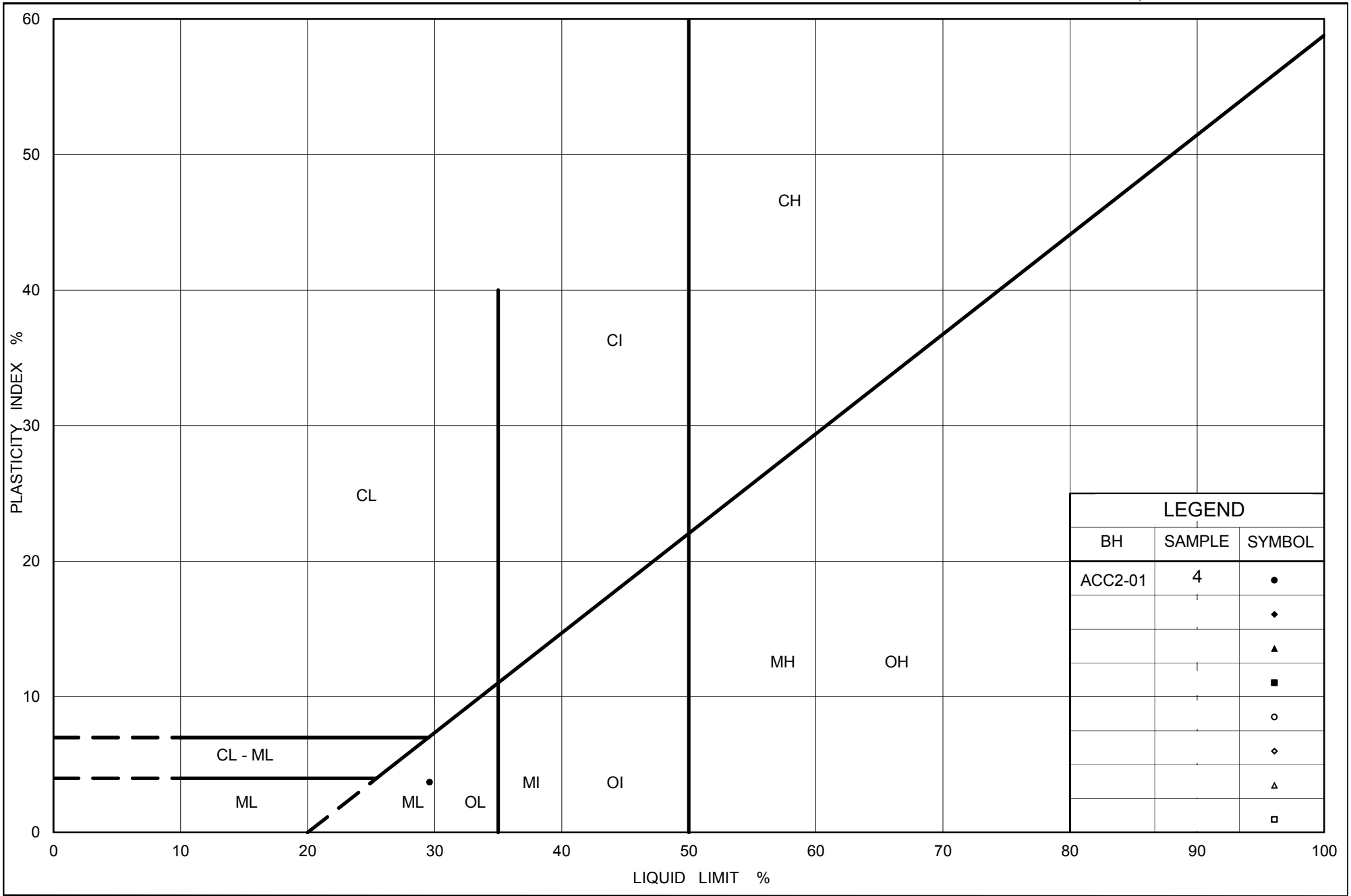
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACC2-03	3	246.5
■	ACC2-01	4	245.7

Project Number: 1670846

Checked By: TZ

Golder Associates

Date: 03-Jul-18



Ministry of Transportation

Ontario

PLASTICITY CHART
Organic Silt

Figure No. B4

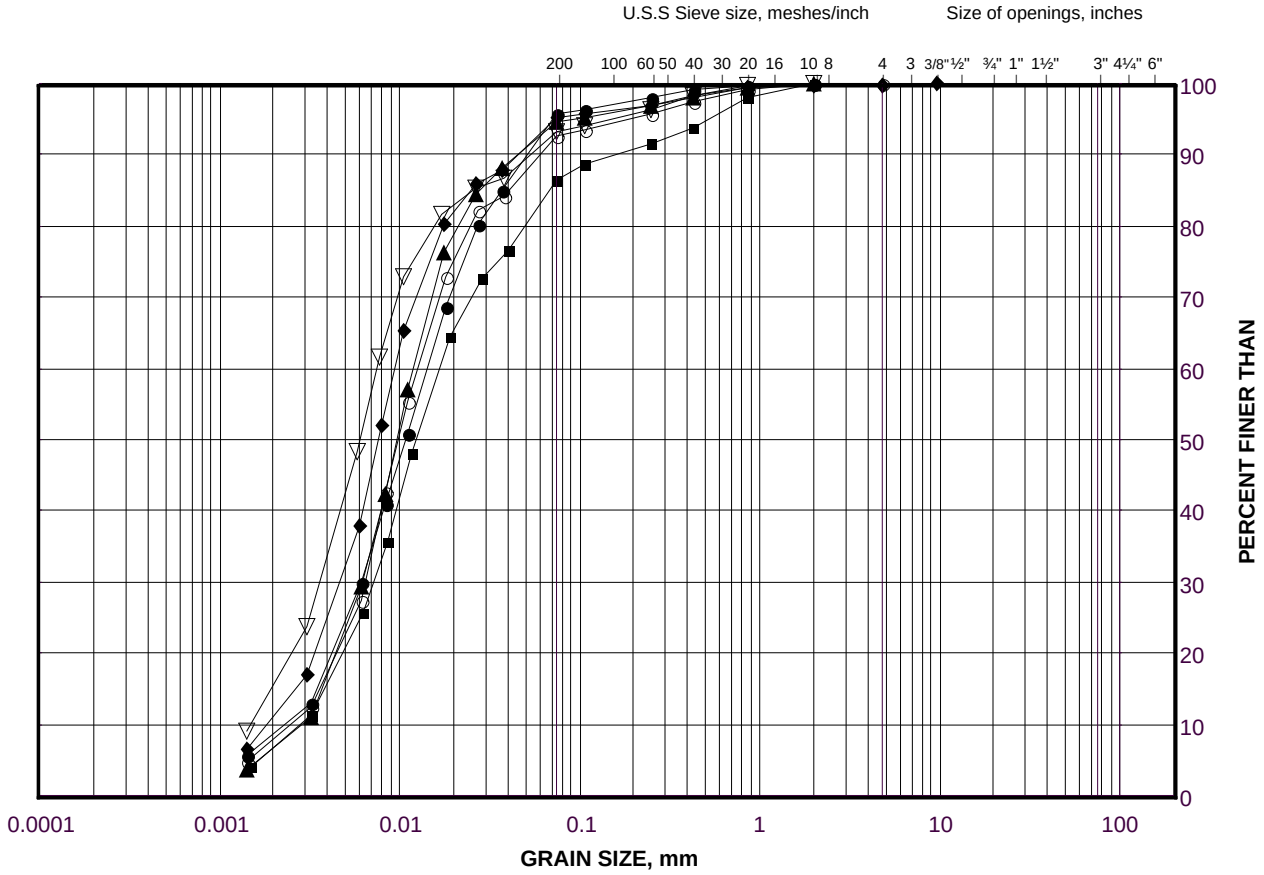
Project No. 1670846

Checked By: TZ

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE B5



LEGEND

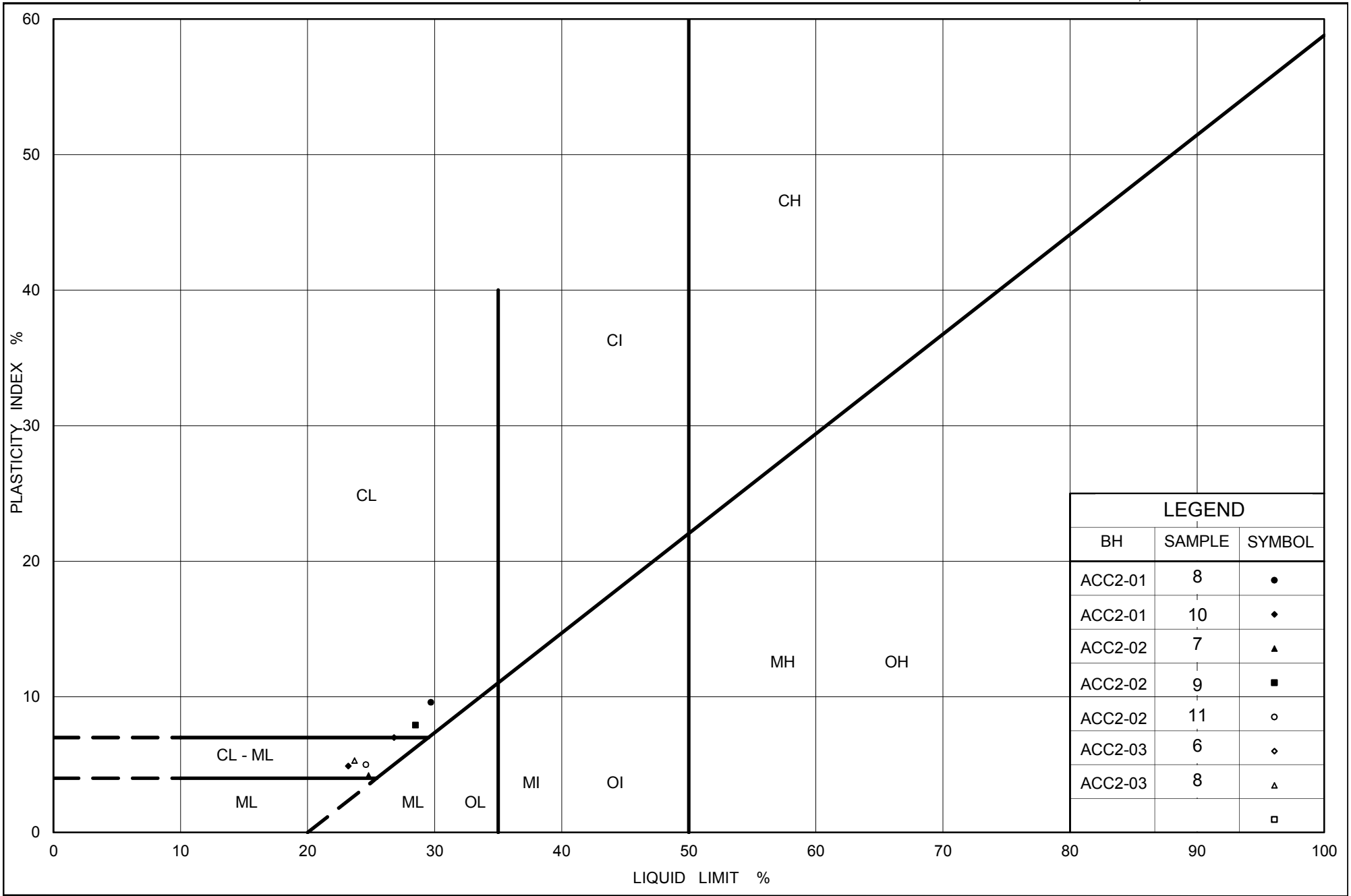
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ACC2-01	10	238.4
■	ACC2-02	11	239.1
◆	ACC2-03	6	243.1
▲	ACC2-02	7	245.2
▽	ACC2-01	8	241.4
❍	ACC2-03	8	240.1

Project Number: 1670846

Checked By: TZ

Golder Associates

Date: 03-Jul-18



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PLASTICITY CHART
Clayey Silt

Figure No. B6

Project No. 1670846

Checked By: TZ

APPENDIX C

Analytical Laboratory Test Results

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Your Project #: MB7J9789
Site Location: 1670846
Your C.O.C. #: B7J9789-M058-01-01

Attention:EMA GITEJ

MAXXAM ANALYTICS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2017/09/18
Report #: R2445858
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B780085
Received: 2017/09/16, 12:10

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Moisture	8	2017/09/18	2017/09/18	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil	8	2017/09/18	2017/09/18	BBY6SOP-00006	SM 22 4500 S2- D m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
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Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

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Your Project #: MB7J9789
Site Location: 1670846
Your C.O.C. #: B7J9789-M058-01-01

Attention:EMA GITEJ

MAXXAM ANALYTICS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2017/09/18
Report #: R2445858
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B780085
Received: 2017/09/16, 12:10

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Letitia Prefontaine, B.Sc., Senior Project Manager
Email: LPrefontaine@maxxam.ca
Phone# (604)639-2616
==========
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Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		RZ2662	RZ2662	RZ2663		RZ2664		
Sampling Date		2017/08/23	2017/08/23	2017/09/07		2017/09/06		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		B7J9789-M058-01-01		
	UNITS	ACB-03 SA4	ACB-03 SA4 Lab-Dup	ACC1-03 SA2	RDL	ACCS-03 SA2	RDL	QC Batch
MISCELLANEOUS								
Sulphide	ug/g	0.69 (1)	<0.50	0.52	0.50	1.06 (2)	0.55	8761700

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
(1) Matrix spike exceeds acceptance limits due to matrix interference. Re-analysis yields similar results.
(2) RDL raised due to high sample moisture content.

Maxxam ID		RZ2665	RZ2666		RZ2667		
Sampling Date		2017/07/16	2017/07/11		2017/08/23		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01		B7J9789-M058-01-01		
	UNITS	MRB-04 SA3	MRB-03 SA5	RDL	DCC-01 SA2	RDL	QC Batch
MISCELLANEOUS							
Sulphide	ug/g	<0.50	0.52	0.50	0.68 (1)	0.55	8761700

RDL = Reportable Detection Limit
(1) RDL raised due to high sample moisture content.

Maxxam ID		RZ2668	RZ2669		
Sampling Date		2017/07/29	2017/08/02		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch
MISCELLANEOUS					
Sulphide	ug/g	0.78	0.57	0.50	8761700

RDL = Reportable Detection Limit

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Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

PHYSICAL TESTING (SOIL)

Maxxam ID		RZ2662	RZ2663	RZ2664	RZ2665		
Sampling Date		2017/08/23	2017/09/07	2017/09/06	2017/07/16		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	ACB-03 SA4	ACC1-03 SA2	ACCS-03 SA2	MRB-04 SA3	RDL	QC Batch
Physical Properties							
Moisture	%	24	22	28	8.2	0.30	8761682
RDL = Reportable Detection Limit							

Maxxam ID		RZ2666	RZ2667	RZ2668	RZ2669		
Sampling Date		2017/07/11	2017/08/23	2017/07/29	2017/08/02		
COC Number		B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01	B7J9789-M058-01-01		
	UNITS	MRB-03 SA5	DCC-01 SA2	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch
Physical Properties							
Moisture	%	13	32	14	17	0.30	8761682
RDL = Reportable Detection Limit							

Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: RZ2662 **Collected:** 2017/08/23
Sample ID: ACB-03 SA4 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2662 Dup **Collected:** 2017/08/23
Sample ID: ACB-03 SA4 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2663 **Collected:** 2017/09/07
Sample ID: ACC1-03 SA2 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2664 **Collected:** 2017/09/06
Sample ID: ACCS-03 SA2 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2665 **Collected:** 2017/07/16
Sample ID: MRB-04 SA3 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2666 **Collected:** 2017/07/11
Sample ID: MRB-03 SA5 **Shipped:**
Matrix: Soil **Received:** 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

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Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: RZ2667
Sample ID: DCC-01 SA2
Matrix: Soil

Collected: 2017/08/23
Shipped:
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2668
Sample ID: MCC-03 SA1
Matrix: Soil

Collected: 2017/07/29
Shipped:
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

Maxxam ID: RZ2669
Sample ID: WRC-01 SA3
Matrix: Soil

Collected: 2017/08/02
Shipped:
Received: 2017/09/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8761682	2017/09/18	2017/09/18	Lolita Obusan
Sulphide in Soil	SPEC/COL	8761700	2017/09/18	2017/09/18	Prabhleen Sodhi

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Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	9.0°C
Package 2	6.0°C

Sample RZ2662 [ACB-03 SA4] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2663 [ACC1-03 SA2] : Sample analyzed past method specified hold time for Sulphide in Soil. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2664 [ACCS-03 SA2] : Sample analyzed past method specified hold time for Sulphide in Soil. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2665 [MRB-04 SA3] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2666 [MRB-03 SA5] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2667 [DCC-01 SA2] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RZ2668 [MCC-03 SA1] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil

Results relate only to the items tested.

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Maxxam Job #: B780085
Report Date: 2017/09/18

QUALITY ASSURANCE REPORT

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8761682	Moisture	2017/09/18					<0.30	%	0 (1)	20
8761700	Sulphide	2017/09/18	39 (2,3)	75 - 125	84	75 - 125	<0.50	ug/g	NC (4)	30

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Duplicate Parent ID

(2) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(3) Matrix Spike Parent ID [RZ2662-01]

(4) Duplicate Parent ID [RZ2662-01]

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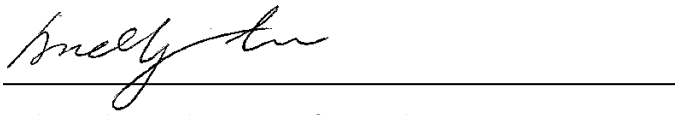
Maxxam Job #: B780085
Report Date: 2017/09/18

MAXXAM ANALYTICS
Client Project #: MB7J9789
Site Location: 1670846
Sampler Initials: DH

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Andy Lu, Ph.D., P.Chem., Scientific Specialist

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Maxxam
A Bureau Veritas Group Company

Your Project #: 1670846
Your C.O.C. #: 628368-01-01

Attention:Darcy Hansen

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2017/09/20
Report #: R4722990
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7J9789
Received: 2017/09/13, 11:39

Sample Matrix: Soil
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	8	N/A	2017/09/18	CAM SOP-00463	EPA 325.2 m
Conductivity	8	N/A	2017/09/18	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	8	2017/09/15	2017/09/15	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2017/09/14	2017/09/18	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	8	N/A	2017/09/18	CAM SOP-00464	EPA 375.4 m
Sulphide (from Campobello) (1)	8	N/A	N/A		

Remarks:

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Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
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Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Campo to Burnaby Subcontract

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Your Project #: 1670846
Your C.O.C. #: 628368-01-01

Attention:Darcy Hansen

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2017/09/20
Report #: R4722990
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7J9789
Received: 2017/09/13, 11:39

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

RESULTS OF ANALYSES OF SOIL

Maxxam ID		FCS510	FCS510	FCS511	FCS512	FCS513	FCS514		
Sampling Date		2017/08/23	2017/08/23	2017/09/07	2017/09/06	2017/07/16	2017/07/11		
COC Number		628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01	628368-01-01		
	UNITS	ACB-03 SA4	ACB-03 SA4 Lab-Dup	ACC1-03 SA2	ACCS-03 SA2	MRB-04 SA3	MRB-03 SA5	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	7300		15000	4100	5900	2400		5165355
Inorganics									
Soluble (20:1) Chloride (Cl)	ug/g	55	58	24	130	58	260	20	5167700
Conductivity	umho/cm	137	133	69	246	169	424	2	5167946
Available (CaCl2) pH	pH	6.48		6.20	5.13	5.62	5.77		5165977
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	64	22	29	<20	20	5167702

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		FCS515	FCS516	FCS517		
Sampling Date		2017/08/23	2017/07/29	2017/08/02		
COC Number		628368-01-01	628368-01-01	628368-01-01		
	UNITS	DCC-01 SA2	MCC-03 SA1	WRC-01 SA3	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	2200	24000	43000		5165355
Inorganics						
Soluble (20:1) Chloride (Cl)	ug/g	190	<20	<20	20	5167700
Conductivity	umho/cm	450	41	23	2	5167946
Available (CaCl2) pH	pH	8.18	6.90	6.62		5165977
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	24	20	5167702

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: FCS510
Sample ID: ACB-03 SA4
Matrix: Soil

Collected: 2017/08/23
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS510 Dup
Sample ID: ACB-03 SA4
Matrix: Soil

Collected: 2017/08/23
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine

Maxxam ID: FCS511
Sample ID: ACC1-03 SA2
Matrix: Soil

Collected: 2017/09/07
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS512
Sample ID: ACCS-03 SA2
Matrix: Soil

Collected: 2017/09/06
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS513
Sample ID: MRB-04 SA3
Matrix: Soil

Collected: 2017/07/16
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: FCS513
Sample ID: MRB-04 SA3
Matrix: Soil

Collected: 2017/07/16
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS514
Sample ID: MRB-03 SA5
Matrix: Soil

Collected: 2017/07/11
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS515
Sample ID: DCC-01 SA2
Matrix: Soil

Collected: 2017/08/23
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

Maxxam ID: FCS516
Sample ID: MCC-03 SA1
Matrix: Soil

Collected: 2017/07/29
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: FCS517
Sample ID: WRC-01 SA3
Matrix: Soil

Collected: 2017/08/02
Shipped:
Received: 2017/09/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5167700	N/A	2017/09/18	Deonarine Ramnarine
Conductivity	AT	5167946	N/A	2017/09/18	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5165977	2017/09/15	2017/09/15	Tahir Ahmed
Resistivity of Soil		5165355	2017/09/18	2017/09/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5167702	N/A	2017/09/18	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A	2017/09/19	Lims Auto Schedule Runner

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.7°C

Custody seal was present and intact.

Sample FCS513 [MRB-04 SA3] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

Sample FCS514 [MRB-03 SA5] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

Sample FCS517 [WRC-01 SA3] : Sample submitted and analyzed past the recommended hold time for pH, Chloride, Sulphate and Conductivity/Resistivity analysis.

Results relate only to the items tested.

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5165977	Available (CaCl2) pH	2017/09/15			99	97 - 103			0.11	N/A
5167700	Soluble (20:1) Chloride (Cl)	2017/09/18	NC	70 - 130	104	70 - 130	<20	ug/g	5.5	35
5167702	Soluble (20:1) Sulphate (SO4)	2017/09/18	124	70 - 130	107	70 - 130	<20	ug/g	NC	35
5167946	Conductivity	2017/09/18			101	90 - 110	<2	umho/cm	3.2	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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Maxxam Job #: B7J9789
Report Date: 2017/09/20

Golder Associates Ltd
Client Project #: 1670846
Sampler Initials: DH

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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13-Sep-17 11:39
Ema Gitej
B7J9789
KES ENV-689
C#628368-01-01

Page of
Bottle Order #: 628368
Project Manager: Ema Gitej

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B70916
Attention:	Accounts Payable	Attention:	Darcy Hansen	P.O. #:	
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	[redacted] 1670846
Tel:	(905) 567-4444 x Fax: (905) 567-6561 x	Tel:	(905) 567-4444 x2064 Fax:	Project Name:	
Email:	AP_CustomerService@golder.com	Email:	Darcy_Hansen@golder.com	Site #:	
				Sampled By:	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ___
☐ PWQO
☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC):

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT:
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Chloride & SO4 (20:1 extract)	Conductivity/Resistivity	pH CaCl2 EXTRACT	Sulphide (Maxxam BIC)	# of Bottles	Comments
1		ACB-03 SA4	Aug 23, 2017	-		1	1	1	1	2	
2		ACC1-03 SA2	sept 7, 2017	—		1	1	1	1	2	
3		ACC2-03 SA2	sept 6, 2017	—		1	1	1	1	2	
4		MRB-04 SA3	Jul 16, 2017	—		1	1	1	1	2	
5		MRB-03 SA5	Jul 11, 2017	—		1	1	1	1	2	
6		PCC-01 SA2	Aug 23, 2017	—		1	1	1	1	2	
7		MCC-03 SA1	Jul 29 2017	—		1	1	1	1	2	
8		WRC-01 SA3	Aug 2, 2017	—		1	1	1	1	2	
9											
10											

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Darcy Hansen	12/09/13	10am	[illegible] USA MUNSTER	2017/09/13	11:39	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal Present	Yes	No
	5 5 7	Intact	✓	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

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