



## **FINAL REPORT**

### **FOUNDATION INVESTIGATION REPORT**

**Construction of new concrete fish ladder at the outlet of the existing Heyrock  
Creek Culvert, Highway 21, Bluewater Municipality**

**Agreement No. 3015-E-0017**

**Assignment No. 2**

**GWP 3186-15-00**

**Geocres No. 40P5-21**

**Prepared for:**

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January 11, 2017

# Ministry of Transportation

## Foundation Investigation Report

Agreement No. 3015-E-0017

Assignment No. 2

GWP 3186-15-00

Geocres No. 40P5-21

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### Project Name:

Foundation Investigation and Design Report for construction of new concrete fish ladder at the outlet of the existing Heyrock Creek Culvert, Highway 21, Bluewater Municipality

### Project Number:

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## Table of Contents

<b>Part I: FOUNDATION INVESTIGATION REPORT .....</b>	<b>1</b>
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 .....	4
1.4 Subsurface Conditions .....	4
1.4.1 Topsoil .....	4
1.4.2 Fill: Gravelly Sand to sand .....	5
1.4.3 Fill: Silty Sand .....	5
1.4.4 Possible Fill: Clayey Silt .....	6
1.4.5 Clayey Silt (Upper) .....	6
1.4.6 Silt .....	7
1.4.7 Sandy Silt (Till) .....	8
1.4.8 Clayey Silt (Lower) .....	8
1.4.9 Summary of Probe Hole Findings .....	9
1.5 Groundwater and Surface Water Conditions .....	10
1.6 Chemical Analyses .....	11
<b>Part II: Closure .....</b>	<b>12</b>
<b>Part III: LIMITATIONS AND USE OF REPORT .....</b>	<b>13</b>

## Appendices

**APPENDIX A: PHOTOGRAPHS**

**APPENDIX B: GA DRAWINGS**

**APPENDIX C: BOREHOLE LOCATION PLAN AND STRATIGRAPHIC SECTIONS**

**APPENDIX D: BOREHOLE LOGS**

**APPENDIX E: LABORATORY DATA**

**APPENDIX F: 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 construction of a new concrete fish ladder at the outlet of the existing Heyrock Creek culvert. The culvert is located on Hwy 21, in the Municipality of Bluewater (Hay Township), approximately 700 m south of the Village of St. Joseph, in Huron County, the Ministry of Transportation (MTO) West Region. The work was undertaken under Agreement # 3015-E-0017, Assignment No. 2 (GWP 3186-15-00). The terms of reference (TOR) were as provided in the email dated October 6, 2016.

The purpose of the investigation was to evaluate the subsurface conditions along the proposed new concrete fish ladder at the outlet of the existing Heyrock Creek Culvert to permit detailed design of all foundation elements for structures and embankments including replacement of the existing steel sheet pile walls with a retaining wall and assessment of potential impacts of retaining wall construction of the existing high fill embankment. The site specific geotechnical investigation consisted of borings, soil sampling, borehole logging, probing holes 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 Heyrock Creek Culvert Concrete Fish Ladder site is located on Hwy 21 (Approximate STA 18+532) in the Municipality of Bluewater (Hay Township), approximately 700 m south of the Village of St. Joseph, in Huron County. The location of the culvert and a cross section of the existing culvert alignment are shown on Drawing 1 in Appendix C.

As noted in the GA drawing provided by the MTO/Parsons ( attached in Appendix B), the existing rigid frame box type culvert with spillways and flume is 42.7 m long, 5.94m wide and 4.57m in height. At this site Hwy 21 is a two lane, north/south roadway having approximately 2.4 m wide granular shoulders and guardrails subsequently on both sides. It is estimated that the highway embankment from the bottom of culvert at the investigated location is between 13 m (east) and 14 m (west) high having side slopes of approximately 2H: 1V from the top of the embankment to the toe of the embankment. The Concrete Fish Ladder is proposed for construction on the outlet (west) side of the culvert, replacing the existing sheet pile retaining structure. Photographs of the site and outlet of the existing culvert are presented in Appendix A.

The terrain surrounding the culvert location is relatively flat, agricultural table land, with an incisive depression towards the culvert creek. At the site location, water flows from east to west crossing Hwy 21 via the culvert towards the lake Huron. Above the top of the culvert, the inlet and outlet embankments are primarily grass covered with occasional shrubs and saplings. The upper grass covered embankments become generally more tree and shrub covered below the top of the culvert elevation.



On the outlet side of the culvert, recent site improvement activities were evident on the northwest embankment and creek bank as indicated by tree stumps and re-vegetated areas with newly introduced rip-rap. Along the southwest creek bank, in the vicinity of the proposed fish ladder and above the existing concrete wing wall, some of the vegetation (trees) had to be removed to facilitate access to the site.

The general, site conditions in the immediate vicinity of the culvert were assessed during the site reconnaissance in October 24, 2016. On the inlet (east) side of the culvert, the embankments, although steep, were noted in an overall stable configuration with no obvious indications of recent slope movement. On the outlet (west) side of the culvert, the embankments exhibit signs of progressive slope movements behind the existing sheet pile walls at the downstream ends of the wing walls. Depressions in the soils of up to 1m were observed behind the sheet pile walls on both sides of the creek. Localized slope instability was noted to have occurred at the west end of the north sheet pile wall as well, also leaving a similar depression. Both sheet pile walls were noted in general deteriorating condition due to corrosion, bowed in the center and leaning toward the creek. Based on visual observation, the culvert and wing walls appeared to be in satisfactory condition with minor indications of age related deterioration. The floor of the culvert and spillway were noted generally intact. Photographs of the soil instabilities are presented in Appendix A.

The water depths of the inlet and outlet streams were about 0.3 m and 0.9 m, respectively where water had pooled in deeper portions of the creek. Water depth within the concrete floored portions of the culvert were between 50mm and 75mm. Water flow through the culvert was unimpeded and the culvert was free from obstructions such as logs, sticks or other debris.

## **1.2.2 Geological Setting**

In accordance with volume 'The Physiography of Southern Ontario, Third Edition, Special Volume 2', by Chapman, L.J. and Putnam, D. F., 1984, the Heyrock Creek Culvert is located within the physiographic region termed the Huron Slope, identified along the eastern shore of Lake Huron. The lakeward border comprises the Algonquin bluff while the eastern boundary of the slope is defined as the Wyoming Moraine sloping up from 182m to 274m above sea level. The slope is generally a till plain with shallow surface lacustrine deposits overlying two clay till sheets. The bluff at the lake rises sharply up to 25m. The fringe of the clay till plain along Lake Huron is dissected by deeply cut gullies created by the numerous streams and creeks flowing toward Lake Huron over the till plain. Hayrock Creek is one of these numerous streams as demonstrated by its narrow channel.

## **1.3 Investigation Procedures**

### **1.3.1 Site Investigation and Field Testing**

The field investigation was performed between November 7 to 16, 2016. The field program consisted of drilling four (4) sampled boreholes (BH-1, BH-2, BH-3 and BH-4) and nine (9) probing in the areas of proposed concrete fish ladder and armourstone scour pool. The boreholes were strategically located to provide subsurface information for the proposed fish ladder, proposed armourstone retaining wall in the GA drawing and existing highway embankment on outlet side,. The locations of the boreholes are generally summarized as follows: (i) BH1 was advanced from embankment crest located approximately

11 m north of the culvert centerline on south bound lane shoulder (outlet site) (ii) BH2 was advanced at accessible location near the new proposed retaining wall at the north-west side located approximately 11 m north of proposed retaining wall and (iii) BH3 and BH4 were advanced at accessible locations near the proposed fish ladder location. BH3 advanced approximately 1.5 m south of existing concrete retaining wall and BH4 was advanced approximately 6 m south of the proposed fish ladder. In addition, nine (9) probe holes PH1 to PH9 were advanced manually using 1.2 m long 'T' bar (see photographs 10, in Appendix A) In the areas of the proposed fish ladder and armourstone scour pool. The borehole and probe hole locations are shown on Drawing 1 in Appendix C.

During the drilling of BH2 at the northwest side of the existing culvert, unexpected auger refusal was encountered at depth of 11.4 m from the ground surface, approximately at Elevation 179.1 m. Assuming that a boulder was hit, BH2 was abandoned, and another BH2A was drilled within an approximately 1.5 m perimeter of BH2. Auger refusal was encountered again at 12.5 m. Technical refusal in soil had occurred at 12.2m just above the auger refusal. BH2 was terminated on suspected boulders on this basis.

The boreholes were advanced using a rubber track mounted Diedrich D50T drill rig and, equipped with hollow stem augers and standard soil sampling equipment operated by a specialist drilling contractor, London Soil Test Ltd. The borehole drilled from embankment crest (BH1) was advanced to depth of about 18 m below road surface and the off-road boreholes (BH2, BH3 and BH4) were advanced to depths of about 12.3 m, 15.7 m and 15.7 m below ground surface, respectively. Prior the geotechnical investigation the tree cutting was performed at the southwest side of the culvert to allow the rig to access at the borehole locations.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel using the Benchmark (GBM 72-U-089) located at top of the culvert at the inlet side. The BM elevation 188.57 m was taken based on the horizontal and vertical control sheets (Sheet# 4, Plate# 0266-0021-036) provided by the MTO. The benchmark location is shown on Drawing. 1 in Appendix C.

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 D). 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 of cohesive soils or relative density of non-cohesive soils. Some field vane tests were attempted. However, the native cohesive soil was generally stiff to very stiff so field vane testing was not successful in measuring the *in-situ* undrained shear strength of those soils. However, several pocket penetrometer readings were taken and recorded on the attached borehole logs (Appendix D).

Upon completion of the boreholes, ground water level measurements were carried out in boreholes 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 D. Two piezometers were also installed in a selected borehole (BH2 and BH3) to permit monitoring of the groundwater level at this location. The piezometers were installed and decommissioned following requirements in Ontario Regulation 903- (Wells Regulation). The piezometer consisted of 50 mm

outside diameter PVC tubing with a 3 m long slotted tip that is sealed at a selected depth within borehole. The boreholes (BH1 and BH4) 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** Brampton 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. 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.

The laboratory test results are provided on the attached borehole log sheets in Appendix D. The results of the grain size analyses and plasticity chart are presented graphically 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 D. Laboratory test results are provided in Appendix E. The "Explanation of Terms Used in Report" preceding the borehole logs in Appendix D 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 C. 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 at the site consist of a fill layer (i.e. the existing highway embankment) comprised of gravelly sand to sand transition to silty sand in off road boreholes. Underlying the fill, native deposits of clayey silt/ silt underlain by silt till followed by clayey silt/silt was encountered. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

### 1.4.1 Topsoil

Topsoil was encountered at the surface of boreholes (BH2, BH3 and BH4) and ranged in thickness from approximately 0.13 m to 0.15 m. Topsoil thicknesses may further vary beyond the borehole locations.

### 1.4.2 Fill: Gravelly Sand to sand

Gravelly sand to sand fill was encountered at the road surface of borehole (BH1). The gravelly sand to sand layer extended to depth of 6.9 m below road surface with elevation about 186.7 m. The explored thickness of this layer was 6.9 m.

The composition of this fill layer is sand and gravel and trace silt. The material is brown in color, and moist. The SPT "N" values within this layer ranged from 4 to 28 blows per 300 mm penetration, suggesting very loose to compact, but generally very loose to loose in compactness condition.

Laboratory testing performed on selected samples consisted of nine (9) moisture content and two (2) grain size distribution tests. The test results are as follows:

Moisture Content:

- 4% to 6%

Grain Size Distribution:

- 10% to 22% gravel;
- 69% to 81% sand; and
- 9% silt and clay

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

### 1.4.3 Fill: Silty Sand

A layer of silty sand fill was encountered below topsoil in boreholes BH2 and BH3. The silty sand fill extended to depths ranging between 1.5 m to 2.3 m below ground surface with elevations ranging between 188.2 m to 184.5 m. The explored thickness of this layer was between 1.4 m to 2.1 m.

The composition of this fill layer is silt and sand, trace to some clay, trace gravel trace topsoil. The material is brown in color, and moist. The SPT "N" values within this layer ranged from 10 to 17 blows per 300 mm penetration, suggesting compact in compactness condition.

Laboratory testing performed on selected samples consisted of five (5) moisture content and one (1) grain size distribution test. The test results are as follows:

Moisture Content:

- 5% to 15%

Grain Size Distribution:

- 5% gravel;
- 50% sand; and
- 45% silt and clay

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

#### **1.4.4 Possible Fill: Clayey Silt**

A layer of clayey silt (possible fill) was encountered below silty sand fill in borehole BH3. The clayey silt fill extended to depth of 3.1 below ground surface with elevation about 182.9 m. The explored thickness of this layer was 1.6 m.

The composition of this layer is clay and silt, trace to some sand and trace gravel. The material is grey in color, and moist. The SPT "N" values within this layer was 7 blows per 300 mm penetration, suggesting firm in consistency.

Laboratory testing performed on selected samples consisted of two (2) moisture content and one (1) grain size distribution test. The test results are as follows:

Moisture Content:

- 16% to 22%

Grain Size Distribution:

- 0% gravel;
- 25% sand; and
- 75% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix D. The result of the grain size distribution test is also provided on Figure 3 in Appendix E

#### **1.4.5 Clayey Silt (Upper)**

A native clayey silt(upper) layer was encountered in all boreholes. The upper clayey silt layer was encountered below fill in BH1 and BH2, below silt in BH3 and below topsoil in BH4. This layer extended to depths ranging between 8.4 m to 12.3 m below ground surface with elevations ranging between 177.6 m to 182.2 m. BH2 was terminated within this layer. The explored thickness of this layer was between 2.3 m to 10.0 m.

The composition of this layer is clay and silt, trace to some sand and trace gravel. The material is brown to grey in color, and moist. The SPT "N" values within this layer ranged from 9 to 44 blows per 300 mm penetration, suggesting stiff to hard generally stiff to very stiff in consistency. One SPT "N" value within this layer in BH 2 recorded to be 100 blows per 76 mm penetration, this could be influence of refusal (possible boulder) encountered.

Laboratory testing performed on selected samples consisted of thirty-five (35) moisture content, eight (8) grain size distribution and eleven (4) Atterberg Limit tests. The test results are as follows:

Moisture Content:

- 6% to 23%

Grain Size Distribution:

- 0% to 3% gravel;
- 3% to 21% sand;
- 45% to 61% silt; and
- 29% to 47% clay

Atterberg Limits:

- Liquid Limit: 25% to 35%
- Plastic Limit: 12% to 16%
- Plasticity Index: 13% to 19%

The results of the moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests and Atterberg Limits tests are also provided on Figure 4 and 9, respectively, in Appendix E.

### 1.4.6 Silt

A native silt layer was encountered in all boreholes except BH2. The silt layer was encountered below clayey silt in BH1, below fill in BH3 and below silt till in BH4. This layer extended to depths ranging between 6.1 m to 15.7 m below ground surface with elevations ranging between 171.4 m to 179.9 m. BH4 was terminated within this layer. The explored thickness of this layer was between 3.0 m to 4.3 m.

The composition of this layer is silt, trace to some clay, trace sand and trace to some gravel. Occasional gravelly sand layer was encountered in BH 3 within this layer\*. The material is grey in color, and moist to wet. The SPT "N" values within this layer ranged from 19 to 53 blows per 300 mm penetration, suggesting compact to very dense in compactness condition.

Laboratory testing performed on selected samples consisted of twelve (12) moisture content and two (2) grain size distribution tests. The test results are as follows:

Moisture Content:

- 9% to 19%

Grain Size Distribution:

- 0% to 14%\* gravel;
- 2% to 71%\* sand;
- 15% to 73% silt; and
- 25% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests are also provided on Figure 5 and 6\* in Appendix E.

### 1.4.7 Sandy Silt (Till)

A native sandy silt till layer was encountered below upper clayey silt in BH1, BH3 and BH4. The sandy silt till layer extended to depths ranging between 11.4 m to 18.0 m below ground surface with elevations ranging between 174.5 m to 175.7 m. BH1 was terminated within this layer. The explored thickness of this layer was between 2.0 m to 3.0 m.

The composition of this layer is sand and silt, trace to some gravel and trace to some clay. The material is grey in color, and moist. The SPT “N” values within this layer ranged from 37 to 106 blows per 300 mm, suggesting dense to very dense in compactness condition.

Laboratory testing performed on selected samples consisted of nine (9) moisture content and two (2) grain size distribution tests. The test results are as follows:

Moisture Content:

- 4% to 17%

Grain Size Distribution:

- 11% to 24% gravel;
- 27% to 36% sand; and
- 49% to 53% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests are also provided on Figure 7 in Appendix E.

### 1.4.8 Clayey Silt (Lower)

A native lower clayey silt layer was encountered below silt and sandy silt till layer in BH1 and BH3, respectively. In BH1 lower clayey silt layer was interbedded between silt and sandy silt till layer. The lower clayey silt layer extended to depths ranging between 15.7 m to 16 m below ground surface with elevations ranging between 170.3 m to 177.6. BH3 was terminated within this layer. The explored thickness of this layer was between 1.5 m to 4.3 m.

The composition of this layer is clay and silt, trace to some sand and trace gravel. The material is grey in color, and moist. The SPT “N” values within this layer ranged from 19 to 56 blows per 300 mm penetration, suggesting very stiff to hard in consistency.

Laboratory testing performed on selected samples consisted of six (6) moisture content, two (2) grain size distribution and one (1) Atterberg Limit tests. The test results are as follows:

Moisture Content:

- 8% to 27%



#### Grain Size Distribution:

- 3% to 5% gravel;
- 15% sand;
- 43% to 45% silt; and
- 25% to 37% clay

#### Atterberg Limits:

- Liquid Limit: 29%
- Plastic Limit: 14%
- Plasticity Index: 15%

The results of the moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix D. The results of the grain size distribution tests and Atterberg Limits tests are also provided on Figure 8 and 10, respectively, in Appendix E.

### 1.4.9 Summary of Probe Hole Findings

The subsurface conditions observed during advancing of probe holes (PH1 to PH9) are summarized in the table below. The probe hole locations are shown on the Drawing 1 in Appendix C.

Table 1.1. Probe hole summary

Probe hole	Approximate Water/Ground Surface Elevation (m)	Creek Water Depth Measured (m)	Description of Encountered Soil Condition at Creek Bottom*
PH1	181.7	1.0	0.15 m thick compact sand and gravel (measured in the existing water pool)
PH2	181.7	0.75	0.5 m thick compact sand and gravel (measured in the existing water pool)
PH3	181.7	0.5	0.7 m thick compact sand and gravel (Measured in the existing water pool)
PH4	181.5	0.1	0.3 m thick cobbles layer followed by stiff clayey silt
PH5	181.5	0.1	0.3 m to 0.6 m thick cobbles layer followed by stiff clayey silt
PH6	181.5	0.1	1 m thick cobbles layers followed by stiff clayey silt
PH7	181.3	0.15	0.5 m thick cobbles layer followed by stiff clayey silt
PH8	181.3	0.15	0.3 m to 0.6 m thick cobbles layer followed by stiff clayey silt
PH9	181.3	-	No cobbles layer, stiff clayey silt
Note: *The presented thickness of layer is below water depth measured			



## 1.5 Groundwater and Surface Water Conditions

Information on groundwater levels at the site was obtained by measuring the water levels in the piezometers and open boreholes after completion of drilling. Two 50 mm O.D. standpipe piezometers were installed for the long term groundwater monitoring following standard procedures in BH2 and BH3. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.2.

Table 1.2. Groundwater data

Borehole	Date Completed	Date Measured	Ground Surface Elevation <sup>2</sup>	Depth/ Elevation of Tip of Piezometer (m)	Groundwater measurement Depth/Elevation (m)
BH-1	Nov. 7/16	Nov. 7/16	193.6	N/A	dry
BH-2	Nov. 8/16	Jan. 4/17	190.5	12.3/178.2	12.3/178.2 <sup>4</sup>
BH-3	Nov. 9/16	Jan. 4/17	186.0	6.1/179.9	3.0/183.0 <sup>4</sup>
BH-4	Nov. 11/16	Nov. 11/16	187.1	N/A	dry
Creek WL Downstream (West) Side	--	Nov 11/16	--	--	182.0 <sup>3</sup>
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to the Benchmark (GBM 72-U-089) located at top of the culvert at inlet side. The BM elevation 188.57 m was taken based on the horizontal and vertical control sheets (Sheet# 4, Plate# 0266-0021-036) provided by the MTO. 3) Indicates top of surface water elevation at culvert location. 4) Based on groundwater measurement performed on January 4, 2017					

Note that water levels measured in open boreholes and piezometers 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 could exist in the embankment fill as well.

## 1.6 Chemical Analyses

One soil sample was selected for chemical analyses and was sent to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix F, and are summarized in Table 1.3, below.

*Table 1.3. Corrosivity chemical analysis*

Sample Identification	pH (unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (umho/cm)	Redox Potential (mV)	Sulphide (ppm)
BH3-SS5 Native silt	7.82	41	110	3,900	257	174	0.96

January 11, 2017

## Part II: 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.

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 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 Robert Walker.

Yours truly,

**exp Services Inc.**



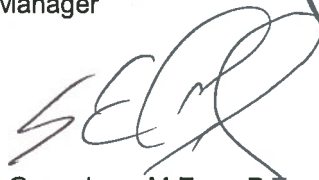
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Encl.

## **Part III: LIMITATIONS AND USE OF REPORT**

### **BASIS OF REPORT**

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

### **RELIANCE ON INFORMATION PROVIDED**

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been

prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

## **STANDARD OF CARE**

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

## **COMPLETE REPORT**

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.

## **USE OF REPORT**

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of exp. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. exp is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

## **REPORT FORMAT**

Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

## **Appendix A – Site Photographs**





Photo 1: HWY 21 Crossing Heyrock Creek Culvert – Looking North



Photo 2: HWY 21 Crossing Heyrock Creek Culvert – Looking South





Photo 3: Heyrock Creek Culvert Outlet – Looking West from Shoulder of HWY 21



Photo 4: Heyrock Creek Culvert Outlet – Looking East





Photo 5: Heyrock Creek Culvert Outlet – South Side Retaining Wall



Photo 6: Heyrock Creek Culvert Outlet – North Side Retaining Wall





Photo 7: Heyrock Creek Culvert Outlet – – South Side Wing Wall



Photo 8: Heyrock Creek Culvert Outlet – – North Side Wing Wall





Photo 9: Looking west (downstream) from the culvert outlet



Photo 10: Probe hole using 'T' bar

## **Appendix B – GA Drawings**

METRIC

PLATE No  
CONT 2016-XX  
WP WPNUM

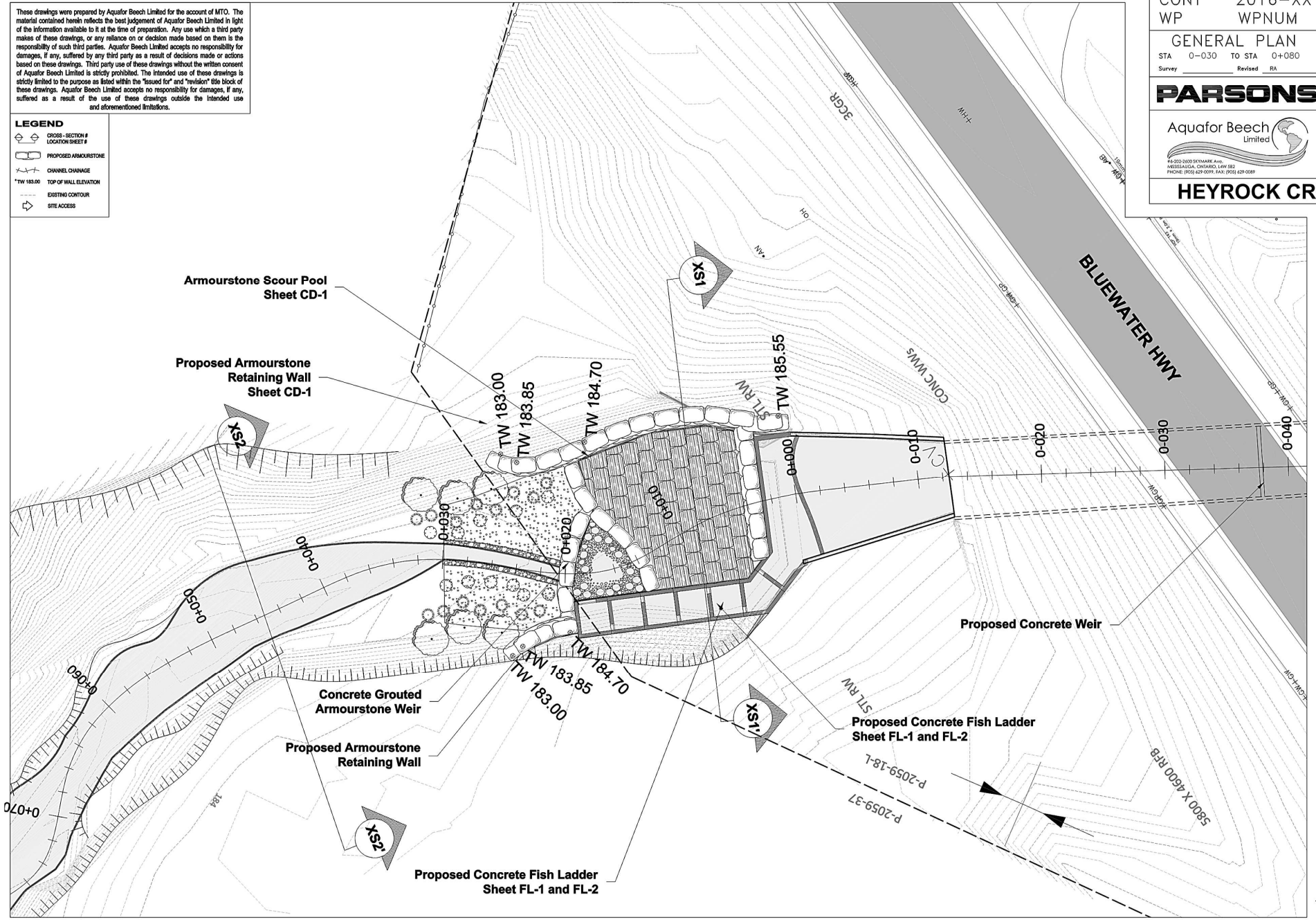
GENERAL PLAN  
STA 0+030 TO STA 0+080  
Survey Revised RA



HEYROCK CREEK

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- LEGEND**
- CD-000 - SECTION # LOCATION SHEET #
  - PROPOSED ARMOURSTONE
  - CHANNEL CHANGE
  - \*TW 183.00 TOP OF WALL ELEVATION
  - EXISTING CONTOUR
  - SITE ACCESS



SCALE  
1m 0  
Horizontal

METRIC

PLATE No

CONT 2016-XX  
WP WPNUM

PLAN AND PROFILE

STA 0+030 TO STA 0+080  
Survey Revised RA

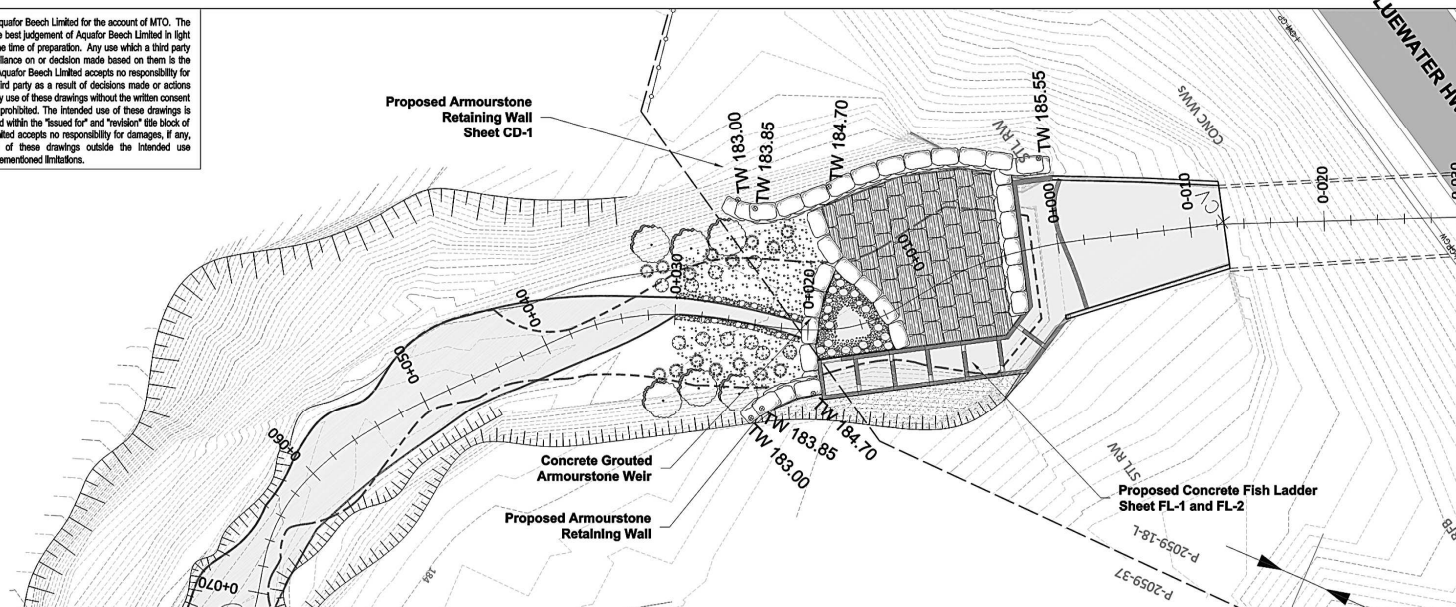
**PARSONS**

Aquafor Beech  
Limited

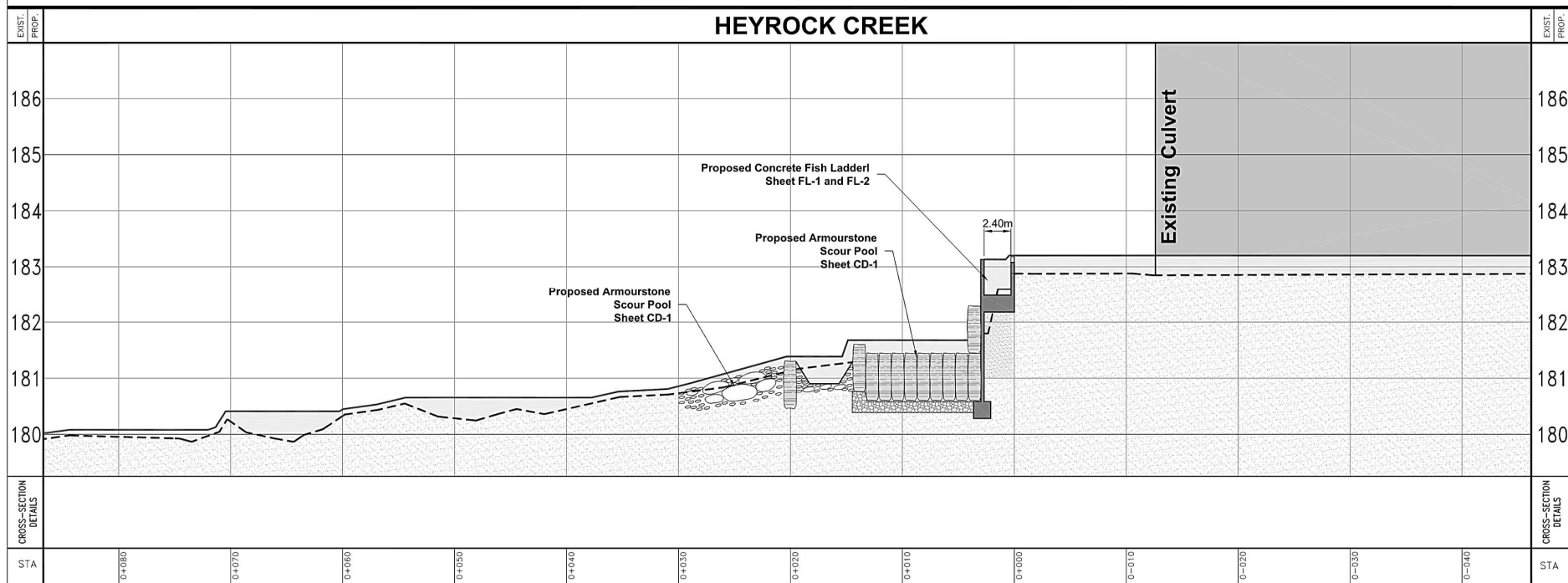
16-202-2600 SYCAMON AVE.  
HEBESAGUA, ONTARIO L0M 0S2  
PHONE: (905) 629-0099, FAX: (905) 629-0089

**HEYROCK CREEK**

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## HEYROCK CREEK



SCALE  
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Horizontal



METRIC

PLATE No

CONT 2016-XX  
WP WPNUM

FISH LADDER DETAIL

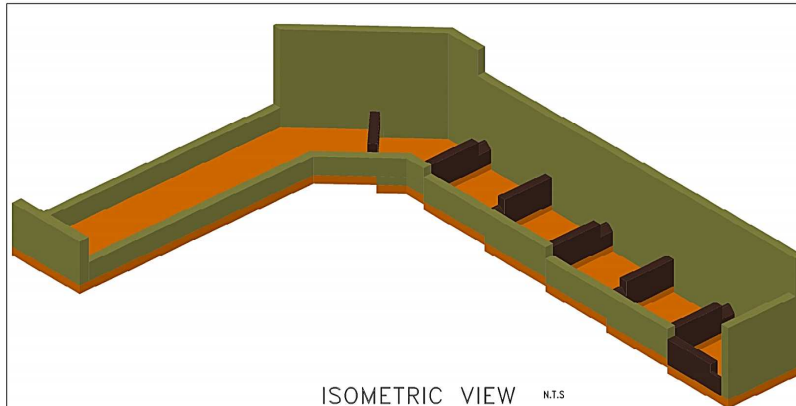
STA 0+030 TO STA 0+080  
Survey Revised RA

**PARSONS**

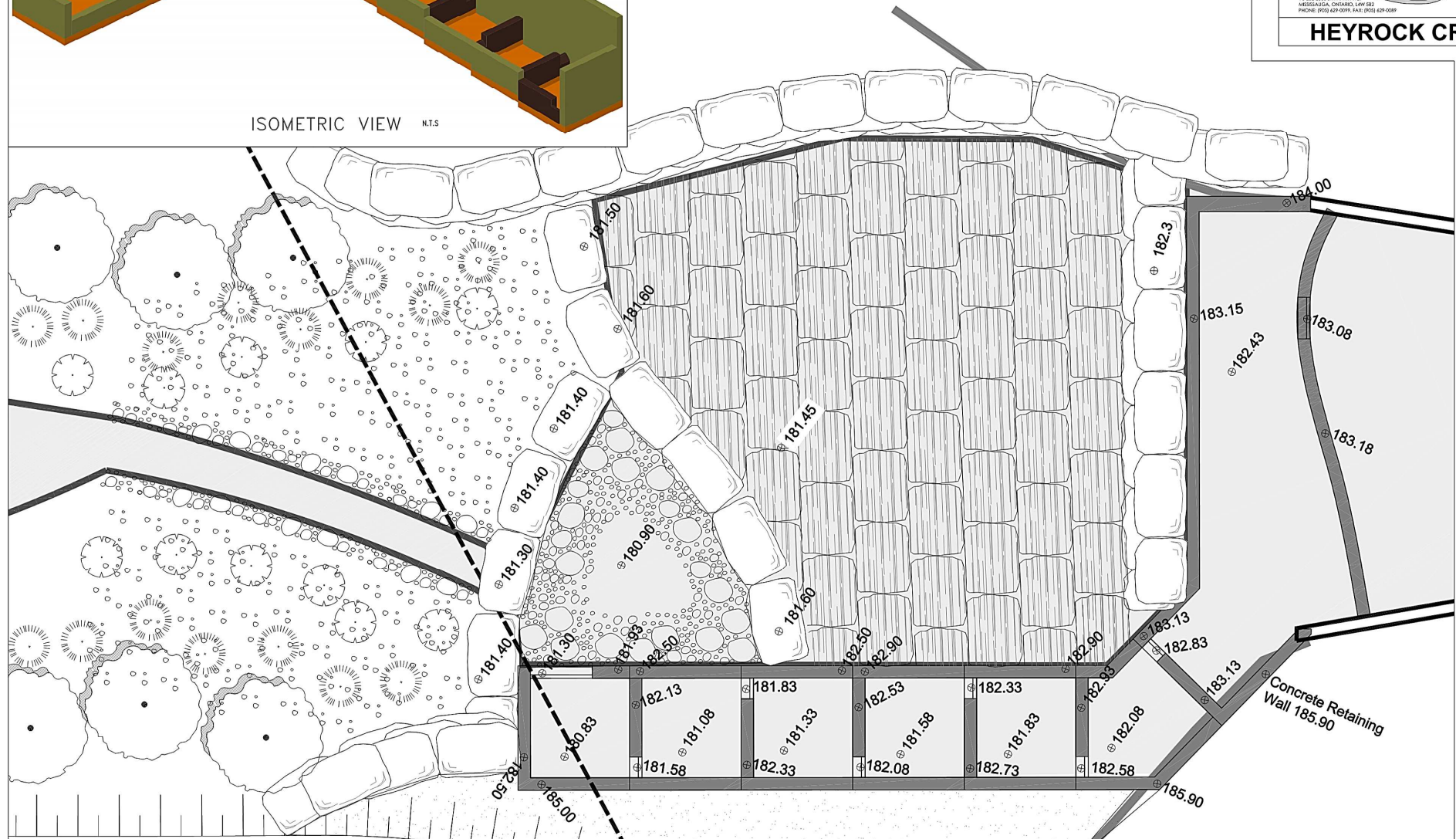
Aquafor Beech Limited  
16-202-2620 SYCAMORE AVE.  
HEBESAGA, ONTARIO L0M 0S2  
PHONE: (905) 629-0099, FAX: (905) 629-0081

**HEYROCK CREEK**

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ISOMETRIC VIEW N.T.S.



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PLATE	No
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CONT	2016-XX
WP	WPNUM

FISH LADDER DETAIL

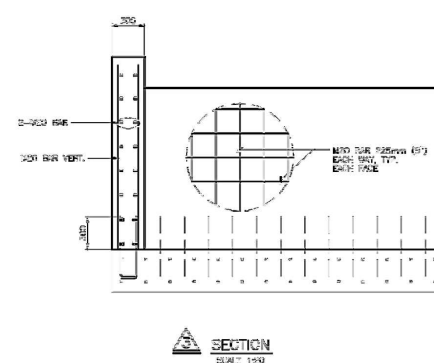
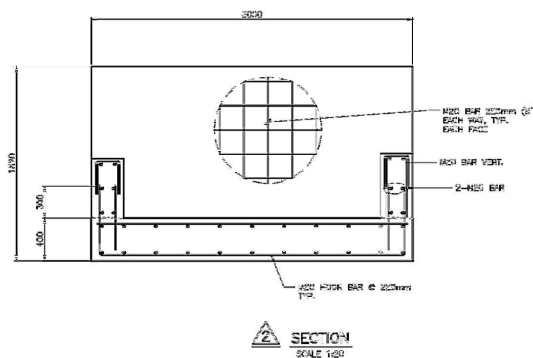
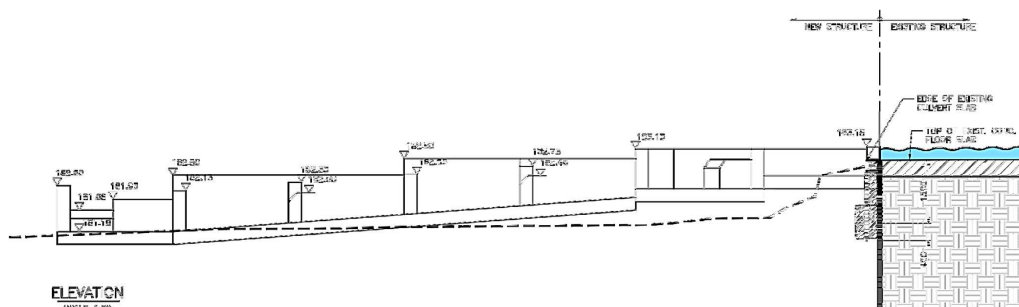
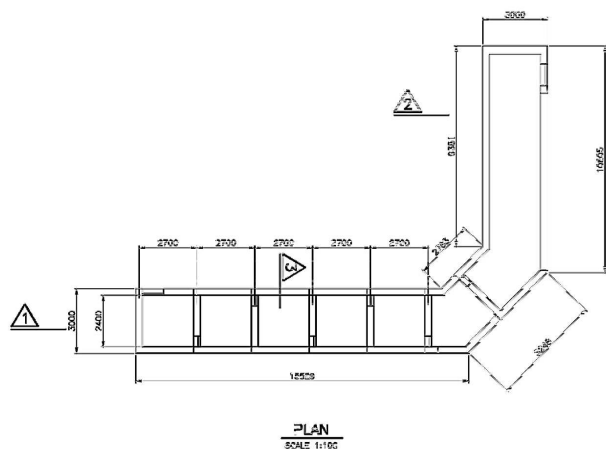
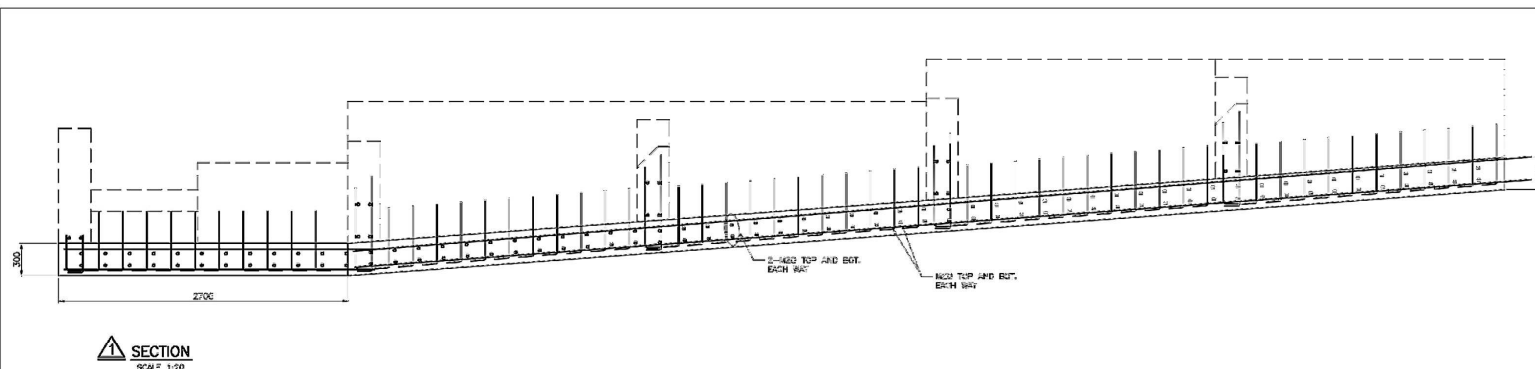
STA	TO STA
Survey	Revised RA

# PARSONS

Aquafor Beech Limited

#6-202-2600 SKYMARK Ave.  
MISSISSAUGA, ONTARIO, L4W 5B2  
PHONE: (905) 629-0099, FAX: (905) 629-0089

## HEYROCK CREEK



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METRIC

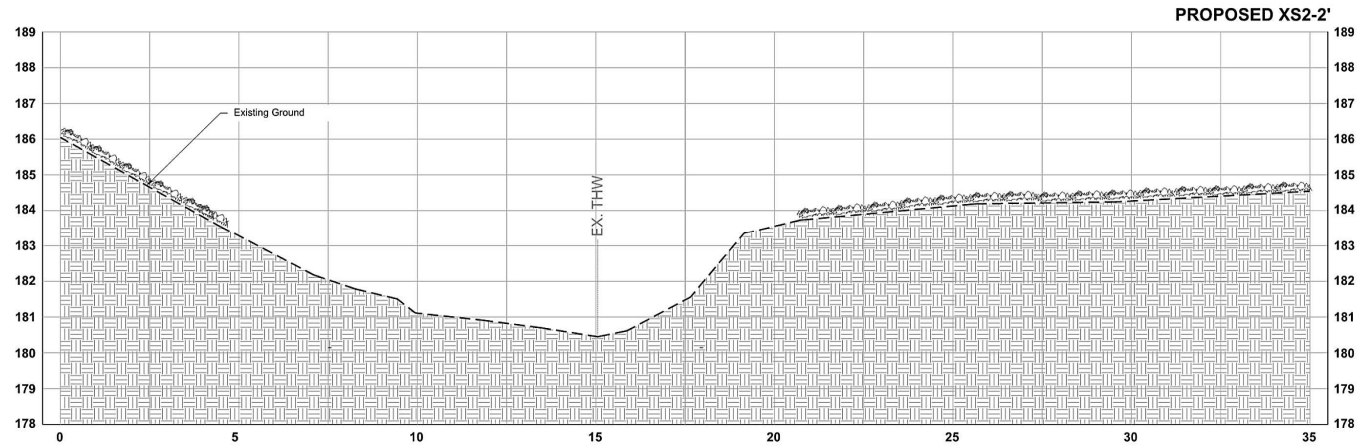
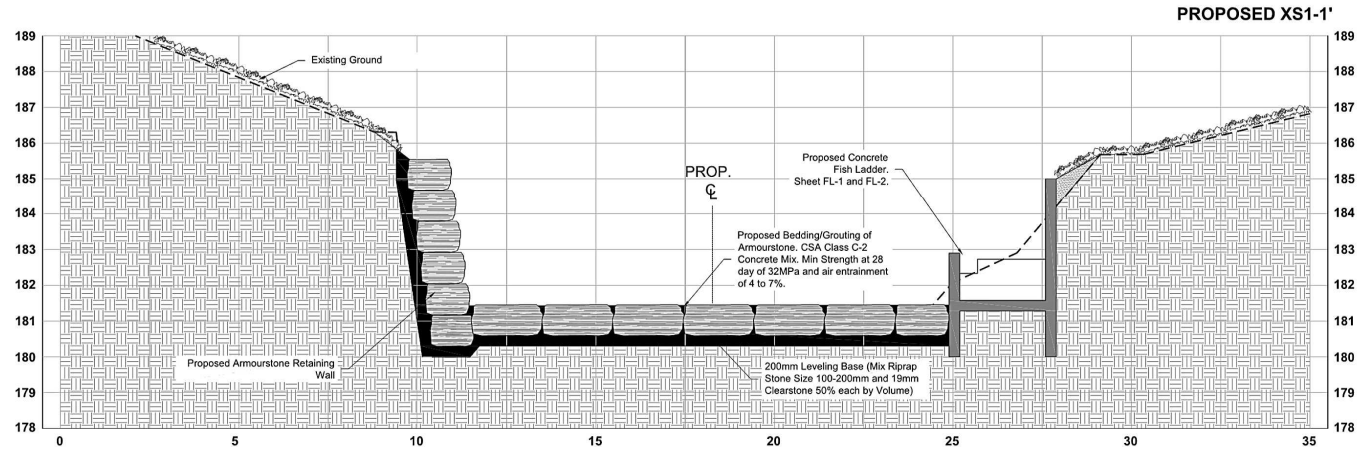
PLATE No  
CONT 2016-XX  
WP WPNUM

SECTIONS  
STA TO STA  
Survey Revised RA



HEYROCK CREEK

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PLATE No

CONT  
WP2016-XX  
WPNUM

## STAGING PLAN

STA TO STA  
Survey Revised RA

PARSONS

Aquafor Beech  
Limited16-202-2620 SYDNEY AVE.  
HESSBURGH, ONTARIO L0M 0S2  
PHONE: (905) 429-0099, FAX: (905) 429-0089

HEYROCK CREEK

## GENERAL NOTES

1. TEMPORARY SEDIMENT CONTROLS TO BE INSTALLED PRIOR TO THE START OF CONSTRUCTION PER EROSION AND SEDIMENT PLAN THIS SHEET.
2. THE CONTRACTOR SHALL PROVIDE A QUALIFIED SEDIMENT AND EROSION CONTROL INSPECTOR ON SITE WHILE CONSTRUCTION IS UNDERWAY.
3. THE CONTRACTOR SHALL DELINEATE THE REQUIRED WORKING AREA ON-SITE PRIOR TO THE START OF WORK AND SHALL CONFINED OPERATIONS WITHIN THE DEFINED AREA.
4. TREE PROTECTION BARRIERS SHALL BE APPROVED BY THE CONTRACT ADMINISTRATOR PRIOR TO THE START OF GRADING ACTIVITIES.
5. TEMPORARY TOPSOIL AND/OR FILL MATERIAL STOCKPILE AREAS TO BE ENCLOSED WITH SILTATION CONTROL FENCE.
6. LOCATION OF STOCKPILE AREAS TO BE DETERMINED ON-SITE PRIOR TO CONSTRUCTION AND APPROVED BY THE CONTRACT ADMINISTRATOR.
7. WORKING AREAS, ACCESS REQUIREMENTS, AND TEMPORARY MATERIAL STORAGE AREAS TO BE MAINTAINED IN GOOD CONDITION BY THE CONTRACTOR AT ALL TIMES. AREAS AFFECTED BY THE CONTRACTOR'S ACTIVITIES TO BE REINSTATED TO THE EXISTING CONDITIONS OR BETTER.
8. ALL THE EXCAVATION AND GRADING WORKS ARE TO BE COMPLETED IN AS "DRY" AS POSSIBLE CONDITIONS.
9. NO RUNOFF FROM EXCAVATED OR UNVEGETATED AREAS SHALL BE DISCHARGED OFF SITE INTO ACTIVE AND/OR INACTIVE STORM SEWERS OR WATERCOURSES.
10. ALL ACCUMULATED SEDIMENTS TO BE REMOVED PRIOR TO THE REMOVAL OF CONTROLS AND DISPOSED OF IN AN APPROVED ON-SITE LOCATION (LOCATION TO BE DETERMINED IN THE FIELD BY THE CONTRACT ADMINISTRATOR).
11. SEDIMENT CONTROLS TO BE INSPECTED DAILY AND AFTER EACH RAINFALL EVENT. SEDIMENT CONTROLS TO BE MAINTAINED AND REPAIRED UNTIL COMPLETION OF CONSTRUCTION AND SITE RESTORATION. EROSION AND SEDIMENT CONTROL FENCE REPAIRS TO BE COMPLETED WITHIN 48 HOURS OF INSPECTION.
12. ALL SITE RESTORATION TO BE IN ACCORDANCE WITH THE LANDSCAPE REHABILITATION PLAN AND DETAILS.

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Erosion and Sediment Control Fence  
Detail 4, This SheetWater Tight Coffor Dam  
Detail 5, This SheetCreek Dewatering  
Detail 3, Sheet CD-1

## STANDARD NOTES FOR CONSTRUCTION

1. ALL ELEVATIONS ARE IN METRES AND ALL DIMENSIONS ARE IN METRIC UNITS.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR LAYOUT, SURVEY, AND LOCATION OF ALL UTILITIES.
3. TO PROTECT LOCAL FISH POPULATIONS DURING THEIR SPAWNING, NURSERY AND MIGRATORY PERIODS, IN- AND NEAR-WATER ACTIVITIES MAY ONLY OCCUR DURING THE WARM WATER CONSTRUCTION TIMING WINDOW OF JULY 1 TO FEBRUARY 28.
4. TO PROTECT LOCAL MIGRATORY BIRD POPULATIONS, TREE REMOVALS MUST BE IN COMPLIANCE WITH MIGRATORY BIRDS CONVENTION ACT. NO TREE REMOVALS BETWEEN APRIL 1 TO AUGUST 31.
5. THE CONTRACTOR SHALL MONITOR THE WEATHER SEVERAL DAYS IN ADVANCE TO ENSURE THAT WORKS ARE CONDUCTED DURING FAVOURABLE WEATHER CONDITIONS. SHOULD AN UNEXPECTED STORM ARISE, THE PROPONENT/CONTRACTOR SHALL REMOVE ALL ITEMS FROM THE REGIONAL STORM FLOOD PLAIN THAT WOULD HAVE THE CAPACITY TO CAUSE AN OBSTRUCTION TO FLOW OR A SPILL (I.E. FUEL TANKS, UNFIXED EQUIPMENT, ETC.).

## CONSTRUCTION STAGING SEQUENCE

1. TEMPORARY SEDIMENT AND EROSIONS CONTROLS TO BE INSTALLED PRIOR TO THE START OF CONSTRUCTION.
2. CLEARING, GRUBBING AND REMOVAL OF TREES AS REQUIRED
3. INSTALLATION OF TREE PROTECTION/HOLDING AREAS
4. CREATE WATERTIGHT COFFER DAM WITHIN THE OUTLET. CONTRACTOR TO MEET PUMPING REQUIREMENTS TO MAINTAIN DRY WORKING AREA.
5. INSTALL DOWNSTREAM CHECK DAM AS DEFINED ON THE DETAILED DESIGN DRAWINGS.
6. INITIATE PUMPING WITH SCOUR OUTLET PROTECTIONS.
7. COMPLETE FISH RESCUE THROUGH REACH. FISH REMOVAL IS TO BE DONE BY QUALIFIED FISHERIES BIOLOGIST UNDER MNR PERMIT.
8. DEWATER WORK AREA AS REQUIRED (I.E., SCOUR POOL DOWNSTREAM OF CULVERT) THROUGH FILTER BAG WITHIN FLOODPLAIN.
9. EXCAVATE / CONSTRUCT CONCRETE FISH LADDER AS PER DETAIL.
10. EXCAVATE / CONSTRUCT ENGINEERED SCOUR POOL WITH GROUTED / STACKED ARMOURSTONE AS PER DETAIL.
11. COMPLETE ROUGH GRADING OF SLOPES AS PER DESIGN DRAWINGS.
12. CONSTRUCT ARMOURSTONE RETAINING WALLS.
13. COMPLETE BANK RESTORATION GRADING AND TOPSOIL APPLICATION
14. DECOMMISSION PUMP, REMOVE UPSTREAM COFFER DAM.
15. IMPLEMENT RESTORATION OF STUDY AREA AS PER RESTORATION PLAN AND DETAILS.
16. REGRADE AND BURY ACCESS ROUTE WITH 15CM OF TOPSOIL.
17. REMOVE ALL SEDIMENT AND EROSION CONTROL MEASURES AFTER DEMOBILIZATION FOR PLANTING MATURATION.

## NOTES:

- Materials removed from trench shall be replaced on top of filter cloth
- Filter cloth shall be horizontally overlapped 500mm
- Silt fence installation work shall avoid the destruction of existing woody vegetation (ie. Shrubs and trees) other than those species which have been approved for removal
- All topsoil stockpiles to be surrounded with sediment control fencing.

ELEVATION

N.T.S.

CROSS SECTION

N.T.S.

DETAIL 4 - SEDIMENT CONTROL FILTER FENCE

## NOTES:

1. TERRAFIX METRE BAGS TO BE FILLED WITH P.I.A. GRAVEL, DWT OR APPROVED EQUIVALENT.
2. HEIGHT OF FLOW-CHECK DAM 1.6 - 2.0 M (OR AS DIRECTED BY ENGINEER).
3. RUBBERGARD NON-REINFORCED EPDM MEMBRANE (OR APPROVED EQUIVALENT) TO ENSURE FLOW CHECK IS WATER TIGHT.

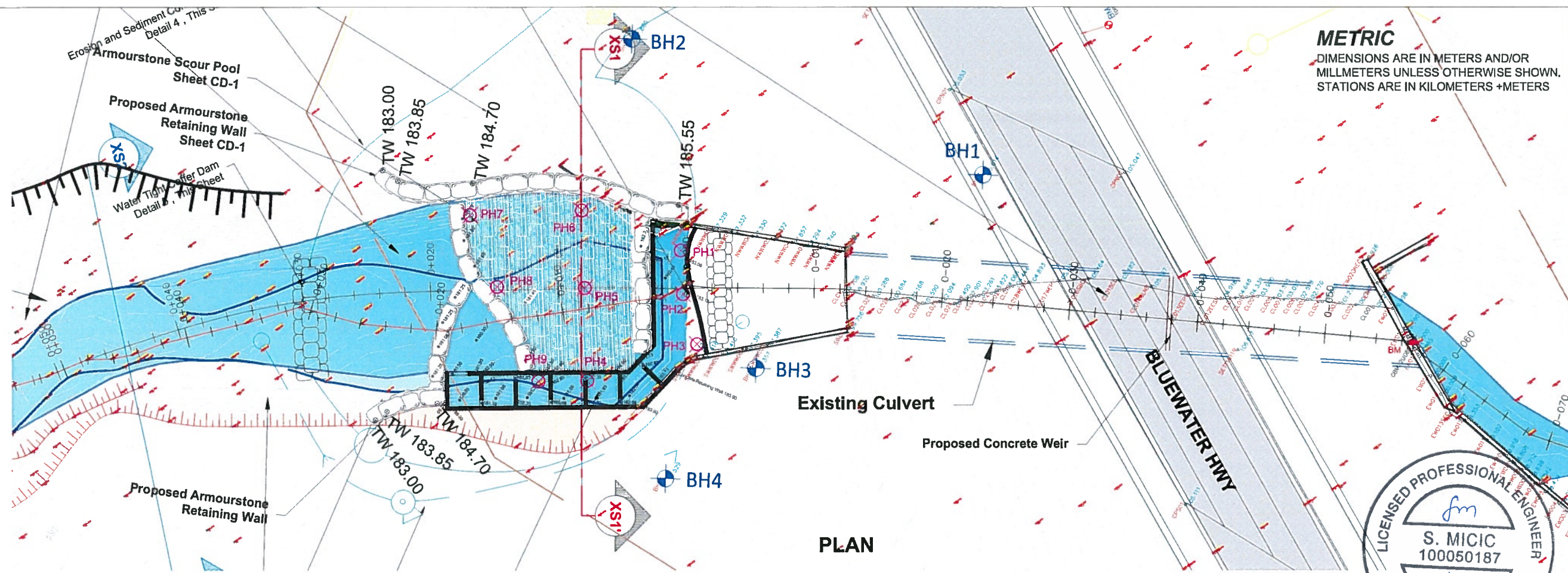
TERRAFIX METRE BAGS (NOTE 1)  
RUBBERGARD NON-REINFORCED  
EPDM MEMBRANE (NOTES)  
PEA-GRAVEL BAGS  
FLOW

DETAIL 5 - TEMPORARY WATER TIGHT COFFER DAM

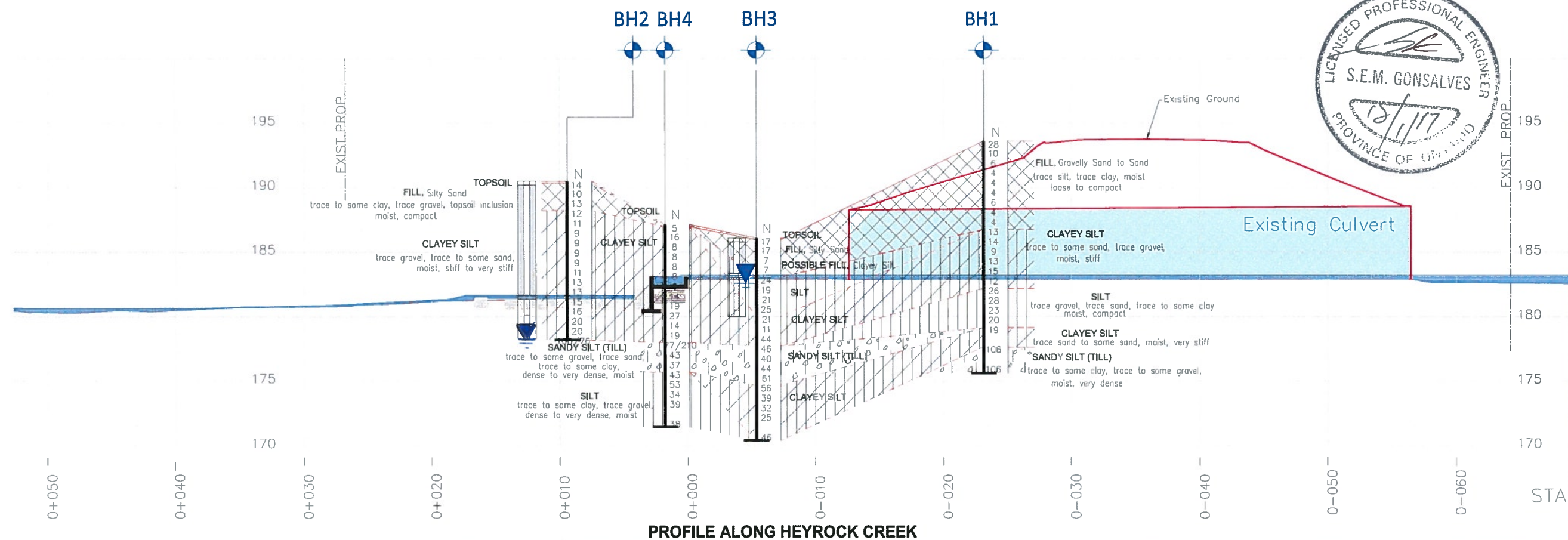
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## **Appendix C – Borehole Location Plan and Stratigraphic Section**





**NOTE: THE PLAN AND PROFILE ARE PROVIDED BY MTO/ PARSONS.**



**METRIC**  
DIMENSIONS ARE IN METERS AND/OR  
MILLIMETERS UNLESS OTHERWISE SHOWN.  
STATIONS ARE IN KILOMETERS +METERS

Agreement No. 3015-E-0017  
Assignment No. 2  
GWP 3186-15-00

**CONSTRUCTION OF CONCRETE FISH  
LADDER AT OUTLET OF THE EXISTING  
HEYROCK CREEK CULVERT  
BOREHOLE LOCATION PLAN AND PROFILE**

exp. Services Inc.

**LEGEND**

- Location of Drilled Boreholes
- Standard Penetration Test (Blows/0.3 m)
- Water Level in Piezometer
- Bench Mark (EL. 188.57m)
- Proposed Probe Location
- Piezometer

**SOIL STRATA SYMBOLS**

Symbol	Description
[Pattern]	TOPSOIL
[Pattern]	FILL
[Pattern]	CLAYEY SILT
[Pattern]	SANDY SILT TILL
[Pattern]	SILT

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH1	193.6	4807741.8	369033.7
BH2	190.5	4807765.9	369016.8
BH3	186.0	4807739.3	369010.6
BH4	187.1	4807736.2	368999.9
GBM	188.57	4807712.1	369054.1

**NOTE**

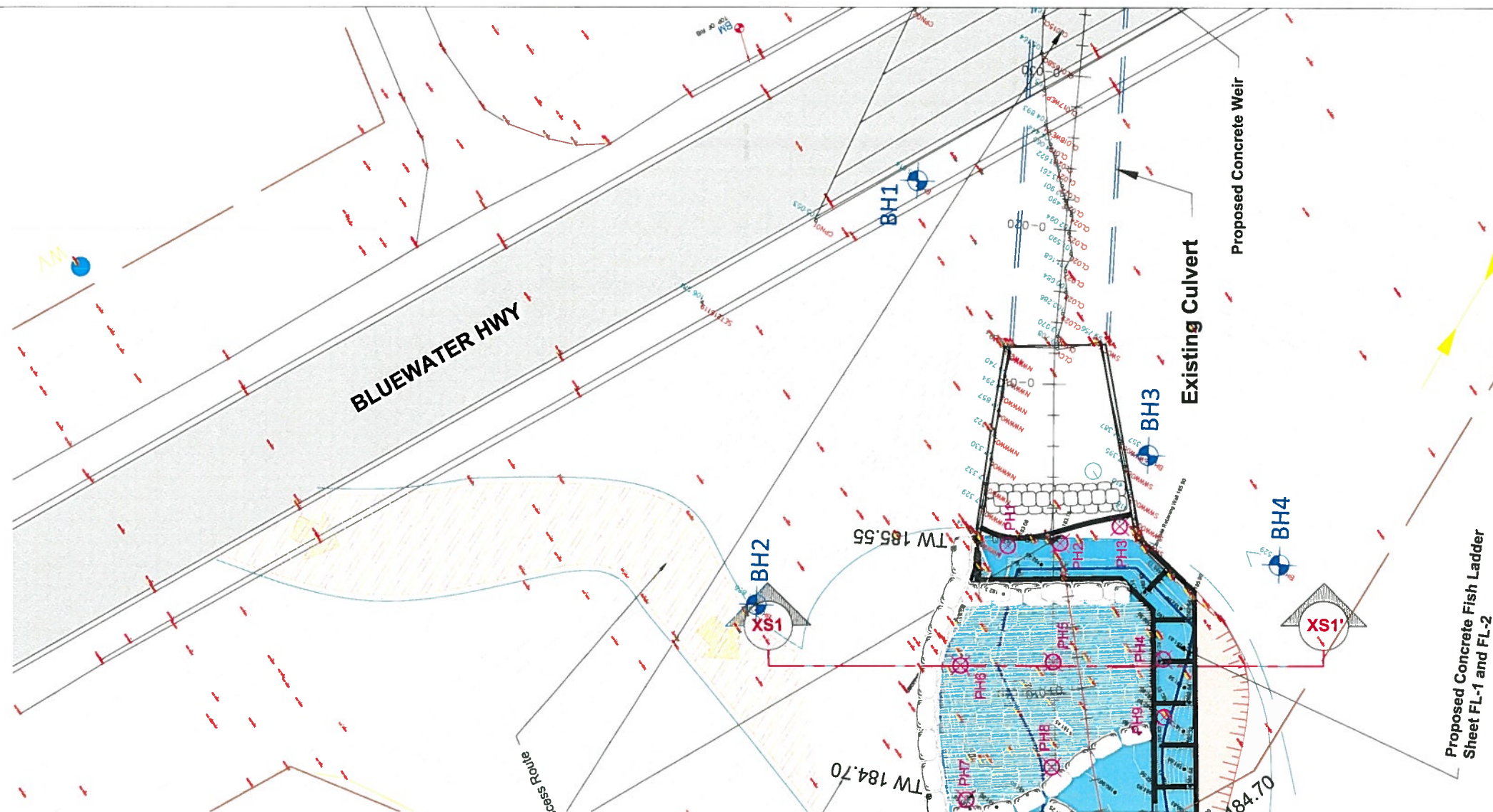
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be constant with the final design configuration as shown elsewhere in the Contracts Documents.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview, information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

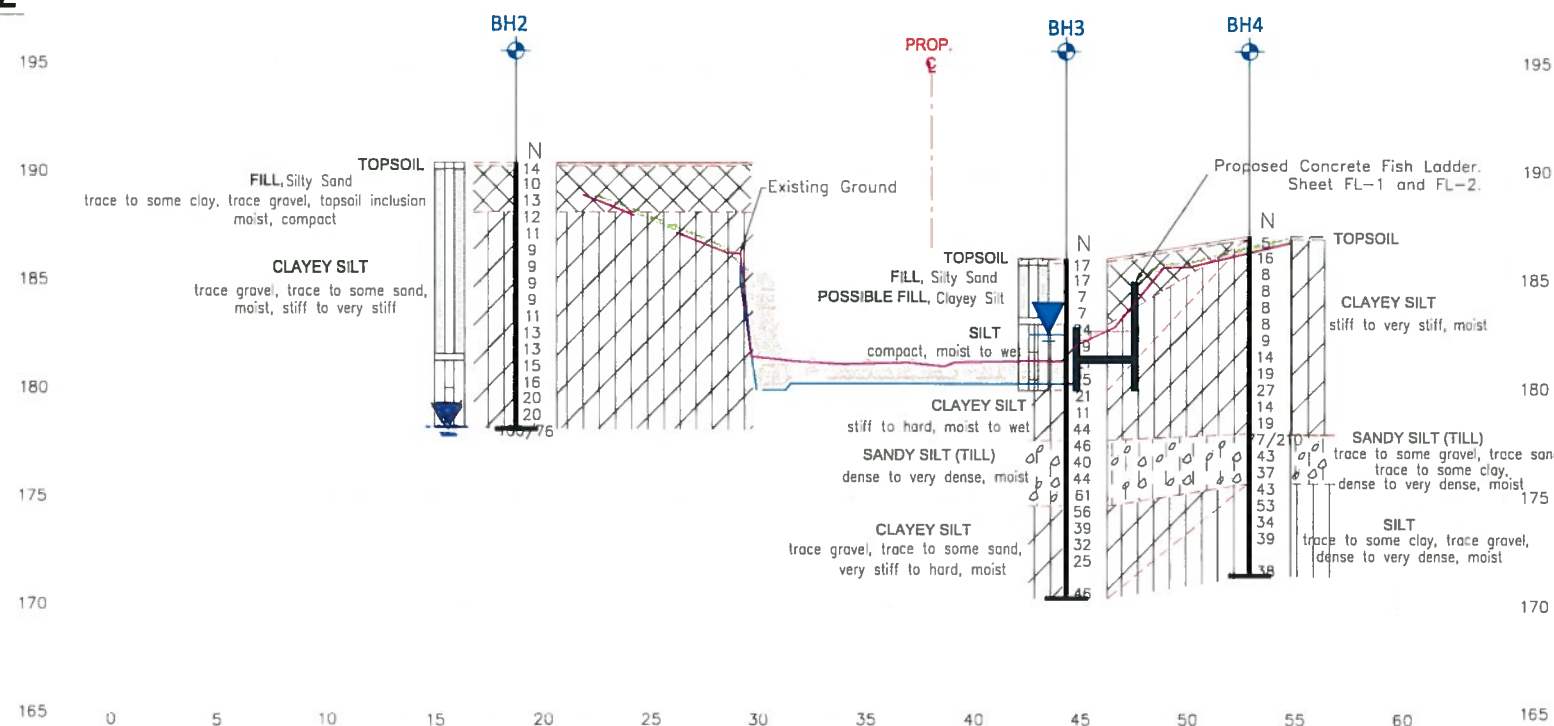
0 5 10 m  
scale

DATE	BY	DESCRIPTION			
15/12/2016	SM	SUBMISSION FOR MTO REVIEW			
		GEOCRES NO. 40P5-21			
		PROJECT NO. ADM-00235197-B0			
SUBM'D	SM	CHECKED	SM	DATE	15/12/2016
DRAWN	SH	CHECKED	SG	APPROVED	DWG. 1





NOTE: THE PLAN AND PROFILE ARE PROVIDED BY MTO/ PARSONS.



SECTION XS1-1'

**METRIC**  
DIMENSIONS ARE IN METERS AND/OR  
MILLIMETERS UNLESS OTHERWISE SHOWN.  
STATIONS ARE IN KILOMETERS +METERS

Agreement No. 3015-E-0017  
Assignment No. 2  
GWP 3186-15-00

CONSTRUCTION OF CONCRETE FISH  
LADDER AT OUTLET OF THE EXISTING  
HEYROCK CREEK CULVERT  
BOREHOLE LOCATION PLAN AND PROFILE

exp. Services Inc.



LEGEND

- Location of Drilled Boreholes
- Standard Penetration Test (Blows/0.3 m)
- Water Level in Piezometer
- Bench Mark (EL. 188.57m)
- Proposed Probe Location
- Piezometer

SOIL STRATA SYMBOLS

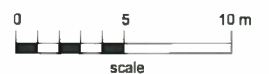
- TOPSOIL
- SANDY SILT TILL
- FILL
- SILT
- CLAYEY SILT

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH1	193.6	4807741.8	369033.7
BH2	190.5	4807765.9	369016.8
BH3	186.0	4807739.3	369010.6
BH4	187.1	4807736.2	368999.9
GBM	188.57	4807712.1	369054.1

NOTE

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

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.



04/01/2017	SM	SUBMISSION FOR MTO REVIEW	
DATE	BY	DESCRIPTION	
		GEOCRES NO. 40P5-21	
		PROJECT NO. ADM-00235197-B0	
SUBM'D SM	CHECKED SM	DATE	04/01/2017
DRAWN SH	CHECKED SG	APPROVED	DWG. 2



## **Appendix D – Borehole Logs**

# 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:

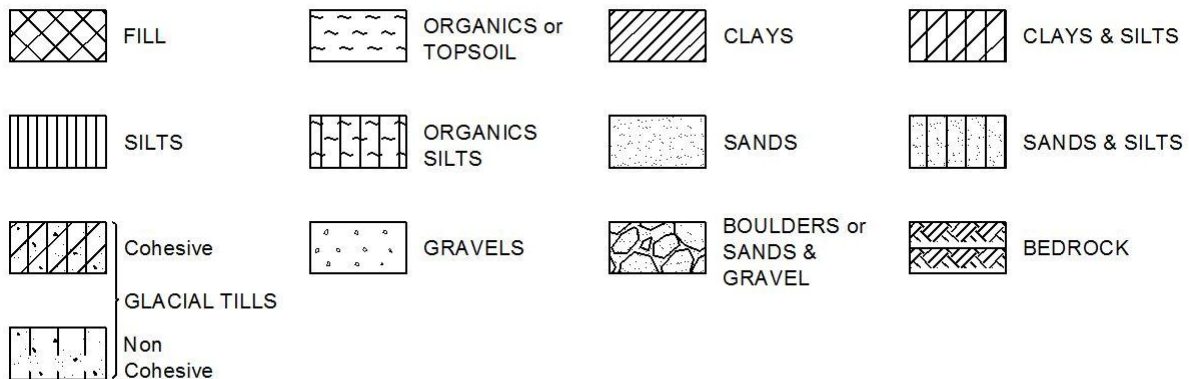
Table c: Consistency of Cohesive Soil

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
$\sigma$	kPa	Total normal stress
$\sigma'$	kPa	Effective normal stress
$\tau$	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
$\varepsilon$	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
$\mu$	1	Coefficient of friction

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	Coefficient of volume change
$c_c$	1	Compression index
$c_s$	1	Swelling index
$c_r$	1	Recompression index
$c_v$	m <sup>2</sup> /s	Coefficient of consolidation
H	m	Drainage path
$T_v$	1	Time factor
U	%	Degree of consolidation
$\sigma'_{v0}$	kPa	Effective overburden pressure
$\sigma'_p$	kPa	Preconsolidation pressure
$\tau_f$	kPa	Shear strength
$c'$	kPa	Effective cohesion intercept
$\phi'$	—°	Effective angle of internal friction
$c_u$	kPa	Apparent cohesion intercept
$\phi_u$	—°	Apparent angle of internal friction
$\tau_R$	kPa	Residual shear strength
$\tau_r$	kPa	Remoulded shear strength
$S_t$	1	Sensitivity = $c_u/\tau_r$

### PHYSICAL PROPERTIES OF SOIL

$P_s$	kg/m <sup>3</sup>	Density of solid particles
$\gamma_s$	kN/m <sup>3</sup>	Unit weight of solid particles
$\rho_w$	kg/m <sup>3</sup>	Density of water
$\gamma_w$	kN/m <sup>3</sup>	Unit weight of water
$\rho$	kg/m <sup>3</sup>	Density of soil
$\gamma$	kN/m <sup>3</sup>	Unit weight of soil
$\rho_d$	kg/m <sup>3</sup>	Density of dry soil
$\gamma_d$	kN/m <sup>3</sup>	Unit weight of dry soil
$\rho_{sat}$	kg/m <sup>3</sup>	Density of saturated soil
$\gamma_{sat}$	kN/m <sup>3</sup>	Unit weight of saturated soil
$\rho'$	kg/m <sup>3</sup>	Density of submerged soil
$\gamma'$	kN/m <sup>3</sup>	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 <sup>3</sup> /s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m <sup>3</sup>	Seepage force

Brampton, Ontario

## RECORD OF BOREHOLE No BH-1

1 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON11 4807742N, 369034E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/07 - 2016/11/07 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa									WATER CONTENT (%)			GR	SA
								○ UNCONFINED	+	FIELD VANE											
								×	QUICK TRIAXIAL	LAB VANE											
193.6	Road Surface																				
	FILL: GRAVELLY SAND TO SAND - trace silt, trace clay, brown, moist loose to compact		1	SS	28		193							○					22 69 (9)		
			2	SS	10									○							
			3	SS	6		192								○						
			4	SS	4		191								○						
			5	SS	4										○						
			6	SS	4										○						
			7	SS	6		189									○					
			8	SS	4		188									○					10 81 (9)
			9	SS	4											○					
186.7						187															
6.9	CLAYEY SILT - trace to some sand, trace gravel, grey, moist, stiff		10	SS	13		186							○				PP = 294 kPa			
		11	SS	14										○							
		12	SS	9	185										○			1 10 47 42			
		13	SS	13	184										○				PP = 147 kPa		
		14	SS	15											○						
		15	SS	12			183									○				PP = 196 kPa	
182.2						182								○							
11.4	SILT - trace gravel, trace sand, trace to some clay, grey, moist, compact		16	SS	26										○						

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-1

2 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON11 4807742N, 369034E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/07 - 2016/11/07 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa ○ UNCONFINED + FIELD VANE × QUICK TRIAXIAL LAB VANE										WATER CONTENT (%)	
								20	40	60	80	100	10	20	30				
179.1	SILT - trace gravel, trace sand, trace to some clay, grey, moist, compact (continued)		17	SS	28		181												
			18	SS	23														
			19	SS	20														
14.5	CLAYEY SILT - trace to some sand, grey, moist, very stiff		20	SS	19		179										PP = 196 kPa 3 15 45 37		
177.6							178												
16.0	SANDY SILT (TILL)- trace to some clay, trace to some gravel, grey, moist, very dense		21	SS	106		177										11 36 (53)		
175.6			22	SS	106		176												
18.0	End of Borehole at 18 m depth																		
	Notes: 1. This borehole log is to be read with the subject report and project numbers as presented above. 2. Groundwater level was dry in open hole upon completion of drilling. 3. Hole open upto 17.5 m upon completion																		

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-2

1 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807765N, 369017E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/08 - 2016/11/08 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
190.5	Ground Surface																
190.4	TOPSOIL - 152 mm topsoil		1	SS	14		190							○			
0.2	FILL: SILTY SAND - trace to some clay, trace gravel, topsoil inclusion, brown, moist, compact		2	SS	10									○			5 50 (45)
			3	SS	13		189							○			
188.2	CLAYEY SILT - trace gravel, trace to some sand, brown to grey, moist, stiff to very stiff		4	SS	12		188							○			PP = 245 kPa
2.3			5	SS	11		187							○			
			6	SS	9		186							○			2 21 48 29
			7	SS	9		185							○			PP = 196 kPa
			8	SS	9		184							○			
			9	SS	9		183							○			1 5 47 47
			10	SS	11		182							○			
			11	SS	13		181							○			PP = 196 kPa
			12	SS	13		180							○			
			13	SS	15		179							○			1 4 49 46
			14	SS	16									○			
			15	SS	20									○			
			16	SS	20									○			
	- unexpected auger refusal @ 11.4 m, drilled another borehole within approx. 1.5 m perimeter of original BH													○			

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-2

2 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807765N, 369017E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/08 - 2016/11/08 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
178.2 12.3	-hit large stone @ 12.25 m, Split Spoon/ auger refusal <b>Split Spoon/ Auger Refusal at 12.25            m (Possible boulder encountered)            End of Borehole</b>  Notes: 1. This borehole log is to be read with the subject report and project numbers as presented above. 2. Groundwater monitoring well installed to depth 12.2 m.  Date Water Level Elevation(m)  Upon Completion dry Jan. 4, 2017 178.2 m		17	SS	100/ 76 mm												

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-3

1 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807739N, 369011E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/09 - 2016/11/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa										WATER CONTENT (%)	
								○ UNCONFINED	+	FIELD VANE									
								× QUICK TRIAXIAL		LAB VANE									
186.0	Ground Surface																		
185.8	TOPSOIL 125 mm thickness		1	SS	17								○						
0.1	trace organics, dark brown, moist																		
	FILL: SILTY SAND trace to some		2	SS	17								○						
	gravel, trace to some clay, topsoil																		
	inclusion, brown, moist, compact																		
184.5	POSSIBLE FILL: CLAYEY SILT		3	SS	7								○			0 25 (75)			
1.5	trace gravel, trace sand, grey, firm, moist													○					
			4	SS	7														
182.9	SILT trace to some sand, trace to some gravel, trace clay, grey, compact, moist to wet		5	SS	24								○						
3.1			6	SS	19								○						
	- becoming gravely sand @ 4.6 m		7	SS	21								○			14 71 (15)			
			8	SS	25								○						
179.9	CLAYEY SILT trace gravel, trace sand, grey, stiff to hard, moist to wet		9	SS	21								○			PP = 294 kPa 3 6 51 40			
6.1			10	SS	11								○						
	- Stone in tip of spoon @ 7.65 m		11	SS	44								○						
177.6	SANDY SILT (TILL) trace to some gravel, trace to some clay, grey, dense to very dense, moist		12	SS	46								○			24 27 (49)			
8.4																			
			13	SS	40								○			PP = 441 kPa			
			14	SS	44								○						
			15	SS	61								○						
174.5	CLAYEY SILT trace gravel, trace to some sand, grey, very stiff to hard, moist		16	SS	56								○						
11.4																			

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-3

2 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807739N, 369011E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/09 - 2016/11/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		GR	SA	SI	CL
170.3	CLAYEY SILT trace gravel, trace to some sand, grey, very stiff to hard, moist (continued)		17	SS	39	173													PP = 245 kPa	
			18	SS	32															5   15   43   37
			19	SS	25															
			20	SS	46															
15.7	End of Borehole																			
<div>Notes: 1. This borehole log is to be read with the subject report and project numbers as presented above. 2. Groundwater monitoring well installed to depth 6.1 m.</div> <div>Date      Water Level Elevation(m)</div> <div>Upon Completion      (182.0 m) Nov. 11, 2016      (182.5 m) Jan. 04, 2017      (183.0 m)</div>																				

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

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17



Brampton, Ontario

## RECORD OF BOREHOLE No BH-4

1 OF 2

METRIC

W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807736N, 368100E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/10 - 2016/11/11 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa									
								○ UNCONFINED	+ FIELD VANE	×	QUICK TRIAXIAL	LAB VANE					
187.1	Ground Surface						20	40	60	80	100						
187.0	TOPSOIL 152 mm thickness trace organics, dark brown, moist		1	SS	5												
0.2	CLAYEY SILT some silty sand, trace gravel, brown to grey, stiff to very stiff, moist		2	SS	16												
			3	SS	8												
			4	SS	8												
			5	SS	8												
			6	SS	8												
			7	SS	9												
			8	SS	14												
			9	SS	19												
			10	SS	27												
			11	SS	14												
			12	SS	19												
178.0	SANDY SILT (TILL) trace to some gravel, trace to some clay, grey, dense to very dense, moist		13	SS	77/ 210 mm												
9.1			14	SS	43												
			15	SS	37												
175.7	SILT trace to some clay, trace gravel, grey, dense to very dense, moist		16	SS	43												
11.4	-Large stone in spoon tip @ 11.45 m																

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

Brampton, Ontario

## RECORD OF BOREHOLE No BH-4

2 OF 2

METRIC

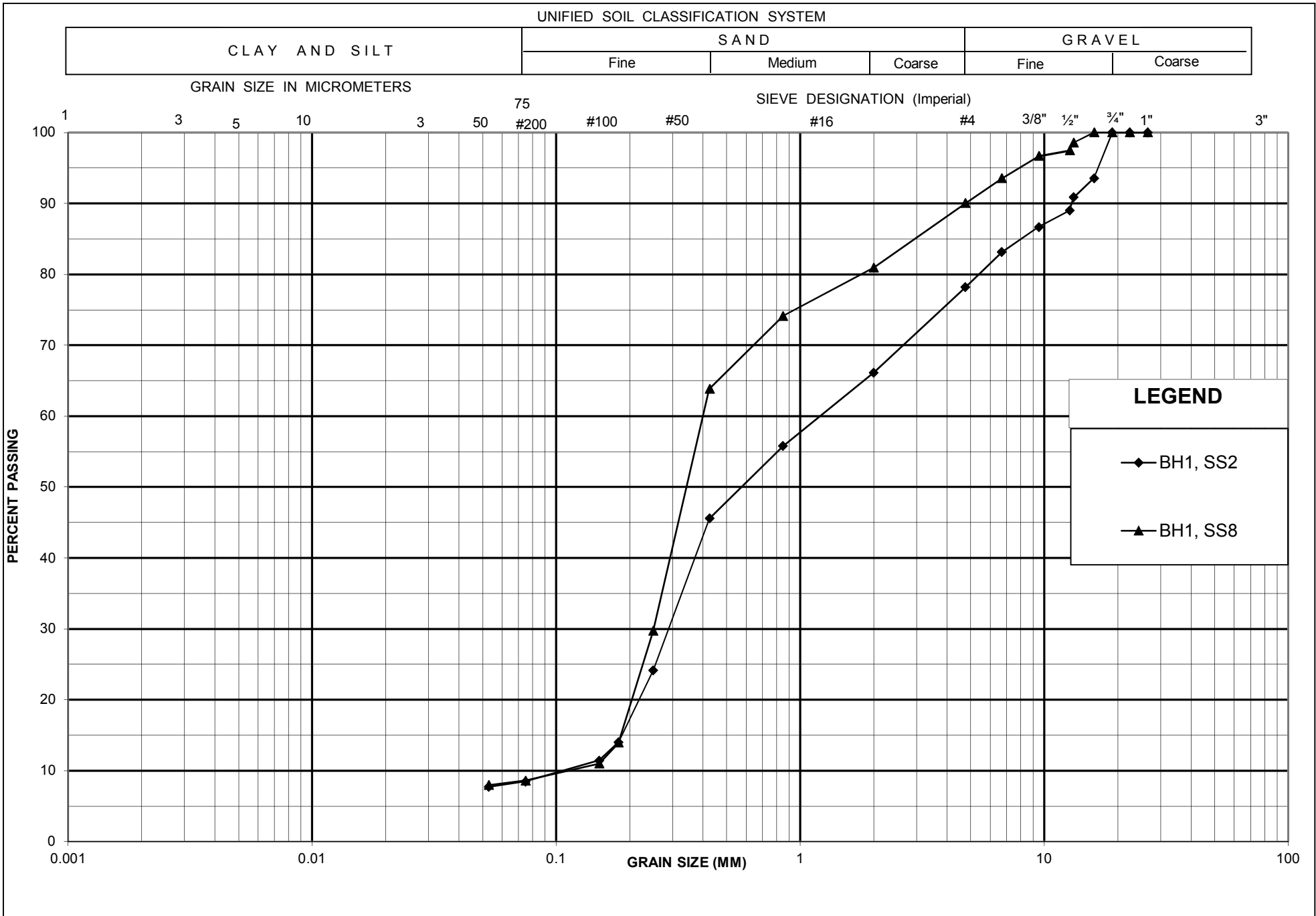
W. P. 3186-15-00 LOCATION Heyrock Creek MTM ON 11 4807736N, 368100E ORIGINATED BY RW  
 DIST Bluewater Mun. HWY Hwy 21 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY NT  
 DATUM Geodetic DATE 2016/11/10 - 2016/11/11 CHECKED BY SM

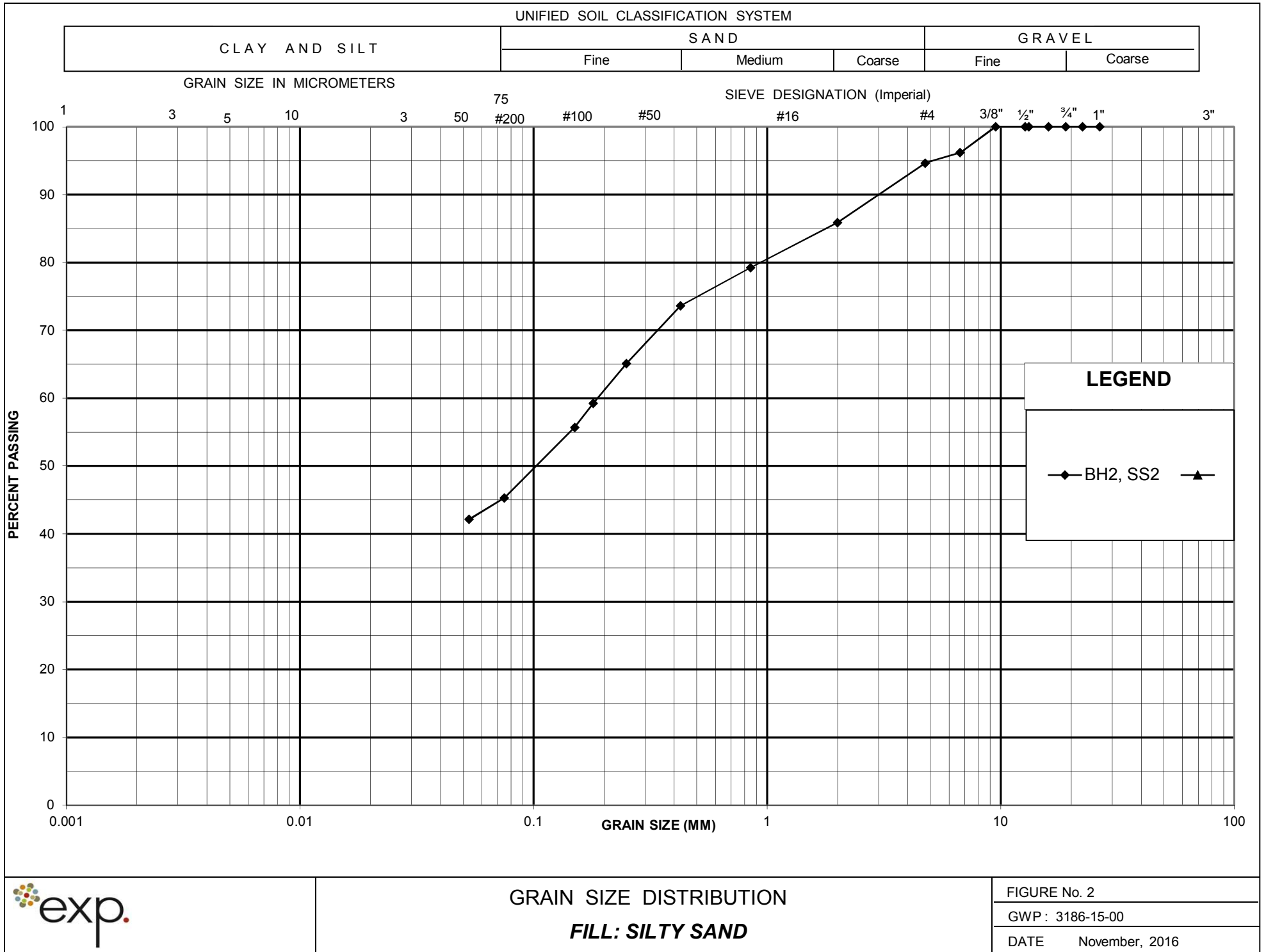
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100								
SHEAR STRENGTH: Cu, KPa								WATER CONTENT (%)												
○ UNCONFINED + FIELD VANE																				
× QUICK TRIAXIAL LAB VANE																				
							20	40	60	80	100	10	20	30						
171.4 15.7	no sample recover <b>SILT</b> trace to some clay, trace gravel, grey, dense to very dense, moist ( <i>continued</i> )	<div><div></div><div></div><div></div><div></div><div></div><div></div></div>	17	SS	53		175													
			18	SS	34		174													
			19	SS	39		173													
	-becoming clayey silt @ 15.25 m		20	SS	38	172														
	<b>End of Borehole</b>																			
	Notes: 1. This borehole log is to be read with the subject report and project numbers as presented above. 2. Groundwater level was dry in open hole upon completion of drilling. 3. Hole open upto 15.25 m upon completion																			

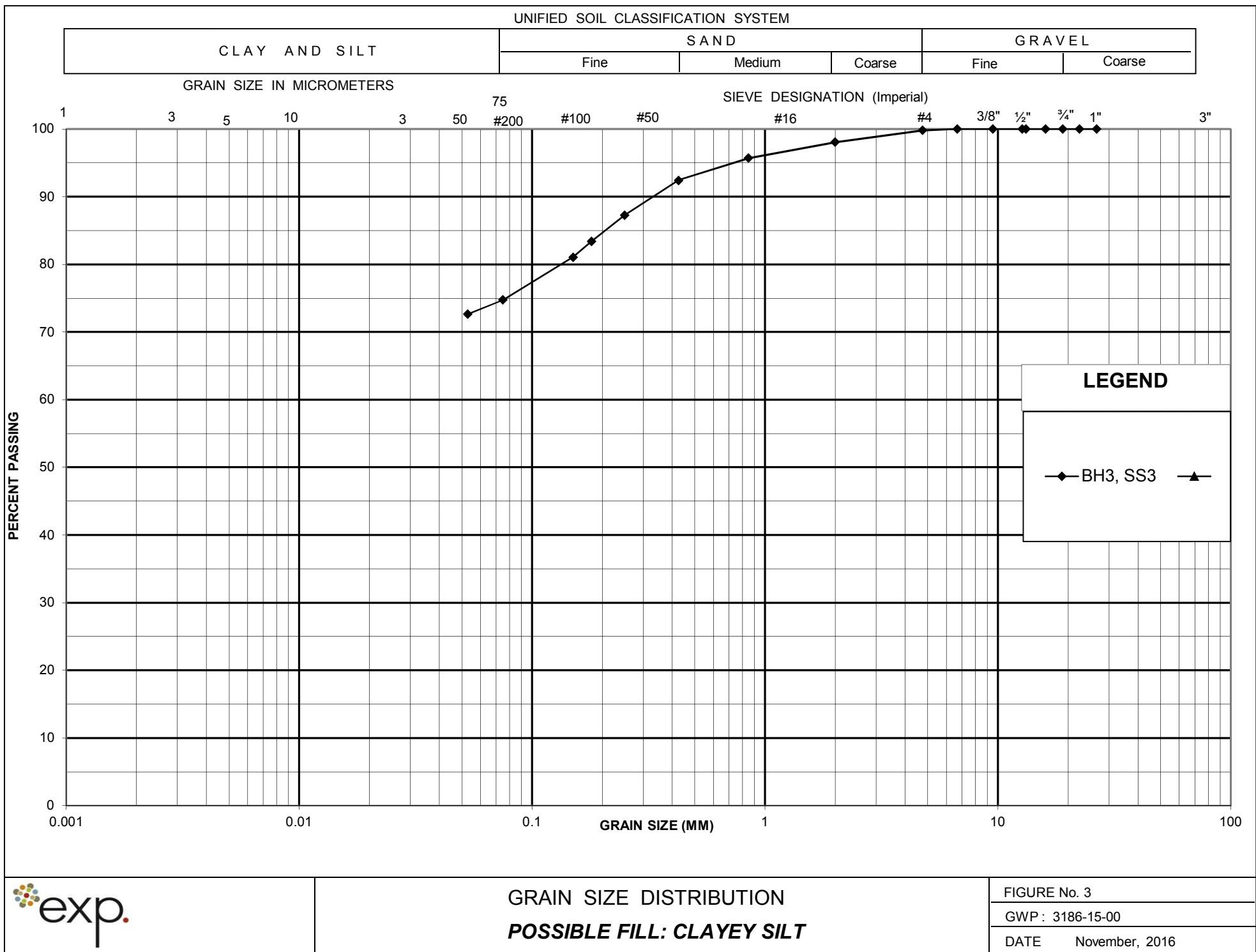
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

EXP RECORD OF BOREHOLE BH LOGS.GPJ ONTARIO MOT.GDT 1/10/17

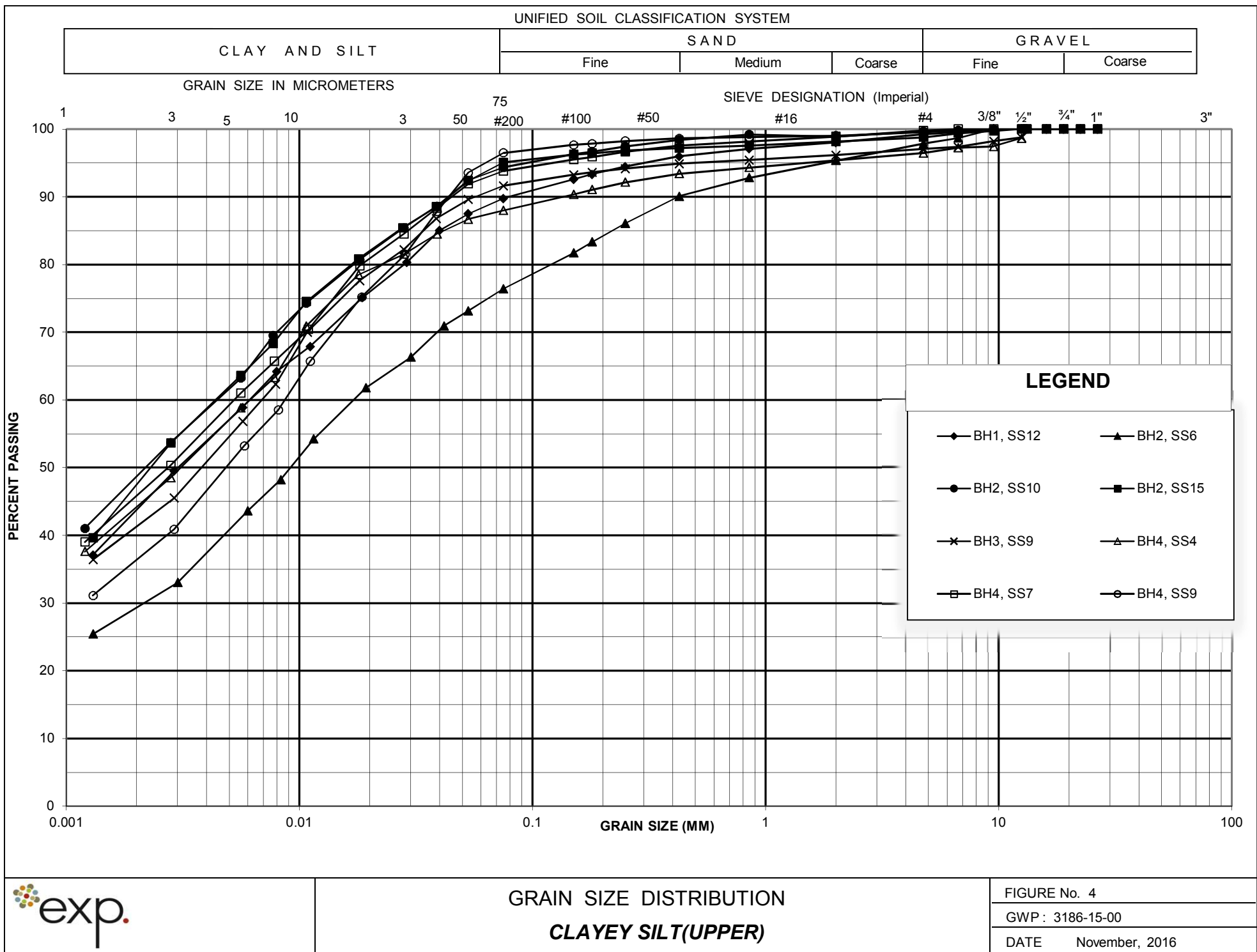
## **Appendix E – Laboratory Data**

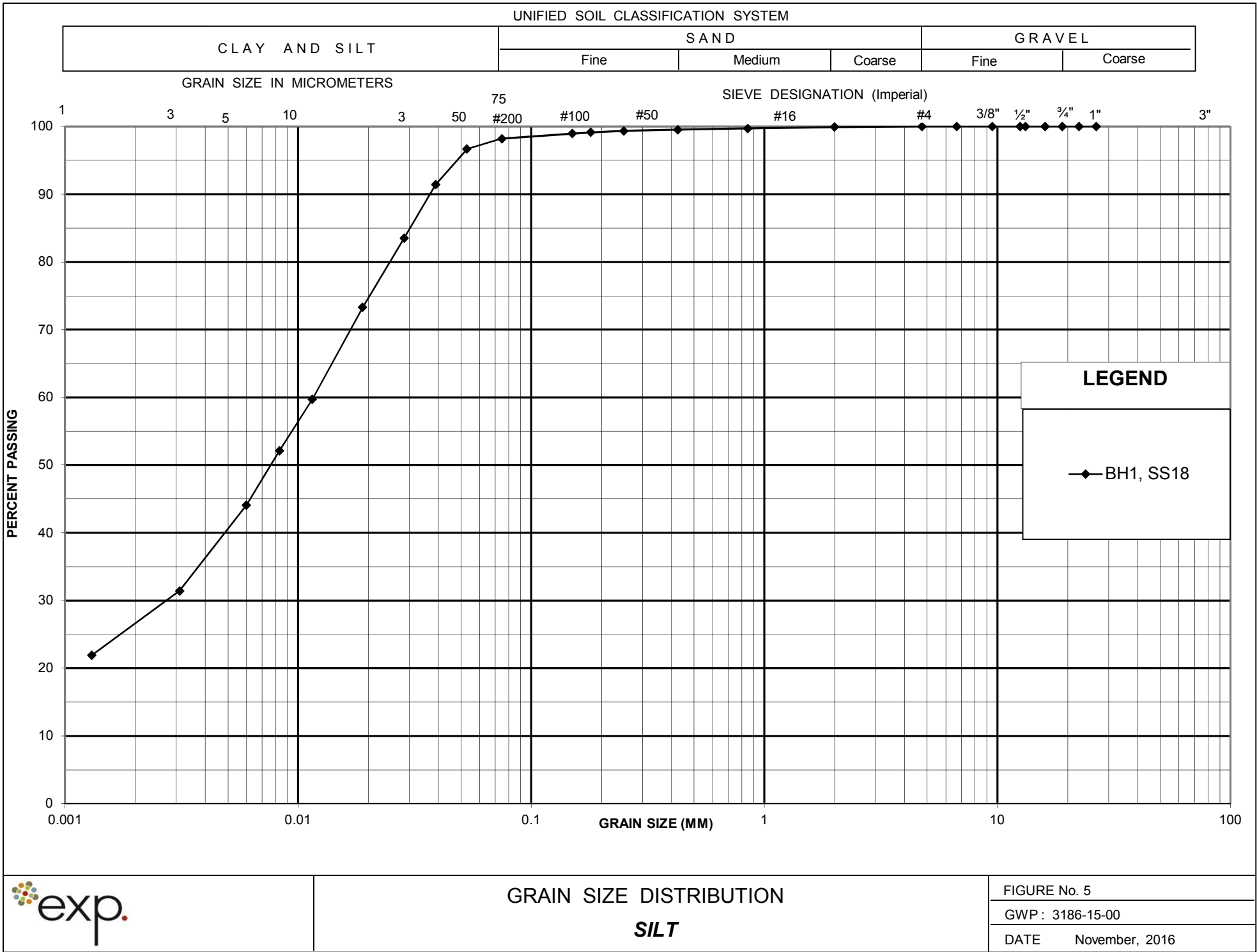


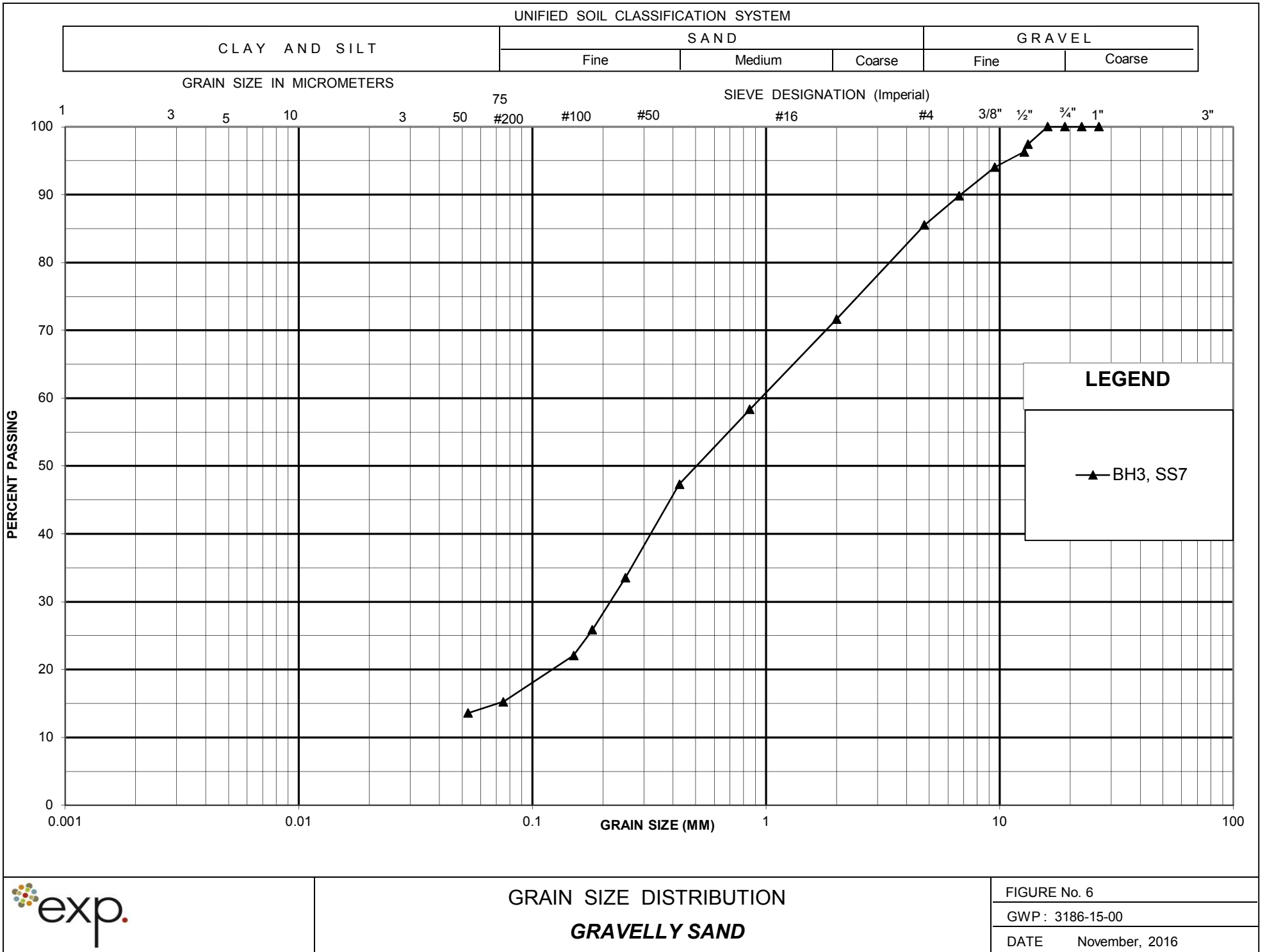


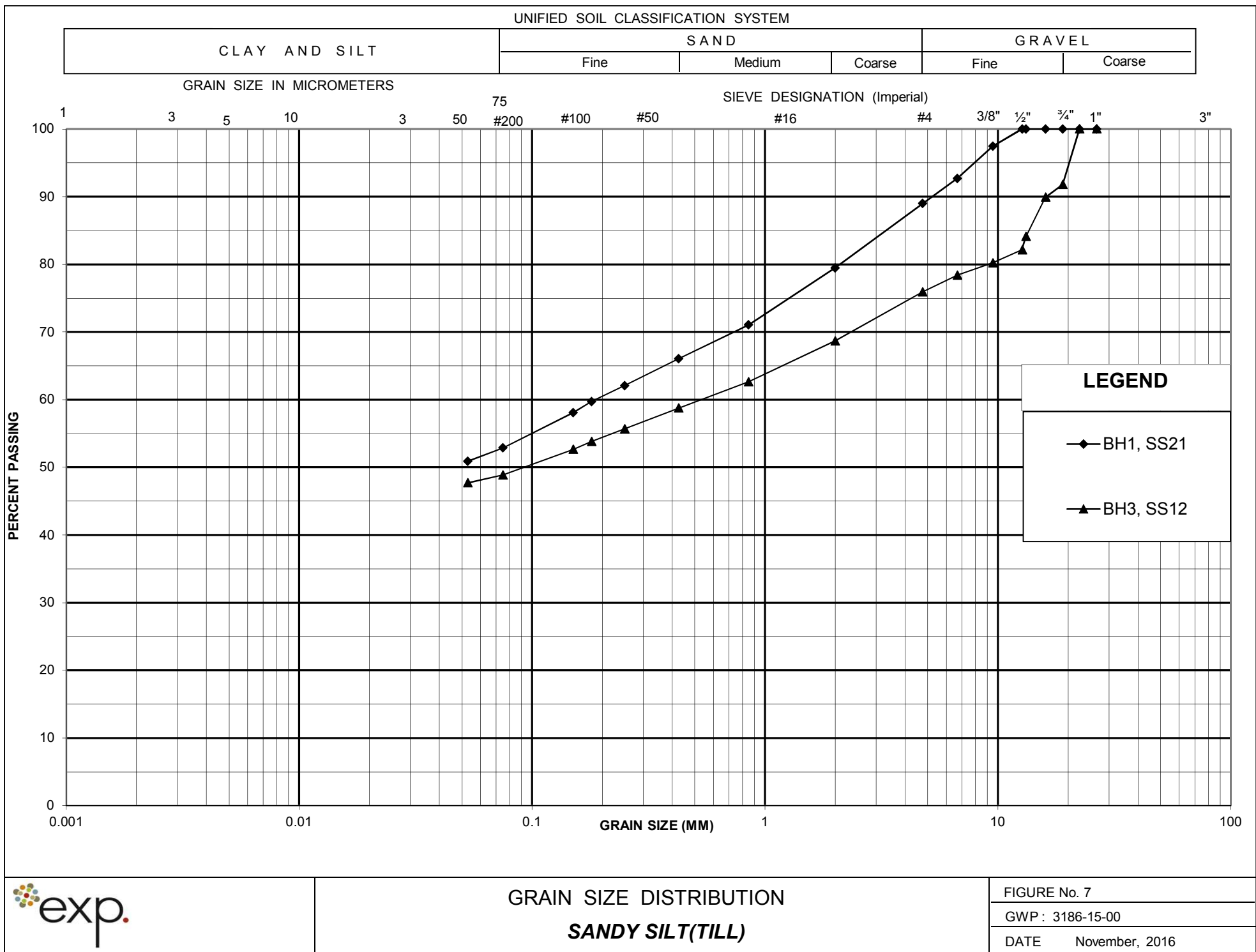




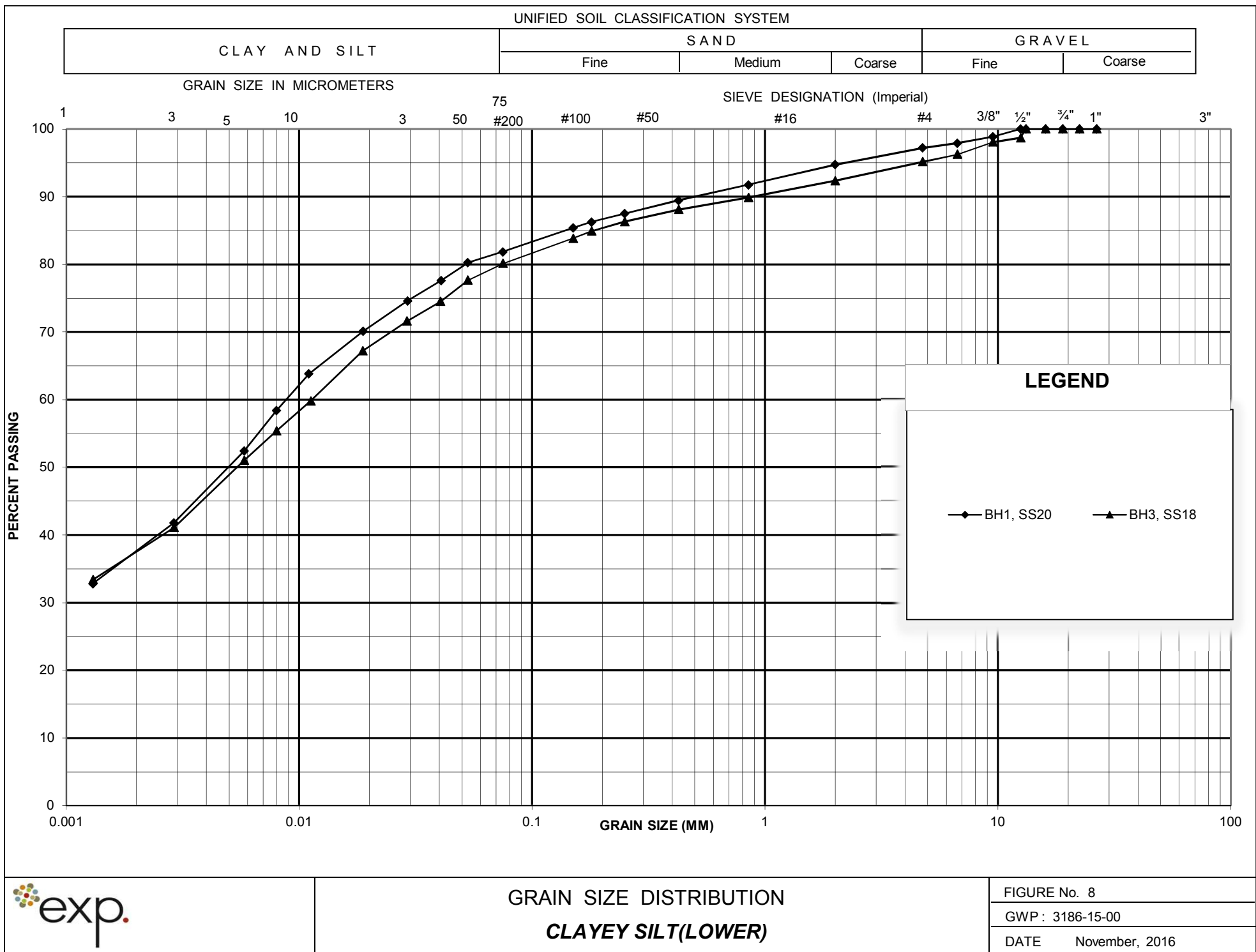




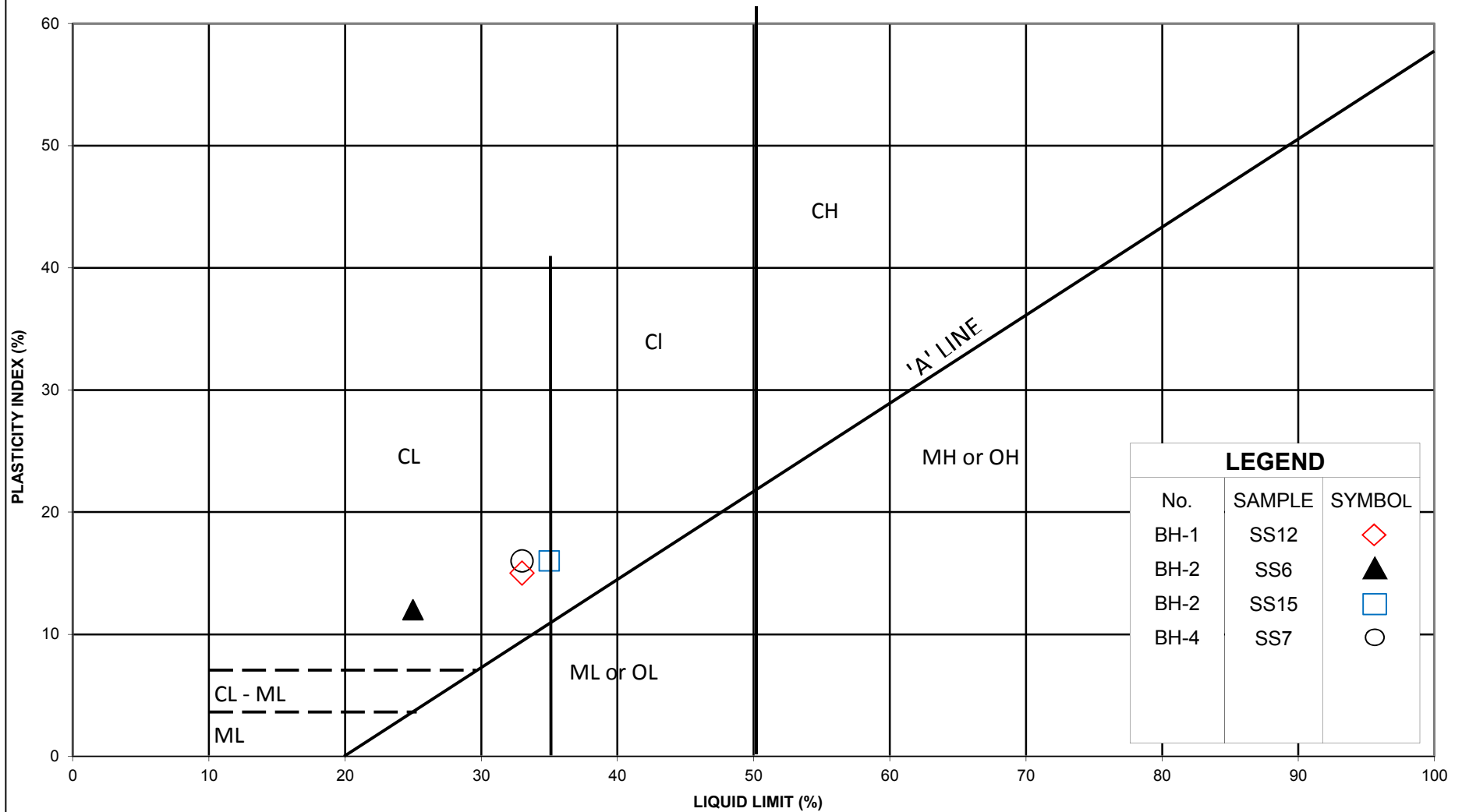




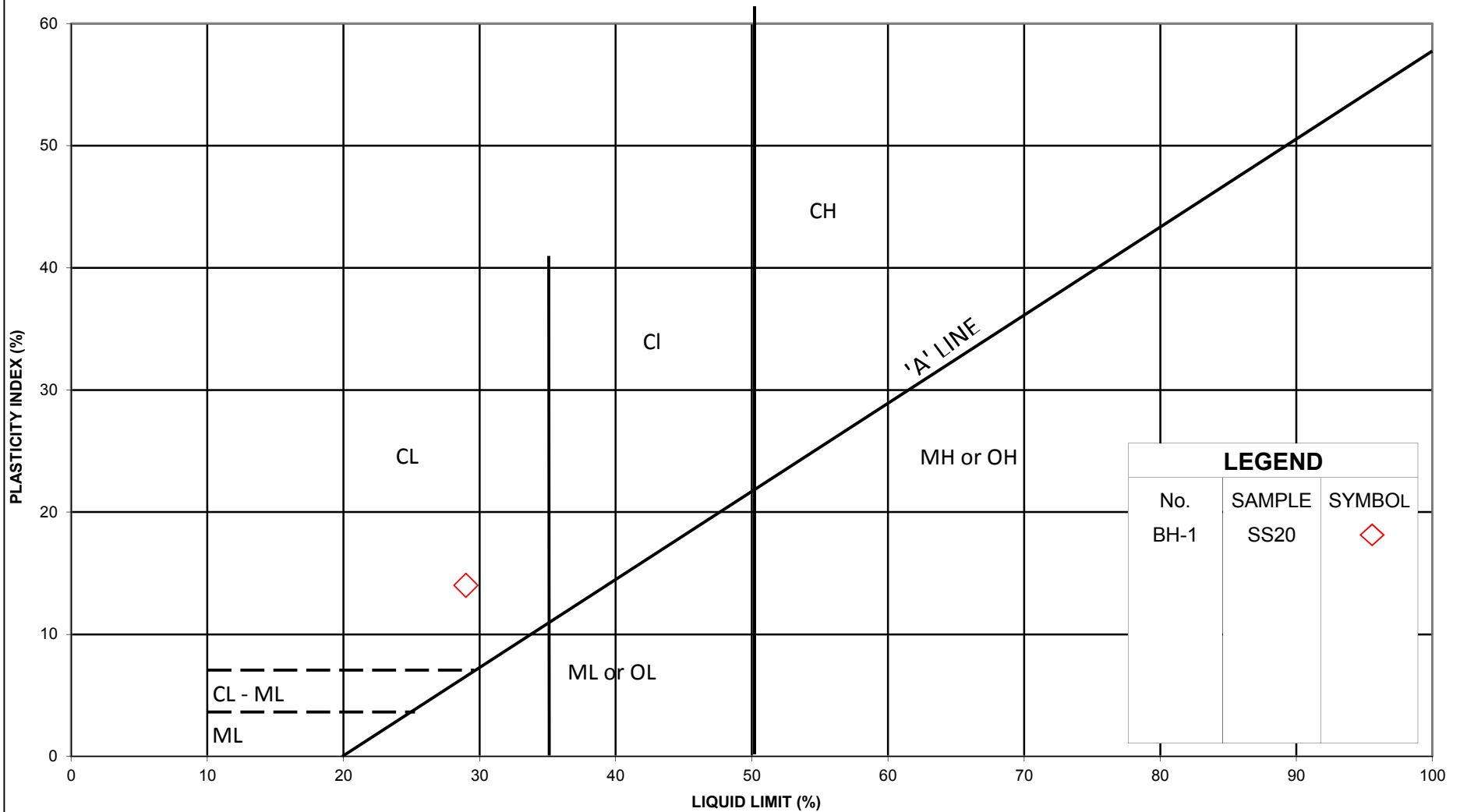




**Construction of Concrete Fish ladder at outlet of Heyrock Creek**  
Hwy 21, Bluewater Municipality, ON



**Construction of Concrete Fish ladder at outlet of Heyrock Creek**  
Hwy 21, Bluewater Municipality, ON



## **Appendix F – Chemical Analyses**

Your P.O. #: GEO  
Your Project #: ADM-00235197-130  
Site Location: HWY 21  
Your C.O.C. #: na

**Attention:Nimesh Tamrakar**

exp Services Inc  
1595 Clark Blvd  
Brampton, ON  
L6T 4V1

**Report Date: 2016/11/21**

Report #: R4253783

Version: 1 - Final

## **CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B6O6837**

**Received: 2016/11/14, 09:38**

Sample Matrix: Soil  
# Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	1	N/A	2016/11/17	CAM SOP-00463	EPA 325.2 m
Conductivity	1	N/A	2016/11/16	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl <sub>2</sub> EXTRACT	1	2016/11/17	2016/11/17	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	1	2016/11/14	2016/11/17	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	1	N/A	2016/11/18	CAM SOP-00464	EPA 375.4 m
Oxidation-Reduction Potential (1, 2)	1	2016/11/16	2016/11/21	SLA SOP-00101	In house

**Remarks:**

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

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

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

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods. Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Maxxam Sladeview Petrochemical

(2) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode.



**Attention:Nimesh Tamrakar**

exp Services Inc  
1595 Clark Blvd  
Brampton, ON  
L6T 4V1

Your P.O. #: GEO  
Your Project #: ADM-00235197-130  
Site Location: HWY 21  
Your C.O.C. #: na

**Report Date: 2016/11/21**  
Report #: R4253783  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B6O6837**  
**Received: 2016/11/14, 09:38**

**Encryption Key**

Please direct all questions regarding this Certificate of Analysis to your Project Manager.  
Sara Singh, B.Sc, Senior Project Manager  
Email: sarasingh@maxxam.ca  
Phone# (905)817-5730

=====

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Maxxam Job #: B6O6837  
Report Date: 2016/11/21

exp Services Inc  
Client Project #: ADM-00235197-130  
Site Location: HWY 21  
Your P.O. #: GEO  
Sampler Initials: RT

### SOIL CORROSIVITY PACKAGE (SOIL)

Maxxam ID		DLD976	DLD976		
Sampling Date		2016/11/14 08:50	2016/11/14 08:50		
COC Number		na	na		
	<b>UNITS</b>	<b>BH3 (SS5)</b>	<b>BH3 (SS5) Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Calculated Parameters</b>					
Resistivity	ohm-cm	3900			4746791
<b>Inorganics</b>					
Soluble (20:1) Chloride (Cl)	ug/g	39	41	20	4751032
Conductivity	umho/cm	257		2	4749169
Available (CaCl2) pH	pH	7.82			4750836
Soluble (20:1) Sulphate (SO4)	ug/g	110	100	20	4751033
<b>Subcontracted Analysis</b>					
Oxidation-Reduction Potential	mV	+174			4750837
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate					

Maxxam Job #: B6O6837  
Report Date: 2016/11/21

exp Services Inc  
Client Project #: ADM-00235197-130  
Site Location: HWY 21  
Your P.O. #: GEO  
Sampler Initials: RT

## TEST SUMMARY

**Maxxam ID:** DLD976  
**Sample ID:** BH3 (SS5)  
**Matrix:** Soil

**Collected:** 2016/11/14  
**Shipped:**  
**Received:** 2016/11/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4751032	N/A	2016/11/17	Alina Dobreanu
Conductivity	AT	4749169	N/A	2016/11/16	Tahir Anwar
pH CaCl2 EXTRACT	AT	4750836	2016/11/17	2016/11/17	Neil Dassanayake
Resistivity of Soil		4746791	2016/11/17	2016/11/17	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4751033	N/A	2016/11/18	Deonarine Ramnarine
Oxidation-Reduction Potential	PH	4750837	2016/11/16	2016/11/21	Grace Sison

**Maxxam ID:** DLD976 Dup  
**Sample ID:** BH3 (SS5)  
**Matrix:** Soil

**Collected:** 2016/11/14  
**Shipped:**  
**Received:** 2016/11/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4751032	N/A	2016/11/17	Alina Dobreanu
Sulphate (20:1 Extract)	KONE/EC	4751033	N/A	2016/11/18	Deonarine Ramnarine

Maxxam Job #: B6O6837  
Report Date: 2016/11/21

exp Services Inc  
Client Project #: ADM-00235197-130  
Site Location: HWY 21  
Your P.O. #: GEO  
Sampler Initials: RT

### GENERAL COMMENTS

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

Package 1	8.0°C
-----------	-------

**Results relate only to the items tested.**

## QUALITY ASSURANCE REPORT

exp Services Inc  
Client Project #: ADM-00235197-130  
Site Location: HWY 21  
Your P.O. #: GEO  
Sampler Initials: RT

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
4749169	Conductivity	2016/11/16			99	90 - 110	<2	umho/cm	0.93	10		
4750836	Available (CaCl <sub>2</sub> ) pH	2016/11/17			99	97 - 103			0.13	N/A		
4750837	Oxidation-Reduction Potential						+74	mV	0.72	20	+243	238 - 248
4751032	Soluble (20:1) Chloride (Cl)	2016/11/17	NC	70 - 130	103	70 - 130	<20	ug/g	NC	35		
4751033	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2016/11/18	NC	70 - 130	104	70 - 130	<20	ug/g	7.6	35		

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).



### 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



Grace Sison, B.Sc., C.Chem, Senior Project Manager - Petroleum Division

---

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.

Your Project #: MB6O6837  
Site Location: ADM-00235197-130  
Your C.O.C. #: 08431035

**Attention: SUB CONTRACTOR**

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

**Report Date: 2016/11/17**  
Report #: R2302222  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B6A2593**

**Received: 2016/11/16, 11:00**

Sample Matrix: Soil  
# Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Moisture	1	2016/11/16	2016/11/17	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulfide (AVS) (soil)	1	2016/11/16	2016/11/16	BBY6SOP-00006	SM 22 4500 S2- D m

**Remarks:**

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

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

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Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods. Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

\* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: MB6O6837  
Site Location: ADM-00235197-130  
Your C.O.C. #: 08431035

**Attention: SUB CONTRACTOR**

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

**Report Date: 2016/11/17**  
Report #: R2302222  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B6A2593**  
**Received: 2016/11/16, 11:00**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Amandeep Nagra, Account Specialist

Email: ANagra@maxxam.ca

Phone# (604)639-2602

=====

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Maxxam Job #: B6A2593  
Report Date: 2016/11/17

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

### RESULTS OF CHEMICAL ANALYSES OF SOIL

<b>Maxxam ID</b>		QB0779		
<b>Sampling Date</b>		2016/11/14 08:50		
<b>COC Number</b>		08431035		
	<b>UNITS</b>	<b>BH3 (SS5) (DLD976)</b>	<b>RDL</b>	<b>QC Batch</b>
<b>MISCELLANEOUS</b>				
Sulphide	ug/g	0.96 (1)	0.75	8472399
RDL = Reportable Detection Limit (1) RDL raised due to sample matrix interference.				

Maxxam Job #: B6A2593  
Report Date: 2016/11/17

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

### PHYSICAL TESTING (SOIL)

<b>Maxxam ID</b>		QB0779		
<b>Sampling Date</b>		2016/11/14 08:50		
<b>COC Number</b>		08431035		
	<b>UNITS</b>	<b>BH3 (SS5) (DLD976)</b>	<b>RDL</b>	<b>QC Batch</b>
<b>Physical Properties</b>				
Moisture	%	12	0.30	8472421
RDL = Reportable Detection Limit				



Maxxam Job #: B6A2593  
Report Date: 2016/11/17

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

## TEST SUMMARY

**Maxxam ID:** QB0779  
**Sample ID:** BH3 (SS5) (DLD976)  
**Matrix:** Soil

**Collected:** 2016/11/14  
**Shipped:**  
**Received:** 2016/11/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8472421	2016/11/16	2016/11/17	Lolita Obusan
Sulfide (AVS) (soil)	SPEC/COL	8472399	2016/11/16	2016/11/16	Jamie Sun

Maxxam Job #: B6A2593  
Report Date: 2016/11/17

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

### GENERAL COMMENTS

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

Package 1	1.3°C
-----------	-------

**Results relate only to the items tested.**

Maxxam Job #: B6A2593  
Report Date: 2016/11/17

## QUALITY ASSURANCE REPORT

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8472399	Sulphide	2016/11/16	56 (1)	75 - 125	94	75 - 125	<0.50	ug/g	NC	30
8472421	Moisture	2016/11/17					<0.30	%	0.60	20

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

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

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

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

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

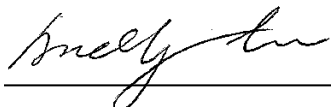
(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B6A2593  
Report Date: 2016/11/17

MAXXAM ANALYTICS  
Client Project #: MB6O6837  
Site Location: ADM-00235197-130

### VALIDATION SIGNATURE PAGE

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



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

---

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**CHAIN OF CUSTODY RECORD**

Page \_\_\_\_ of \_\_\_\_

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required	
Company Name: <u>EXP Services Inc.</u>		Company Name:		Quotation #:		<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses	
Contact Name: <u>Nimesh Tamrakar</u>		Contact Name:		P.O. #/ AFE#: <u>GEO</u>		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS	
Address: <u>56 BURN ST. EAST</u>		Address:		Project #: <u>ADM-00235197-130</u>		Rush TAT (Surcharges will be applied)	
<u>Suite 301, Brampton</u>				Site Location: <u>HWY 21</u>		<input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days	
Phone: <u>905-746-3206</u> Fax:		Phone: Fax:		Site #:		Date Required:	
Email: <u>nimesh.tamrakar@exp.com</u>		Email:		Sampled By: <u>Nimesh Tamrakar</u>		Rush Confirmation #:	
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY							
Regulation 153		Other Regulations		Analysis Requested		LABORATORY USE ONLY	
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table ____ FOR RSC (PLEASE CIRCLE) Y / N		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO <input type="checkbox"/> Region <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED)		REFER TO BACK OF COC REG 153 METALS & INORGANICS REG 153 METALS REG 153 METALS (Hg, Cr VI, UCNMS Metals, HYS, B) <u>corrosivity, pH, DO, &amp; sulphides</u>		CUSTODY SEAL Y / N Present Intact <u>N N 81818</u> COOLING MEDIA PRESENT: <u>0</u> / N COMMENTS	
Include Criteria on Certificate of Analysis: Y / N							
SAMPLES MUST BE KEPT COOL (< 10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM							
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / Cr VI	HOLD-DO NOT ANALYZE
1 <u>BH 3 (SSS)</u>		<u>2016/11/14</u>	<u>8:50</u>	<u>Soil</u>			
2							
3							
4							
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)
<u>Nimesh Tamrakar</u>		<u>2016/11/14</u>	<u>8:50</u>	<u>Sara Singh</u>		<u>2016/11/14</u>	<u>09:38</u>

14-Nov-16 09:38

Sara Singh



B606837

RK6 ENV-626