



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

Mills Creek Culvert Replacement, Highway 516, Site No. 41S-011/C, District of Kenora

**Agreement No. 6014-E-0017
Assignment No. 7
GWP 6913-12-01
Geocres No. 52J-015**

Prepared for:

Ontario Ministry of Transportation
Regional Director's Office -NW Region
615 James Street South
Thunder Bay, ON P7E 6P6
Attn: Mike Satten

Ontario Ministry of Transportation
Pavements and Foundations Section
Foundations Group
Building 'C', Room 223
1201 Wilson Avenue
Downsview, ON M3M 1J8
Attn: K.Ahmad

exp Services Inc.
December 17, 2015

Ministry of Transportation

Foundation Investigation Report

Agreement No. 6014-E-0017

Assignment No. 7

GWP 6913-12-01

Geocres No. 52J-015

Type of Document:

Final

Project Name:

Foundation Investigation Report for Mills Creek Culvert Replacement
Highway 516, Site No. 41S-011/C, District of Kenora

Project Number:

ADM-00223648-F0

Prepared By:

Ahileas Mitsopoulos, P.Eng.

Nimesh Tamrakar, M.Eng, EIT.

Demetri N. Georgiou, MASc. P.Eng.

Silvana Micic, Ph.D., P.Eng.

Reviewed By:

TaeChul Kim, M.E.Sc. P.Eng.

Stan E. Gonsalves, M.Eng., P.Eng.

exp Services Inc.

56 Queen St, East, Suite 301

Brampton, ON L6V 4M8

Canada



Silvana Micic, Ph.D., P.Eng.
Senior Geotechnical Engineer
Project Manager



Stan E. Gonsalves, M.Eng., P.Eng.
Executive Vice President
Designated MTO Contact

Date Submitted:

December 17, 2015

Table of Contents

Part I: FOUNDATION INVESTIGATION REPORT	1
1.1 Introduction	1
1.2 Site Description and Geological Setting	1
1.2.1 Site Description	1
1.2.2 Geological Setting	2
1.3 Investigation Procedures	2
1.3.1 Site Investigation and Field Testing	2
1.3.2 Laboratory Testing	3
1.4 Subsurface Conditions	4
1.4.1 Poorly Graded Sand with Silt and Gravel Fill to Poorly Graded Gravel with Silt and Sand Fill	4
1.4.2 Cobbles and Boulders Fill	5
1.4.3 Poorly Graded Gravel with Silt and Sand Fill to Silty Sand Fill	5
1.4.4 Peat	6
1.4.5 Clayey Silt with Sand	6
1.4.6 Poorly Graded Sand with Gravel to Sandy Silt	7
1.4.7 Silty Sand Till	7
1.4.8 Bedrock	8
1.5 Groundwater and Surface Water Conditions	8
1.6 Chemical Analyses	9
1.7 Closure	10

Appendices

APPENDIX A: PHOTOGRAPHS

APPENDIX B: DRAWING

APPENDIX C: BOREHOLE LOGS AND BEDROCK CORE PHOTOS

APPENDIX D: LABORATORY DATA

APPENDIX E: CHEMICAL ANALYSES

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 the Mills Creek Culvert, located on Highway 516, about 32.5 km east of the junction of Hwy 516 and Hwy 642, in the District of Kenora, the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 7 (GWP 6913-12-01). The terms of reference (TOR) were as presented in the MTO letter dated July 7, 2015.

Based on preliminary information provided and our observations on site, the existing culvert is a corrugated steel pipe with a diameter of about 3.8 m, and a length of about 33.2 m. It is understood that the existing culvert was constructed in 1978, 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 Mills Creek Culvert is located on Highway 516, about 32.5 km east of the junction of Hwy 516 and Hwy 642, in the District of Kenora, northeast of Sioux Lookout, Ontario. At the site, Hwy 516 is a two lane roadway, with a speed limit of 80 km/h and is about 7.0 m wide from edge of pavement to edge of pavement, with sand and gravel shoulders. Based on drawings provided, the roadway embankment is about 6.5 m high with side slopes of about 2H:1V and at culvert location embankment is about 8.4 m high.

During the fieldwork on August 15 to 17 and 20 to 22, 2015, the general site conditions were assessed. Hwy 516 runs in a generally east and west direction and the water in Mills Creek generally flows from south to north beneath the highway. At the time of this investigation, the approximate creek elevations at the inlet and outlet were both about 356.85 m, and the streambed elevations at the inlet and outlet were both about 355.1 m. The elevation of highway pavement centerline at the culvert centerline is about 363.5 m. Guard rails were present on both sides of the road at the culvert location.

The vicinities of the inlet and outlet of the culvert are free from vegetation. The area surrounding the culvert (i.e. the shoreline) contained some tall grasses. The inlet and outlet appeared to be

generally clear of debris and as such, the flow does not appear to be restricted. Bedrock outcrops were noted east and west of the culvert.

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 5114, Scale 1:100,000, dated 1979, the underlying native soil at the site consists of rock ridges and/or sand till ground moraines overlying bedrock with a drift veneer the terrain is generally mixed, ridged to undulating local relief with dry surface conditions. In addition to the above terrain, subordinate landforms consisting of peat organic terrain and/or silt glaciolacustrine plains with low local relief and mixed wet and dry surface conditions are present in the area.

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 intrusive Foliated Tonalite Suites of the Neo to Mesoarchean Era (2.5 to 3.4 Ga), and generally consists of tonalite to granodiorite rock in massive or foliated formations.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed on August 15 to 17 and 20 to 22, 2015. The field program consisted of drilling seven (7) sampled boreholes (BH201 to BH207). Two (2) boreholes were located within the highway, BH201 and BH202. BH201 was located about 4.9 m west of the culvert centerline and about 2.8 m south of the highway centerline. BH202 was located about 7.5 m east of the culvert centerline and about 1.8 m north of the highway centerline. An additional five (5) boreholes (BH203 to BH207) were advanced off of the highway. BH203, BH204 and BH205 were located about 12 m east of the culvert centerline and about 20 m, 21.5 m and 23 m south of the highway centerline, respectively, on the inlet/upstream side of the culvert. BH206 was located about 11 m west of the culvert centerline and about 19 m north of the highway centerline, and BH207 was located about 5 m west of the culvert centerline and about 21.5 m north of the highway centerline, both on the outlet/downstream side of the culvert. The borehole locations are shown on Drawing 1 in Appendix B.

The roadway boreholes (BH201 and BH202) were advanced using a CME 850 track mounted drill rig. 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). BH201 and BH202 were advanced to depths of about 13.7 m and 16.1 m below ground surface, respectively.

Due to drill rig access issues, the off-road boreholes (BH203 to BH207) were advanced using a hand gas powered auger. Boreholes, BH203 to BH207, were advanced to refusal depths ranging

between about 0.7 m and 3.1 m below ground surface. The off-road boreholes were terminated at the refusal depths.

At BH201 and BH202, initial refusal to auger was encountered at about 1.6 m and 1.5 m depth, respectively; however, using rock coring techniques, the boreholes were advanced beyond the initial and subsequent refusals.

At depths of 10.7 m at BH201 and 13.1 m at BH202 rock coring techniques were used to advance the boreholes 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 benchmark (BM) provided (spike in rock) east of the site and north of the highway. The BM elevation is 364.902 m. The location of the BM is shown on Drawing 1, in Appendix B.

During the drilling of the roadway boreholes (BH201, BH202), 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. For all other boreholes (BH203 to BH207), samples were collected directly from the auger flights.

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. Atterberg Limits tests were carried out on select cohesive 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 fill material composed of poorly graded sand to poorly graded gravel, and cobbles and boulders. In general, the fill was overlying sand, overlying silty sand till and overlying bedrock. The off-road boreholes generally consisted of peat overlying clayey silt. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

1.4.1 Poorly Graded Sand with Silt and Gravel Fill to Poorly Graded Gravel with Silt and Sand Fill

Poorly graded sand with silt and gravel fill to poorly graded gravel with silt and sand fill was encountered beneath the asphalt at BH201 and BH202. The asphalt thickness at BH201 and BH202 was about 25 mm. The poorly graded sand to poorly graded gravel was generally described as very dense to compact at depth, brown, damp, containing trace to some asphalt pieces in the upper 0.4 m. In addition, crushed gravel was observed in the upper 0.2 m. The SPT “N” values ranged between 28 and 81 blows per 300 mm penetration, with an average “N” value of about 60. The poorly graded sand and poorly graded gravel fill extended to depths ranging between about 1.5 m (362.0 m elevation) and 2.1 m (361.3 m elevation) below ground surface.

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

Moisture content:

- 3.0% to 3.8%

Grain size distribution:

- 41% to 51% gravel;
- 41% to 48% sand;
- 8% to 11% silt and clay size.

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 tests are also provided on Figures 1 and 2, in Appendix D.

1.4.2 Cobbles and Boulders Fill

Cobbles and boulders fill, containing some sand and some gravel was encountered beneath the poorly graded sand and poorly graded gravel. No SPT “N” values were obtained within the cobble and boulder layers. The cobbles and boulders fill ranged in thickness between about 1.0 m at BH201 and about 4.6 m at BH202. The cobbles and boulders extended to depths of about 3.1 m (360.3 m elevation) and 6.1 m (357.5 m elevation) below ground surface.

1.4.3 Poorly Graded Gravel with Silt and Sand Fill to Silty Sand Fill

Poorly graded gravel with silt and sand fill to silty sand fill was encountered beneath the cobbles and boulders fill, at BH201 and BH202, respectively. The poorly graded gravel and silty sand was generally described as very loose to compact, brown and damp to wet. Occasional cobbles were noted at BH201. A 50 mm clay seam was observed within the silty sand at BH202, at about 7.2 m depth. The SPT “N” values ranged between 2 and 60 blows per 300 mm penetration, with an average “N” value of about 14. The poorly graded gravel fill to silty sand fill extended to depths ranging between about 7.6 m (355.8 m elevation) and 8.4 m (355.2 m elevation) below ground surface.

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

Moisture content:

- 0.7% to 18.9%

Grain size distribution:

- 1% to 86% gravel;
- 12% to 76% sand;
- 2% to 23% silt and clay size.

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 tests are also provided on Figures 2 and 4, in Appendix D.

1.4.4 Peat

Peat was generally encountered surfacing the off-road boreholes (BH203 to BH207). The peat was generally described as soft, brown, and wet. Occasional cobbles were noted in the upper 0.15 m at BH203 and BH204. In addition, moderate to strong fuel odours were noted at BH203 from about 0.2 m to 2.9 m below ground surface. No SPT “N” values were measured within the peat. The peat thicknesses and depths (below ground surface) ranged between about 0.1 m and 2.9 m. The peat extended to elevations ranging between about 354.1 m and 356.9 m.

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

Moisture content:

- 142.8% to 668.8%

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

1.4.5 Clayey Silt with Sand

Clayey silt with sand was generally encountered underlying the peat in the off-road boreholes. The clayey silt with sand was generally described as stiff, brown to grey, wet, containing occasional cobbles and trace organics in about the upper 0.3 m to 0.5 m. As the off-road holes were manually advanced, no SPT “N” values were measured within the clayey silt with sand. The clayey silt with sand extended to depths ranging between about 1.1 m and about 3.0 m below ground surface, and elevations ranging between 354.1 m and 355.9 m.

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

Moisture content:

- 18.9% to 28.3%

Grain size distribution:

- 0% gravel;
- 18% to 25% sand;
- 56% to 58% silt; and
- 18% to 24% clay size.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 19.3 to 20.8 kN/m³. Four (4) Atterberg Limits tests were performed on representative samples of the clayey silt (BH204-S3, BH205-S2, BH205-S5 and BH207-S2). The results indicated that the soil is of low plasticity. The data is shown on the plasticity chart, Figure 6. The liquid limit, plastic limit and plasticity index ranged between about 24 and 26, 15 and 17, and 8 and 10, respectively.

The results of the moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figure 3 in Appendix D, and Atterberg Limits tests are provided on Figure 6 in Appendix D.

1.4.6 Poorly Graded Sand with Gravel to Sandy Silt

Poorly graded sand with gravel to sandy silt was generally encountered beneath the fill, peat and clayey silt. The poorly graded sand to sandy silt was generally described as loose to very dense, brown, wet, and containing occasional cobbles. At BH202, a layer of cobbles was noted beneath the silty sand, and was about 0.8 m in thickness. The SPT "N" values ranged between 5 and 61 blows per 300 mm penetration, with an average "N" value of about 25. The poorly graded sand with gravel to sandy silt extended to depths ranging between about 0.7 m and 10.7 m below ground surface, and elevations ranging between about 352.7 m and 356.0 m.

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

Moisture content:

- 7.8% to 23.0%

Grain size distribution:

- 2% to 29% gravel;
- 33% to 71% sand;
- <3% to <43% silt; and
- <3% to <43% clay size.

Total saturated unit weight has been calculated based on the moisture contents and are estimated to range from about 20.1 to 23.5 kN/m³.

The results of the moisture content and grain size distribution 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 4 in Appendix D.

1.4.7 Silty Sand Till

Silty sand till was encountered beneath the cobbles at BH202 and beneath the clayey silt with sand at BH205. The till was generally described as compact to very dense, grey and wet. At BH202, gravel, cobbles and boulders were encountered within the till. Two SPT "N" values were obtained and were 40 and 65 blows per 300 mm penetration. The till extended to depths ranging between about 3.1 m (353.9 m elevation) and 13.1 m (350.4 m elevation) below ground surface.

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

Moisture content:

- 7.1% to 14.7%

Grain size distribution:

- 28% gravel;
- 58% sand;
- 11% to <14% silt; and
- 3% to <14% clay size.

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 tests are also provided on Figure 5, in Appendix D.

1.4.8 Bedrock

Bedrock was encountered underlying the silty sand with gravel at BH201, and beneath the silty sand till at BH202, at depths of about 10.7 m (352.7 m elevation) and 13.1 m (350.4 m elevation), respectively. The bedrock was generally described as a medium strong (25 MPa to 50 MPa compressive strength), very severely fractured to severely fractured, pink to white (some green at BH202), and medium grained. The boreholes were extended by rock coring about 3.0 m into bedrock, and to depths ranging about 13.7 m and 16.1 m below ground surface. The boreholes were terminated at elevations ranging between about 347.4 m and 349.7 m. Photographs of the bedrock core samples are presented in Appendix C, after the Borehole Logs.

Gross recoveries ranged between about 97% and 100%. The Rock Quality Designation (RQD), which is a modified core recovery, ranged from 0% to 42% (very severely fractured to severely fractured).

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. 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	Aug. 20/15	Aug. 20/15	363.38	6.68	356.70
BH202	Aug. 21/15	Aug. 22/15	363.58	6.50	357.08
BH203	Aug. 20/15	Aug. 20/15	357.00	0.15	356.85
BH204	Aug. 20/15	Aug. 21/15	356.95	0.10	356.85
BH205	Aug. 20/15	Aug. 21/15	357.03	0.08	356.95
BH206	Aug. 20/15	Aug. 20/15	356.70	-0.15 ⁴	356.85
BH207	Aug. 20/15	Aug. 20/15	357.00	0.15	356.85
Mills Creek WL Upstream (South) Side	--	Aug. 21/15	--	--	356.85 ⁵
Mills Creek WL Downstream (North) Side	--	Aug. 21/15	--	--	356.85 ⁵
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to a geodetic benchmark (BM) provided (spike in rock) east of the site and north of the highway. The BM elevation is 364.902 m. 3) Depths are relative to ground surface. 4) Negative value indicates water level above ground surface. 5) Indicates top of surface water elevation at Mills 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-S9	7.50	<20	<20	15,000	65
BH204-S4	6.98	57	<20	4,800	208

December 17, 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,


exp Services Inc.



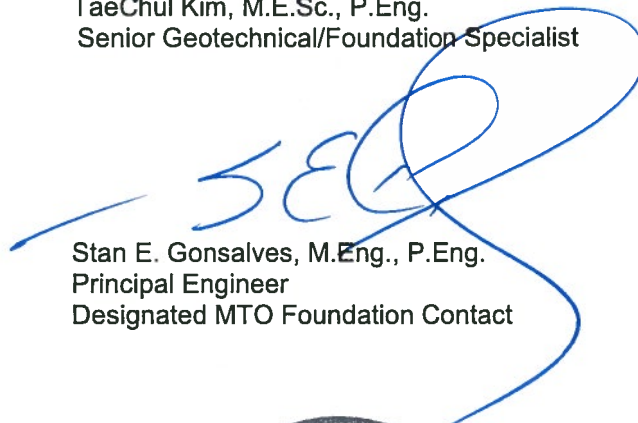
Nimesh Tamrakar, M.Eng., EIT.
Technical Specialist



TaeChul Kim, M.E.Sc., P.Eng.
Senior Geotechnical/Foundation Specialist

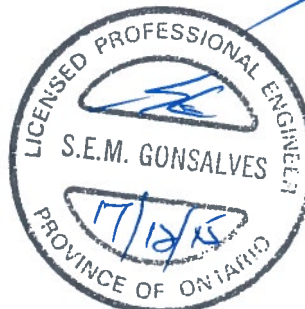


Silvana Micic, Ph.D., P.Eng.
Senior Geotechnical Engineer
Project Manager



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 west on Highway 516 before the existing culvert



Photo 4. Facing east on Highway 516 before the existing culvert

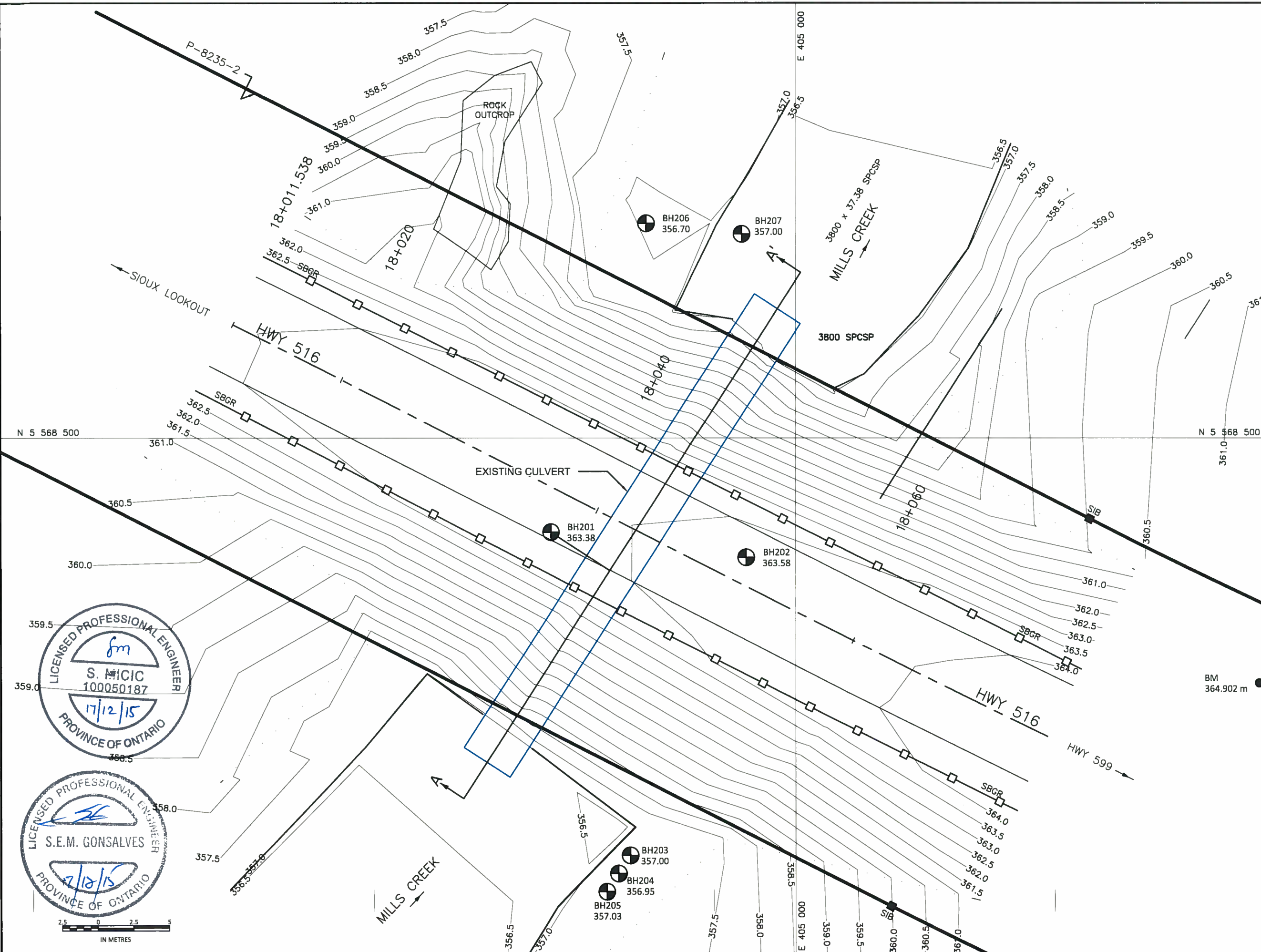


Photo 5. Embankment slope on north side facing east



Photo 6. Embankment slope on south side facing southeast

Appendix B – Drawings



Agreement No. 6014-E-0017
Assignment No. 7
GWP 6913-12-01

MILLS CREEK CULVERT
(Highway 516, District of Kenora, ON)
PLAN

DWG
1

exp.

exp Services Inc.

KEY PLAN

DISTRICT OF KENORA
UNSURVEYED TERRITORY

LEGEND

BH201 363.38
GROUND SURFACE ELEVATION IN METRES

BM 364.902
GEODETIC ELEVATION IN METRES

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH201	363.38	5,568,494	404,983
BH202	363.58	5,568,492	404,994
BH203	357.00	5,568,470	404,988
BH204	356.95	5,568,468	404,987
BH205	357.03	5,568,467	404,985
BH206	356.70	5,568,513	404,987
BH207	357.00	5,568,510	404,998

NOTES

1. ALL DIMENSIONS ARE IN METRES.

2. BASE MAP PROVIDED BY CLIENT.

3. MTM COORDINATES BASE ON MTM ZONE ON-16 PROJECTION, AS PER PROVIDED FIGURE.

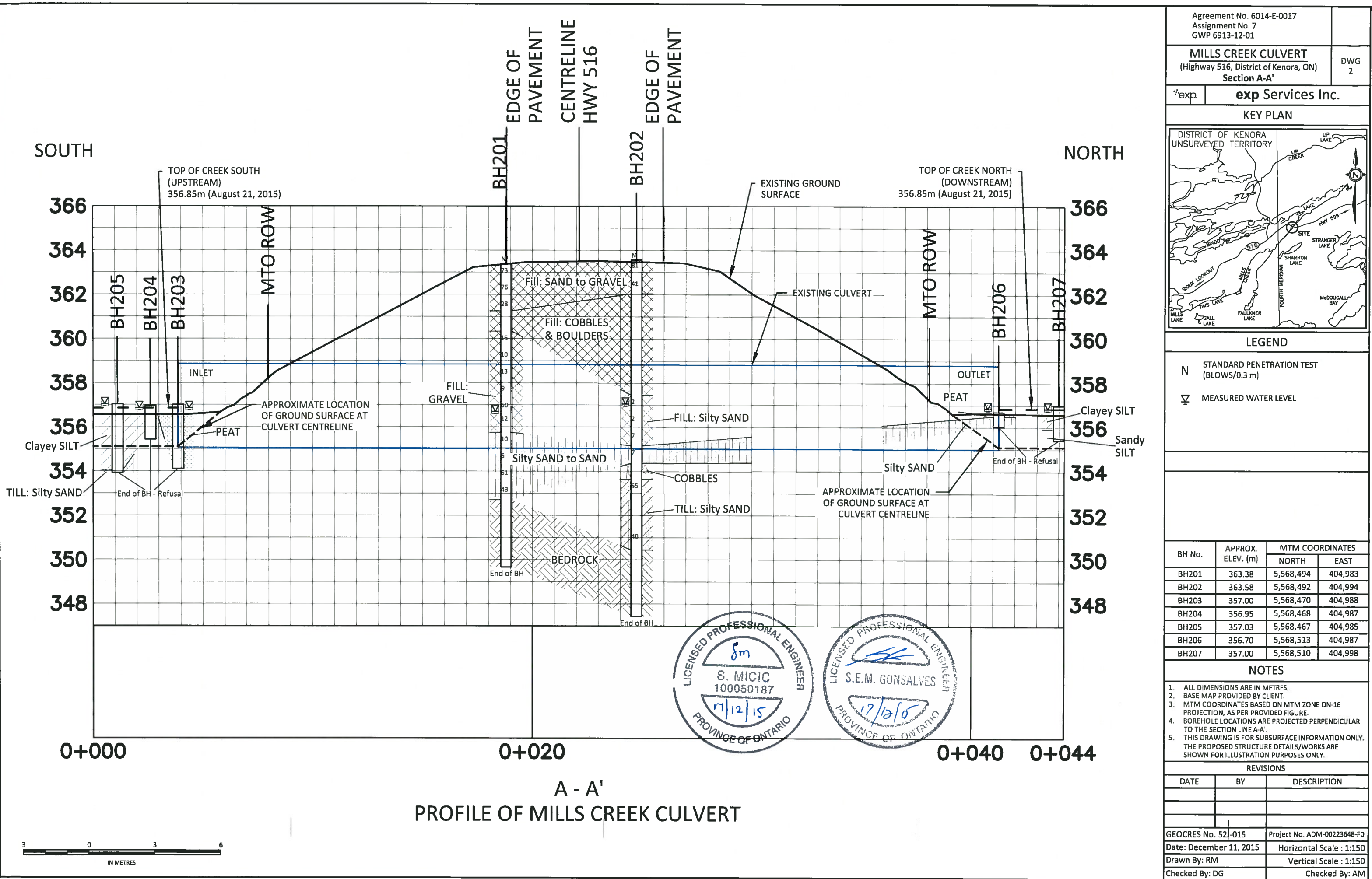
4. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

REVISIONS

DATE	BY	DESCRIPTION

GEOCREs No. 521-015
Date: December 11, 2015
Drawn By: RM

Project No. ADM-00223648-F0
Scale : 1:250
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:

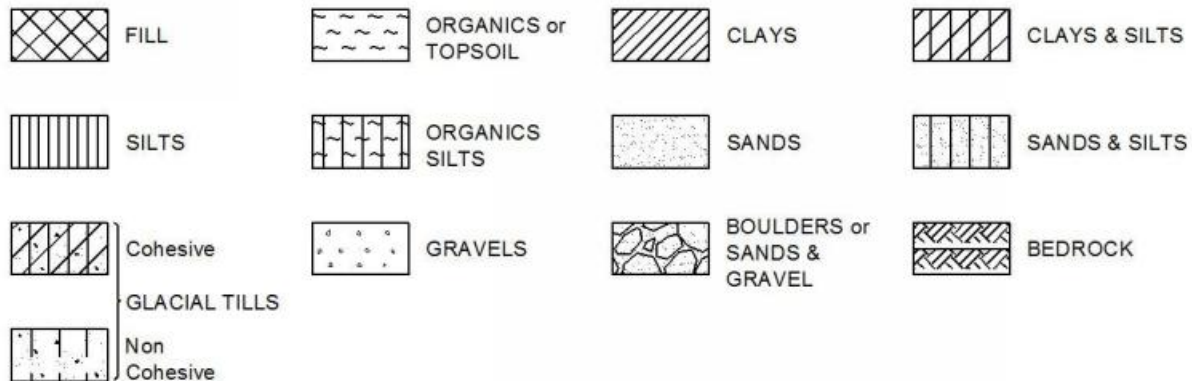
Table c: Consistency of Cohesive Soil

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



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 BH201

1 OF 2

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,494N 404,983E ORIGINATED BY EF
DIST 61 HWY Hwy 516 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY AM/RM
DATUM Geodetic DATE 8.16.15 - 8.20.15 CHECKED BY DG

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									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20					40	60	80				
363.4	Asphalt																						
360.0	ASPHALT - about 25 mm Poorly Graded SAND with Silt and Gravel (FILL) - very dense to compact, brown, damp, some crushed material in upper 0.2 m - some asphalt pieces from about 0.2 m to 0.4 m depth		S1A	SS			363																
			S1B	SS	73																		
			S1C	SS																			
			S2	SS	76		362																
	- refusal to auger at about 1.6 m depth, borehole advanced using HW casing		S3	SS	28							○					41	48	(11)				
361.3	COBBLES & BOULDERS (FILL)						361																
			S4	CORE																			
360.3	Poorly Graded GRAVEL (FILL) - loose to compact, brown, damp, occasional cobbles			SS	16		360											No recovery					
			S5	SS	10		359					○					86	12	(2)				
			S6	SS	13		358																
				SS	9													No recovery					
	- becoming very dense at about 6.1 m depth			SS	60		357											No recovery					
	- becoming compact at about 6.7 m depth		S7	SS	12		356					○											
355.8	Poorly Graded SAND with Gravel - loose to compact, brown, wet		S8	SS	10		355					○						27	70 (3)				
			S9	SS	5							○											
354.2	Silty SAND with Gravel - dense to very dense, brown, wet, occasional cobbles		S10	SS	61		354					○						26	56 (18)				

Continued Next Page

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

RECORD OF BOREHOLE No BH202

1 OF 2

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,492N 404,994E ORIGINATED BY EF
DIST 61 HWY Hwy 516 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY AM/RM
DATUM Geodetic DATE 8.15.15 - 8.22.15 CHECKED BY DG

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								WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL × LAB VANE										
363.6	Asphalt						20	40	60	80	100							
360.0	ASPHALT - about 25 mm Poorly Graded GRAVEL with Silt and Sand (FILL) - very dense to dense, brown to dark brown, damp, trace asphalt pieces in upper 0.4 m		S1A	SS														
			S1B	SS	81													
			S1C	SS														
			S2	SS	41								○				51 41 (8)	
362.0																		
1.5	COBBLES & BOULDERS (FILL) - some gravel, some sand - refusal to auger at about 1.5 m depth, borehole advanced using HW casing		S3	CORE														
			S4	CORE														
			S5	CORE														
357.5																		
6.1	Silty SAND (FILL) - very loose to loose, brown, wet, fine grained		S6	SS	2									○				
			S7	SS	2									○			1 76 (23)	
	- about 50 mm clay seam at about 7.2 m depth																	
			S8	SS	7									○				
355.2																		
8.4	Silty SAND - loose, brown, wet, fine grained		S9	SS	7									○			2 71 (27)	
354.4																		
9.2	COBBLES - refusal to advance HW casing, rock coring initiated at about 9.2 m depth		S10	CORE														
353.6																		

Continued Next Page

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

RECORD OF BOREHOLE No BH202

2 OF 2

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,492N 404,994E ORIGINATED BY EF
DIST 61 HWY Hwy 516 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY AM/RM
DATUM Geodetic DATE 8.15.15 - 8.22.15 CHECKED BY DG

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 (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _p	W						W _L
9.9	Silty SAND (TILL) - dense to very dense, grey, wet - gravel, cobbles and boulders from about 10.7 m to 12.2 m depth		S11	SS	65								○				28	58	(14)	
				S12	CORE															
			S13	SS	40								○				28	58	11 3	
350.4																				
13.1	BEDROCK - medium strong, very severely fractured to severely fractured, pink, some green, medium grained		S14	CORE															Recovery=99%, RQD=0%	
				S15	CORE															Recovery=100%, RQD=42%
				S16	CORE															Recovery=98%, RQD=16%
347.4																				
16.1	End of Borehole																			

RECORD OF BOREHOLE No BH203

1 OF 1

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,470N 404,988E ORIGINATED BY EF
 DIST 61 HWY Hwy 516 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM/RM
 DATUM Geodetic DATE 8.20.15 - 8.20.15 CHECKED BY DG

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						W _p W W _L			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%)						
357.0	0.0	Peat		S1	AUGER		356													
		PEAT - soft, brown, wet, occasional cobbles in upper 0.15 m - moderate to strong fuel odours from about 0.2 m to 2.9 m depth		S2	AUGER															
				S3	AUGER															
							355													
				S4	AUGER															
		- cobbles noted during augering at about 2.6 m depth																		
354.1	2.9	End of Borehole - refusal to auger																		


ON_MOT_F-15137-BG - ADM-00223648-F0 - MTO 7 - MILLS CREEK CULVERT.GPJ ON_MOT.GDT 11/17/15

RECORD OF BOREHOLE No BH204

1 OF 1

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,468N 404,987E ORIGINATED BY EF
DIST 61 HWY Hwy 516 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM/RM
DATUM Geodetic DATE 8.20.15 - 8.21.15 CHECKED BY DG

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					WATER CONTENT (%)
357.0	Peat							20 40 60 80 100							
356.8	PEAT - soft, brown, wet, trace silt, trace clay, occasional cobbles Clayey SILT with Sand - stiff, brown to grey, wet, occasional cobbles, trace organics in upper 0.5 m		S1	AUGER		▽	356								GR SA SI CL
0.2			S2	AUGER											
			S3	AUGER											
			S4	AUGER											
			S5	AUGER											
355.4															
1.5	End of Borehole - refusal to auger														


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

RECORD OF BOREHOLE No BH205

1 OF 1

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,467N 404,985E ORIGINATED BY EF
 DIST 61 HWY Hwy 516 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM/RM
 DATUM Geodetic DATE 8.20.15 - 8.21.15 CHECKED BY DG

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 (%)					
357.0	Peat		S1	AUGER		356								0 24 56 20	
356.0	PEAT - soft, brown, wet Clayey SILT with Sand - stiff, brown to grey, wet, occasional cobbles in upper 1.5 m, trace organics in upper 0.5 m		S2	AUGER											
			S3	AUGER											
			S4	AUGER											
			S5	AUGER											
			S6	AUGER											
354.1						354								0 21 57 22	
353.9	Silty SAND (TILL) - compact to dense, grey, wet End of Borehole - refusal to auger	S7	AUGER												
3.1															

ON_MOT F-15137-BG - ADM-00223648-F0 - MTO 7 - MILLS CREEK CULVERT.GPJ ON_MOT.GDT 11/17/15

RECORD OF BOREHOLE No BH206

1 OF 1

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,513N 404,987E ORIGINATED BY EF
 DIST 61 HWY Hwy 516 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM/RM
 DATUM Geodetic DATE 8.20.15 - 8.20.15 CHECKED BY DG

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				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)							
356.7	Water																			
0.0 356.5	PEAT - soft, brown, wet		S1	AUGER																
0.2	Silty SAND with Gravel - loose, brown, wet, occasional cobbles, some peat and organics		S2	AUGER														29	33 (38)	
356.0	End of Borehole - refusal to auger																			
0.7																				

ONL_MOT_F-15137-BG - ADM-00223648-F0 - MTO 7 - MILLS CREEK CULVERT.GPJ ON_MOT.GDT 11/17/15

RECORD OF BOREHOLE No BH207

1 OF 1

METRIC

W.P. GWP No. 6913-12-01 LOCATION Mills Creek Culvert (Site No. 41S-011/C) MTM ON-16 5,568,510N 404,998E ORIGINATED BY EF
 DIST 61 HWY Hwy 516 BOREHOLE TYPE Power Hand Auger / SSA COMPILED BY AM/RM
 DATUM Geodetic DATE 8.20.15 - 8.20.15 CHECKED BY DG

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				
								20 40 60 80 100	W _p ——— W ——— W _L							
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%)							
357.0	Clayey Silt		S1	AUGER		356									GR SA SI CL	
0.0	Clayey SILT with Sand - soft to stiff, grey, wet, some peat and organics in upper 0.3 m		S2	AUGER												0 25 57 18
			S3	AUGER												
			S4	AUGER												
355.9			S5	AUGER										2 44 43 11		
1.1	Sandy SILT - compact to dense, grey, wet, occasional cobbles															
355.4																
1.6	End of Borehole - refusal to auger															

ONL MOT F-15137-BG - ADM-00223648-F0 - MTO 7 - MILLS CREEK CULVERT.GPJ ON_MOT.GDT 11/17/15

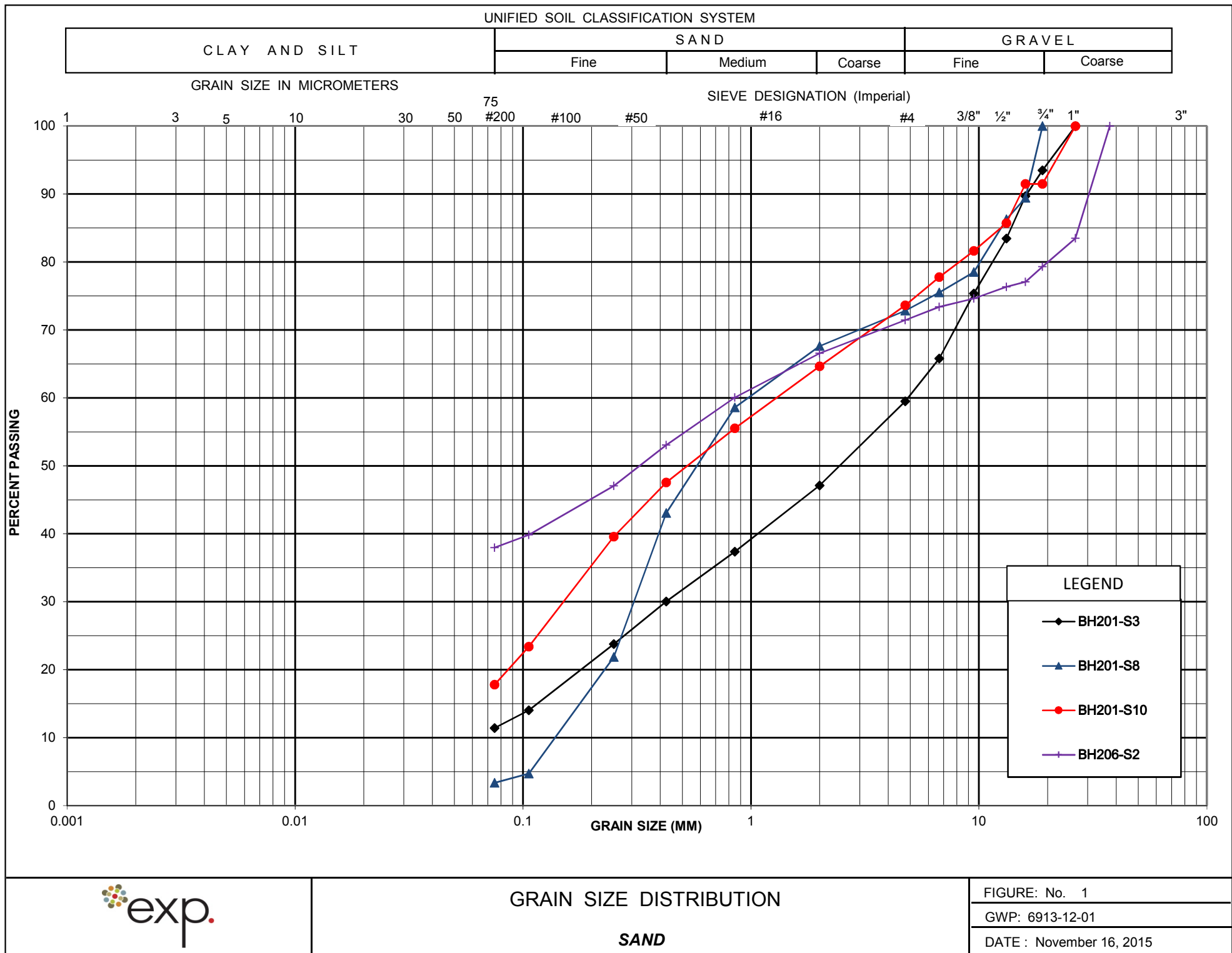


BH201 - Bedrock Core Samples with Depths and Elevations



BH202 - Bedrock Core Samples with Depths and Elevations

Appendix D – Laboratory Data

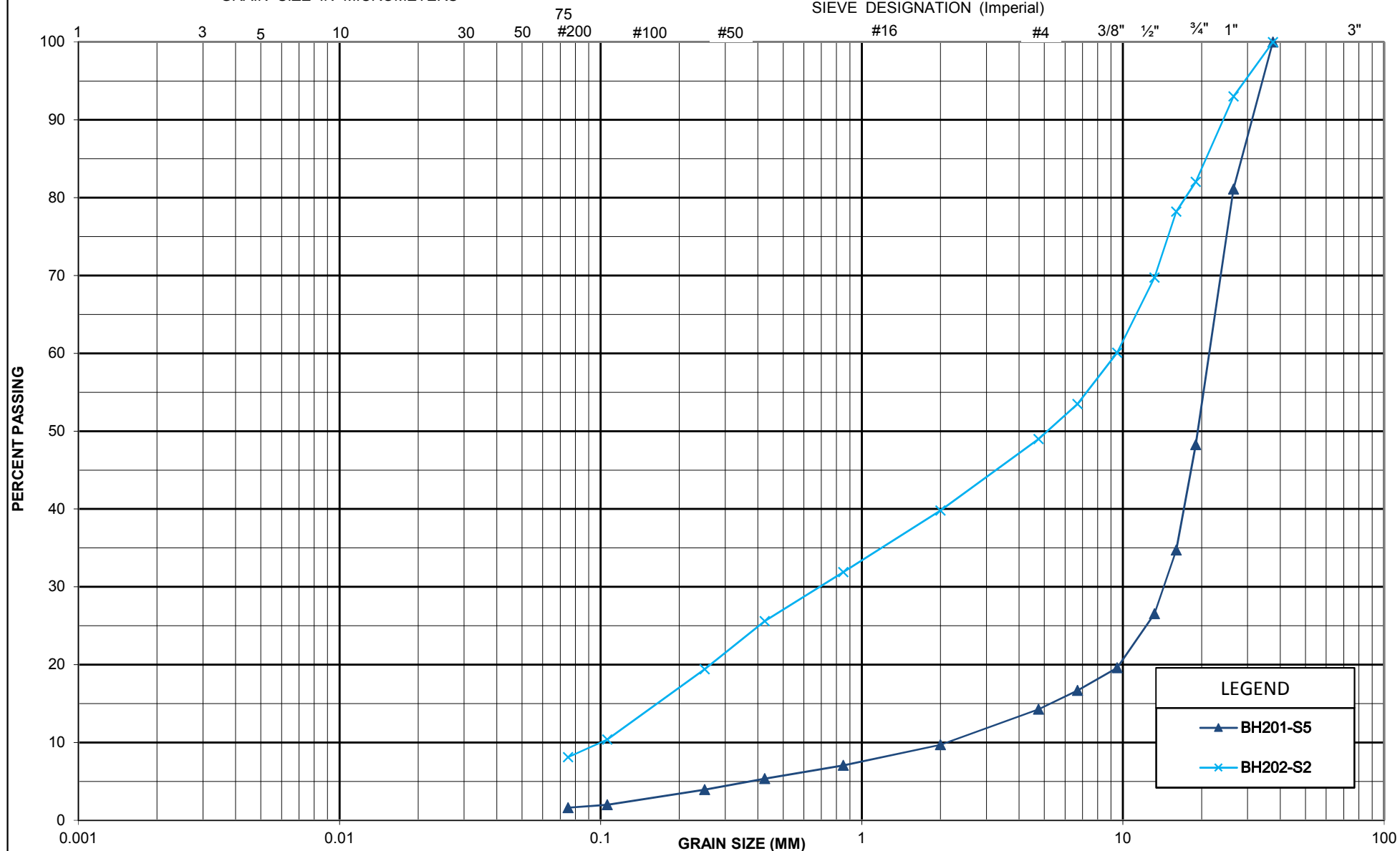


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



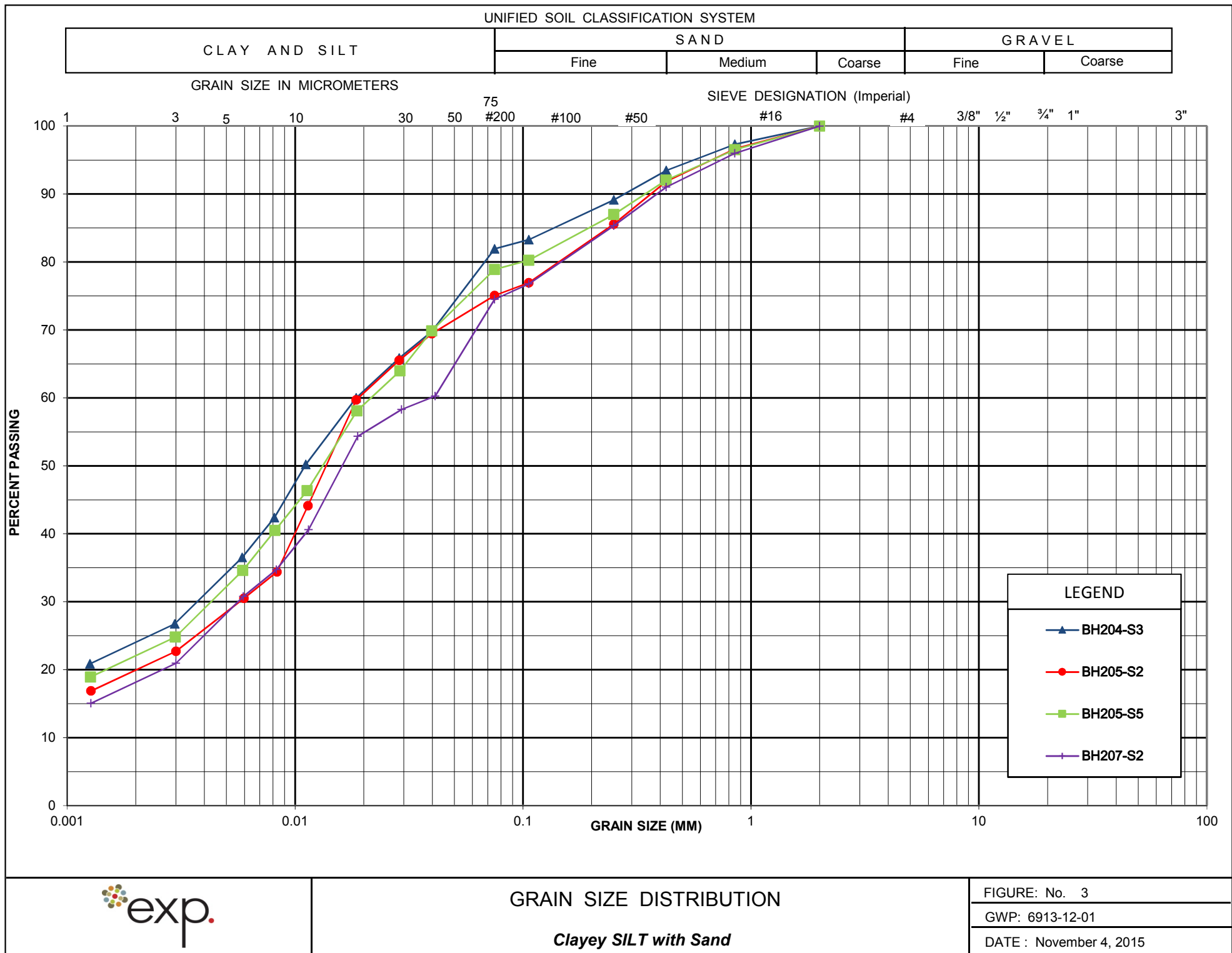
GRAIN SIZE DISTRIBUTION

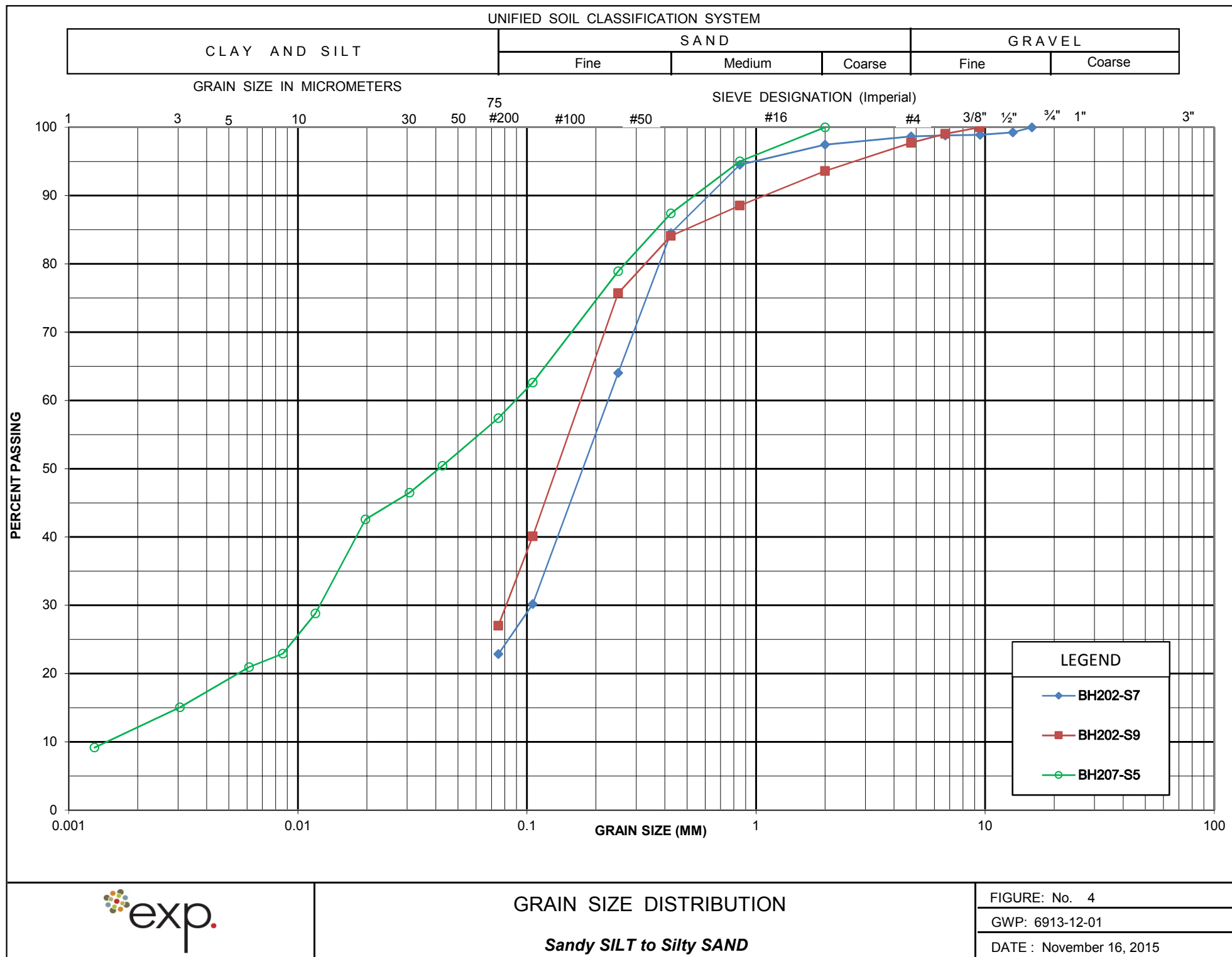
Poorly Graded GRAVEL

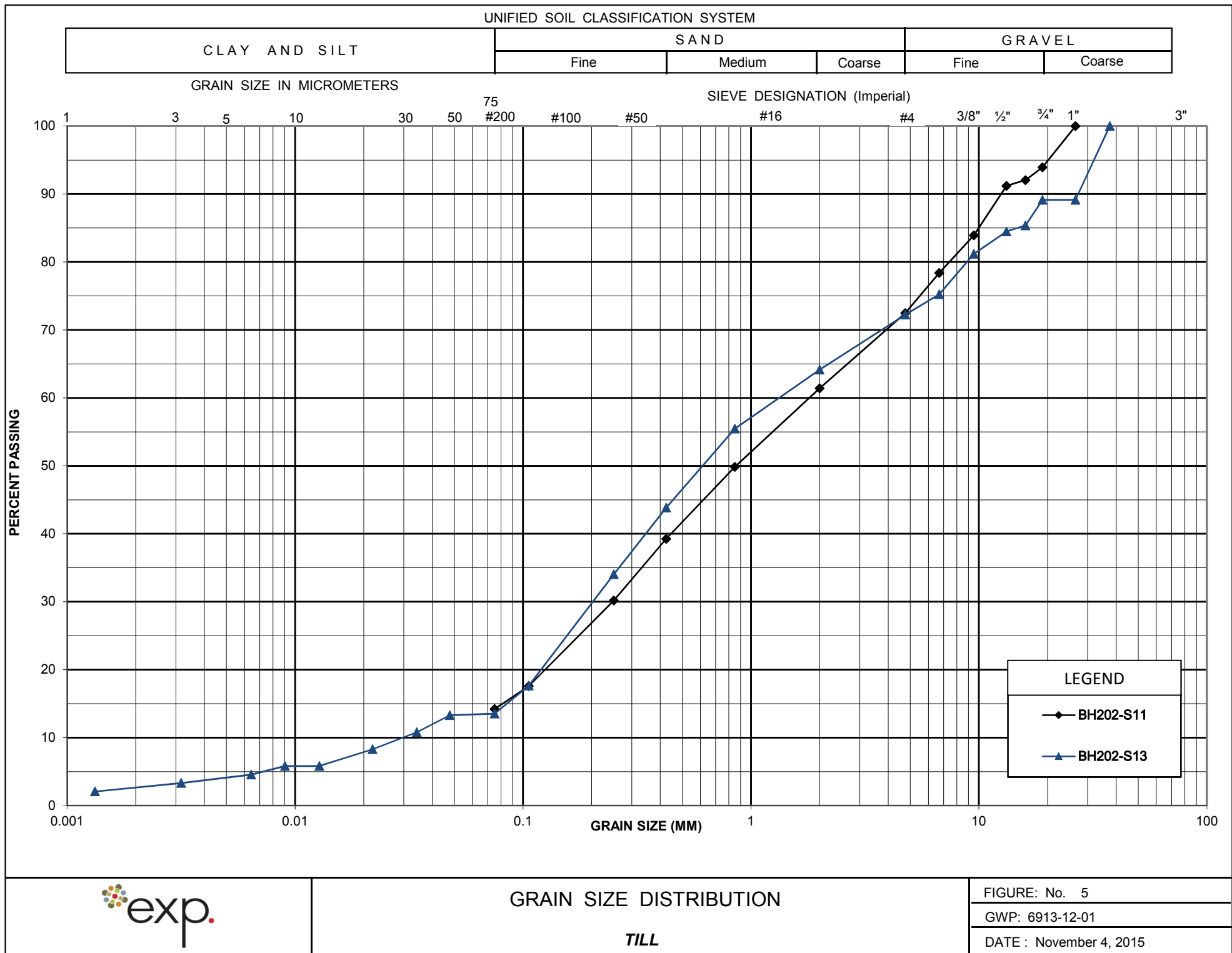
FIGURE: No. 2

GWP: 6913-12-01

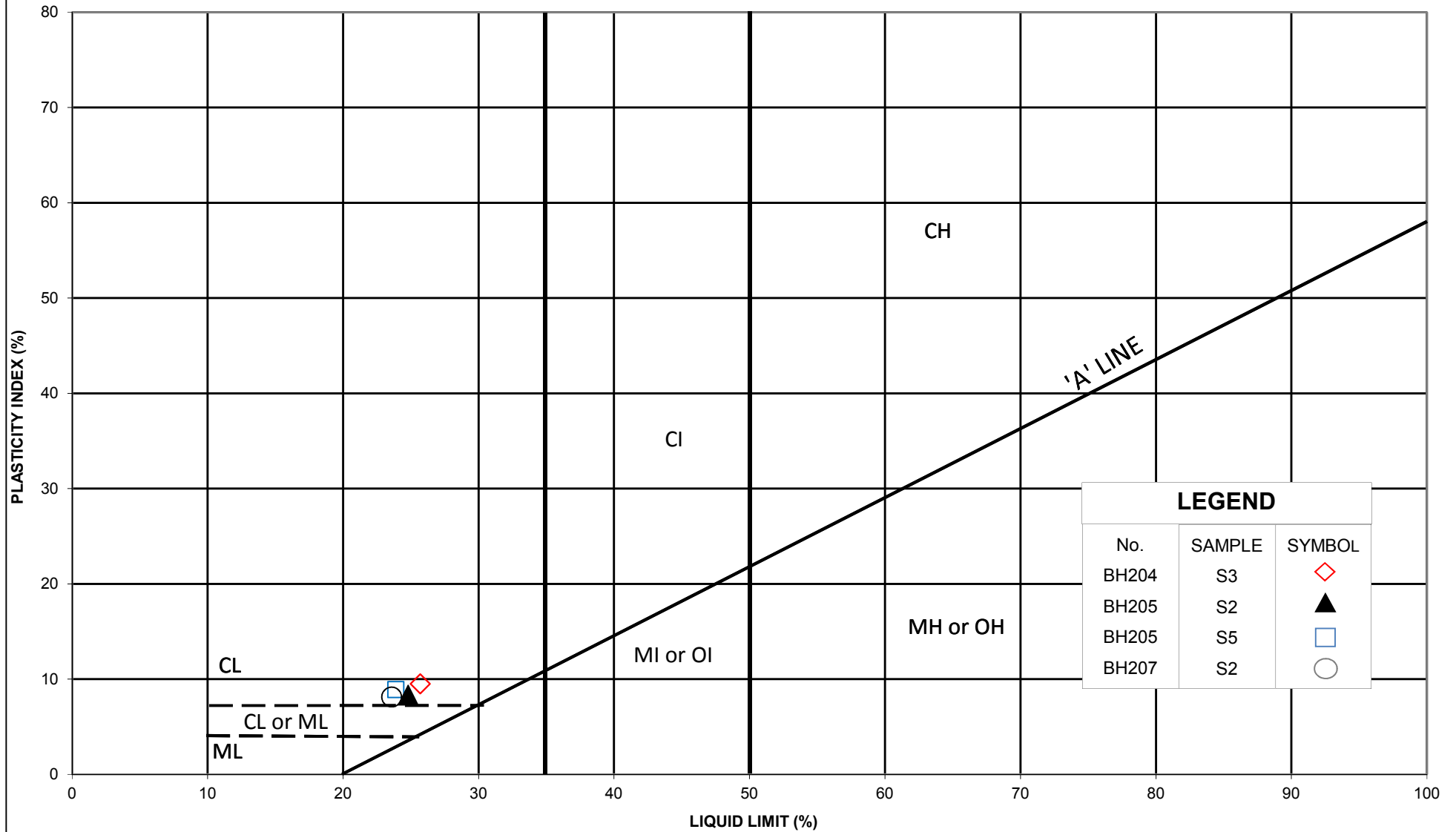
DATE : November 4, 2015







Mills Creek Culvert (Site No. 41S-011/C)
GWP No. 6913-12-01, Highway 516, District of Kenora, Ontario



Appendix E – Chemical Analyses

Your Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
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: 2015/09/15
Report #: R3661790
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5I2028

Received: 2015/09/09, 09:30

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	6	N/A	2015/09/15	CAM SOP-00463	EPA 325.2 m
Conductivity	6	N/A	2015/09/14	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	6	2015/09/14	2015/09/14	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	6	2015/09/11	2015/09/14	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	6	N/A	2015/09/14	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.

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.

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 #: B5I2028
Report Date: 2015/09/15

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

RESULTS OF ANALYSES OF SOIL

Maxxam ID			AYK667	AYK668	AYK669	AYK670	AYK670	AYK671		
Sampling Date			2015/08/12 14:00	2015/08/14 17:00	2015/08/17 10:00	2015/08/20 01:15	2015/08/20 01:15	2015/08/11 12:00		
COC Number			NA	NA	NA	NA	NA	NA		
	UNITS	Criteria	BH101-S10	BH104-S2	BH201-S9	BH204-S4	BH204-S4 Lab-Dup	BH302-S5	RDL	QC Batch

Calculated Parameters										
Resistivity	ohm-cm	-	7400	5700	15000	4800		27000		4186431
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	-	41	45	<20	57	45	<20	20	4188251
Conductivity	umho/cm	470	135	176	65	208	208	38	2	4188121
Available (CaCl2) pH	pH	-	7.93	7.56	7.50	6.98		5.99	N/A	4188358
Soluble (20:1) Sulphate (SO4)	ug/g	-	<20	<20	<20	<20	<20	<20	20	4188113

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Criteria: Ontario Reg. 153/04 (Amended April 15, 2011)

Table 1: Full Depth Background Site Condition Standards

Soil - Agricultural or Other Property Use

N/A = Not Applicable

Maxxam ID			AYK672		
Sampling Date			2015/08/12 13:00		
COC Number			NA		
	UNITS	Criteria	BH303-S4B	RDL	QC Batch
Calculated Parameters					
Resistivity	ohm-cm	-	5600		4186431
Inorganics					
Soluble (20:1) Chloride (Cl)	ug/g	-	<20	20	4188251
Conductivity	umho/cm	470	178	2	4188121
Available (CaCl2) pH	pH	-	7.34	N/A	4188358
Soluble (20:1) Sulphate (SO4)	ug/g	-	<20	20	4188113
RDL = Reportable Detection Limit					
QC Batch = Quality Control Batch					
Criteria: Ontario Reg. 153/04 (Amended April 15, 2011)					
Table 1: Full Depth Background Site Condition Standards					
Soil - Agricultural or Other Property Use					
N/A = Not Applicable					

Maxxam Job #: B5I2028
Report Date: 2015/09/15

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

TEST SUMMARY

Maxxam ID: AYK667
Sample ID: BH101-S10
Matrix: Soil

Collected: 2015/08/12
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK668
Sample ID: BH104-S2
Matrix: Soil

Collected: 2015/08/14
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK669
Sample ID: BH201-S9
Matrix: Soil

Collected: 2015/08/17
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK670
Sample ID: BH204-S4
Matrix: Soil

Collected: 2015/08/20
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK670 Dup
Sample ID: BH204-S4
Matrix: Soil

Collected: 2015/08/20
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine

Maxxam Job #: B5I2028
Report Date: 2015/09/15

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

TEST SUMMARY

Maxxam ID: AYK670 Dup
Sample ID: BH204-S4
Matrix: Soil

Collected: 2015/08/20
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK671
Sample ID: BH302-S5
Matrix: Soil

Collected: 2015/08/11
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam ID: AYK672
Sample ID: BH303-S4B
Matrix: Soil

Collected: 2015/08/12
Shipped:
Received: 2015/09/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4188251	N/A	2015/09/15	Deonarine Ramnarine
Conductivity	AT	4188121	N/A	2015/09/14	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4188358	2015/09/14	2015/09/14	Neil Dassanayake
Resistivity of Soil		4186431	2015/09/14	2015/09/14	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	4188113	N/A	2015/09/14	Alina Dobreanu

Maxxam Job #: B5I2028
Report Date: 2015/09/15

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

GENERAL COMMENTS

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

Package 1	3.3°C
-----------	-------

Results relate only to the items tested.

Maxxam Job #: B5I2028
Report Date: 2015/09/15

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
4188113	Soluble (20:1) Sulphate (SO ₄)	2015/09/14	113	70 - 130	102	70 - 130	<20	ug/g	NC	35		
4188121	Conductivity	2015/09/14			99	90 - 110	<2	umho/cm	0	10	117	75 - 125
4188251	Soluble (20:1) Chloride (Cl)	2015/09/15	NC	70 - 130	101	70 - 130	<20	ug/g	NC	35		
4188358	Available (CaCl ₂) pH	2015/09/14			99	97 - 103			1.9	N/A		

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.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

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 #: B5I2028
Report Date: 2015/09/15

exp Services Inc
Client Project #: ADM-00223648-F0
Site Location: SIOUX LOOKOUT, ONTARIO
Sampler Initials: EF

VALIDATION SIGNATURE PAGE

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

Cristina Carriere

Cristina Carriere, Scientific Services

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.

Page 1 of 1

Maxxam Analytics International Corporation o/a Maxxam Analytics