



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

**Alice Creek Culvert Replacement, Highway 596, Site No. 41S-252/C, District of
Kenora**

**Agreement No. 6014-E-0017
Assignment No. 8
GWP 6368-14-00
Geocres No. 52E-061**

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Ministry of Transportation

Foundation Investigation Report

Agreement No. 6014-E-0017

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Foundation Investigation Report Alice Creek Culvert Replacement
Highway 596, 41S-252/C, District of Kenora

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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 a Alice Creek Culvert, located on Hwy 596, about 38 km north of Hwy 17A, in the District of Kenora, the Ministry of Transportation (MTO) Northeastern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 8 (WO 6368-14-00). The terms of reference (TOR) were as presented in the MTO letter dated August 20, 2015.

The purpose of the investigation is to evaluate the subsurface condition along the proposed culvert replacement alignment, to permit preliminary 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

The Culvert replacement site is located on Hwy. 596 in an Unsurveyed Territory in the Minaki Area, at the Alice Creek Crossing (approx. Station 17+720). The location of the culvert and a cross section of the existing culvert alignment are shown on Dwg. Nos. 1 and 2 in Appendix B.

The existing culvert consists of a corrugated steel pipe (CSP), approximately 3.05 m in diameter and 30.0 m long. At this site, Hwy. 596 is a surface treated two lane, north/south roadway having approximately 0.5 to 1.0 m wide granular shoulders and cable guide rails on both sides of the roadway. The highway embankment at the investigated location is approximately 5.0 m high on both sides of the roadway, having side slopes of approximately 1H:1V to 4H:1V from the top of the embankment to the toe of the embankment. Photographs of the site and existing culverts are presented in Appendix A.

The general site conditions were assessed during the drilling operations between October 27 and 29, 2015. The surrounding terrain of culvert location is generally undulating to rolling hills and is heavily forested with both deciduous and coniferous trees. A mix of low lying vegetation/shrubs and long grasses are also present adjacent to the culvert and creek. At the site location, water flows from east to west and had a moderate to rapid flow at the time of the field investigation. The embankment surrounding the culvert inlet and outlet consisted of exposed granular fill and low lying vegetation. Surficial erosion is visible in the granular fill materials along the embankments. Boulders as large as 0.75 m in diameter were observed within the embankments on both sides of the roadway and boulders as large as 2.0 in diameter were observed within the creek bed.

1.2.2 Geological Setting

The Map 2542 (Bedrock Geology of Ontario, West-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the bedrock formation of the project area consists of tonalite to granodiorite, foliated to massive. The Map 2554 (Quaternary Geology of Ontario, West-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the surface conditions in the vicinity of site consist of bedrock, consisting of undifferentiated igneous and metamorphic rock, exposed at surface or covered by a discontinuous, thin layer of drift.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed between October 27, 2015 and October 29, 2015. The field program consisted of drilling four (4) sampled boreholes (BH-A1, BH-A2, BH-A3, and BH-A4). The boreholes were strategically located along the existing culvert alignment to provide subsurface information for the design of the proposed new culvert. Boreholes BH-A2 and BH-A4 were advanced within the travelled northbound and southbound lanes, respectively, as close as possible to the embankments. Boreholes BH-A1 and BH-A3 were advanced at accessible locations near the inlet and outlet of the culvert, respectively. The borehole locations are shown on Dwg. No. 1 in Appendix B.

All of the boreholes were advanced using a track mounted CME-850 drill rig, equipped with hollow stem augers and standard soil sampling equipment operated by a specialist drilling contractor, Cartwright Drilling Inc. Each borehole that did not encounter bedrock was terminated approximately 10 m below the base of the existing culvert. Auger refusal was encountered at Elev. 317.5 m in BH-A2 and at Elev. 322.1 m in BH-A4. Coring procedures were utilized to penetrate the soils below the refusal depths. At borehole BH-A3, bedrock was encountered at Elev. 321.0 and was cored 3.1 m using NW casing and NQ core barrels.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel. The benchmark utilized is based on information provided on Site Plan drawings provided by the MTO. The benchmark location is shown on Dwg. No. 1 in Appendix B. Borehole locations were determined using a hand-held GPS.

For the drilling program, 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) at intervals ranging from 0.75 m to 1.5 m in depth as shown on the attached borehole logs (Appendix C). The original field (uncorrected) SPT "N" values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual (CFEM, pg. 40) and used to provide an assessment of in-situ consistency or relative density of non-cohesive soils.

Upon completion of the boreholes, ground water level measurements were carried out within the in accordance with the Ministry of Transportation guidelines. The measured ground water levels after completion of drilling boreholes were recorded on the borehole log sheets in Appendix C. The boreholes were decommissioned by bentonite/cement mixtures in 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 members 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 for subsequent laboratory testing and identification.

All of the recovered soil samples placed in labelled moisture-proof bags returned to **exp's** Sudbury laboratory for additional visual, textual, olfactory examination and selective testing.

1.3.2 Laboratory Testing

All samples returned 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.

The laboratory test results are provided on the attached borehole log sheets in Appendix B. The results of the grain size analyses and plasticity chart are presented graphically in Appendix D.

In addition, soil chemical testing was completed on one (1) as required by the TOR. The chemical testing included pH, water soluble sulphate, chloride, resistivity, sulphide, electrical conductivity analyses and redox potential. The results of the soil chemical testing 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 log sheets in Appendix C. Laboratory test results are provided in Appendix D. The "Explanation of Terms Used in Report" preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A borehole location plan and stratigraphic section are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic section 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 within the roadway embankment consist of sand and gravel, sand, and sand silt fill. The native soils consist of silt and sand/sand and silt, silty sand, and boulders. Bedrock was encountered within borehole BH-A3 at Elev. 321.0 m. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections. A cross-section soil profile is included on Dwg. No. 2 in Appendix B.

1.4.1 Asphalt

Asphalt was encountered at the surface of boreholes BH-A2 and BH-A4 and was approximately 25 mm thick. Asphalt thicknesses may further vary beyond the borehole locations.

1.4.2 Topsoil

Topsoil was encountered at the surface of boreholes BH-A1 and BH-A3 and ranged in thickness from approximately 76 to 100 mm. Topsoil thicknesses may further vary beyond the borehole locations.

1.4.3 Fill – Sand and Gravel

Sand and gravel fill was encountered below the asphalt at BH-A2. The layer was 1.2 m thick and extended from Elev. 330.3 to 329.1 m. The sand and gravel fill contained some silt, some cobbles, and was brown in colour and moist. Uncorrected SPT “N” values within the fill ranged from 41 to 60 blows per 300 mm, classifying the fill as dense to very dense in compactness condition.

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

Moisture Content:

- 4.2% to 4.8%

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

1.4.4 Fill – Sand and Silt

Sand and silt fill was encountered below the asphalt at BH-A4. The layer was 2.1 m thick and extended from Elev. 330.2 to 328.1 m. The sand and silt fill contained trace to some gravel and was brown in colour and moist. Uncorrected SPT “N” values within the fill ranged from 47 to 67 blows per 300 mm, classifying the fill as dense to very dense in compactness condition.

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

Moisture Content:

- 3.5% to 9.0%

Grain Size Distribution:

- 7% gravel;
- 58% sand; and
- 35% silt.

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

1.4.5 Fill –Sand

Sand fill was encountered below the sand and gravel fill at BH-A2. The layer was 1.7 m thick and extended from Elev. 329.1 to 327.4 m. The sand fill contained some gravel, some silt, and was

brown in colour and moist. Uncorrected SPT “N” values within the fill ranged from 44 to 59 blows per 300 mm, classifying the fill as dense to very dense in compactness condition.

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

Moisture Content:

- 6.1% to 7.4%

Grain Size Distribution:

- 11% gravel;
- 72% sand; and
- 17% silt.

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

1.4.6 Sand and Silt/Silt and Sand

Native sand and silt/silt and sand was encountered below the topsoil and below the upper silty sand later at BH-A1, below the suspected boulders at BH-A2, below the topsoil at BH-A3, and below the fill and below the boulders at BH-A4. Sand and silt/silt and sand layers ranged in thickness from 1.8 to 6.9 m and were encountered as high as Elev. 328.1 m and as low as Elev. 316.2 m. The sand and silt/silt and sand extended to bedrock at Elev. 321.0 at BH-A3 and to the borehole termination depth at Elev. 316.2 m at BH-A4. The soil was dark brown to brown in colour and moist becoming grey and wet with depth. The soil contained trace to with organics, some wood, trace gravel to gravelly, trace clay, some cobbles, and some boulders. Uncorrected SPT “N” values within the soil ranged from 3 to 127 blows per 300 mm, classifying the soil as very loose to very dense in compactness condition.

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

Moisture Content:

- 6.1% to 40.3%

Grain Size Distribution:

- 1 to 9% gravel;
- 37 to 56% sand;
- 36 to 54% silt; and,
- 4 to 9% clay.

The results of the moisture content and grain size distribution tests are provided on the borehole logs in Appendix C. The results of the grain size distribution tests are also provided on Figure 3 in Appendix D.

1.4.7 Silty Sand

Native silt sand was encountered below the silt and sand and below the suspected boulders at BH-A1, below the fill at BH-A2, and below the silt and sand at BH-A4. Silty sand layers ranged in thickness from 0.6 to 4.4 m and were encountered as high as Elev. 327.4 m and as low as Elev. 317.1 m. The silty sand extended to the borehole termination depth at Elev. 317.1 m in BH-A1. The silty sand was reddish brown to brown in colour and moist, becoming grey and wet with depth. The silty sand contained trace to some organics, trace to some gravel, trace clay, some cobbles, and was with suspected boulders at BH-A2. Uncorrected SPT "N" values within the soil ranged from 5 to 141 blows per 300 mm, classifying the soil as very loose to very dense in compactness condition.

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

Moisture Content:

- 3.5% to 15.5%

Grain Size Distribution:

- 3 to 19% gravel;
- 45 to 66% sand;
- 25 to 31% silt; and,
- 4 to 6% clay.

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

1.4.8 Boulders/Suspected Boulders

Boulders or suspected boulders were encountered below the silt and sand at BH-A1, below the silty sand and below the sand and silt at BH-A2, and below the silty sand at BH-A3. The boulder layers ranged in thickness from 1.2 to 2.0 m and were encountered as high as Elev. 323.0 m and as low as Elev. 316.2 m. The boulders extended to the borehole termination depth at Elev. 316.2 m at BH-A2. Where suspected boulders are encountered, no sampling was performed as the augers were able to penetrate the layer. The remaining boulders were cored using coring procedures and were found to range in diameter from 0.2 to 0.3 m.

1.4.9 Bedrock

Bedrock was encountered the sand silt at borehole BH-A3 at depth of about 7.0 m below ground surface (Elev. 321.0 m). The bedrock was cored about 3.1 m upto depth of about 10.1 m below ground surface (Elev. 317.9 m). The encountered bedrock consisted of granite, medium grained, with amphibole, mica, alkali feldspar, plagioclase and quartz. Core recovery ranged between about 75% and 100% and water recovery was very good (80-90%) and red in colour. The Rock Quality Designations (RQD) of the core samples ranged from 55 to 65%, which indicates a fair quality rock.

1.5 Groundwater and Surface Water Conditions

Groundwater levels were measured within boreholes BH-A1 and BH-A2 upon completion of the drilling program and are shown on the borehole logs in Appendix C. Groundwater was not measured within boreholes BH-A3 and BH-A4, as accurate measurements could not be made due to water being pumped into the boreholes for coring procedures. The boreholes were not left open long enough during the short term of this investigation for the groundwater table to stabilize within the boreholes.

Groundwater was encountered at the following Elevations at the time of the investigation (October, 2015):

- BH-A1, Elev. 326.8 m (surface); and,
- BH-A2, Elev. 328.8 m.

Water levels were also measured at the culvert inlet and outlet. At the culvert inlet, the water level was at Elev. 326.8 m and at the outlet, Elev. 326.0 m.

Note that water levels measured in open boreholes might not be stabilized due to short term observation.

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. Some perched water over clayey silt layers could exist in the embankment fill as well.

1.6 Corrosivity Testing

One (1) representative soils sample was submitted to a CALA Certified Laboratory for chemical corrosivity analysis. The samples were analyzed for chloride, sulphate, pH, electrical conductivity, resistivity, redox potential, and sulphide concentrations. The results of the corrosivity testing are summarized below, with detailed results included in Appendix E.

Borehole BH-A4, Sample SS5 (Elev. 327.5 m)

- Sulphide: 0.03%;

- Chloride: 66 µg/g;
- Sulphate: 12 µg/g;
- pH: 7.10;
- Electrical Conductivity: 0.195 mS/cm;
- Resistivity: 5130 ohm.cm; and,
- Redox Potential: 328 mV.

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 Ian MacMillan, P.Eng., Nimesh Tamrakar, M.Eng, EIT., 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 Shane Tobias.

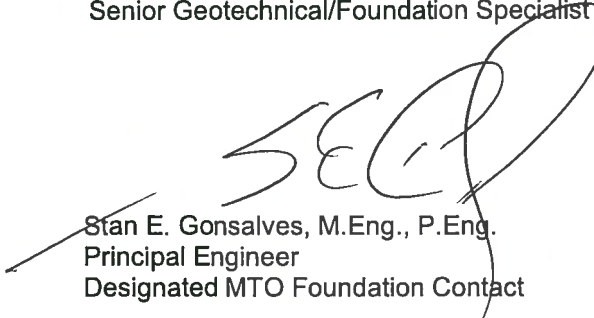
Yours truly,

exp Services Inc.


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Encl.



Appendix A – Site Photographs

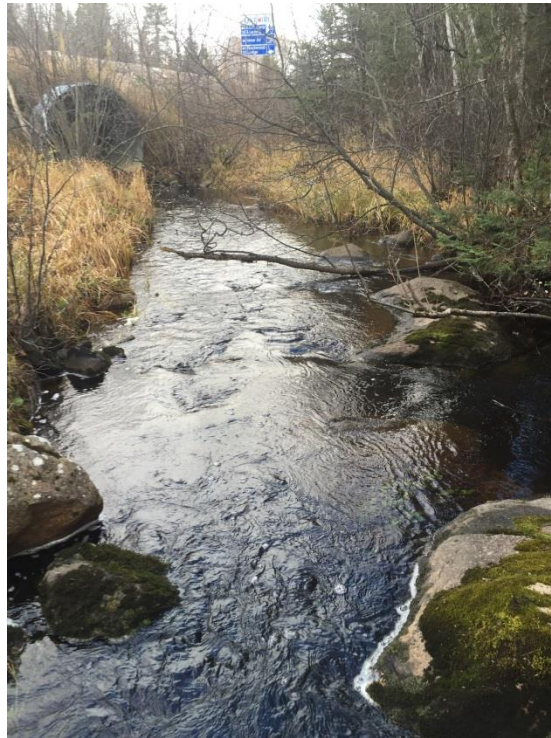


Photo 1. Culvert inlet facing northwest



Photo 2. Alice Creek facing east from inlet



Photo 3. Facing west on outlet side of existing culvert



Photo 4. Alice Creek at outlet



Photo 5. Embankment on inlet side facing north from culvert



Photo 6. Embankment on inlet side facing south from culvert

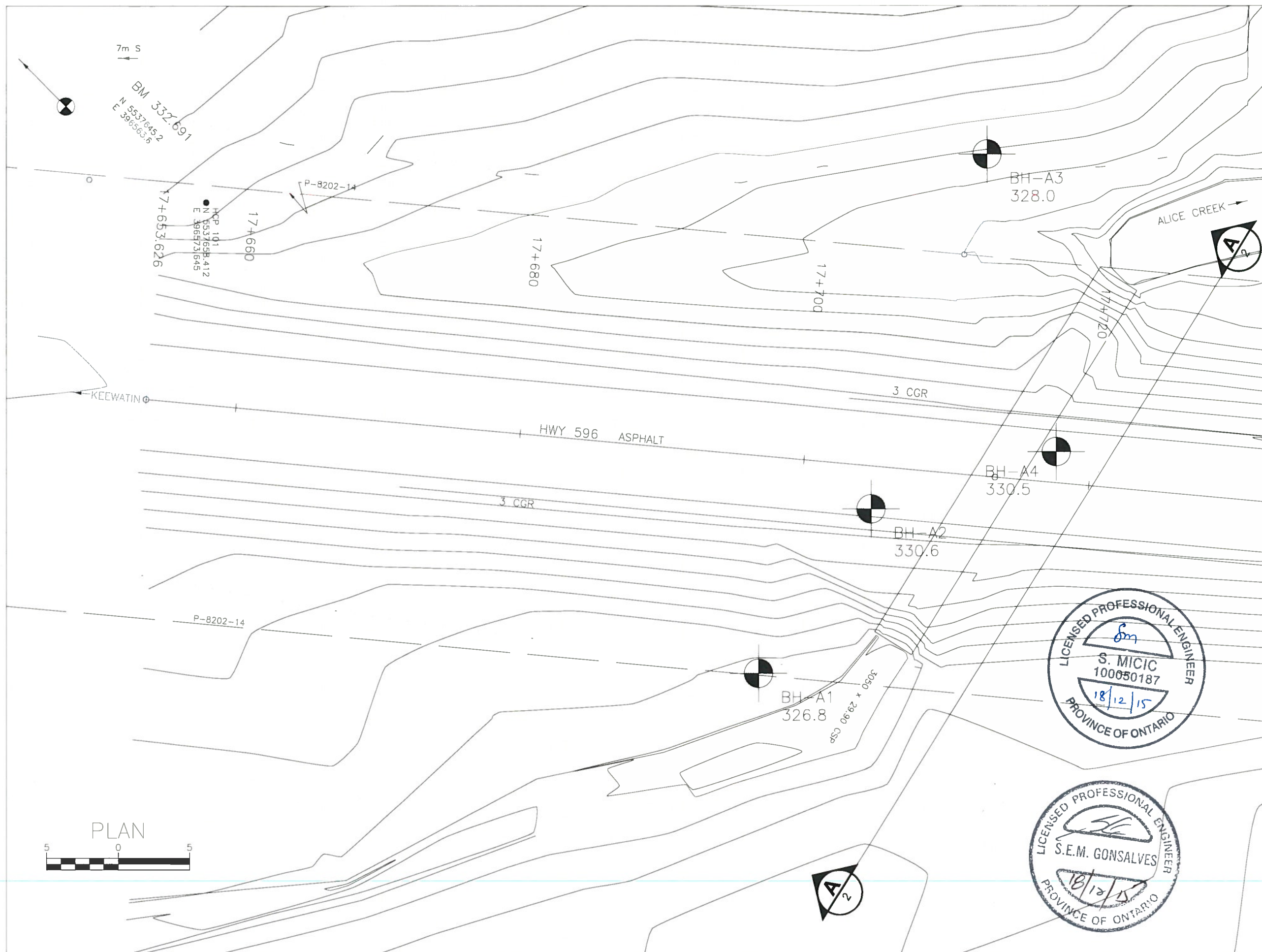


Photo 7. Embankment on outlet side facing north at culvert



Photo 8. Embankment on outlet side facing south at culvert

Appendix B – Drawings

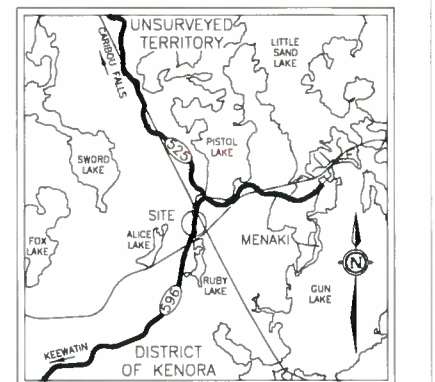


Agreement No. 6014-E-0017
Assignment No. 8
GWP 6368-14-00

ALICE CREEK CULVERT
(Highway 596, Minaki Area)
PLAN

DWG
1

exp Services Inc.



KEY PLAN
1.0 km 0 1.0 km

LEGEND

BOREHOLE LOCATION
GROUND SURFACE ELEVATION IN METRES
BH-A1
326.8

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH-A1	326.8	5,537,697	396,606
BH-A2	330.6	5,537,705	396,595
BH-A3	328.0	5,537,713	396,570
BH-A4	330.5	5,537,718	396,591

NOTES

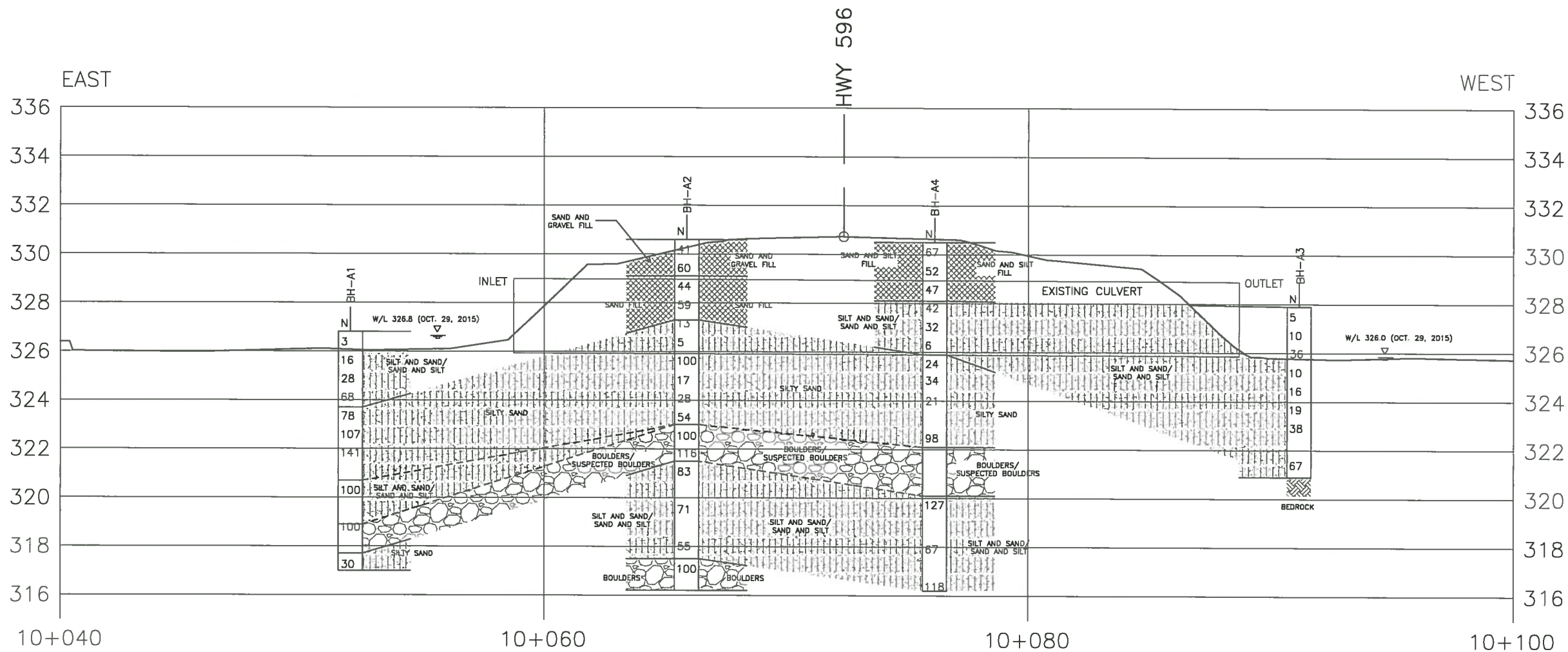
1. ALL DIMENSIONS ARE IN METRES.
2. BASE MAP PROVIDED BY CLIENT.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

REVISIONS

DATE	BY	DESCRIPTION

GEOCREs No.52E-061 Project No.ADM-00223648-60
Date: Dec. 17, 2015 Scale : 1:250
Drawn By: IM Checked By: IM



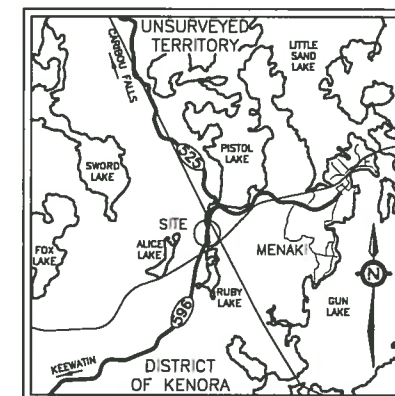


Agreement No. 6014-E-0017
Assignment No. 8
GWP 6368-14-00

ALICE CREEK CULVERT
(Highway 596, Minaki Area)
Cross Section

DWG
2

*exp. **exp Services Inc.**



KEY PLAN
1.0 km 0 1.0 km

LEGEND

N STANDARD PENETRATION TEST (BLOWS/300 mm)

MEASURED WATER LEVEL

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH-A1	326.8	5,537,697	396,606
BH-A2	330.6	5,537,705	396,595
BH-A3	328.0	5,537,713	396,570
BH-A4	330.5	5,537,718	396,591

NOTES

1. ALL DIMENSIONS ARE IN METRES.
2. BASE MAP PROVIDED BY CLIENT.
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REVISIONS

DATE	BY	DESCRIPTION
GEOCRE No.52E-061		Project No.ADM-00223648-0
Date: Dec. 17, 2015		Scale : 1:20
Drawn By: IM		Checked By: I



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:

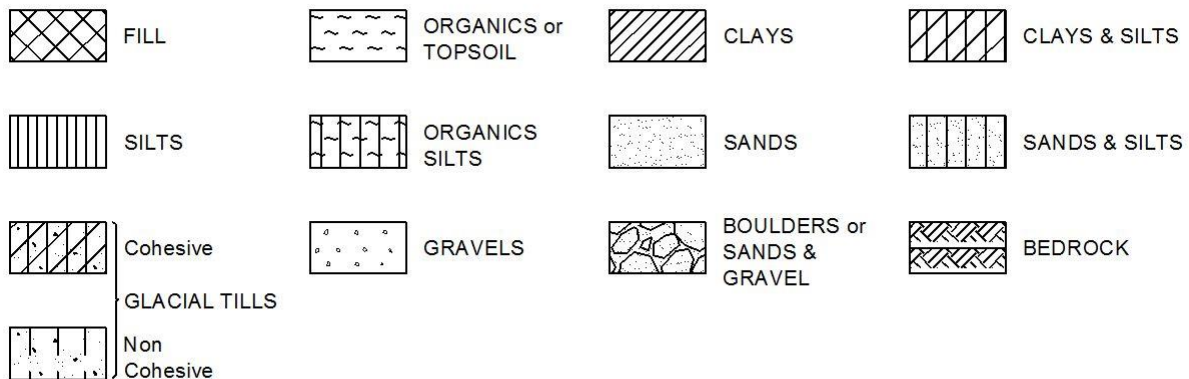
Table c: Consistency of Cohesive Soil

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'	—°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	—°	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 BH-A1

SHEET 1 OF 1

METRIC

GWP No. 6368-14-00 LOCATION Alice Creek Culvert (Site No. 41S-253/C), MTM-17, 5,537,714N, 396,593E ORIGINATED BY ST
DIST Kenora HWY 596 BOREHOLE TYPE CME 850, 200mm Dia. HSA COMPILED BY KR
DATUM Geodetic DATE 27/10/2015 - 29/10/2015 CHECKED BY IM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION					PLASTIC LIMIT PL	NATURAL WATER CONTENT W	LIQUID LIMIT LL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					GR	SA	SI	CL
326.8	TOPSOIL (~ 76 mm thick)		1	SS	3		326													
326.7	SILT AND SAND , with organics, some wood, brown, moist, very loose to compact. no organics/wood below ~ 0.8 m depth. trace gravel, trace clay, grey, wet below ~ 1.5 m depth. very dense below ~ 2.3 m depth.		2	SS	16		325										2	40	54	4
			3	SS	28		324													
			4	SS	68		323													
323.8	SILTY SAND , some gravel, trace clay, grey, wet, very dense.		5	SS	78		322										16	50	30	4
3.1			6	SS	107		321													
			7	SS	141		320													
			8	SS	100		319													
320.7	SILT AND SAND , trace gravel, trace clay, grey, wet, very dense. some boulders below ~ 6.3 m depth.		9	SS	100		318										1	37	53	9
6.1																				
318.9	gravelly below ~ 7.6 m depth.																			
7.9	SUSPECTED BOULDERS , augered through, no sampling.																			
317.7	SILTY SAND , some gravel, grey, wet, dense.		10	SS	30															
9.1																				
317.1																				
9.8	END OF BOREHOLE																			
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before use by others.																			

RECORD OF BOREHOLE No BH-A2

SHEET 1 OF 1

METRIC

GWP No. 6368-14-00 LOCATION Alice Creek Culvert (Site No. 41S-253/C), MTM-17, 5,537,714N, 396,593E ORIGINATED BY ST
DIST Kenora HWY 596 BOREHOLE TYPE CME 850, 200mm Dia. HSA and Cased COMPILED BY KR
DATUM Geodetic DATE 28/10/2015 - 29/10/2015 CHECKED BY IM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION					PLASTIC LIMIT PL	NATURAL WATER CONTENT W	LIQUID LIMIT LL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					GR	SA	SI	CL
330.6	ASPHALT (~ 25 mm thick) FILL, sand and gravel, some silt, brown, moist, dense to very dense. some cobbles below ~ 0.8 m depth.		1	SS	41		330													
330.0			2	SS	60															
329.1	FILL, sand, some gravel, some silt, brown, moist, dense to very dense.		3	SS	44		329										11	72	17	0
1.5			4	SS	59		328													
327.4	SILTY SAND , trace organics, trace clay, trace gravel, reddish brown, grey, moist, loose to very dense. with suspected boulders, some gravel, grey, wet, compact to very dense below ~ 4.6 m depth. trace clay below ~ 6.1 m depth.		5	SS	13		327													
3.3			6	SS	5		326										3	66	25	6
			7	SS	100		325													
			8	SS	17		324													
			9	SS	28		323										16	51	28	5
			10	SS	54		322													
			11	SS	100		321													
			12	SS	116		320										9	44	43	4
			13	SS	83		319													
			14	SS	71		318													
323.0	SUSPECTED BOULDERS , augered through, no sampling.		15	SS	55		317													
7.6			16	SS	100															
321.5	SAND AND SILT , trace to some gravel, trace clay, grey, wet, very dense.																			
9.1																				
317.5	BOULDERS (up to 300 mm dia.). Coring commenced																			
13.1																				
316.2	END OF BOREHOLE NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before use by others.																			
14.4																				

RECORD OF BOREHOLE No BH-A3

SHEET 1 OF 1

METRIC

GWP No. 6368-14-00 LOCATION Alice Creek Culvert (Site No. 41S-253/C), MTM-17, 5,537,714N, 396,593E ORIGINATED BY ST
DIST Kenora HWY 596 BOREHOLE TYPE CME 850, 200mm Dia. HSA and Diamond Drilling COMPILED BY KR
DATUM Geodetic DATE 28/10/2015 - 29/10/2015 CHECKED BY IM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION					PLASTIC LIMIT PL	NATURAL WATER CONTENT W	LIQUID LIMIT LL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
328.0																	
328.0	TOPSOIL (~ 100 mm thick)		1	SS	5		327										
	SAND AND SILT , brown, moist to wet, loose.		2	SS	10												
	loose to very dense below ~ 0.8 m depth.																
	grey, wet below ~ 1.5 m depth.		3	SS	36		326										
			4	SS	10												
	some cobbles below ~ 3.1 m depth.		5	SS	16		325										5 53 38 4
			6	SS	19		324										
			7	SS	38		323										
	very dense below ~ 6.1 m depth.		8	SS	67		322										3 56 36 5
321.0							321										
7.0	BEDROCK , granite, light coloured (pink), medium grained, massive. With amphibole and mica (dark), alkali felspar (pink), plagioclase (white), quartz (glassy). No visible alteration, no carbonate minerals, no visible sulphides. Small quartz vein (less than 1 cm wide) at approximately 30 degrees to core axis.		R1	HQ			320										
			R2	HQ			319										
317.9	Run 1 Start/End: 7.0 m - 8.5 m Recovery: 75% RQD: 55% Water Colour & Return: Red, very good (80-90%)						318										
10.1	Run 2 Start/End: 8.5 m - 10.1 m Recovery: 100% RQD: 65% Water Colour & Return: Red, very good (80-90%) END OF BOREHOLE																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before use by others. 3. No groundwater level was measured due to coring procedures utilized.																

RECORD OF BOREHOLE No BH-A4

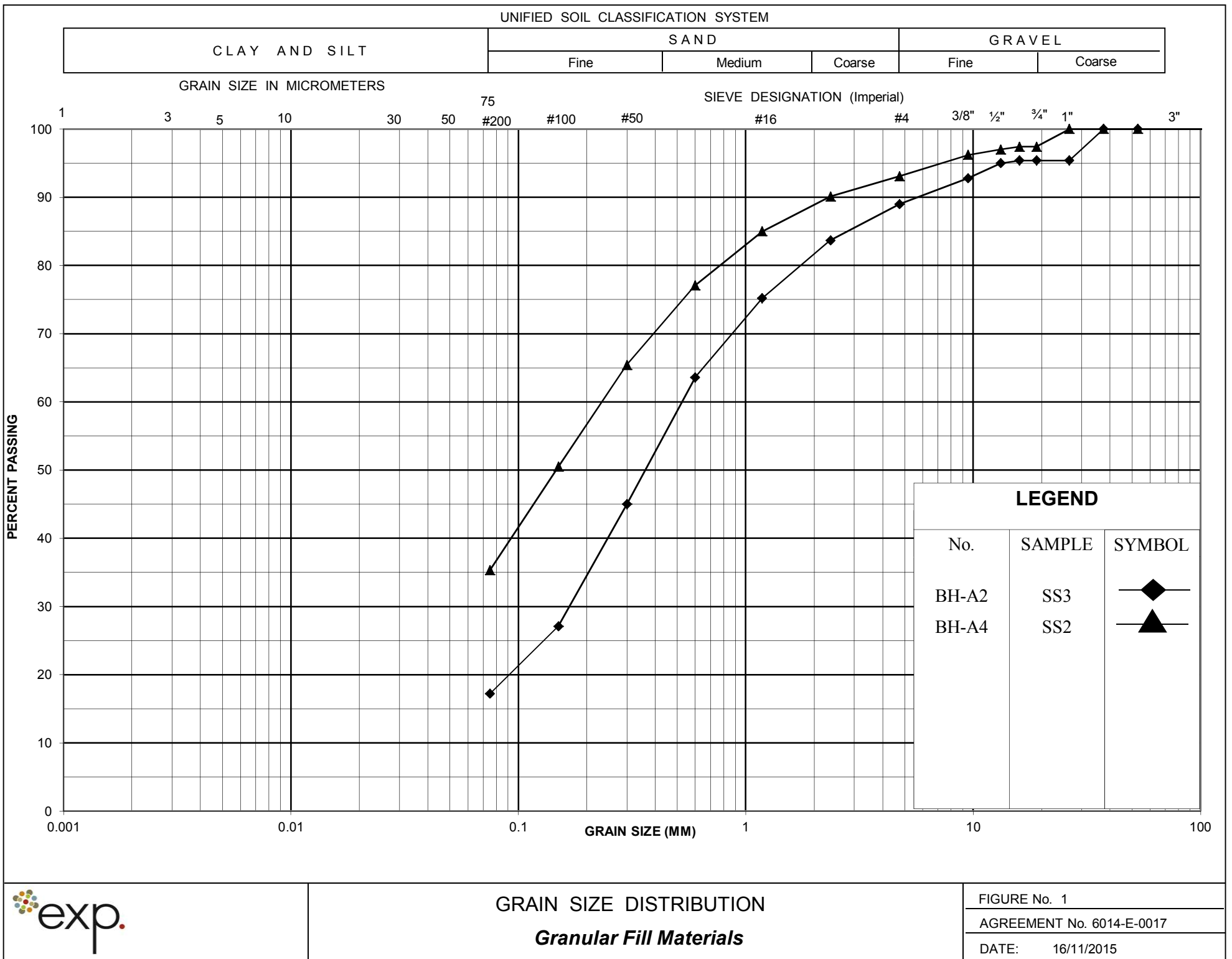
SHEET 1 OF 1

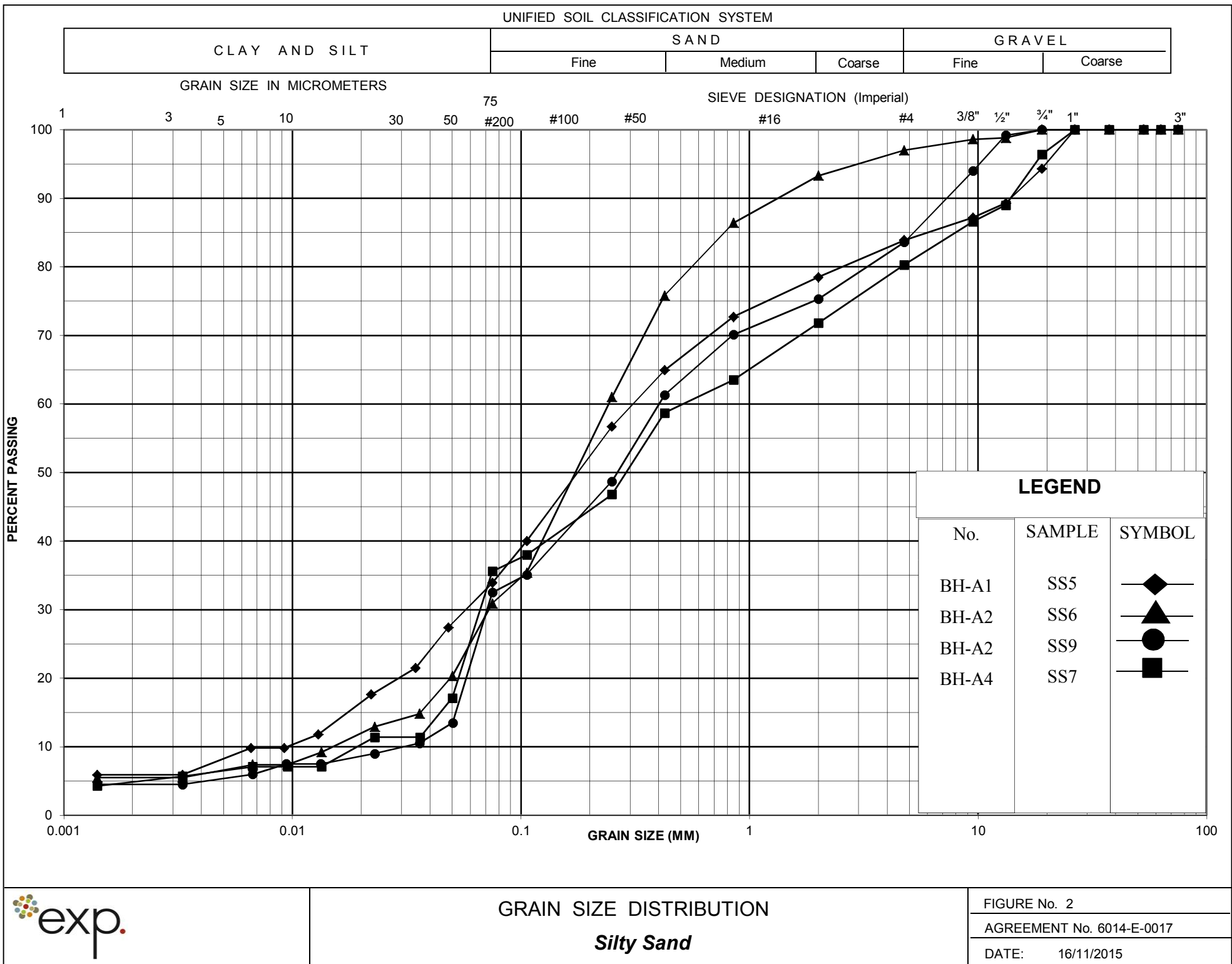
METRIC

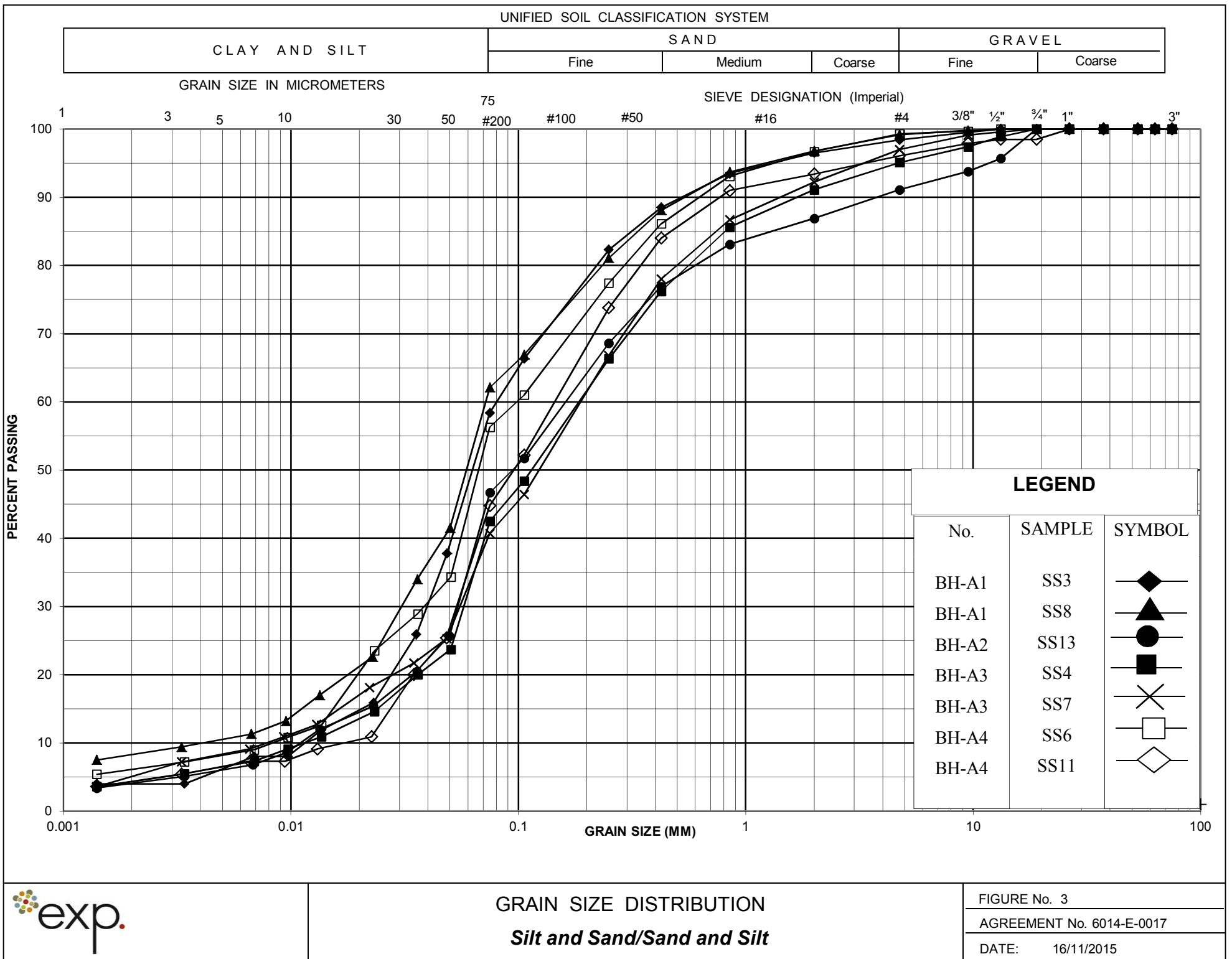
GWP No. 6368-14-00 LOCATION Alice Creek Culvert (Site No. 41S-253/C), MTM-17, 5,537,714N, 396,593E ORIGINATED BY ST
 DIST Kenora HWY 596 BOREHOLE TYPE CME 850, 200mm Dia. HSA and Cased COMPILED BY KR
 DATUM Geodetic DATE 29/10/2015 - 29/10/2015 CHECKED BY IM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION					PLASTIC LIMIT PL	NATURAL WATER CONTENT W	LIQUID LIMIT LL	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					GR	SA	SI	CL
330.5	ASPHALT (~ 25 mm thick) FILL, sand and silt, trace to some gravel, brown, moist, dense to very dense.		1	SS	67		330										7	58	35	0
330.0			2	SS	52															
			3	SS	47		329													
328.1	SILT AND SAND , brown, moist, dense. trace gravel, trace organics, dark brown below ~ 3.1 m depth. trace clay, moist to wet, loose below ~ 3.8 m depth.		4	SS	42		328													
2.4			5	SS	32															
			6	SS	6		327										1	43	50	6
325.9	SILTY SAND , some organics, some gravel, trace clay, dark brown and black, wet, compact to dense. grey, some cobbles, below ~ 5.3 m depth.		7	SS	24		326										19	45	31	5
4.6			8	SS	34		325													
			9	SS	21		324													
	very dense below ~ 7.6 m depth.																			
			10	SS	98		323													
322.1							322													
8.4	BOULDERS (up to 200 mm dia.). Coring commenced.						321													
320.1	SAND AND SILT , trace clay, trace gravel, grey, moist, very dense. trace to some gravel below ~ 12.2 m depth.		11	SS	127		320										4	51	41	4
10.4							319													
			12	SS	67		318													
			13	SS	118		317													
316.2	END OF BOREHOLE NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before use by others. 3. No groundwater level was measured due to wash boring technique used.																			
14.3																				

Appendix D – Laboratory Data







Appendix E – Chemical Analyses

CLIENT NAME: EXP. SERVICES INC.
885 REGENT ST
SUDBURY, ON P3E5M4
(705) 674-9681

ATTENTION TO: Ian MacMillan

PROJECT: ADM-00223648

AGAT WORK ORDER: 15U040280

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 16, 2015

PAGES (INCLUDING COVER): 5

VERSION*: 1

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

***NOTES**

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



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 15U040280

PROJECT: ADM-00223648

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

CLIENT NAME: EXP. SERVICES INC.

SAMPLING SITE:

ATTENTION TO: Ian MacMillan

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2015-11-06

DATE REPORTED: 2015-11-16

		BH-W4, SAMPLE SS9, 22 1/2 - 24 1/2		BH-M1, Sample SS7, 15-17 Ft		BH-A4, Sample SS5, 10-12 Ft	
SAMPLE DESCRIPTION:		Soil		Soil		Soil	
SAMPLE TYPE:		Soil		Soil		Soil	
DATE SAMPLED:		10/26/2015		10/19/2015		10/29/2015	
Parameter	Unit	G / S	RDL	7181054	7181063	7181065	
Sulfide	%		0.01	0.03	0.02	0.03	
Chloride (2:1)	µg/g	NA	2	174	10	66	
Sulphate (2:1)	µg/g		2	5	15	12	
pH (2:1)	pH Units		NA	8.00	8.91	7.10	
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	0.407	0.113	0.195	
Resistivity (2:1)	ohm.cm		1	2460	8850	5130	
Redox Potential (2:1)	mV		5	278	237	328	

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

7181054-7181065 * Sulphide analyses were performed at AGAT Laboratories Vancouver.

EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Certified By:

Amanjot Bhela

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

PROJECT: ADM-00223648

SAMPLING SITE:

AGAT WORK ORDER: 15U040280

ATTENTION TO: Ian MacMillan

SAMPLED BY:

Soil Analysis

RPT Date: Nov 16, 2015			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

Corrosivity Package

Sulfide	7181043		0.03	0.03	NA	< 0.01	108%	80%	120%						
Chloride (2:1)	7181065	7181065	66	68	3.0%	< 2	94%	80%	120%	102%	80%	120%	104%	70%	130%
Sulphate (2:1)	7181065	7181065	12	13	8.0%	< 2	92%	80%	120%	101%	80%	120%	100%	70%	130%
pH (2:1)	7181065	7181065	7.10	7.00	1.4%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	7181065	7181065	0.195	0.199	2.0%	< 0.005	98%	90%	110%	NA			NA		
Redox Potential (2:1)	7181065	7181065	328	331	0.9%	< 5	105%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.

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

Certified By:


Method Summary

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 15U040280

PROJECT: ADM-00223648

ATTENTION TO: Ian MacMillan

SAMPLING SITE:

SAMPLED BY:

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



AGAT

Laboratories

5835 Coopers Avenue
Mississauga, ON
L4Z 1Y2
www.agatlabs.com • webearth.agatlabs.com

Chain of Custody Record

P: 905.712.5100 • F: 905.712.5122

Client Information

Company: EXP
Contact: Don Macmillan
Address: 825 Regent St.
Subway
Phone: 705 674 9681 Fax: 705 674 8271
Project: ADM-00223648 PO: _____
AGAT Quotation #: 5.0.A.

Please note, if quotation number is not provided,
client will be billed full price for analysis.

Regulatory Requirements

☒ Regulation 153/04
(reg. S11 Amend.)
Table 1 Indicate one
☒ Ind/Com
☐ Res/Park
☐ Agriculture
☐ Soil Texture (check one)
☐ Coarse ☐ Fine
☐ Sewer Use
☐ Regulation 558
☐ CCME
☐ Other (specify) _____
☐ Sanitary
☐ Storm
☐ Prow. Water Quality
☐ Objectives (PWQO)
☐ None

Invoice To

Company: _____
Contact: _____
Address: _____

Same: Yes ☒ No ☐

Report Information - reports to be sent to:

Legend Matrix
GW Ground Water **O** Oil
SW Surface Water **P** Paint
SD Sediment **S** Soil

1. Name: Don Macmillan
Email: don.macmillan@exp.com
2. Name: yes beaver park
Email: yes.beaverpark@exp.com

Is this a drinking water sampler?
(potable water intended for human consumption)
☐ Yes ☒ No

If "Yes", please use the
Drinking Water Chain of Custody Form

Is this submission for a Record of Site Condition?
☐ Yes ☐ No

Sample Identification

Date Sampled: Oct 29/15 Time Sampled: N/A Sample Matrix: S # of Containers: 2 Site/Sample Information: _____

Metals and Inorganics	
Metal Scan	
Hydride Forming Metals	
Client Custom Metals	
ORPs: <input type="checkbox"/> B-HWS <input type="checkbox"/> Cl- <input type="checkbox"/> CN- <input type="checkbox"/> EC <input type="checkbox"/> FOC <input type="checkbox"/> Cr+6- <input type="checkbox"/> SAR <input type="checkbox"/> NO ₃ /NO ₂ <input type="checkbox"/> N- Total <input type="checkbox"/> Hg <input type="checkbox"/> pH	
Nutrients: <input type="checkbox"/> TP <input type="checkbox"/> NH ₃ <input type="checkbox"/> TKN <input type="checkbox"/> NO ₃ <input type="checkbox"/> NO ₂ <input type="checkbox"/> NO ₃ /NO ₂	
VOC: <input type="checkbox"/> VOC <input type="checkbox"/> THM <input type="checkbox"/> BTEX	
CCME Fractions 1 to 4	
ABNs	
PAHs	
Chlorophenols	
PCBs	
Organochlorine Pesticides	
TCLP Metals/Inorganics	
Sewer Use	
Corrosivity Package	

Laboratory Use Only
Arrival Temperature: 15.0 040280
AGAT WO #: _____
Lab Temperature: 64/61/66
Notes: _____

Turnaround Time Required (TAT) Required*

Regular TAT

☒ 5 to 7 Working Days

Rush TAT (please provide prior notification)

Rush Surcharges Apply

☐ 3 Working Days

☐ 2 Working Days

☐ 1 Working Day

OR

Date Required (Rush surcharges may apply): _____

* TAT is exclusive of weekends and statutory holidays

Samples Requisitioned By: Print Name and Sign: <u>Paula Frabouze</u> <u>Trillium</u>	Date/Time: <u>Nov 6/15</u> <u>1100</u>	Samples Received By: Print Name and Sign: <u>Katherine Decker</u> <u>Shamun</u>	Date/Time: <u>Nov 6 11:30am</u>	Pink Copy - Client	Page <u>1</u> of <u>1</u>
Samples Requisitioned By: Print Name and Sign: _____	Date/Time: _____	Samples Received By: Print Name and Sign: _____	Date/Time: _____	Yellow Copy - AGAT	Nº: <u>40738</u>