



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

**Flood Creek West Timber Culvert Replacement, Highway 11, 48W-261/C, District
of Rainy River**

Agreement No. 6014-E-0017

Assignment No. 6

GWP 6319-14-00

Geocres No. 52B-025

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December 10, 2015

Ministry of Transportation

Foundation Investigation Report

Agreement No. 6014-E-0017

Assignment No. 6

GWP 6319-14-00

Geocres No. 52B-025

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Foundation Investigation Report for Flood Creek West Timber Culvert Replacement
Highway 11, Site No. 48W-261/C, District of Rainy River

Project Number:

ADM-00223648-E0

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Part I: FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This foundation investigation report presents the results of a geotechnical investigation completed by **exp** Services Inc. for the replacement of Flood Creek West Timber Culvert, located on Highway 11, about 650 m west of the junction of Hwy 11 and Hwy 623, in the District of Rainy River, the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 6 (GWP 6319-14-00). The terms of reference (TOR) were as presented in the MTO letter dated May 27, 2015.

Based on preliminary information provided, it is understood the existing culvert is a twin cell timber structure with a width of about 4.2 m (2.1 m for each cell of the twin culvert), length of about 22 m and a height of about 1.5 m. It is also understood that the existing culvert construction date was unknown, and is intended to be replaced with a new culvert along the same alignment.

The purpose of the investigation was to evaluate the subsurface conditions along the alignment, to permit detailed design for the culvert replacement. The site specific geotechnical investigation consisted of borings, soil sampling, borehole logging, and field and laboratory testing.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

1.2 Site Description and Geological Setting

1.2.1 Site Description

As shown on Drawing 1 (Appendix B), the Flood Creek West Timber Culvert is located on Highway 11, about 650 m west of the junction of Hwy 11 and Hwy 623, in the District of Rainy River, south of Sapawe, Ontario. At the site, Hwy 11 is a two lane roadway, with a speed limit of 90 km/h and is about 9.6 m wide from edge of pavement to edge of pavement (includes asphalt paved shoulders, about 1.9 m and 0.5 m wide on the north and south sides, respectively).

Based on a true north direction, Highway 11 runs generally in a northwest and southeast direction, and Flood Creek generally flows from the southwest to the northeast. However, for simplicity and for the purposes of this report a "project north" has been established and project north is oriented to the centerline alignment of the Flood Creek West Culvert (i.e. project north is in the same direction as true north's northeast direction). The orientation of project north is presented on Drawing 1 in Appendix B. Hereinafter, the directions indicated in this report are in referenced to project north.

Based on field measurements, the roadway embankment is about 4.0 m and 3.1 m high on the south and north sides, respectively, with mild side slopes of about 2.5H:1V on the south side and 2.8H:1V on the north side.

During the fieldwork on June 27 and 28, 2015, the general site conditions were assessed. Hwy 11 runs in an east and west direction, and Flood Creek flows from south to north beneath the highway, ultimately towards Niobe Lake which is about 50 m east of the site. At the time of this investigation, the approximate creek elevations at the inlet and outlet were about 431.67 m and 431.60 m, respectively. The elevation of highway pavement centerline at the culvert centerline is about 434.8 m. Overhead wires were observed along the north and south side of the highway with some wires crossing the highway west of the culvert.

At the vicinity of the inlet and outlet of the culvert some tall grass was noted at both culvert ends. The surrounding area of the culvert also contained tall grass with mature trees further away from the culvert. The inlet and outlet appeared to be generally clear of debris and excess vegetation, and as such the flow does not appear to be restricted.

Select photographs are provided in Appendix A.

1.2.2 Geological Setting

According to the MNR Northern Ontario Engineering Geology Terrain Data Base Map, Ontario Geological Survey Map 5073, Scale 1:100,000, dated 1979, the underlying native soil at the site lies along the border of two landforms. The landform to the west consists of clay glaciolacustrine plain deposit with low local relief and wet surface conditions. The landform to the east consists of bedrock ridge subordinate bedrock knobs with moderate local relief including knobby, hummocky, ridged and dry surface conditions.

According the Ministry of Northern Development and Mines (MNDM) Bedrock Geology of Ontario, West-Central Sheet Map No. 2542, Scale 1:1,000,000, dated 1991, the bedrock geology of the site is of the Neo to Mesoproterozoic Era (2.5 to 3.4 Ga). Two formations border the site. To the north is supracrustal rock, generally consisting of metasedimentary rock. The metasedimentary rock include wacke, arkose, argillite, slate, marble, chert, iron formation, and minor metavolcanic rock complexes. To the south, intrusive rock consisting of massive to foliated, granodiorite to granite rock.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed on June 27 and 28, 2015. The field program consisted of advancing four (4) sampled boreholes (BH201 to BH204). Two (2) boreholes were located within the highway, BH201, and BH202. BH201 was located about 5 m east of the culvert centerline and about 3.7 m south of the highway centerline. BH202 was located about 5 m west of the culvert centerline and about 1.8 m north of the highway centerline. An additional two (2) boreholes (BH203 and BH204) were advanced off of the highway. BH203 was located about 5.6 m east of the culvert centerline and about 15 m north of the highway centerline (outlet/downstream side). BH204 was located about 6.3 m west of the culvert centerline and about 15 m south of the highway centerline (inlet/upstream side). The borehole locations are shown on Drawing 1 in Appendix B.

Three (3) boreholes (BH201, BH202 and BH204) were advanced using a CME 850 track mounted drill rig and due to access issues, one borehole (BH203) was advanced using a hand probe / hand shovel. The drill rig was equipped with hollow stem continuous flight augers and standard soil sampling equipment (includes 51 mm outside diameter split spoon samplers and *in situ* shear vane testing equipment). In addition, the CME 850 drill rig was equipped with rock coring equipment (HQ size). The roadway boreholes BH201 and BH202 were advanced to depths of about 9.6 m and 7.0 m below ground surface, respectively. The off-road boreholes, BH203 and BH204, were advanced to refusal, at depths of about 0.5 m and 1.2 m below ground surface, respectively. The off-road boreholes were terminated at the refusal depth.

At BH201 at about 4.9 m below ground surface, auger refusal was encountered and rock coring techniques were conducted to advance the borehole to determine the nature of refusal (i.e. cobbles and boulders). Rock coring techniques at BH201 were continued through the cobbles and boulders and into the bedrock. Rock coring techniques were initiated at about 4.3 m below ground surface at BH202 to advance the borehole into the bedrock. Rock core samples were collected at both borehole locations. No rock coring techniques were conducted at the remaining borehole locations.

The borehole locations were referenced to the MTM ON-16 NAD83 coordinate system and their ground surface elevations were surveyed by **exp** personnel. The ground surface elevations, including top of water in the creek, were referenced to a geodetic elevation located at the highway centerline at the culvert centerline. The elevation at the centerline is 434.83 m. The centerline elevation was tied into a round iron bar [RIB] in rock east of the site and north of the highway. The RIB elevation is 434.65 m. The location of the RIB is shown on Drawing 1, in Appendix B.

During the advancement of the three (3) boreholes with the drill rig (BH201, BH202, BH204), soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586), and were generally performed at intervals of about 0.75 m. The original field (uncorrected) SPT "N" values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual and used to provide an assessment of *in-situ* compactness (cohesionless) or consistency (cohesive) soils.

Upon completion of the boreholes, groundwater level measurements were carried out in boreholes in accordance with the Ministry of Transportation guidelines. The measured groundwater levels after completion of drilling boreholes were recorded on borehole log sheets in Appendix C. The boreholes were backfilled with a mixture of bentonite and auger cuttings. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the *Ontario Water Resources Act*).

The fieldwork was supervised by a member of **exp**'s engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples. All of the recovered soil samples were placed in labelled moisture-proof bags which, along with the rock cores, were brought to **exp**'s Thunder Bay laboratory for additional visual, textual and olfactory examination, and for subsequent examination by a geotechnical engineer and laboratory testing.

1.3.2 Laboratory Testing

All samples brought to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content and particle size distribution for approximately 25% of the collected soil samples. All of the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate, at the **exp** laboratory in Thunder Bay, Ontario.

The laboratory test results are provided on the attached borehole log sheets in Appendix C as well as graphically in Appendix D.

In addition, chemical testing of two select soil samples were conducted. The soil samples were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. Details of the chemical testing are discussed below and the lab results are included in Appendix E.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the Borehole Records in Appendix C. Laboratory test results are provided in Appendix D. The "Explanation of Terms Used on Borehole Records" preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report. In addition, photographs of the bedrock core obtained are included in Appendix C.

A borehole location plan and stratigraphic sections are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic sections are inferred from semi-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be interpreted as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions along the proposed culvert alignment consist of a layer of sand fill, overlying native sand, overlying cobbles and boulders and sand till, and overlying bedrock. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

1.4.1 Well Graded Sand with Silt and Gravel Fill

Well graded sand with silt and gravel fill was encountered beneath the asphalt at BH201 and BH202. The asphalt thickness at BH201 and BH202 was about 90 mm. The sand fill was generally described as compact to very dense, brown, damp to moist, and containing trace asphalt pieces in the upper 0.25 m. Cobbles and boulders were encountered in BH201 from about 0.8 m to 1.5 m below ground surface during augering. The SPT "N" values of the fill ranged between 10 and 66 blows per 300 mm penetration, with an average "N" value of about 34. The fill extended to depths of about 4.3 m (430.7 m elevation) and 3.1 m (431.8 m elevation) below ground surface at BH201 and BH202, respectively.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture content:

- 1.8% to 9.8%

Grain size distribution:

- 43% gravel;
- 46% sand; and
- 11% silt and clay sizes.

The results of the moisture content and grain size distribution test are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 1, in Appendix D.

1.4.2 Peat / Rootmat

Peat and rootmat was encountered surfacing BH203 and BH204, respectively. The peat / rootmat was generally described as soft to very soft, dark brown and wet. The peat contained trace gravel, trace sand and trace roots and rootlets. The rootmat contained some peat. The thickness of the peat was about 0.2 m and the thickness of the rootmat was about 0.1 m. The peat extended to 0.2 m (431.5 m elevation) below ground surface and the rootmat extended to about 0.1 m (431.8 m elevation) below ground surface.

Laboratory testing performed on selected sample consisted of moisture content. The test results are as follows:

Moisture content:

- 59.0% to 81.2%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.3 Sand

Native sand was encountered underling the fill, peat and rootmat. The native sand ranged in composition from silty sand with gravel to well graded sand with silt and gravel. The sand was generally described as loose to very dense, brown to grey, wet, and containing trace peat and /or trace organics. Occasional to some cobbles and boulders were encountered at BH201 and BH204. The SPT "N" values ranged between 16 and 100 (i.e. SPT refusal) blows per 300 mm penetration, with an average "N" value of about 37. The native sand extended to depths ranging between about 0.5 m and about 4.9 m below ground surface, and elevations ranging between 430.1 m and 431.2 m.

Laboratory testing performed on selected samples consisted of moisture content, and grain size distribution tests. The test results are as follows:

Moisture content:

- 8.7% to 43.5%

Grain size distribution:

- 25% to 45% gravel;
- 43% to 62% sand; and
- 5% to 41% silt and clay sizes.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 17.5 to 23.3 kN/m³.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figures 1 and 2 in Appendix D.

1.4.4 Silty Sand Till

At BH204, silty sand till was encountered underlying the poorly graded sand with silt and gravel. The till was described as very dense, grey, moist to wet and containing occasional cobbles. One SPT was conducted in the till. The SPT "N" value was 100 blows (i.e. SPT refusal) per 300 mm penetration. The till extended to a depth of about 1.2 m (430.7 m elevation) below ground surface.

Laboratory testing performed on a selected sample consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture content:

- 17.6%

Grain size distribution:

- 12% gravel;
- 49% sand; and
- 39% silt and clay sizes.

Total saturated unit weight has been calculated based on the moisture content and is estimated to be about 21.1 kN/m³.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figure 2 in Appendix D.

1.4.5 Cobbles and Boulders

Cobbles and boulders were encountered underlying the silty sand with gravel at BH201. No SPT sampling was conducted. The cobbles and boulders extended to about 6.6 m below ground surface (elevation 428.4 m).

No laboratory testing was performed on the cobbles and boulders.

1.4.6 Bedrock

Bedrock was encountered beneath the cobbles and boulders at BH201 and beneath the sand at BH102, at depths of about 6.6 m (428.4 m elevation) and 4.3 m (430.5 m elevation) below ground surface, respectively. The bedrock was generally described as a medium strong (25 MPa to 50 MPa compressive strength), fractured to very sound, greenish dark grey, and fine grained. The boreholes were extended by rock coring between about 2.7 m and 3.0 m into bedrock, and to depths ranging between about 7.0 m and 9.6 m below ground surface. The boreholes were terminated at elevations ranging between about 425.4 m and 427.8 m. Photographs of the bedrock core samples are presented in Appendix C, after the Borehole Logs.

Gross recoveries ranged between about 99% and 100%. The Rock Quality Designation (RQD), which is a modified core recovery, ranged from 59% to 100% (fractured to very sound).

No laboratory testing was performed on the bedrock.

1.5 Groundwater and Surface Water Conditions

Information on groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling and probe. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.1.

Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods.

Table 1.1. Groundwater data

Borehole	Date Completed	Date Measured	Ground Surface Elevation ²	Depth to Water ³	Groundwater Elevation
BH201	Jun. 28/15	Jun. 28/15	434.99	3.40	431.59
BH202	Jun. 28/15	Jun. 28/15	434.82	3.30	431.52
BH203	Jun. 28/15	Jun. 28/15	431.65	0.15	431.50
BH204	Jun. 27/15	Jun. 27/15	431.89	0.25	431.64
Flood Creek WL Upstream (South) Side	--	Jun. 27/15			431.67 ⁴

Borehole	Date Completed	Date Measured	Ground Surface Elevation ²	Depth to Water ³	Groundwater Elevation
Flood Creek WL Downstream (North) Side	--	Jun. 27/15	--	--	431.60 ⁴
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to a geodetic elevation located at the highway centerline at the culvert centerline. The elevation at the centerline is 434.83 m. 3) Depths are relative to ground surface. 4) Indicates top of surface water elevation at Flood Creek.					

1.6 Chemical Analyses

Two soil samples were selected for chemical analyses and were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix E, and are summarized in Table 1.2, below.

Table 1.2. Corrosivity Chemical Analysis

Borehole	pH (unitless)	Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (μS/cm)
BH201-S7A	5.49	170	<20	3,300	301
BH203-S3	5.43	320	<20	1,800	557

December 10, 2015

1.7 Closure

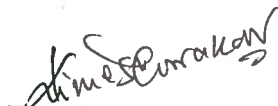
A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.


This Foundation Investigation and Design Report has been prepared by Ahileas Mitsopoulos, P.Eng., Nimesh Tamrakar, M.Eng, EIT., Demetri N. Georgiou, MSc. P.Eng., and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Elwin Farkas.

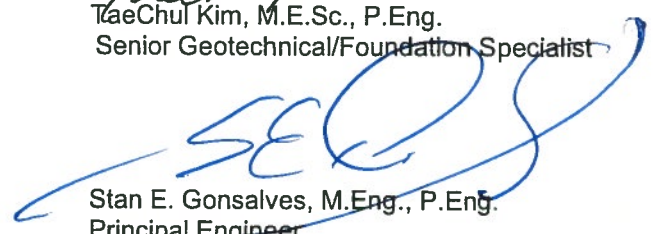
Yours truly,

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Stan E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
Designated MTO Foundation Contact

Encl.



Appendix A – Site Photographs



Photo 1. Existing culvert inlet on south side of highway



Photo 2. Existing culvert outlet on north side of highway



Photo 3. Facing east on Highway 11 before the existing culvert



Photo 4. Facing west on Highway 11 before the existing culvert



Photo 5. Embankment slope on north side facing east



Photo 6. Embankment slope on south side facing west

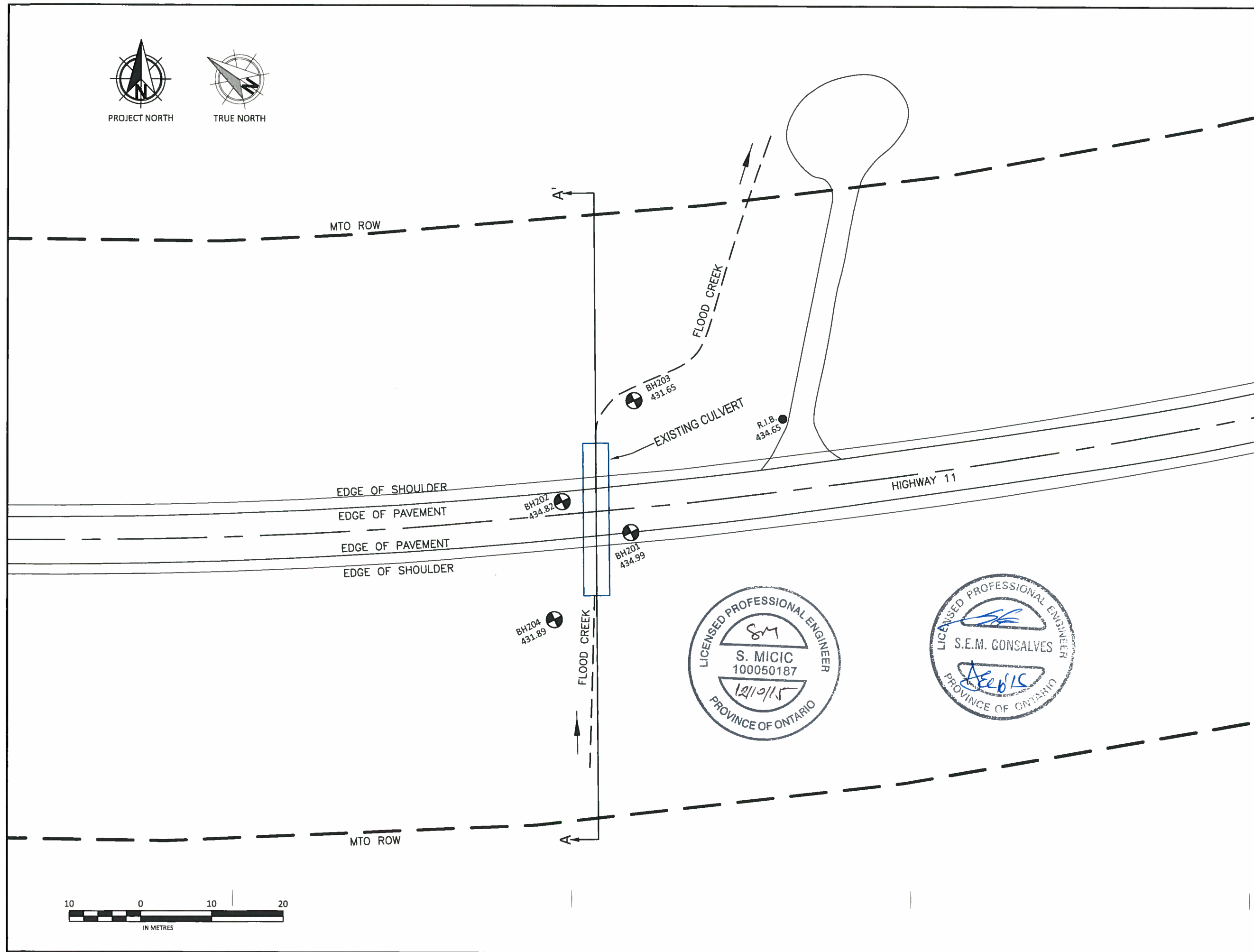
Appendix B – Drawings



PROJECT NORTH



TRUE NORTH



Agreement No. 6014-E-0017
Assignment No. 6
GWP 6319-14-00

FLOOD CREEK WEST CULVERT
(Hwy 11, Rainy River District, Sapawee, ON)

DWG
1

PLAN

exp.

exp Services Inc.

KEY PLAN



LEGEND

- BH201 434.99 BOREHOLE LOCATION
GROUND SURFACE ELEVATION IN METRES
- R.I.B. 434.65 ROUND IRON BAR LOCATION
GEODETIC ELEVATION IN METRES

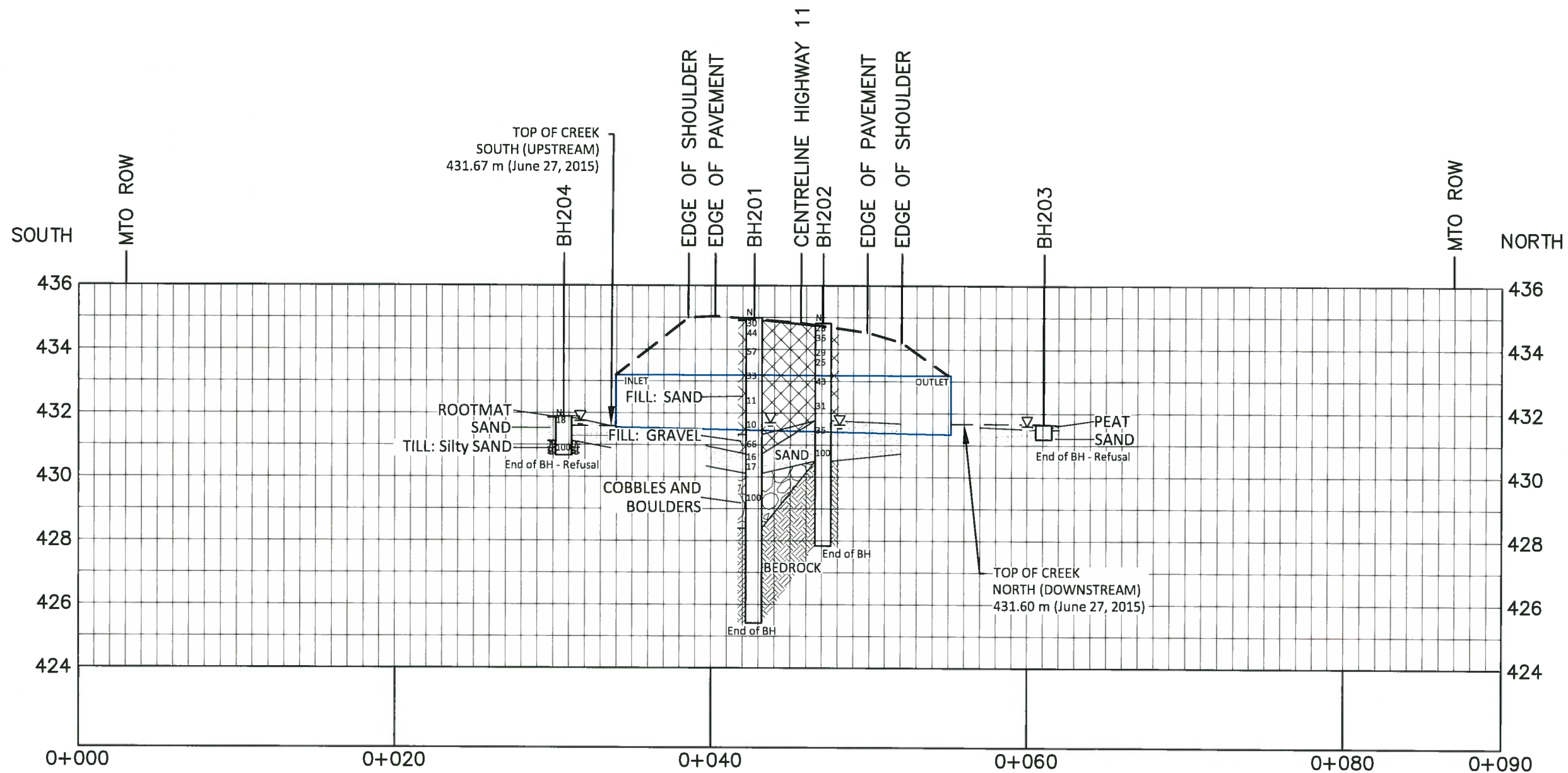
BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH201	434.99	5,400,586	427,349
BH202	434.82	5,400,594	427,346
BH203	431.65	5,400,591	427,361
BH204	431.89	5,400,588	427,330

NOTES

- ALL DIMENSIONS ARE IN METRES.
- BASE MAP PROVIDED BY CLIENT.
- LOCATIONS OF FEATURES AND OBJECTS ARE BASED ON BOTH FIELD MEASUREMENTS AND CLIENT'S BASE MAP. WHERE CONFLICTS OCCUR FIELD MEASUREMENTS TAKE PRECEDENCE. BH LOCATIONS ARE BASED ON HAND HELD GPS UNIT COORDINATES
- COORDINATES PROJECTED TO MTM ON-16.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.
- CENTRELINE ELEVATION (434.83m) USED TO TIE IN ELEVATIONS OF R.I.B. AND OTHER SURVEYED POINTS.

REVISIONS

DATE	BY	DESCRIPTION
GEOCRES No. 52B-025		Project No. ADM-00223648-E0
Date: December 8, 2015		Scale : 1:500
Drawn By: RM		Checked By: AM
		Checked By: DG



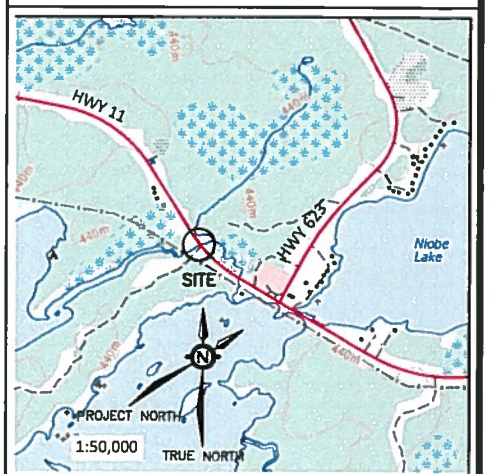
A - A'
PROFILE OF FLOOD CREEK WEST CULVERT



Agreement No. 6014-E-0017 Assignment No. 6 GWP 6319-14-00	
FLOOD CREEK WEST CULVERT (Hwy 11, Rainy River District, Sapaw, ON) SECTION A-A'	DWG 2

exp. exp Services Inc.

KEY PLAN



LEGEND

N	STANDARD PENETRATION TEST (BLOWS/0.3 m)
▽	MEASURED WATER LEVEL

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH201	434.99	5,400,586	427,349
BH202	434.82	5,400,594	427,346
BH203	431.65	5,400,591	427,361
BH204	431.89	5,400,588	427,330

NOTES

- ALL DIMENSIONS ARE IN METRES.
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REVISIONS

DATE	BY	DESCRIPTION

GEOCRE No. 52B-025	Project No. ADM-00223648-E0
Date: December 8, 2015	Horizontal Scale : 1:300
Drawn By: RM	Vertical Scale : 1:150
Checked By: AM	Checked By: DG

Appendix C – Borehole Logs and Bedrock Core Photos

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.

ISSMFE SOIL CLASSIFICATION											
CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
<div><div>0.002</div><div>0.006</div><div>0.02</div><div>0.06</div><div>0.2</div><div>0.6</div><div>2.0</div><div>6.0</div><div>20</div><div>60</div><div>200</div></div>											
EQUIVALENT GRAIN DIAMETER IN MILLIMETRES											
CLAY (PLASTIC) TO				FINE		MEDIUM		CRS.		FINE COARSE	
SILT (NONPLASTIC)				SAND				GRAVEL			
UNIFIED SOIL CLASSIFICATION											

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Note 16 in ASTM D2488-09a:

Table a: Percent or Proportion of Soil, Pp

	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	$5 \leq Pp \leq 10\%$
Little	$15 \leq Pp \leq 25\%$
Some	$30 \leq Pp \leq 45\%$
Mostly	$50 \leq Pp \leq 100\%$

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	$N < 5$
Loose	$5 \leq N < 10$
Compact	$10 \leq N < 30$
Dense	$30 \leq N < 50$
Very Dense	$50 \leq N$

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

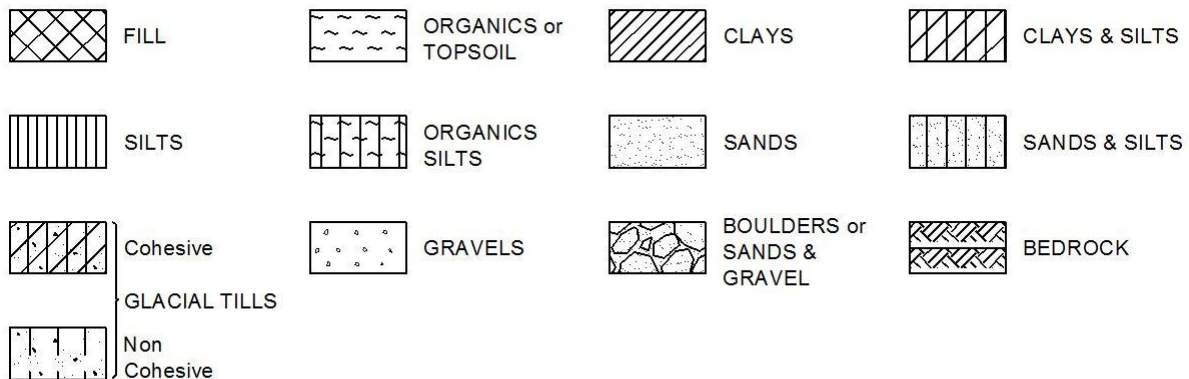
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m^2/s	Coefficient of consolidation
H	m	Drainage path
T_v	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_p	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	$-\circ$	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	$-\circ$	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	Density of solid particles
γ_s	kN/m^3	Unit weight of solid particles
ρ_w	kg/m^3	Density of water
γ_w	kN/m^3	Unit weight of water
ρ	kg/m^3	Density of soil
γ	kN/m^3	Unit weight of soil
ρ_d	kg/m^3	Density of dry soil
γ_d	kN/m^3	Unit weight of dry soil
ρ_{sat}	kg/m^3	Density of saturated soil
γ_{sat}	kN/m^3	Unit weight of saturated soil
ρ'	kg/m^3	Density of submerged soil
γ'	kN/m^3	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_p	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_p$
I_C	%	Consistency index = $(W_L - W)/I_p$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m^3/s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m^3	Seepage force

RECORD OF BOREHOLE No BH201

1 OF 1

METRIC

W.P. GWP No. 6319-14-00 LOCATION Flood Creek West (Site No. 48W-261C) MTM ON-16 5,400,586N 427,349E ORIGINATED BY EF
 DIST 61 HWY Hwy 11 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY RM
 DATUM Geodetic DATE 6.28.15 - 6.28.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)					
								○ UNCONFINED ● QUICK TRIAXIAL		+ FIELD VANE × LAB VANE		W _p	W	W _L			
435.0	Asphalt						20	40	60	80	100		20	40	60		
430.0	ASPHALT - about 90 mm		S1A	SS	30												
0.1	Well Graded SAND with Silt and Gravel (FILL) - very dense to compact, brown, damp to moist, trace asphalt pieces in upper 0.25 m		S1B	SS	44												
	- cobbles and boulders noted during augering from about 0.8 m to 1.5 m depth		S2	SS	57												
			S3	SS	33												43 46 (11)
			S4	SS	11												
	- becoming compact to loose, moist to wet at about 3.0 m depth		S5	SS	10												
431.3	Poorly Graded GRAVEL with Silt and Sand (FILL) - very dense, brown, wet		S6	SS	66												
430.7	Silty SAND with Gravel - compact to dense, brown to grey, wet, trace peat in upper 4.5 m		S7A	SS	16												25 62 (13)
4.3	- becoming grey, occasional to some cobbles at about 4.5 m depth		S7B	SS	17												
430.1	COBBLES AND BOULDERS		S8	CORE													No Recovery
4.9			S9	SS	100												
			S10	CORE													
			S11	CORE													
428.4	BEDROCK - medium strong, greenish dark grey, very sound, fine grained		S12	CORE													Recovery=100%, RQD=100%
6.6	- becoming fractured at about 7.1 m depth		S13	CORE													Recovery=100%, RQD=59%
			S14	CORE													Recovery=100%, RQD=61%
425.4	End of Borehole																
9.6																	

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

RECORD OF BOREHOLE No BH202

1 OF 1

METRIC

W.P. GWP No. 6319-14-00 LOCATION Flood Creek West (Site No. 48W-261C) MTM ON-16 5,400,594N 427,346E ORIGINATED BY EF
 DIST 61 HWY Hwy 11 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY RM
 DATUM Geodetic DATE 6.28.15 - 6.28.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _p W W _L								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)								
434.8	Asphalt						20	40	60	80	100					GR	SA	SI	CL	
430.0	ASPHALT - about 90 mm		S1A	SS	28	▽							○							
0.1	Well Graded SAND with Silt and Gravel (FILL) - dense to very dense, brown, damp to moist, trace asphalt pieces in upper 0.25 m		S1B	SS	36									○						
			S2A	SS	29									○						
			S2B	SS	25									○						
			S3	SS	43															
			S4	SS	31									○						
431.8	Silty SAND with Gravel - dense, grey, wet		S5	SS	36								○			16	43	(41)		
3.1																				
431.0	Well Graded SAND with Silt and Gravel - very dense, grey, wet		S6	SS	100								○			40	48	(12)		
3.8																				
430.5	BEDROCK - medium strong, greenish dark grey, very sound to sound, fine grained		S7	CORE															Recovery=99%, RQD=99%	
4.3			S8	CORE															Recovery=99%, RQD=80%	
427.8	End of Borehole																			
7.0																				

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

RECORD OF BOREHOLE No BH203

1 OF 1

METRIC

W.P. GWP No. 6319-14-00 LOCATION Flood Creek West (Site No. 48W-261C) MTM ON-16 5,400,591N 427,361E ORIGINATED BY EF
 DIST 61 HWY Hwy 11 BOREHOLE TYPE Hand Probe / Hand Shovel COMPILED BY RM
 DATUM Geodetic DATE 6.28.15 - 6.28.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
431.7	Peat		S1	AUGER													
430.8	PEAT - very soft, dark brown, wet, trace gravel, trace sand, trace roots and rootlets		S2	AUGER													
0.2																	
431.2																	
0.5	Poorly Graded SAND with Silt and Gravel - loose, brown, wet, some peat, trace roots and rootlets End of Borehole - refusal		S3	AUGER													45 50 (5)

ONL MOT F-15122-BG - ADM-00223648-E0 - MTO 6 - FLOOD CREEK WEST.GPJ ONL MOT.GDT 10/21/15

RECORD OF BOREHOLE No BH204

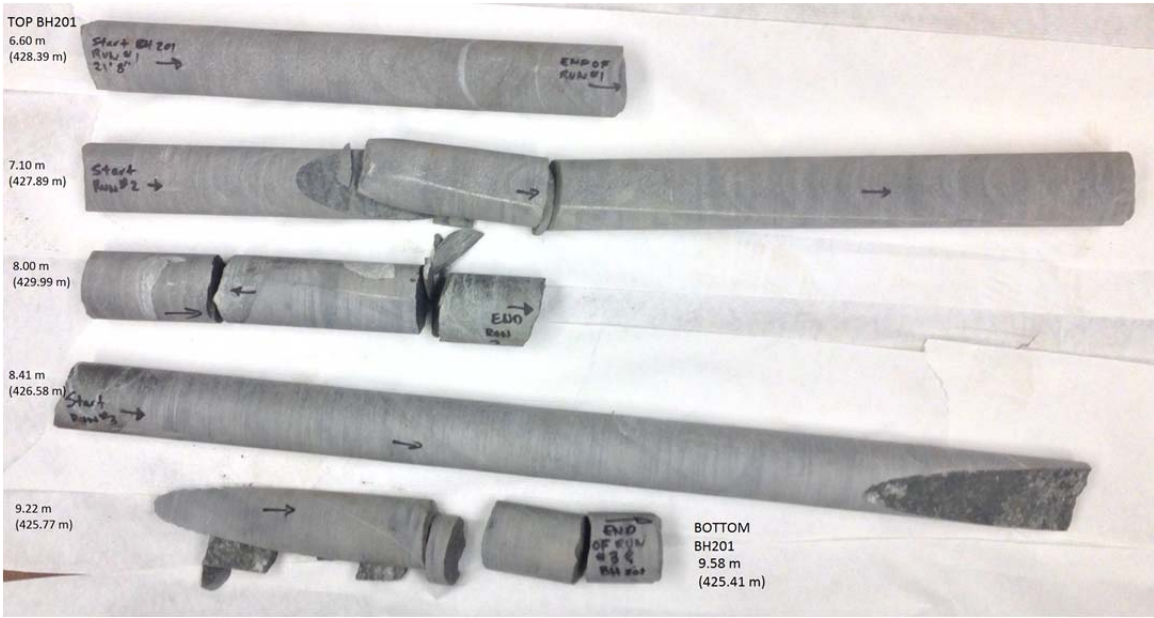
1 OF 1

METRIC

W.P. GWP No. 6319-14-00 LOCATION Flood Creek West (Site No. 48W-261C) MTM ON-16 5,400,588N 427,330E ORIGINATED BY EF
 DIST 61 HWY Hwy 11 BOREHOLE TYPE CME 850 Track Carrier / HSA COMPILED BY RM
 DATUM Geodetic DATE 6.27.15 - 6.27.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)		
431.9	Rootmat		S1A	SS			431											
430.9	ROOTMAT - soft, dark brown, wet, some peat		S1B	SS	18													
	Poorly Graded SAND with Silt and Gravel - compact, brown to grey, moist to wet, occasional cobbles and boulders, trace organics in upper 0.6 m		S1C	SS														
431.1																		
0.8	Silty SAND (TILL) - very dense, grey, moist to wet, occasional cobbles		S2	SS	100											12 49 (39)		
430.7																		
1.2	End of Borehole - refusal to SPT and auger																	

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

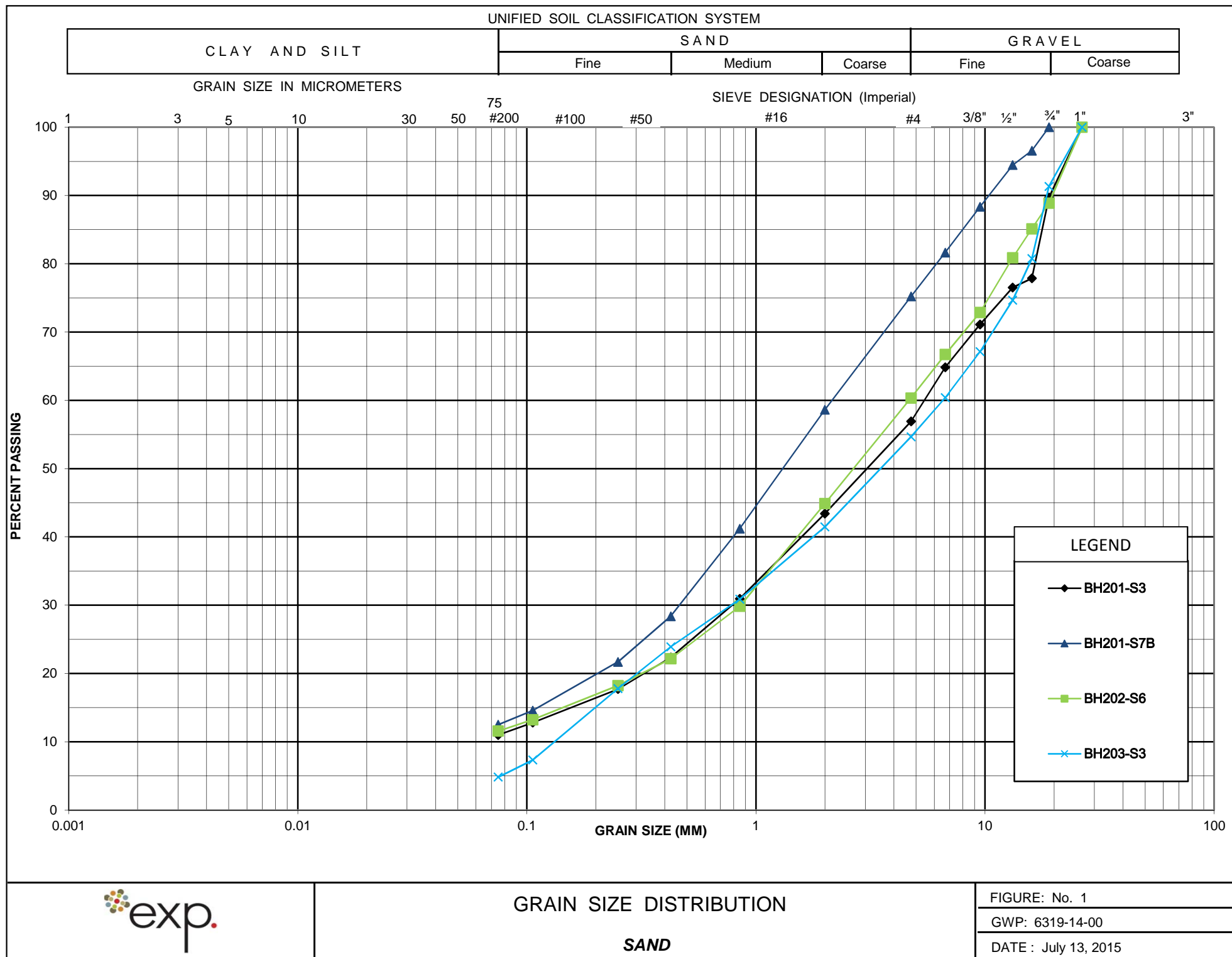


BH201 - Bedrock Core Samples with Depths and Elevations



BH202 - Bedrock Core Samples with Depths and Elevations

Appendix D – Laboratory Data

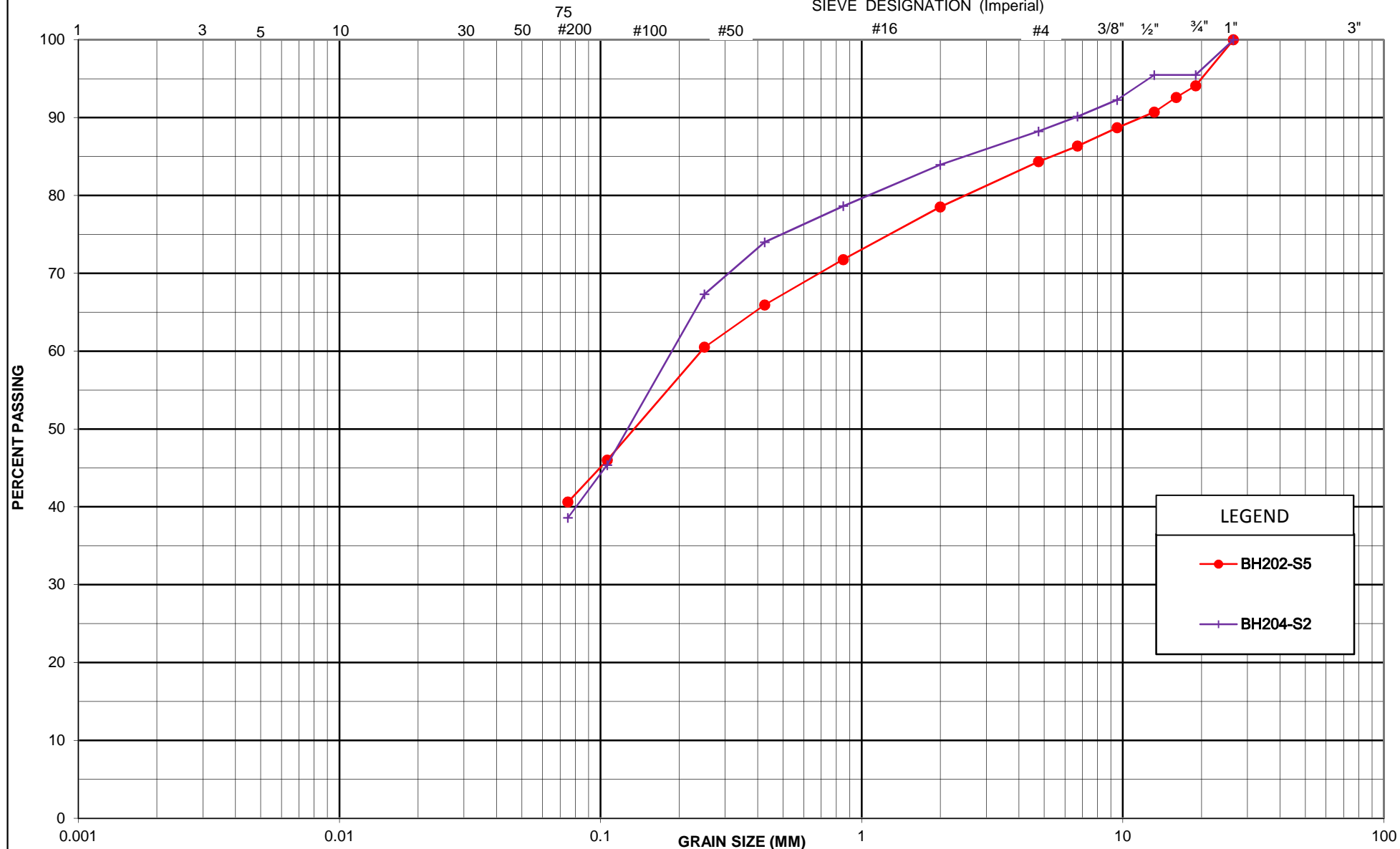


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



GRAIN SIZE DISTRIBUTION

SILTY SAND

FIGURE: No. 2

GWP: 6319-14-00

DATE : August 4, 2015

Appendix E – Chemical Analyses

Your Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502
Your C.O.C. #: na

Attention: Ahileas Mitsopoulos/Michael S

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
P7B 5M4

Report Date: 2015/07/09
Report #: R3568313
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9097

Received: 2015/07/03, 10:55

Sample Matrix: Soil
Samples Received: 10

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	10	N/A	2015/07/09	CAM SOP-00463	EPA 325.2 m
Conductivity	10	N/A	2015/07/08	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	10	2015/07/08	2015/07/08	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	5	2015/07/03	2015/07/08	CAM SOP-00414	SM 22 2510 m
Resistivity of Soil	5	2015/07/03	2015/07/09	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	10	N/A	2015/07/09	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

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.

Your Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502
Your C.O.C. #: na

Attention:Ahileas Mitsopoulos/Michael S

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
P7B 5M4

Report Date: 2015/07/09
Report #: R3568313
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9097
Received: 2015/07/03, 10:55

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Hina Siddiqui, Project Manager –Environmental Customer Service
Email: HSiddiqui@maxxam.ca
Phone# (905) 817-5700

=====

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.

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

RESULTS OF ANALYSES OF SOIL

Maxxam ID		AOD715	AOD716	AOD716	AOD717	AOD718		
Sampling Date		2015/06/19 14:10	2015/06/27 12:15	2015/06/27 12:15	2015/06/28 10:20	2015/06/28 17:00		
COC Number		na	na	na	na	na		
	Units	BH101-S7	BH104-S3B/S4/S5	BH104-S3B/S4/S5 Lab-Dup	BH201-S7A	BH203-S3	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	1300	2500		3300	1800		4091370
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	790	190	200	170	320	20	4094438
Conductivity	umho/cm	773	395	399	301	557	2	4096183
Available (CaCl2) pH	pH	6.34	6.65		5.49	5.43	N/A	4094481
Soluble (20:1) Sulphate (SO4)	ug/g	270	25	24	<20	<20	20	4094443
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable								

Maxxam ID		AOD719	AOD720	AOD721	AOD722	AOD723	AOD724		
Sampling Date		2015/06/20 07:25	2015/06/26 06:20	2015/06/26 16:15	2015/06/25 15:30	2015/06/25 10:30	2015/06/25 14:10		
COC Number		na	na	na	na	na	na		
	Units	BH301-S9B/S10/S11	BH304-S3	BH403-S3	BH404-S5B	BH503-S4	BH504-S1B	RDL	QC Batch

Calculated Parameters									
Resistivity	ohm-cm	2300	7000	4800	8400	5300	1500		4091370
Inorganics									
Soluble (20:1) Chloride (Cl)	ug/g	220	36	81	<20	89	370	20	4094438
Conductivity	umho/cm	435	143	209	119	190	646	2	4096183
Available (CaCl2) pH	pH	6.54	6.72	6.59	6.72	5.89	4.90	N/A	4094481
Soluble (20:1) Sulphate (SO4)	ug/g	30	<20	<20	27	<20	<20	20	4094443
RDL = Reportable Detection Limit QC Batch = Quality Control Batch N/A = Not Applicable									

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD715
Sample ID: BH101-S7
Matrix: Soil

Collected: 2015/06/19
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD716
Sample ID: BH104-S3B/S4/S5
Matrix: Soil

Collected: 2015/06/27
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD716 Dup
Sample ID: BH104-S3B/S4/S5
Matrix: Soil

Collected: 2015/06/27
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD717
Sample ID: BH201-S7A
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD718
Sample ID: BH203-S3
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD718
Sample ID: BH203-S3
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD719
Sample ID: BH301-S9B/S10/S11
Matrix: Soil

Collected: 2015/06/20
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD720
Sample ID: BH304-S3
Matrix: Soil

Collected: 2015/06/26
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD721
Sample ID: BH403-S3
Matrix: Soil

Collected: 2015/06/26
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD722
Sample ID: BH404-S5B
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD723
Sample ID: BH503-S4
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD724
Sample ID: BH504-S1B
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

GENERAL COMMENTS

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

Package 1	2.7°C
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Results relate only to the items tested.

Maxxam Job #: B5C9097
Report Date: 2015/07/09

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
4094438	Soluble (20:1) Chloride (Cl)	2015/07/09	NC	70 - 130	107	70 - 130	<20	ug/g	6.5	35
4094443	Soluble (20:1) Sulphate (SO4)	2015/07/09	NC	70 - 130	109	70 - 130	<20	ug/g	NC	35
4094481	Available (CaCl2) pH	2015/07/08			100	97 - 103			0.51	N/A
4096183	Conductivity	2015/07/08			102	90 - 110	<2	umho/cm	1.0	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 spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

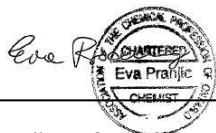
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

VALIDATION SIGNATURE PAGE

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



Ewa Pranjić, M.Sc., C.Chem, Scientific 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.

Maxxam Analytics International Corporation o/a Maxxam Analytics