



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
ELLIS CREEK BRIDGES – EBL & WBL  
HIGHWAY 7-NEW, KITCHENER TO GUELPH  
G.W.P. 408-88-00**

**GEOCREs No. 40P9-59**

**Report**

to

**WSP**

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### APPENDICES

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**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual findings obtained from a detailed foundation investigation conducted for the proposed Ellis Creek bridges along the proposed Highway 7-New mainline alignment in the Regional Municipality of Waterloo, Ontario. Two bridges are proposed to carry the westbound and eastbound lanes (WBL and EBL) of Highway 7-New over Ellis Creek.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profiles, cross sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

Thurber was retained by WSP to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 3014-E-0013.

**2. SITE DESCRIPTION**

At the site of the proposed Ellis Creek bridges, the Highway 7-New alignment runs parallel to the existing Hwy 7 and is approximately 750 m to the north. The site lies at the eastern edge of the City of Waterloo, and it is approximately 200 m east of Township Road 3 (Guelph Road 3).

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within an area referred to as the Guelph Drumlin Field, an area of drumlinized till plain, also mapped as containing eskers. The till is described as stony with boulders at the surface. Chapman and Putnam give a typical gradation of the till as being 50% sand, 35% silt and 15% clay. Swampy valleys are reported to occur between the drumlins and associated gravel terraces.



Ellis creek is part of the spillway landform and the drift thickness is shallow with the overburden soil underlain by bedrock of the Guelph Formation consisting of shale and dolostone. The locations of the proposed bridges around Ellis Creek is a flood plain that is prone to flooding.

### 3. INVESTIGATION PROCEDURES

The geotechnical investigation was conducted at the site from December 4, 2017 to January 19, 2018 and July 9, 2018 to July 10, 2019. Borehole drilling for EC16-07 and EC16-08 was delayed until July of 2018 due to flooding of Ellis Creek. Thirteen boreholes, numbered EC16-01 to EC16-13, were drilled at the proposed bridge foundation units. The boreholes drilled near the east and west approaches of the WBL and EBL ranged from 9.5 m to 9.8 m depth (Elevations 314.5 to 313.4). Boreholes drilled at the foundation units (abutments and piers) were terminated at depths ranging from 12.2 m to 15.0 m (Elevations 311.1 to 308.4). Five boreholes (EC16-04 to EC16-08) were further advanced into dolostone bedrock by coring to depths of 15.5 m to 17.8 m (Elevations 307.8 to 305.5), with a minimum 3.0 m of rock core recovered in each borehole. The Record of Borehole sheets are included in Appendix A.

Details of the location of the boreholes are presented in Table 3.1.

**Table 3.1 – Borehole locations**

Foundation Element		Borehole
Hwy 7-New EBL	West approach	EC16-02
	West abutment	EC16-04
		EC16-05
	Pier	EC16-07
		EC16-08
	East abutment	EC16-10
		EC16-11
East approach	EC16-13	
Hwy 7-New WBL	West approach	EC16-01
	West abutment	EC16-03
		EC16-04
	Pier	EC16-06



Foundation Element		Borehole
	East abutment	EC16-07
		EC16-09
	EC16-10	
East approach	EC16-12	

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix C. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendix A.

The ground surface elevations and coordinates of the as-drilled boreholes were provided by WSP.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations.

During the current investigation, track mounted D52 and truck mounted CME75 drill rigs were used in conjunction with hollow-stem augers and tricone equipment to advance the boreholes through the overburden. NQ and HQ rock coring equipment were used to recover core samples of the underlying bedrock in selected boreholes. In general, soil samples were obtained at selected intervals using a 50mm diameter split spoon sampler in conjunction with the Standard Penetration Testing (SPT). All rock cores were logged and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and Fracture Indices (FI) were determined.

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples and rock cores for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

Groundwater conditions in the open boreholes were observed throughout the drilling operations.

Seven standpipe piezometers were installed in selected boreholes (EC16-01, EC16-03, EC16-04, EC16-07, EC16-10, EC16-11 and EC16-13). Each piezometer consisted of a 19 mm or 25 mm Schedule 40 PVC pipe with a 1.5 m or 3.0 m long slotted screen enclosed in a column of filter sand to permit groundwater level monitoring. Piezometer installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. Upon



completion of the drilling operations, the boreholes without piezometers were abandoned in general accordance with Ontario Regulation 903. The details of standpipe piezometer installation and borehole completion are summarized in Table 3.2. Upon completion of the investigation in the summer of 2020, the piezometer installations will be decommissioned as per O.Reg. 903.

**Table 3.2 – Borehole Completion Details**

Foundation Element		Borehole	Borehole Ground Surface Elevation (m)	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
Hwy 7- New EBL	West approach	EC16-02	323.9	9.8/314.2	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	West abutment	EC16-04	323.3	17.8/305.5	13.8/309.6	Piezometer with 3.0 m slotted screen installed. Sand filter from 17.8 m to 9.7 m, bentonite holeplug from 9.7 m to surface.
		EC16-05	323.1	16.5/306.6	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
	Pier	EC16-07	323.3	15.5/307.8	12.2/311.1	Piezometer with 3.0 m slotted screen installed. Bentonite from 15.5 m to 12.5 m, sand filter from 12.5 m to 8.5 m, bentonite holeplug from 8.5 m to 6.1 m, grout from 6.1 m to 0.3 m, then holeplug to surface.
		EC16-08	323.1	15.7/307.4	None Installed	Borehole backfilled with grout to 0.2 m, then holeplug to surface.
	East abutment	EC16-10	323.0	12.3/310.8	12.3/310.8	Piezometer with 1.5 m slotted screen installed. Sand filter from 12.3 m to 9.2 m, bentonite holeplug from 9.2 m to surface.
		EC16-11	323.3	12.2/311.1	12.2/311.1	Piezometer with 1.5 m slotted screen installed. Sand filter from 12.2 m to 10.1 m, bentonite holeplug from 10.1 m to surface.
	East approach	EC16-13	323.2	9.5/313.7	9.1/314.1	Piezometer with 1.5 m slotted screen installed. Sand filter from 9.5 m to 7.0 m, bentonite holeplug from 7.0 m to surface.
Hwy 7- NewW BL	West approach	EC16-01	324.2	9.8/314.5	9.1/315.1	Piezometer with 3.0 m slotted screen installed. Sand filter from 9.8 m to 5.5 m, bentonite holeplug from 5.5 m to surface.



Foundation Element	Borehole	Borehole Ground Surface Elevation (m)	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
West abutment	EC16-03	323.4	15.0/308.4	12.2/311.2	Piezometer with 3.0 m slotted screen installed. Sand filter from 15.0 m to 8.5 m, bentonite holeplug from 8.5 m to surface.
Pier	EC16-06	323.3	17.8/305.6	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
East abutment	EC16-09	323.2	12.2/310.9	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.
East approach	EC16-12	323.2	9.8/313.4	None Installed	Borehole backfilled with bentonite and auger cuttings to surface.

#### 4. LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

Core samples of the bedrock were carefully protected to prevent drying during transport to the laboratory. Point load tests were carried out on selected samples of intact dolostone upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the selected rock core samples are included in Appendix B and on the Record of Borehole sheets in Appendix A.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil was collected. The sample was submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

#### 5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and bedrock stratigraphy along the proposed alignment are presented in this Appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix C. An overall description of the



stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, topsoil and organics were encountered surficially at this site. Below the topsoil/organics, layers of native silty sand, sand and gravel, silty clay, silty clay till and silty sand to sand and silt till were encountered. Grey dolostone bedrock was encountered below the native soils. Descriptions of the individual strata are presented below.

### **5.1 Topsoil**

A layer of topsoil was encountered surficially in Borehole EC16-01 and EC16-13. The thickness of topsoil was 400 mm in EC 16-01 and 200 mm in EC 16-13.

Moisture content measured in the topsoil in Borehole EC16-01 was 23 percent.

The topsoil thickness may vary between and beyond the borehole locations, and the data is not intended for the purpose of estimating quantities.

### **5.2 Topsoil and Organics**

A layer of dark brown to black topsoil and organics containing occasional rootlets and wood pieces was encountered surficially in all the boreholes, except in Boreholes EC16-01 and EC 16-13. The organic layer within the floodplain ranged in thickness from 0.5 m to 1.8 m.

The depth to the base of the organic layer ranged from 0.5 m to 1.8 m (Elevations 323.4 to 321.5).

The organic layer is classified as very loose to loose, based on SPT 'N' values ranging from 0 to 5 blows for 0.3 m of penetration. The natural moisture content ranged from 21 percent to 745 percent.

### **5.3 Upper Sand and Gravel and Gravelly Sand**

Upper layers of native brown to grey sand and gravel and gravelly sand containing trace to some silt, trace clay and occasional cobbles were contacted below the topsoil, silty clay or sand and silt at depths ranging from 0.4 m to 4.9 m (Elevations 323.8 to 318.4) in Boreholes EC16-01, EC16-03, EC16-07 and EC16-09 to EC16-13. The thickness of the layer ranged from 1.1 m to 3.8 m. The depth to the base of the sand and gravel and gravelly sand layers ranged from 3.0 m to 7.2 m (Elevations 321.2 to 316.1).



The SPT 'N' values of the upper sand and gravel and gravelly sand ranged from 16 to 96 blows per 0.3 m of penetration indicating a compact to very dense relative density. SPT 'N' values of 4 and 8 blows per 0.3 m of penetration, indicating a loose state, were measured in Borehole EC16-07. The natural moisture contents generally lay in the range of 6 percent to 25 percent.

Grain size distribution curves for the upper sand and gravel and gravelly sand samples tested are presented on the Record of Borehole sheets in Appendix A and on Figure B1 of Appendix B. The results of a gradation test carried out on selected sample is summarized follows:

Soil Particles	Percentage (%)
Gravel	18 to 58
Sand	35 to 79
Silt and Clay	3 to 22

#### 5.4 Upper Silt to Silty Sand

Layers of native brown to grey silt, sandy silt, silty sand and sand and silt containing trace to some gravel and trace to some clay were contacted below the topsoil and organics in all the boreholes, except Boreholes EC16-01 and EC16-07, at depths ranging from 0.2 m to 1.6 m (Elevations 321.5 to 323.4). The thickness of the upper silt to silty sand layers ranged from 1.0 m to 5.6 m.

The depth to the base of these layers ranged from 2.1 m to 7.2 m (Elevations 321.7 to 315.9).

The SPT 'N' values of the sand ranged from 0 to 34 blows per 0.3 m of penetration indicating a very loose to compact state. The natural moisture contents generally lay in the range of 10 percent to 22 percent.

Results of grain size distribution testing carried out on upper silt to silty sand samples are presented on the Record of Borehole sheets in Appendix A and on Figure B3 of Appendix B. The results of the gradation tests are summarized below:

Soil Particles	Sandy Silt to Silty Sand Percentage (%)	Silt Percentage (%)
Gravel	0 to 16	0
Sand	31 to 71	11
Silt	20 to 59	71
Clay	5 to 14	18



The results of Atterberg Limits testing conducted in the clayey zones within this layer are presented on the Record of Borehole sheets in Appendix A and on Figure B9 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	19
Plastic Limit	13
Plasticity Index	6 to 7

The above results show that the clayey zones within this layer are of slight plasticity with a group symbol of CL-ML.

### 5.5 Lower Silt to Silty Sand

A lower layer of native brown to grey silt, sandy silt, sand and silt and silty sand containing trace to some gravel, trace to some clay and occasional cobbles was encountered either below the silty clay till, upper sand and sand and gravel to gravelly sand or upper silt to silty sand deposits in Boreholes EC 16-01 to EC 16-07 and EC 16-13 at depths ranging from 2.2 m to 8.7 m (Elevations 321.1 to 314.6). The thickness of this layer, where fully penetrated, ranged from 6.7 m to 12.1 m. Boreholes EC 16-01 to EC 16-03 and EC16-13 were terminated within this layer at depths ranging from 9.5 m to 15.0 m (Elevations 314.5 to 308.4).

The depth of the base of this layer, where fully penetrated, ranged from 12.3 m to 14.7 m (Elev. 311.0 to 308.6).

The SPT 'N' values of this layer typically ranged from 12 to greater than 100 blows for 0.3 m of penetration indicating a compact to very dense relative density. One value of 8 blows per 0.3 m of penetration was recorded in Borehole EC 16-04 at the top of this layer, indicating a loose relative density. The natural moisture content ranged from 8 percent to 22 percent.

Results of grain size distribution testing carried out on samples collected from this layer are presented on the Record of Borehole sheets in Appendix A and on Figures B4 and B5 in Appendix B. The results are summarized in the table below:

Soil Particles	Silty Sand to Sand and Silt Percentage (%)	Sandy Silt to Silt Percentage (%)
Gravel	0 to 15	0 to 3
Sand	42 to 64	6 to 26
Silt	20 to 48	54 to 88
Clay	2 to 6	6 to 17



## 5.6 Silty Clay

Layers of silty clay containing trace sand and trace to gravel were encountered in Boreholes EC 16-03, EC 16-04, EC 16-08 to EC 16-10, EC 16-12 and EC 16-13 below the upper sand and gravel to gravelly sand, upper silt to silty sand layer, within the lower silt to silty sand layer and within the lower sand and gravel layer. The upper boundary of the silty clay was contacted at depths ranging from 2.1 m to 12.2 m (Elevations 321.3 to 311.1). The thickness of the silty clay layer ranged from 0.8 m to 3.1 m. The depth to the base of the silty clay layers varied from 2.9 m to 13.4 m (Elevations 320.5 to 309.9 m).

SPT 'N' values measured in the silty clay varied from 4 per 0.3 m of penetration to 100 blows for 275 mm of penetration, indicating a firm to hard consistency. The natural moisture content ranged from 15 percent to 22 percent.

Results of grain size distribution testing carried out on the silty clay are presented on the Record of Borehole sheets in Appendix A, and on Figure B2 of Appendix B. The results are summarized in the table below:

Soil Particle	Silty clay Percentage (%)
Gravel	0
Sand	0 to 6
Silt	61 to 79
Clay	21 to 37

The results of Atterberg Limits testing are presented on the Record of Borehole sheets in Appendix A and on Figure B10 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	20 to 22
Plastic Limit	13
Plasticity Index	7 to 9

The above results show that the silty clay is of low plasticity with a group symbol of CL.

## 5.7 Silty Clay Till

Layers of silty clay till containing some sand to with sand and trace to some gravel were encountered in Boreholes EC 16-01 to EC 16-03, EC 16-06, EC 16-11, and EC 16-13 below the



the upper sand and gravel to gravelly sand, upper silt to silty sand layer. The upper boundary of the silty clay till was contacted at depths ranging from 2.2 m to 7.2 m (Elevations 321.7 to 316.1). The thickness of the silty clay layer ranged from 1.5 m to 3.7 m. The depth to the base of the silty clay layers varied from 5.8 m to 8.7 m (Elevations 318.5 to 314.6 m).

SPT 'N' values measured in the silty clay till varied from 13 to 89 per 0.3 m of penetration to 100 blows for 250 mm of penetration, indicating a stiff to hard consistency. The natural moisture content ranged from 9 percent to 21 percent.

Results of grain size distribution testing carried out on the silty clay are presented on the Record of Borehole sheets in Appendix A, and on Figures B6 and B11 of Appendix B. The results are summarized in the table below:

Soil Particle	Silty clay Percentage (%)
Gravel	2 to 14
Sand	27 to 40
Silt	29 to 50
Clay	17 to 31

The results of Atterberg Limits testing are presented on the Record of Borehole sheets in Appendix A and on Figure B10 of Appendix B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	20 to 25
Plastic Limit	10 to 13
Plasticity Index	10 to 12

The above results show that the silty clay is of low plasticity with a group symbol of CL.

## 5.8 Sand and Silt to Silty Sand Till

Native grey sand and silt to silty sand till containing some gravel, some clay and occasional cobbles, was contacted below the silty clay in Borehole EC 16-10 and below the upper sand and gravel and gravelly sand in Borehole EC 16-12. This cohesionless till was contacted at a depth of 5.6 m (Elevations 317.6 and 317.4). The thickness of the cohesionless till ranged from 1.6 m to 3.1 m.



The depth to the base of the cohesionless till ranged from 7.2 m to 8.7 m (Elevations 316.0 and 314.3).

SPT 'N' values measured in the till varied from 39 to 63 blows per 0.3 m of penetration, indicating a dense to very dense state. The natural moisture content ranged from 8 percent to 20 percent.

Results of grain size distribution testing carried out on cohesionless till samples are presented on the Record of Borehole sheets in Appendix A, and on Figure B7 of Appendix B. The results of laboratory tests carried out on selected samples are as follows:

Soil Particle	Percentage (%)
Gravel	14 to 16
Sand	38 to 49
Silt	23 to 37
Clay	11 to 12

### 5.9 Lower Sand and Gravel

A lower layer of sand and gravel containing trace silt and trace to some clay was encountered in Boreholes EC16-08 to EC16-12 at depths ranging from 7.2 m to 8.7 m (Elevation 315.9 to 314.3).

Boreholes EC16-09 to EC16-12 were terminated in the lower sand and gravel layer at depths ranging from 9.8 m to 12.3 m (Elevation 313.4 to 310.8). Borehole EC 16-08 fully penetrated the lower sand and gravel layer and the layer was 5.3 m thick.

The SPT 'N' values of the lower sand and gravel ranged from 64 to over 100 blows per 0.3 m of penetration indicating a very dense relative density. The natural moisture contents generally lay in the range of 7 percent to 10 percent.

Results of grain size distribution testing carried out on lower sand and gravel samples are presented on the Record of Borehole sheets in Appendix A and on Figure B8 of Appendix B. The results of the gradation tests are summarized below:

Soil Particles	Percentage (%)
Gravel	34 to 59
Sand	33 to 46
Silt and Clay	8 to 23



## 5.10 Bedrock

The overburden soils described above are underlain by grey slightly weathered to fresh dolostone bedrock. Occasional mechanical breaks were noted throughout the bedrock cores. A rubble zone was encountered within the bedrock at 15.1 m depth (Elevation 308.2) in Borehole EC16-07.

Depths and elevations of the top of bedrock are shown in Table 5.1.

**Table 5.1 – Elevation of Top of Bedrock**

Foundation Element		Borehole	Top of Bedrock Depth (m)	Top of Bedrock Elevation (m)
Hwy 7- New EBL	West abutment	EC16-04	14.3	309.0
		EC16-05	13.1	310.0
	Pier	EC16-07	12.3	311.0
		EC16-08	12.5	310.6
Hwy 7- New WBL	West abutment	EC16-04	14.3	309.0
	Pier	EC16-06	14.7	308.6
		EC16-07	12.3	311.0

Total Core Recovery (TCR) in the bedrock ranged from 77% and 100% with Solid Core Recovery (SCR) of 58% and 100%. The Rock Quality Designation (RQD) determined from the recovered cores was 0% to 95%, indicating very poor to excellent rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 6.

Average unconfined compressive strengths (UCS) of the rock ranged from 110 MPa to 250 MPa, indicating that the rock is strong to very strong. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results are presented in Appendix B.



## 5.11 Groundwater Conditions

Groundwater conditions were observed during drilling operations, and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes EC16-01, EC16-03, EC16-04, EC16-07, EC16-10, EC16-11, EC16-13 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized below. Decommissioning of piezometers is planned to take place in the summer of 2020.

**Table 5.1 – Water Level Measurements for EBL**

Foundation Unit	Borehole	Date	Water Level (m)		Remark
			Depth	Elevation	
West Approach	EC16-02	January 9, 2018	3.7	320.2	Open borehole
West Abutment	EC16-04	August 31, 2018	-0.5	323.8 <sup>(1)</sup>	Piezometer
	EC16-05	January 18, 2018	Water level not taken due to the use of mud while drilling		-
Pier	EC16-07	August 31, 2018	-0.1	323.4 <sup>(1)</sup>	Piezometer
	EC16-08	July 10, 2018	Water level not taken due to the use of mud while drilling		-
East Abutment	EC16-10	December 7, 2017	1.5	321.5	Open borehole
		March 23, 2018	-0.2	323.2 <sup>(1)</sup>	Piezometer
		May 1, 2018	0.3	322.7	Piezometer
		August 31, 2108	0.2	322.8	Piezometer
East Abutment	EC16-11	December 5, 2017	1.5	321.8	Open borehole
		March 23, 2018	0.1	323.2	Piezometer
		May 1, 2018	0.0	323.3	Piezometer
		August 31, 2108	0.0	323.3	Piezometer
East Approach	EC16-13	December 4, 2017	1.5	321.7	Open borehole
		March 23, 2018	0.0	323.2	Piezometer
		May 1, 2018	-0.2	323.4 <sup>(1)</sup>	Piezometer
		August 31, 2018	0.3	322.9	Piezometer

<sup>(1)</sup> Artesian conditions observed, as groundwater level was measured above ground surface.



**Table 5.2 – Water Level Measurements for WBL**

Foundation Unit	Borehole	Date	Water Level (m)		Remark
			Depth	Elevation	
West Approach	EC16-01	January 10, 2018	4.3	319.9	Open borehole
		March 23, 2018	0.4	323.9	Piezometer
		August 31, 2018	0.6	323.6	Piezometer
West Abutment	EC16-03	January 10, 2018	3.7	319.7	Open borehole
		March 23, 2018	-0.3	323.7 <sup>(1)</sup>	Piezometer
		August 31, 2018	-0.1	323.5 <sup>(1)</sup>	Piezometer
	EC16-04	August 31, 2018	-0.5	323.8 <sup>(1)</sup>	Piezometer
Pier	EC16-06	January 11, 2018	Water level not taken due to the use of mud while drilling		-
	EC16-07	August 31, 2018	-0.1	323.4 <sup>(1)</sup>	Piezometer
East Abutment	EC16-09	December 9, 2017	1.5	321.7	Open borehole
	EC16-10	December 7, 2017	1.5	321.5	Open borehole
		March 23, 2018	-0.2	323.2 <sup>(1)</sup>	Piezometer
		May 1, 2018	0.3	322.7	Piezometer
		August 31, 2108	0.2	322.8	Piezometer
East Approach	EC16-12	December 5, 2017	1.8	321.4	Open borehole

<sup>(2)</sup> Artesian conditions observed, as groundwater level was measured above ground surface.

The above values are short-term readings, and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The General Arrangement (GA) drawings provided by WSP indicate that the water levels at Ellis Creek are estimated to be at following elevations:

- 100-year water level – Elevation 324.12
- 2-year water level – Elevation 323.85

## 6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the native silty sand was submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



**Table 6.1 – Analytical Test Results**

Parameter	Units (Soil)	EC16-08 SS3 Depth 1.8 m
		Silty sand
Sulphide	%	0.86
Chloride	µg/g	4.4
Sulphate	µg/g	710
pH	No unit	8.15
Electrical Conductivity	µS/cm	227
Resistivity	Ohms.cm	4410
Redox Potential	mV	169

## 7. MISCELLANEOUS

Altech Drilling & Investigative Services of Elmira, Ontario supplied a D-120 track-mounted drill rig and conducted the drilling, sampling and in-situ testing operations for the present investigation, except for Boreholes EC16-07 and EC16-08 which were completed by Landshark Drilling of Brantford, Ontario, who supplied a rubber-track mounted B-57 drill rig and conducted the drilling, sampling and in-situ testing operations.

The coordinates for the boreholes were obtained with GPS equipment by Thurber, and the elevations were provided by WSP.

The drilling and sampling operations in the field for the current investigation, were supervised on a full-time basis by Thurber field technicians.

Overall supervision of the field program for the present investigation was conducted by Dr. Nancy Berg, P.Eng. Interpretation of the data and preparation of the current report was carried out by Ms. R. Palomeque Reyna, P.Eng. and Dr. Nancy Berg, P.Eng.

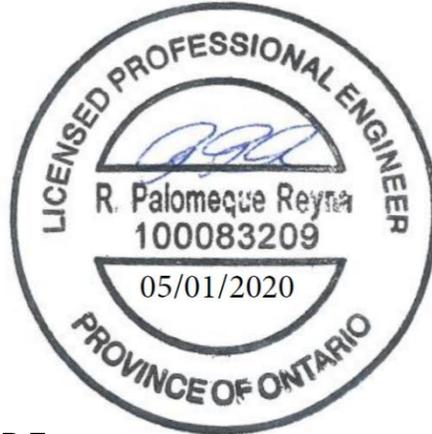
Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.



Thurber Engineering Ltd.



Nancy Berg, P.Eng.  
Geotechnical Engineer



Rocío Palomeque Reyna, P.Eng.  
Geotechnical Engineer



P.K. Chatterji, P.Eng.  
Review Principal, Designated MTO Contact



## Appendix A

### Record of Borehole Sheets

# SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

## 1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

## 2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

## 3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer

## 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

## 5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

 Water Level  
 $C_{pen}$  Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ( $W_L < 30\%$ ).
		CI	Inorganic clays of medium plasticity, silty clays. ( $30\% < W_L < 50\%$ ).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS	Pt	Peat and other highly organic soils.	
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

## EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>			
<b>Fresh (FR)</b>	No visible signs of weathering.				
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.				CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.				SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.				SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.				COAL
<b>Completely Weathered (CW)</b>	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.				Bedrock (general)
<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
<b><u>TERMS</u></b>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

### RECORD OF BOREHOLE No EC16-01

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 606.7 E 237 101.1 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.09 - 2018.01.10 LATITUDE 43.531316 LONGITUDE -80.337579 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
						20	40	60	80	100	20	40	60	GR	SA	SI	CL		
324.2	GROUND SURFACE																		
0.0	<b>TOPSOIL</b>																		
323.8	Gravelly <b>SAND</b> , some silt, trace clay Dense Brown Moist to Wet		1	SS	4														
0.4																			
					2	SS	31												
					3	SS	38									31	47	17	5
			4	SS	36														
321.2	Silty <b>CLAY</b> , sandy, trace gravel, occasional cobbles Very Stiff to Hard Grey Moist (TILL)		5	SS	29									6	27	46	21		
	Auger grinding from 4.4m to 4.6m		6	SS	60														
318.5	<b>SILT</b> , trace to some sand, trace clay Dense Grey Wet		7	SS	38														
					8	SS	47									0	6	88	6
					9	SS	48												
314.5	END OF BOREHOLE AT 9.8m.																		

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-01**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 606.7 E 237 101.1 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.09 - 2018.01.10 LATITUDE 43.531316 LONGITUDE -80.337579 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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		
	Continued From Previous Page													
	WATER LEVEL AT 4.3m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.1m slotted screen.  WATER LEVEL READINGS DATE            DEPTH(m)    ELEV.(m) 2018.03.23      0.4            323.9 2018.08.31      0.6            323.6													

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      20  
15 10 5 0 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No EC16-02

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 593.3 E 237 130.8 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.09 - 2018.01.09 LATITUDE 43.531198 LONGITUDE -80.337210 CHECKED BY RPR

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 kPa 20 40 60 80 100							
323.9	GROUND SURFACE														
0.0	<b>ORGANICS</b> Loose Dark Brown Wet		1	SS	5										
323.4															
0.5	Silty <b>SAND</b> , some gravel, some clay Compact Brown Moist		2	SS	15									11 58 20 11	
			3	SS	13										
321.7															
2.2	Silty <b>CLAY</b> , with sand, trace to some gravel, occasional cobbles Very Stiff to Hard Grey Moist to Wet (TILL)		4	SS	20									14 40 29 17	
			5	SS	37										
			6	SS	79									3 35 39 23	
318.1															
5.8	Silty <b>SAND</b> , trace gravel, trace clay Dense to Very Dense Grey Wet		7	SS	47										
			8	SS	68										
			9	SS	84										
314.2															
9.8	END OF BOREHOLE AT 9.8m.														

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



### RECORD OF BOREHOLE No EC16-03

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 622.9 E 237 107.3 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.10 - 2018.01.10 LATITUDE 43.531463 LONGITUDE -80.337503 CHECKED BY RPR

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			20	40	60					
323.4	GROUND SURFACE														
0.0	<b>ORGANICS</b> Loose Dark Brown Wet		1	SS	4								122		
322.7															
0.8	<b>SAND and SILT</b> , trace gravel Loose to Compact Brown Wet		2	SS	6										
321.3			3	SS	19										
2.1	<b>Silty CLAY</b> Stiff Brown to Grey Moist		4	SS	12									0	0 68 32
320.5															
2.9	<b>SAND and GRAVEL</b> , trace silt, occasional cobbles Dense Brown Wet		5	SS	37										
318.8	<b>Silty CLAY</b> , sandy to with sand, trace to some gravel Stiff to Very Stiff Grey Wet (TILL)  Moist		6	SS	13									11	35 34 20
317.8			7	SS	19									9	29 43 19
316.2	<b>Silty SAND to SAND and SILT</b> , trace gravel, trace clay Compact to Dense Grey Wet		8	SS	14										
314.2			9	SS	38										

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-03**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 622.9 E 237 107.3 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.10 - 2018.01.10 LATITUDE 43.531463 LONGITUDE -80.337503 CHECKED BY RPR

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	NUMBER	TYPE	"N" VALUES			20	40	60					
	Continued From Previous Page													
	Silty SAND to SAND and SILT, trace gravel, trace clay Dense to Very Dense Grey Wet	10	SS	36										
		11	SS	100										
		12	SS	100/ 0.075										
308.4		13	SS	100/ 0.250										3 45 46 6
15.0	END OF BOREHOLE AT 9.8m. WATER LEVEL AT 3.7m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.1m slotted screen.  WATER LEVEL READINGS DATE      DEPTH(m)      ELEV.(m) 2018.03.23      -0.3      323.7 Artesian Condition 2018.08.31      -0.1      323.5 Artesian Condition													

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**RECORD OF BOREHOLE No EC16-04**

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 613.2 E 237 126.4 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.19 - 2018.01.19 LATITUDE 43.531377 LONGITUDE -80.337267 CHECKED BY RPR

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					
323.3	GROUND SURFACE														
0.0	<b>ORGANICS</b> , occasional roots Very Loose to Loose Black Wet		1	SS	1									745	
322.1			2	SS	4										
1.2	Sandy <b>SILT</b> , trace clay Loose to Compact Grey Wet		3	SS	11										0 33 59 8
321.1			4	SS	8										
2.2	Silty <b>SAND</b> , trace to some gravel, trace clay Loose to Dense Brown Wet to Moist		5	SS	13										
			6	SS	15										15 63 20 2
			7	SS	12										
			8	SS	36										
	Grey		9	SS	29										7 64 26 3

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-04**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 613.2 E 237 126.4 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.19 - 2018.01.19 LATITUDE 43.531377 LONGITUDE -80.337267 CHECKED BY RPR

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 kPa								WATER CONTENT (%)		
						20	40	60	80	100	20	40	60	GR	SA	SI	CL	
311.1	Continued From Previous Page Silty <b>SAND</b> , trace clay, trace gravel Very Dense Brown to Grey Moist		10	SS	53													
309.9	Silty <b>CLAY</b> Hard Brown Wet		11	SS	50									0	0	78	22	
309.0	Silty <b>SAND</b> , some gravel, occasional cobbles Very Dense Brown Wet Coring started at 14.3m		12	SS	63													
305.5	<b>BEDROCK</b> , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) sub horizontal joint at 14.6m horizontal joint at 14.6m sub-vertical joint at 15.3m  sub-vertical joint at 15.6m  horizontal joint at 14.7m, 14.8m, 15.0m, 15.1m, 15.4m and 15.6m horizontal joint at 16.5m, 16.8m, 17.0m and 17.4m		1	RUN										FI				
305.5			2	RUN										2				
305.5			3	RUN										0				
17.8	END OF BOREHOLE AT 17.8m Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.08.31 -0.5 323.8 Artesian Condition													1				
														1				

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15 10 5 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No EC16-05

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 605.1 E 237 149.4 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.17 - 2018.01.18 LATITUDE 43.531307 LONGITUDE -80.336981 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
323.1	GROUND SURFACE														
0.0	<b>ORGANICS</b> , occasional roots Very Loose to Loose Black Wet		1	SS	1										
322.1															
1.0	Sandy <b>SILT</b> , trace to some clay, trace gravel Loose to Compact Grey Moist		2	SS	4										
	clayey zone		3	SS	14									0 31 59 10	
320.8															
2.3	Silty <b>SAND</b> , trace clay, trace gravel Compact to Very Dense Brown Wet		4	SS	16										
			5	SS	100/ 0.250										
			6	SS	52										
			7	SS	29										
			8	SS	43									0 63 32 5	
			9	SS	65										

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-05**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 605.1 E 237 149.4 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.17 - 2018.01.18 LATITUDE 43.531307 LONGITUDE -80.336981 CHECKED BY RPR

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			SHEAR STRENGTH kPa							
	Continued From Previous Page						20 40 60 80 100	20 40 60	W P	W	W L				
							○ UNCONFINED + FIELD VANE								
							● QUICK TRIAXIAL × LAB VANE								
	Silty <b>SAND</b> , trace clay, trace gravel Very Dense Brown Wet		10	SS	82										
			11	SS	100/ 0.075										
310.0	Coring started at 13.1m												FI		
13.1	<b>BEDROCK</b> , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) sub-horizontal joint at 13.3m  horizontal joint at 13.6m, 13.7m, 13.9m, 14.2m, 14.3m, 14.5m, 14.9m and 15.0m sub-vertical joint at 14.2m vertical joint at 14.4m and 15.0m  horizontal joint at 15.3m, 15.7m, 15.8m, 16.0m, 16.1m and 16.2m		1	RUN			310						1	RUN #1 TCR=91% SCR=64% RQD=0% UCS=169MPa	
			2	RUN			309						2	RUN #2 TCR=93% SCR=77% RQD=29% UCS=147MPa (Average)	
			3	RUN			308						3	RUN #3 TCR=84% SCR=84% RQD=47% UCS=178MPa	
							307						2		
306.6	END OF BOREHOLE AT 16.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.												1		
16.5															

ONTMT4S2\_MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 11/9/18

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  $\frac{20}{15} \pm \frac{5}{10}$  (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No EC16-06

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 648.0 E 237 126.2 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.11 - 2018.01.17 LATITUDE 43.531690 LONGITUDE -80.337274 CHECKED BY RPR

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			20	40	60					
323.3	GROUND SURFACE														
0.0	<b>ORGANICS</b> Very Loose Dark Brown Wet		1	SS	2										
			2	SS	2										
321.9															
1.4	Silty <b>SAND</b> , some clay, some gravel Compact Grey Wet		3	SS	12										
			4	SS	14									16 40 30 14	
320.3															
3.0	Silty <b>CLAY</b> , some sand to sandy, trace gravel Very Stiff to Hard Grey Wet (TILL)		5	SS	29										
			6	SS	32										
			7	SS	32									3 27 39 31	
316.6															
6.7	Sandy <b>SILT</b> , trace gravel, trace clay Very Dense to Dense Grey Wet		8	SS	58										
			9	SS	43										

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-06**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 648.0 E 237 126.2 ORIGINATED BY SB  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.01.11 - 2018.01.17 LATITUDE 43.531690 LONGITUDE -80.337274 CHECKED BY RPR

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 kPa						
	Continued From Previous Page													
	Sandy SILT, trace gravel, trace clay Dense Grey Wet		10	SS	39	313								0 20 74 6
			11	SS	40	311								
	Possible hydraulic disturbance		12	SS	12	309								
308.6	Coring started at 14.7m													
14.7	<b>BEDROCK</b> , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) vertical joint at 14.7m sub-vertical joint at 14.9m  sub-horizontal joint at 15.2m  horizontal joint at 15.0m, 15.1m, 15.3m, 15.4m, 15.8m and 16.1m  vertical joint at 17.1m  horizontal joint at 16.4m, 16.6m, 16.9m, 17.3m, 17.4m and 17.5m		1	RUN		308							FI 3 3 6 2 2	RUN #1 TCR=100% SCR=95% RQD=62% UCS=185MPa (Average)
			2	RUN		307							1 1 2 2	RUN #2 TCR=98% SCR=95% RQD=82% UCS=159MPa (Average)
305.6	END OF BOREHOLE AT 12.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.					306							1	
17.8														

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### RECORD OF BOREHOLE No EC16-07

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 633.1 E 237 149.8 ORIGINATED BY SJ  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.09 - 2018.07.09 LATITUDE 43.531558 LONGITUDE -80.336980 CHECKED BY RPR

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
323.3	GROUND SURFACE												
0.0	<b>ORGANICS</b> Very Loose to Loose Dark Brown Wet	1	SS	1									
		2	SS	1									
321.5													
1.8	Gravelly <b>SAND</b> , trace silt, trace clay Loose Grey Wet	3	SS	4									
		4	SS	4									
		5	SS	8									
		6	SS	60									
317.6	Sandy <b>SILT</b> , trace to some clay, trace gravel Dense Grey Moist	7	SS	39									
		8	SS	35									
		9	SS	67									

26 70 4 (SI+CL)

3 26 54 17

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE



### RECORD OF BOREHOLE No EC16-08

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 625.7 E 237 172.3 ORIGINATED BY SJ  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.531494 LONGITUDE -80.336700 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
						20	40	60	80	100	20	40	60	GR	SA	SI	CL
323.1	GROUND SURFACE																
0.0	<b>ORGANICS</b> Very Loose Dark Brown Wet		1	SS	2												
			2	SS	1												
321.5	Silty <b>SAND</b> , trace gravel, trace clay, occasional cobbles Very Loose to Dense Grey Moist		3	SS	3												
1.6			4	SS	5												
			5	SS	11												
			6	SS	34												
	Wet		7	SS	25												
	Auger grinding at 6.7m																
315.9	<b>SAND and GRAVEL</b> , occasional cobbles Very Dense Grey Wet		8	SS	100/ 0.300												
7.2																	
314.9	Silty <b>CLAY</b> , trace sand Hard Grey Wet		9	SS	75												
8.2			10	SS	100/ 0.275												

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-08**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 625.7 E 237 172.3 ORIGINATED BY SJ  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone/NQ Coring COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.531494 LONGITUDE -80.336700 CHECKED BY RPR

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			SHEAR STRENGTH kPa								W <sub>p</sub>
Continued From Previous Page																
313.0 10.1	<b>SAND and GRAVEL</b> , trace to some silt, trace to some clay Very Dense Grey Wet  Auger grinding at 11.1m		11	SS	100/ 0.200										39 46 15 (SI+CL)	
310.6			Coring started at 12.5m		12	SS	100/ 0.050									
12.5	<b>BEDROCK</b> , dolostone, slightly weathered to fresh, very strong, grey, occasional vertical joints: (Guelph Formation) vertical joint (75mm) at 12.5m horizontal joint at 12.6m sub vertical joint (50mm) at 13.1m  horizontal joint at 13.6m, 13.7m, 14.4m and 14.8m  sub vertical joint (25mm) at 14.0m vertical joint (200mm) at 14.2m, (125mm) at 14.5m  vertical joint (100mm) at 14.8m  horizontal joint at 15.3m		1	RUN										RUN #1 TCR=84% SCR=68% RQD=45% UCS=161MPa  RUN #2 TCR=100% SCR=82% RQD=45% UCS=112MPa (Average)  RUN #3 TCR=83% SCR=81% RQD=81% UCS=159MPa		
307.4					2	RUN										
15.7	END OF BOREHOLE AT 15.7m. BOREHOLE BACKFILLED WITH GROUT TO 0.2m, THEN HOLEPLUG TO SURFACE.		3	RUN												

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### RECORD OF BOREHOLE No EC16-09

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 672.5 E 237 150.3 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.07 - 2017.12.09 LATITUDE 43.531913 LONGITUDE -80.336978 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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
323.2	GROUND SURFACE													
0.0	<b>ORGANICS</b> , occasional roots Very Loose Black Wet		1	SS	0									
			2	SS	2									
321.7														
1.4	<b>SAND and SILT</b> , some clay, trace gravel Compact to Loose Grey to Brown Wet		3	SS	11									
			4	SS	8									
320.2														
3.0	<b>Silty CLAY</b> Firm Brown Wet		5	SS	4									0 0 73 27
319.1														
4.1	<b>SAND and GRAVEL</b> , trace silt, trace clay Compact Grey Wet		6	SS	19									58 35 7 (SI+CL)
317.5														
5.6	<b>Silty CLAY</b> Hard Grey Wet		7	SS	33									
			8	SS	40									0 0 79 21
314.5														
8.7	<b>SAND and GRAVEL</b> , some silt Very Dense Grey Wet		9	SS	100/ 0.200									

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  $\frac{20}{15} \pm \frac{5}{10}$  (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-09**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 672.5 E 237 150.3 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.07 - 2017.12.09 LATITUDE 43.531913 LONGITUDE -80.336978 CHECKED BY RPR

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					
	Continued From Previous Page														
	<b>SAND</b> and <b>GRAVEL</b> , some silt Very Dense Grey Wet		10	SS	100/ 0.275		313								
							312							43 45 12 (SI+CL)	
310.9							311								
12.2	END OF BOREHOLE AT 12.2m. WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.		11	SS	100/ 0.050										

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### RECORD OF BOREHOLE No EC16-10

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 662.3 E 237 171.6 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.07 - 2017.12.07 LATITUDE 43.531823 LONGITUDE -80.336713 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L			
323.0	GROUND SURFACE												
0.0	ORGANICS, occasional roots, occasional wood pieces Very Loose Black Wet		1	SS	2							133	
			2	SS	2							195	
321.6													
1.4	SAND and SILT, trace gravel, trace clay Compact to Loose Grey Wet		3	SS	16								3 55 36 6
			4	SS	7								
320.0													
3.0	Gravelly SAND, trace silt, trace clay Compact Grey Wet		5	SS	16								29 63 8 (SI+CL)
318.9													
4.1	Silty CLAY, trace sand Firm Brown Wet		6	SS	6								
317.4													
5.6	Silty SAND, some gravel, some clay Very Dense to Dense Grey Wet (TILL)		7	SS	54								16 49 23 12
			8	SS	39								
314.3													
8.7	SAND and GRAVEL, trace silt Very Dense Grey Wet		9	SS	100/ 0.250								59 33 8 (SI+CL)

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20  
15 10 5 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-10**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 662.3 E 237 171.6 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.07 - 2017.12.07 LATITUDE 43.531823 LONGITUDE -80.336713 CHECKED BY RPR

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					
Continued From Previous Page															
310.8	SAND and GRAVEL, trace silt Very Dense Grey Wet		10	SS	100/ 0.225		312								
12.3	END OF BOREHOLE AT 12.3m. WATER LEVEL AT 1.5m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.03.23 -0.2 323.2 Artesian Condition 2018.05.01 0.3 322.7 2018.08.31 0.2 322.8		11	SS	100/ 0.075		311								

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### RECORD OF BOREHOLE No EC16-11

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 653.4 E 237 193.2 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531745 LONGITUDE -80.336445 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
323.3	GROUND SURFACE														
0.0	ORGANICS, occasional roots Very Loose Black Wet		1	SS	2										
			2	SS	2										
321.8															
1.4	SAND and SILT, trace gravel, trace clay Loose to Compact Brown to Grey Wet		3	SS	8									0	59 36 5
			4	SS	12										
			5	SS	12										
319.2															
4.1	Gravelly SAND, trace silt, trace clay Compact Brown Wet		6	SS	15									18	79 3 (SI+CL)
			7	SS	83										
	Very Dense Grey														
316.1															
7.2	Silty CLAY, sandy, trace gravel Hard Grey Wet (TILL)		8	SS	89									2	27 50 21
314.6															
8.7	SAND and GRAVEL, some silt to silty Very Dense Grey Wet		9	SS	100/ 0.200										

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Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-11**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 653.4 E 237 193.2 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531745 LONGITUDE -80.336445 CHECKED BY RPR

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 $\gamma$ 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					
311.1	Continued From Previous Page <b>SAND</b> and <b>GRAVEL</b> , some silt to silty Very Dense Grey Wet		10	SS	100/ 0.150										34 43 23 (SI+CL)
12.2	END OF BOREHOLE AT 12.2m. WATER LEVEL AT 1.5m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen.  WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.03.23 0.1 323.2 (Frozen) 2018.05.01 0.0 323.3 At surface 2018.08.31 0.0 323.2		11	SS	100/ 0.050										

ONTMT4S2\_MTO-11375.GPJ\_2017TEMPLATE(MTO).GDT\_11/9/18

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

### RECORD OF BOREHOLE No EC16-12

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 669.9 E 237 170.2 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531892 LONGITUDE -80.336732 CHECKED BY RPR

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			20	40	60					
323.2	GROUND SURFACE														
0.0	<b>ORGANICS</b> , occasional roots Very Loose Black Wet		1	SS	2										
			2	SS	3										
321.7	<b>SILT</b> , trace to some sand, some clay Compact to Loose Grey to Brown Wet		3	SS	17										
1.4			4	SS	11										
	clayey zone		5	SS	9										
319.1	<b>SAND and GRAVEL</b> Dense Grey Wet		6	SS	32										
4.1															
317.6	<b>SAND and SILT</b> , some gravel, some clay Very Dense Grey Wet (TILL)		7	SS	63										
5.6															
316.0	Silty <b>CLAY</b> , trace sand Hard Grey Wet		8	SS	64										
7.2															
314.5	<b>SAND and GRAVEL</b> , some silt Very Dense Grey Wet		9	SS	64										
8.7															
313.4	END OF BOREHOLE AT 9.8m.														
9.8															

ONTMT4S2\_MTO-11375.GPJ\_2017TEMPLATE(MTO).GDT\_11/9/18

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-12**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 669.9 E 237 170.2 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.05 - 2017.12.05 LATITUDE 43.531892 LONGITUDE -80.336732 CHECKED BY RPR

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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	PLASTIC LIMIT W <sub>p</sub>		
	Continued From Previous Page WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.														

ONTMT4S2\_MTO-11375.GPJ\_2017TEMPLATE(MTO).GDT\_11/9/18

**RECORD OF BOREHOLE No EC16-13**

1 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 671.4 E 237 198.6 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.04 - 2017.12.04 LATITUDE 43.531908 LONGITUDE -80.336381 CHECKED BY RPR

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60						80	100	20	40
323.2	GROUND SURFACE																		
0.0	TOPSOIL																		
0.2	Silty SAND, trace to some gravel, occasional roots Very Loose to Compact Brown to Grey Wet		1	SS	0														
			2	SS	8														
			3	SS	20														
320.7	Silty CLAY Firm to Stiff Brown Wet		4	SS	5														
2.6			5	SS	8														0 0 63 37
318.4	SAND and GRAVEL Compact to Very Dense Brown to Grey Wet		6	SS	12														
4.9																			
316.8	Silty CLAY, sandy, trace gravel Hard Grey Wet (TILL)		7	SS	96														
6.4																			5 30 37 28
314.6	SAND and SILT, trace gravel, trace clay Very Dense Grey Wet		8	SS	100/ 0.250														
8.7																			
313.7	END OF BOREHOLE AT 9.5m. WATER LEVEL AT 1.5m UPON COMPLETION.		9	SS	100/ 0.225														
9.5																			5 42 48 5

ONTMT4S2\_MTO-11375.GPJ\_2017TEMPLATE(MTO).GDT\_11/9/18

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity  
 20  
 15  
 10  
 (%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No EC16-13**

2 OF 2

**METRIC**

GWP# 408-88-00 LOCATION Ellis Creek, MTM NAD 83 Zone 10: N 4 821 671.4 E 237 198.6 ORIGINATED BY GA  
 DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP  
 DATUM Geodetic DATE 2017.12.04 - 2017.12.04 LATITUDE 43.531908 LONGITUDE -80.336381 CHECKED BY RPR

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					
	Continued From Previous Page														
	Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen.  WATER LEVEL READINGS DATE      DEPTH(m)    ELEV.(m) 2018.03.23    0.0            323.3 Artesian Condition 2018.05.01    -0.2            323.4 Artesian Condition 2018.08.31    0.3            322.9														

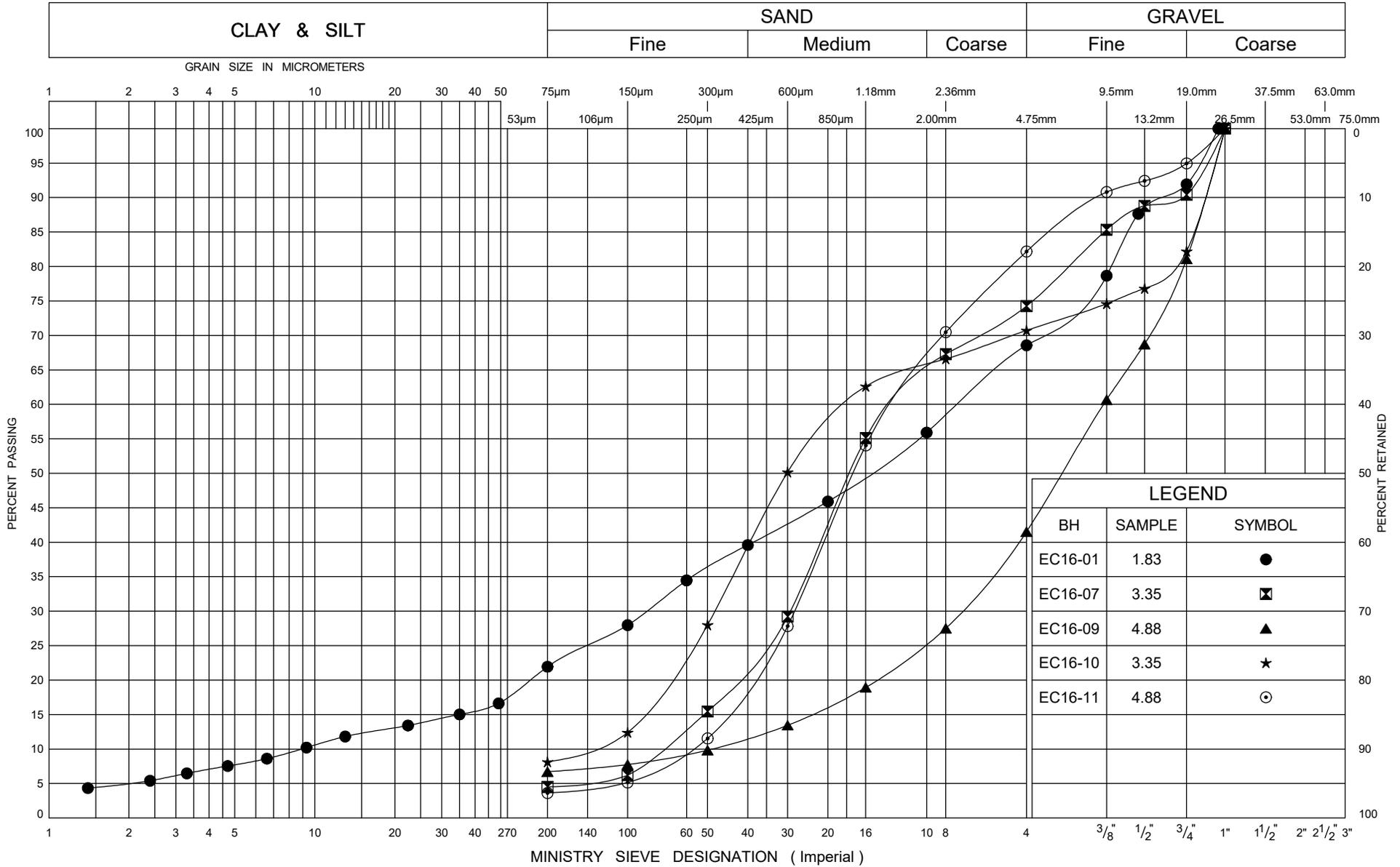
ONTMT4S2\_MTO-11375.GPJ\_2017TEMPLATE(MTO).GDT\_11/9/18



## **Appendix B**

### **Laboratory Test Results and Analytical Laboratory Test Results**

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
EC16-01	1.83	●
EC16-07	3.35	⊠
EC16-09	4.88	▲
EC16-10	3.35	★
EC16-11	4.88	⊙

ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

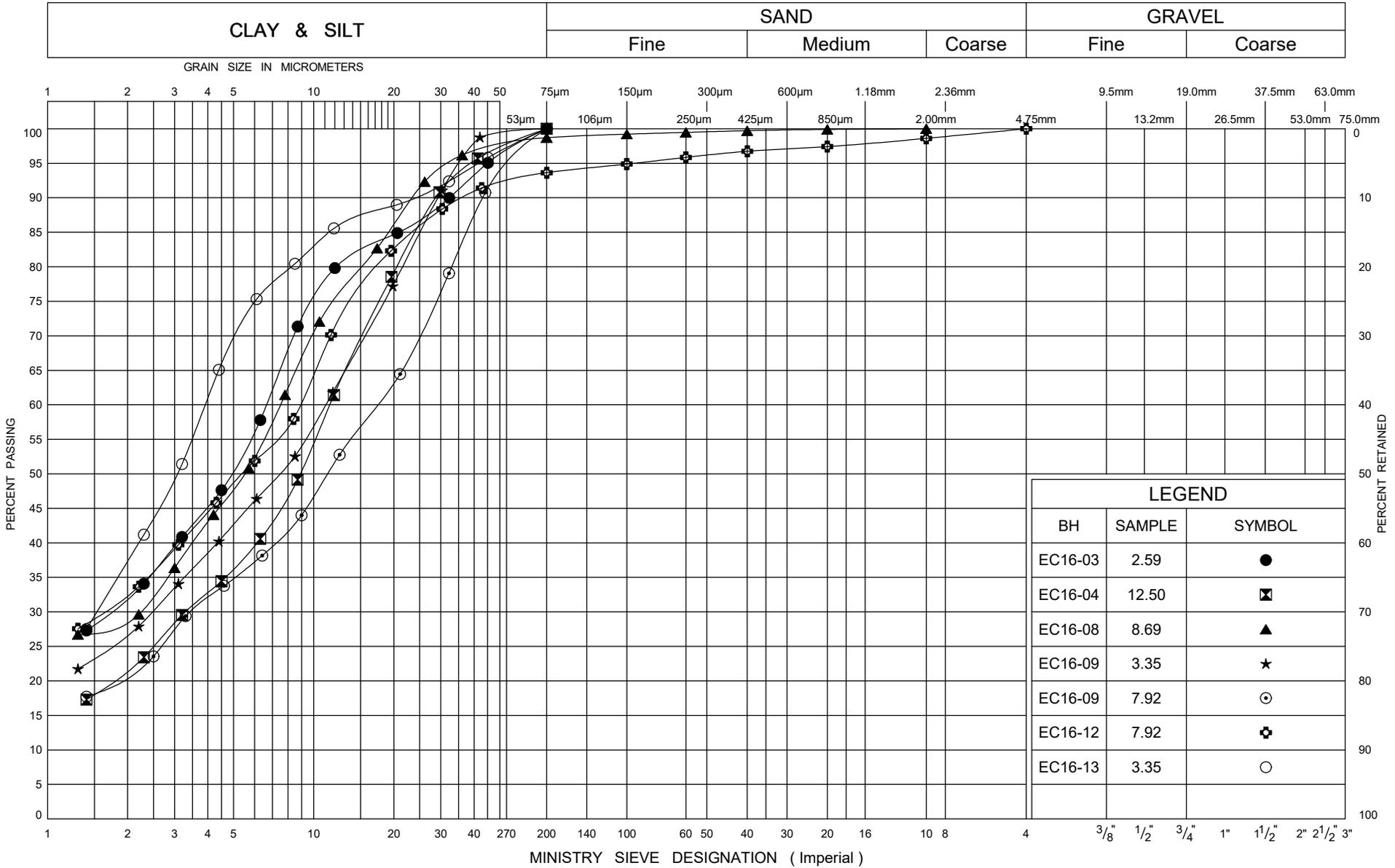
### Upper Sand and Gravel and Gravelly Sand

FIG No B1

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

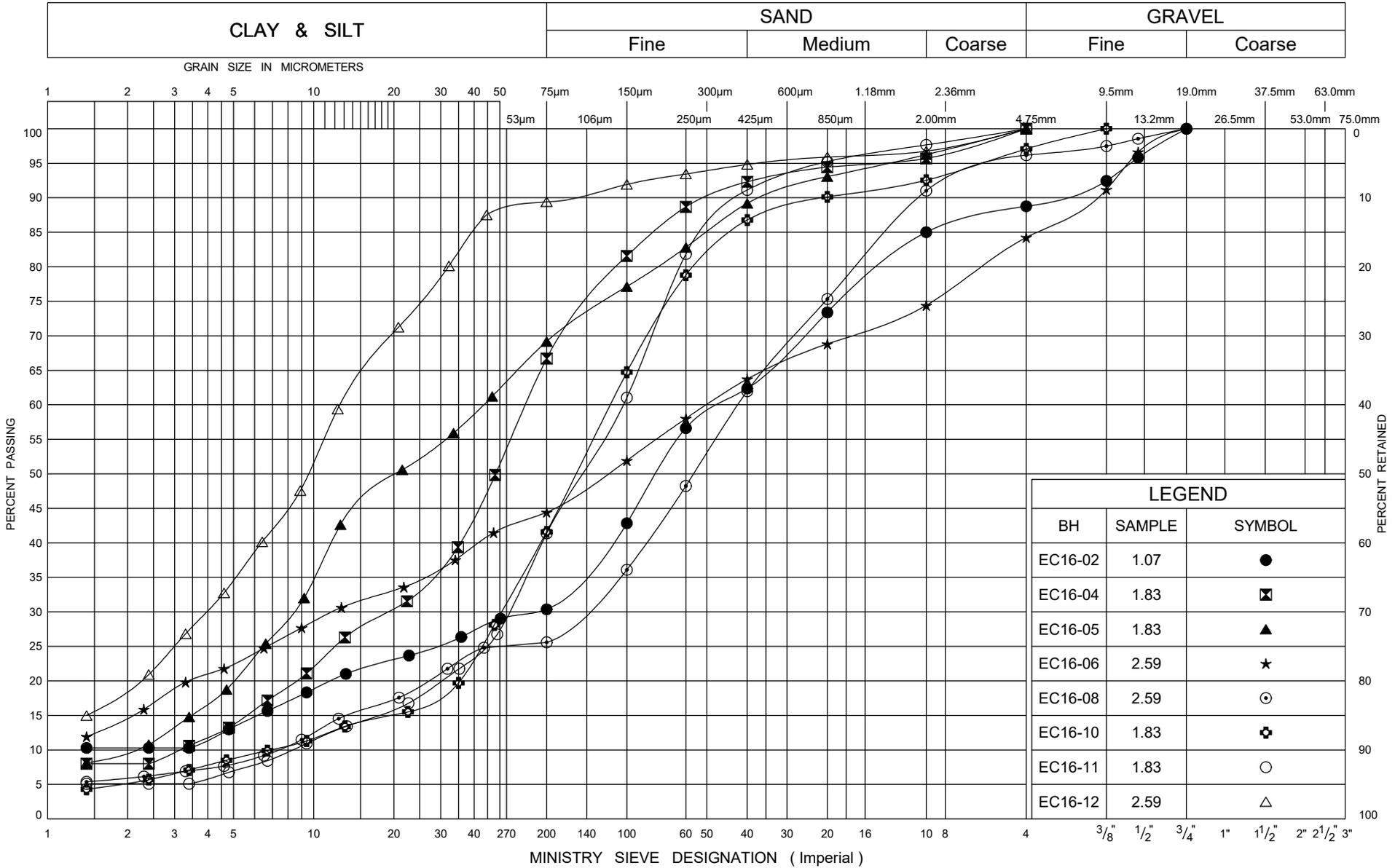
### Silty Clay

FIG No B2

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

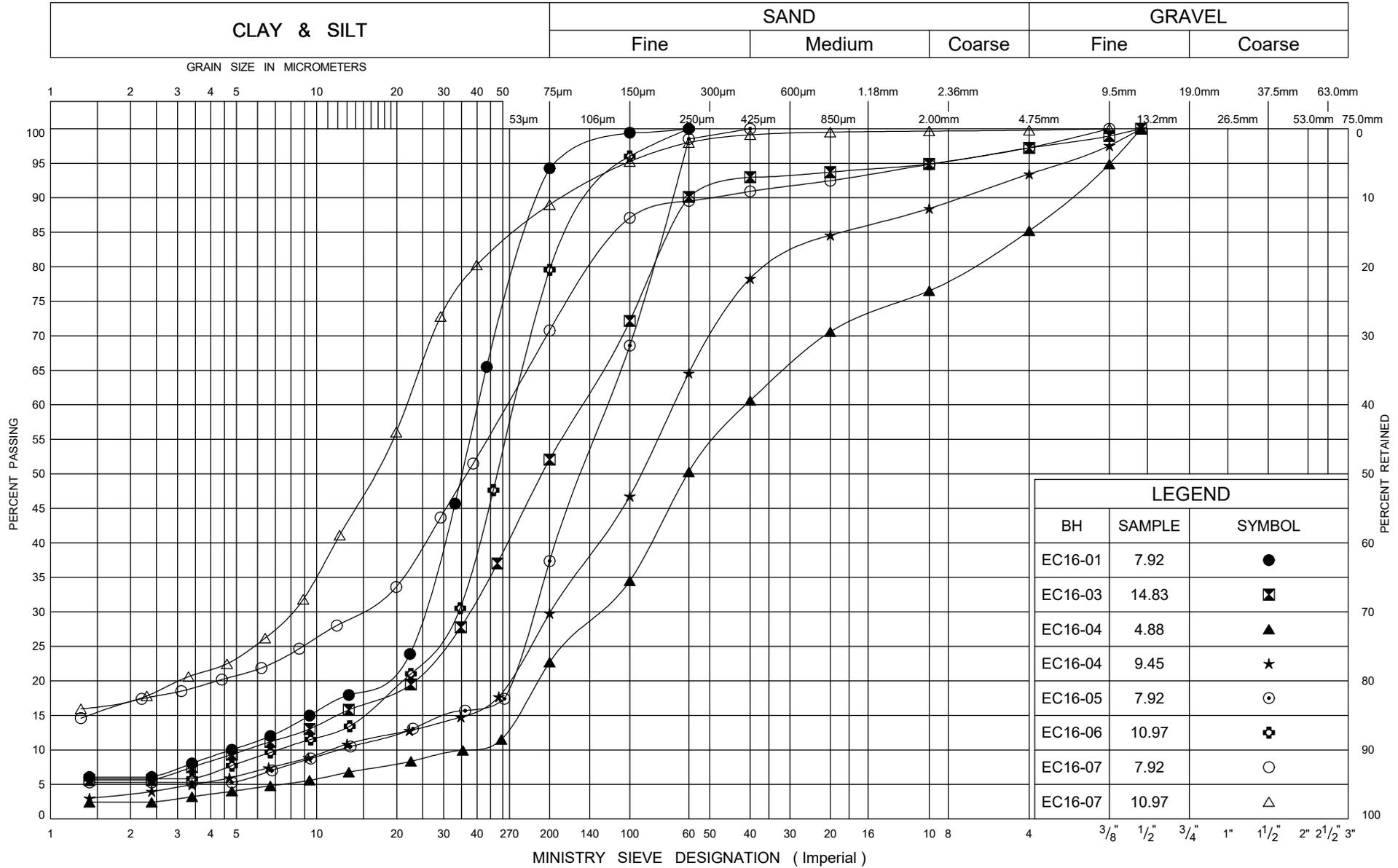
### Upper Silt to Silty Sand

FIG No B3

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

### Lower Silt to Silty Sand

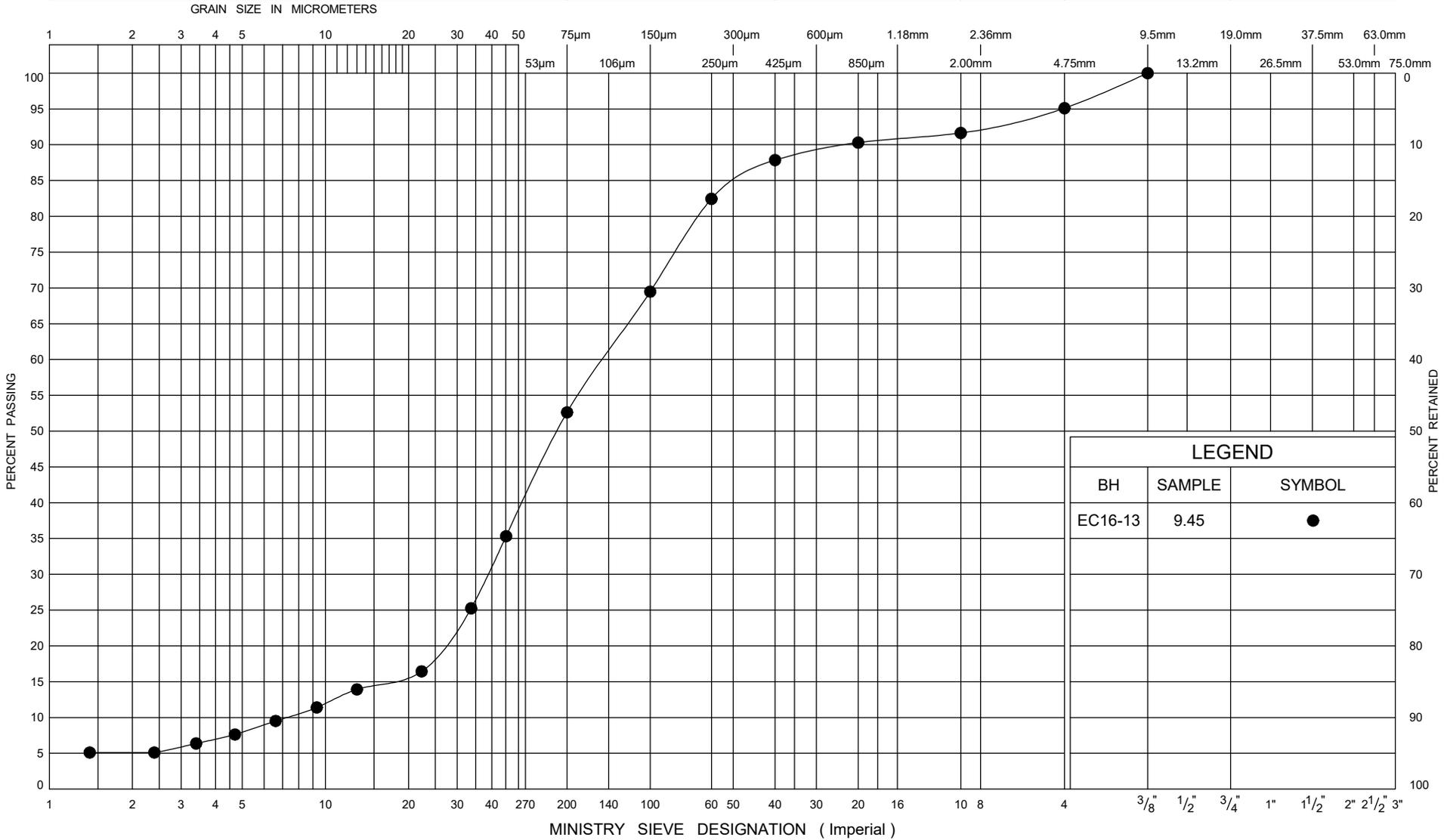
FIG No B4

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



LEGEND		
BH	SAMPLE	SYMBOL
EC16-13	9.45	●

ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

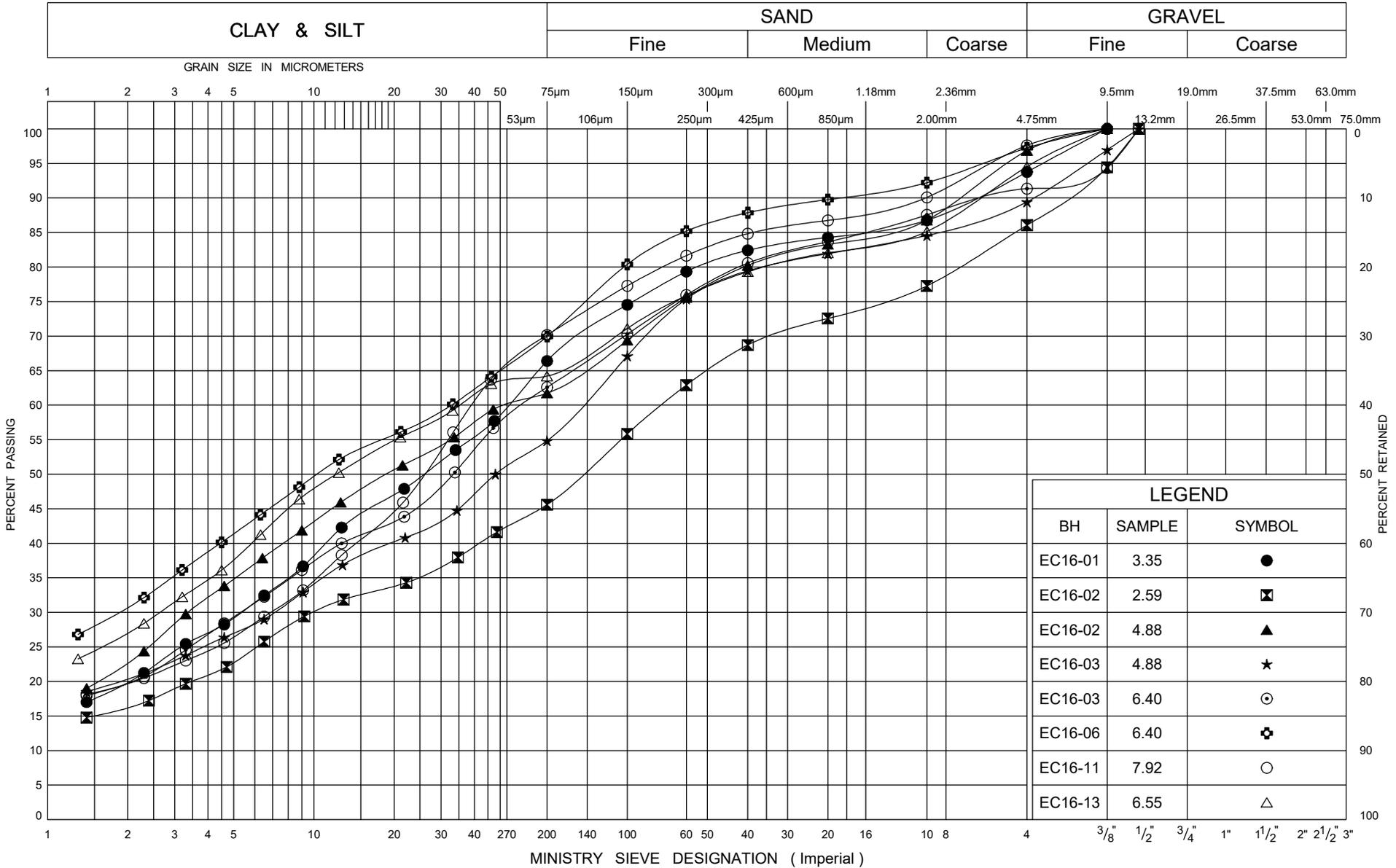
### Lower Silt to Silty Sand

FIG No B5

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM



## GRAIN SIZE DISTRIBUTION

### Silty Clay Till

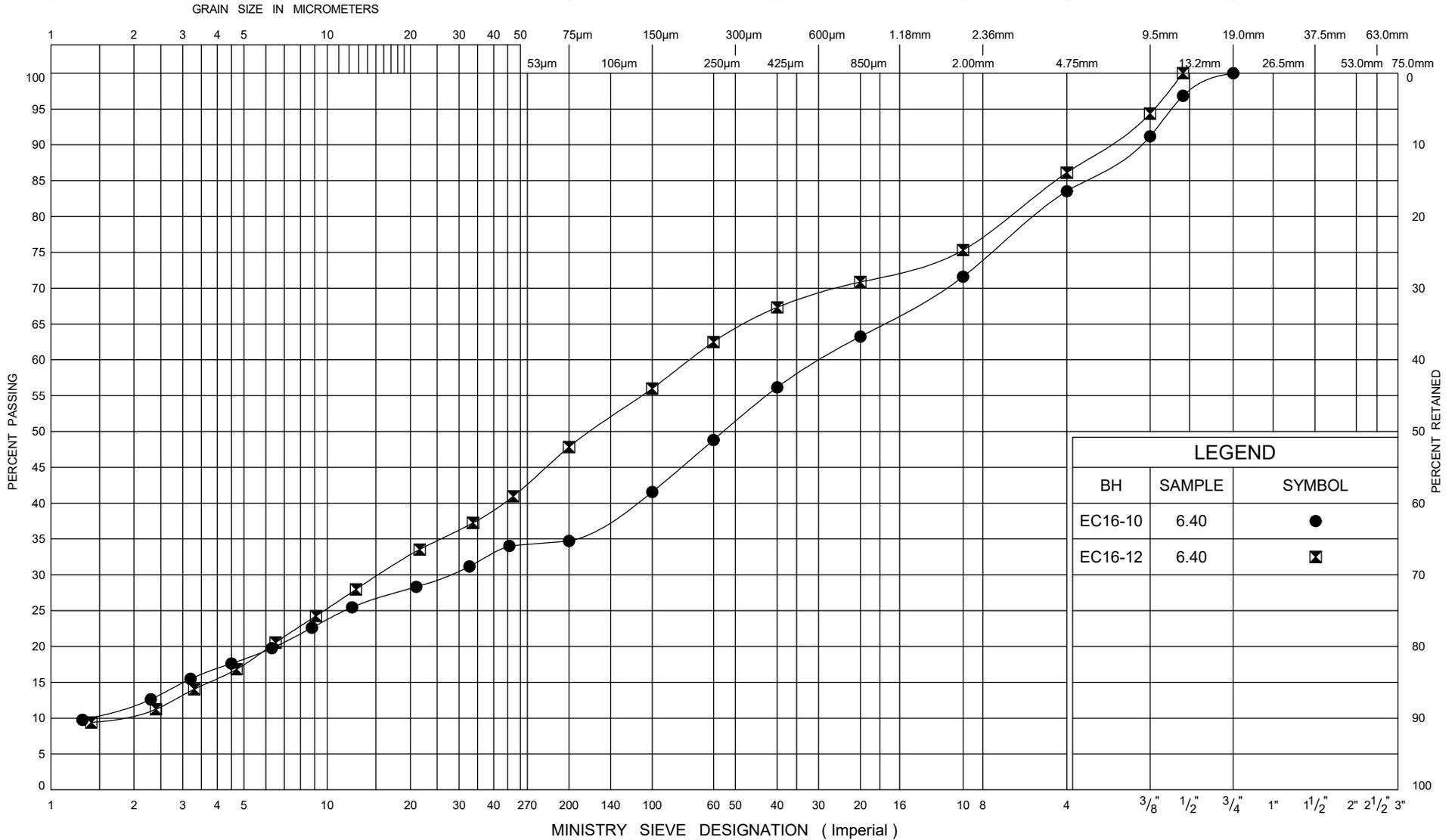
FIG No B6

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## GRAIN SIZE DISTRIBUTION

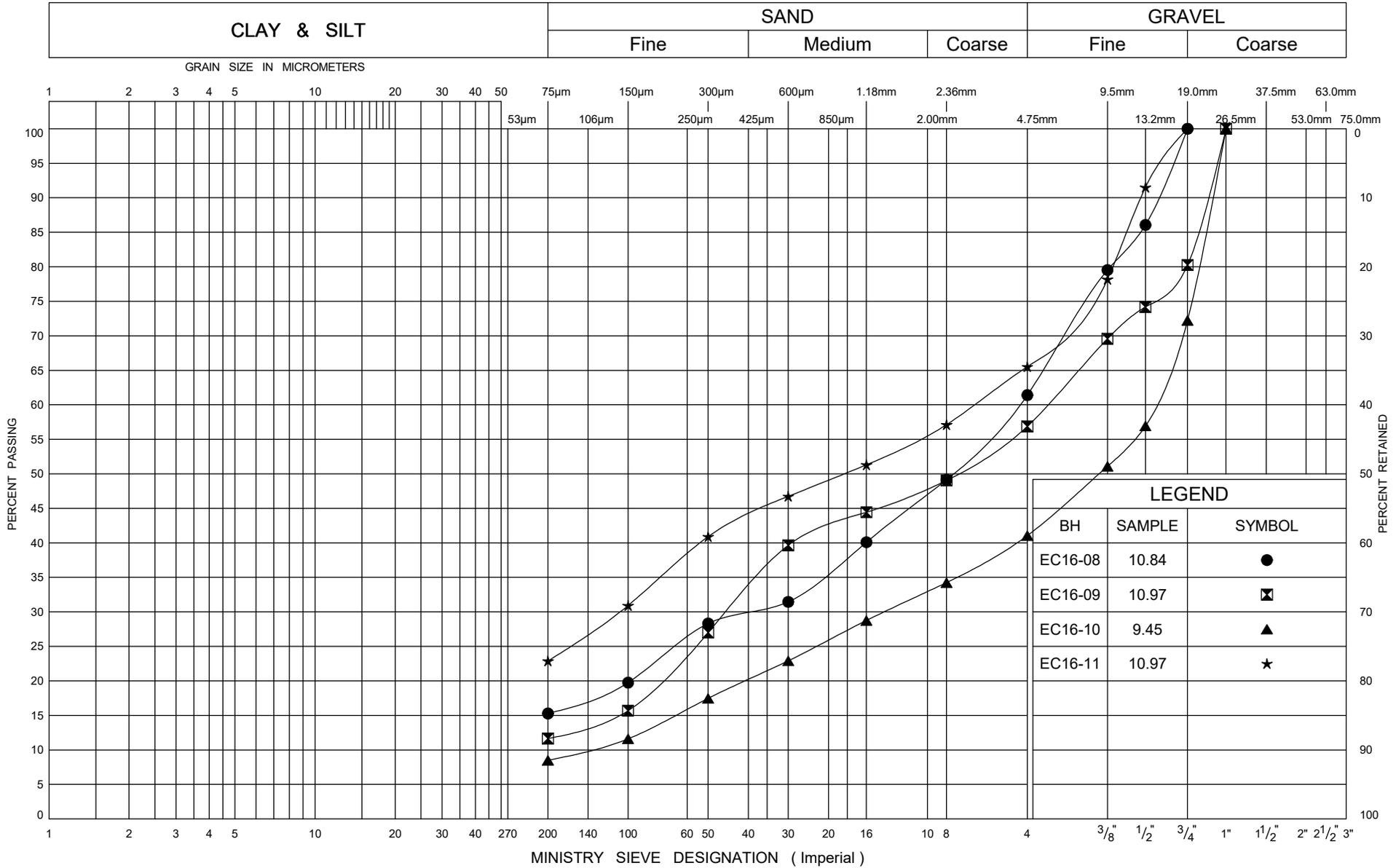
Sand and Silt to Silty Sand Till

FIG No B7

W P 408-88-00

Ellis Creek

### UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



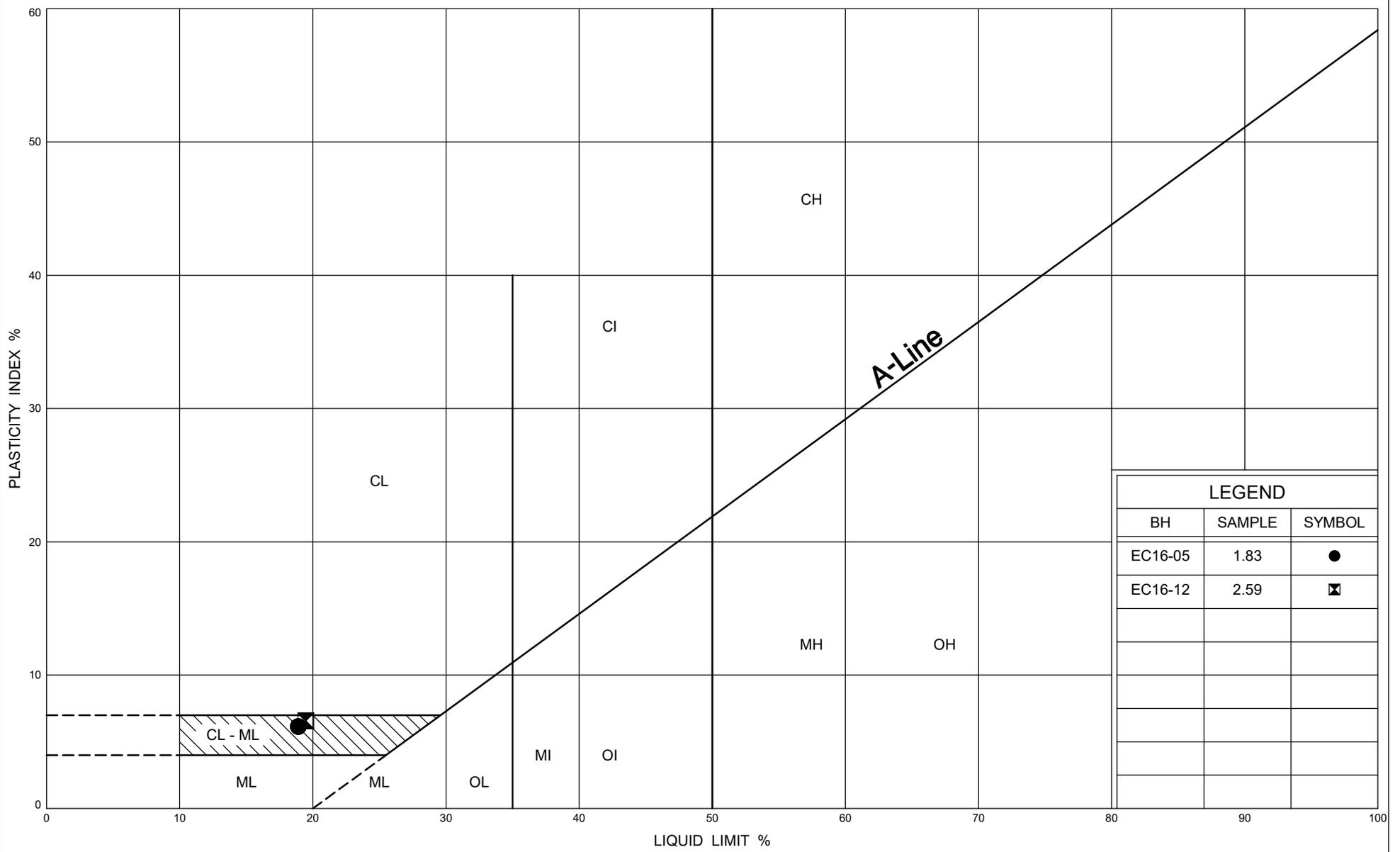
## GRAIN SIZE DISTRIBUTION

### Lower Sand and Gravel

FIG No B8

W P 408-88-00

Ellis Creek



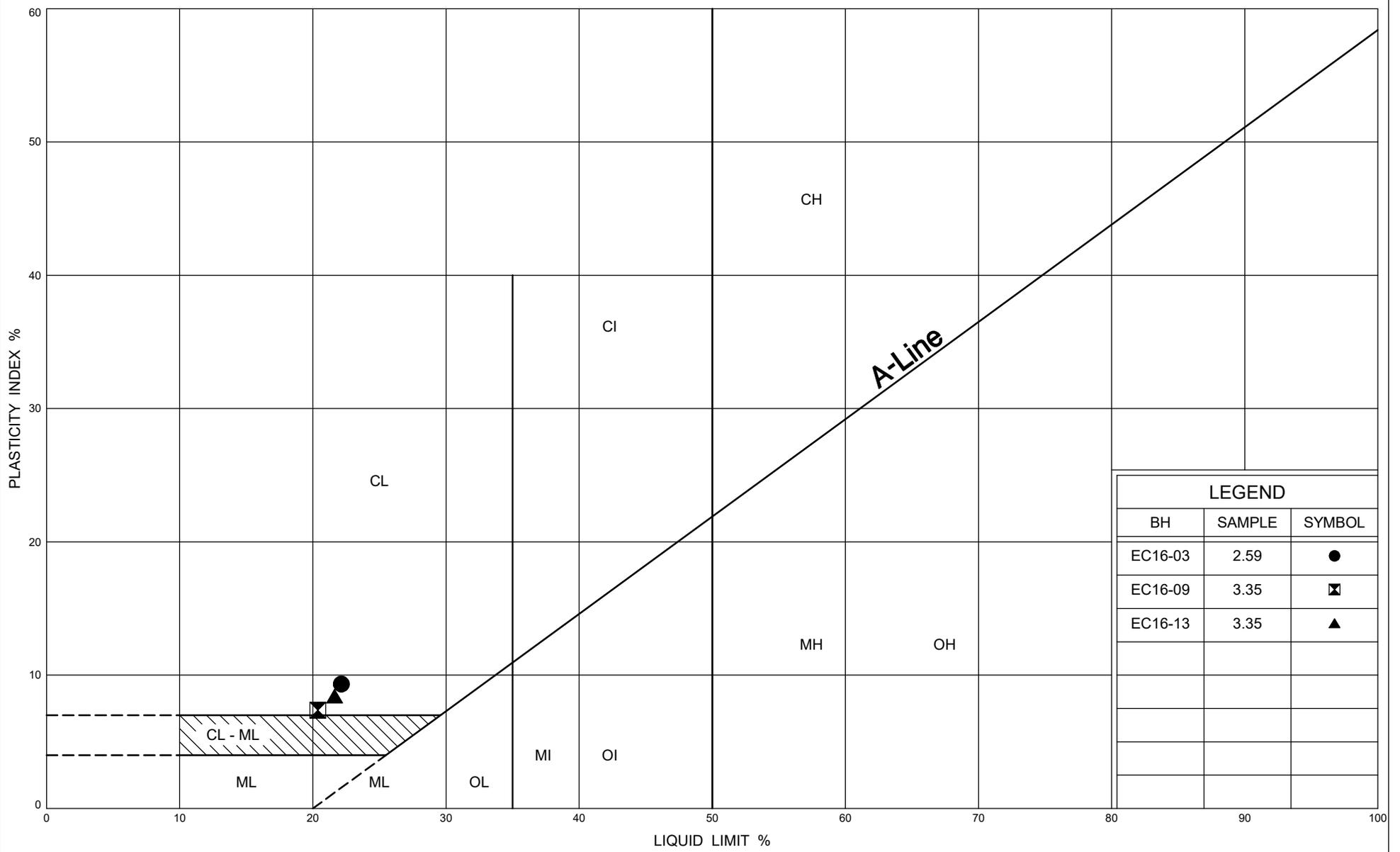
LEGEND		
BH	SAMPLE	SYMBOL
EC16-05	1.83	●
EC16-12	2.59	⊠

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



**PLASTICITY CHART**  
Upper Silt to Silty Sand (Clayey Zones)

FIG No B9  
W P 408-88-00  
Ellis Creek



LEGEND		
BH	SAMPLE	SYMBOL
EC16-03	2.59	●
EC16-09	3.35	⊠
EC16-13	3.35	▲

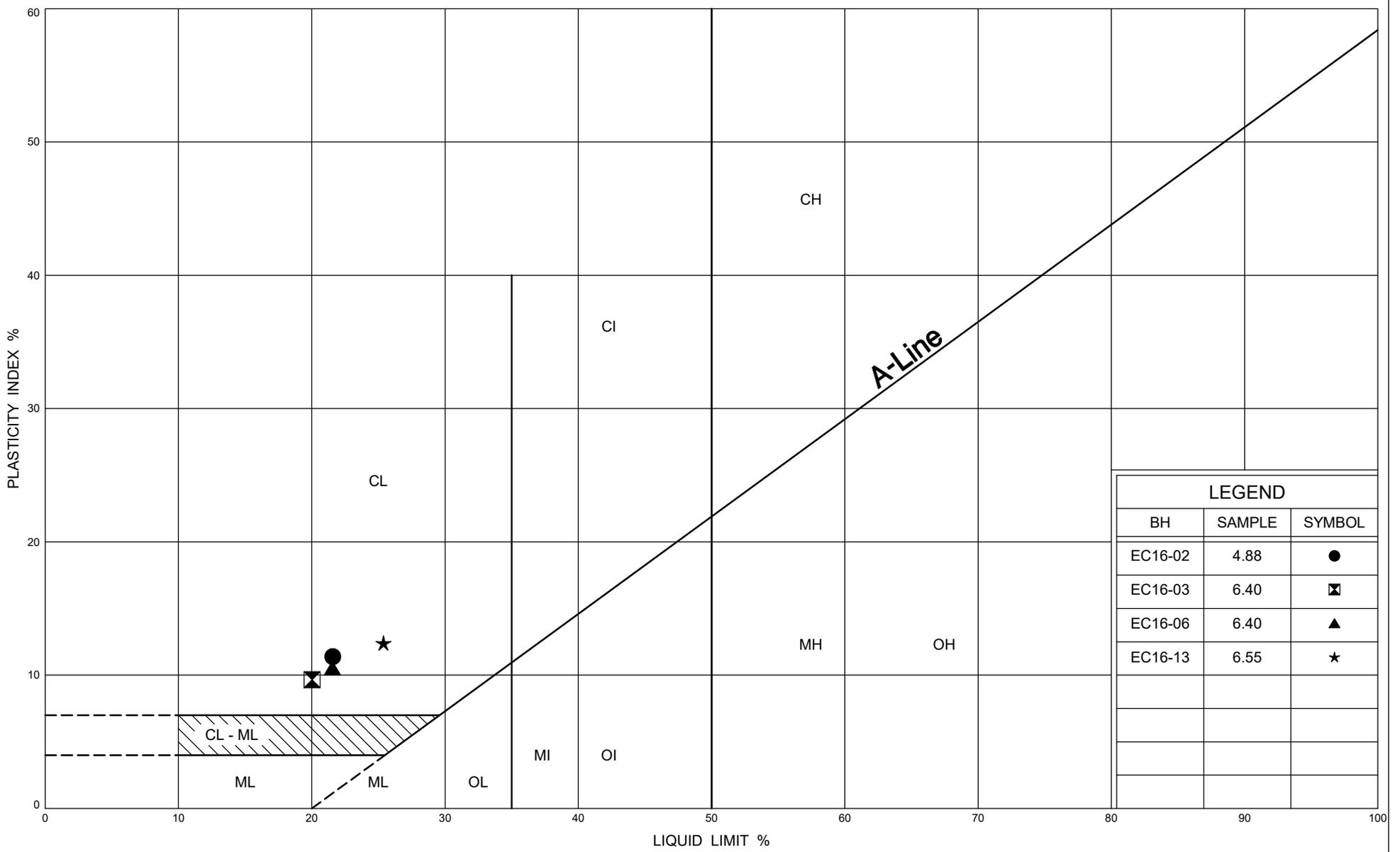
ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



## PLASTICITY CHART

Silty Clay

FIG No B10  
 W P 408-88-00  
 Ellis Creek



LEGEND		
BH	SAMPLE	SYMBOL
	EC16-02	●
	EC16-03	⊠
	EC16-06	▲
	EC16-13	★

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 11/9/18



**PLASTICITY CHART**  
Silty Clay Till

FIG No B11  
W P 408-88-00  
Ellis Creek



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375  
 Client: WSP  
 Project Name: Hwy 7-New Ellis Creek Bridges  
 Core Size: NQ BH No : EC16-04

Date Drilled: 19-Jan-18  
 Date Tested: 25-Jan-18  
 Tester: KF  
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	14.5	D	19.6	46.8	78.3	8.2	197.2	Dolostone	Very Strong
2	2	15.0	D	21.1	46.9	114.4	8.8	212.3	Dolostone	Very Strong
3	2	15.5	D	20.5	47.2	97.3	8.5	203.8	Dolostone	Very Strong
4	3	16.6	D	30.2	47.3	103.0	12.5	299.5	Dolostone	Extremely Strong
5	3	17.4	D	20.2	47.1	94.1	8.4	201.3	Dolostone	Very Strong
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\* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1  
 Long pieces of core can be tested diametrically to produce suitable lengths for axial testing  
 \* Diametral Test should have 0.7 x D on either side of test point.  
 \* Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375  
 Client: WSP  
 Project Name: Hwy 7-New Ellis Creek Bridges  
 Core Size: NQ BH No : EC16-05

Date Drilled: 18-Jan-18  
 Date Tested: 22-Jan-18  
 Tester: KF  
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	13.3	D	16.9	47.0	78.6	7.0	169.1	Dolostone	Very Strong
2	2	13.6	A	17.5	47.5	52.5	5.5	132.2	Dolostone	Very Strong
3	2	14.7	D	16.3	47.3	82.0	6.7	161.9	Dolostone	Very Strong
4	3	16.1	D	18.0	47.4	138.3	7.4	177.7	Dolostone	Very Strong
5										
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\* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1  
 Long pieces of core can be tested diametrically to produce suitable lengths for axial testing  
 \* Diametral Test should have 0.7 x D on either side of test point.  
 \* Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375  
 Client: WSP  
 Project Name: Hwy 7-New Ellis Creek Bridges  
 Core Size: NQ BH No : EC16-06

Date Drilled: 17-Jan-18  
 Date Tested: 22-Jan-18  
 Tester: KF  
 Reviewed by:

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	14.7	D	20.7	46.9	88.8	8.7	208.7	Dolostone	Very Strong
2	1	15.5	D	16.3	47.2	107.5	6.7	161.6	Dolostone	Very Strong
3	2	16.3	D	14.6	47.3	131.5	6.1	145.3	Dolostone	Very Strong
4	2	17.0	D	17.5	47.5	179.4	7.2	172.2	Dolostone	Very Strong
5										
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\* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1  
 Long pieces of core can be tested diametrically to produce suitable lengths for axial testing  
 \* Diametral Test should have 0.7 x D on either side of test point.  
 \* Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375  
 Client: WSP  
 Project Name: Hwy 7-New Ellis Creek Bridges  
 Core Size: HQ BH No : EC16-07

Date Drilled: 09-Jul-18  
 Date Tested: 17-Jul-18  
 Tester: BS  
 Reviewed by: \_\_\_\_\_

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	12.6	D	15.1	62.4	64.5	4.1	97.4	Dolostone	Strong
2	1	13.2	D	16.4	62.3	62.3	4.4	106.1	Dolostone	Very Strong
3	1	13.8	D	22.5	62.4	67.7	6.0	145.1	Dolostone	Very Strong
4	2	14.2	D	4.1	62.4	61.5	1.1	26.2	Dolostone	Medium Strong
5	2	14.8	D	22.1	62.3	66.0	5.9	142.8	Dolostone	Very Strong
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- \* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
- Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- \* Diametral Test should have 0.7 x D on either side of test point.
- \* Correlation factor to obtain UCS values is 24.



THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 11375  
 Client: WSP  
 Project Name: Hwy 7-New Ellis Creek Bridges  
 Core Size: HQ BH No : EC16-08

Date Drilled: 10-Jul-18  
 Date Tested: 17-Jul-18  
 Tester: BS  
 Reviewed by: \_\_\_\_\_

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	I <sub>s(50)</sub> (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	2	13.8	D	18.7	62.4	63.5	5.0	120.7	Dolostone	Very Strong
2	2	14.4	D	16.1	62.3	62.0	4.4	104.5	Dolostone	Very Strong
3	3	15.2	D	24.5	62.2	64.3	6.6	158.8	Dolostone	Very Strong
4										
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- \* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
- Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- \* Diametral Test should have 0.7 x D on either side of test point.
- \* Correlation factor to obtain UCS values is 24.



## FINAL REPORT

CA14445-AUG18 R1

11375

Prepared for

**Thurber Engineering Ltd.**

## First Page

### CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **103, 2010 Winston Park Drive  
Oakville, ON  
L6H 5R7, Canada**

Contact **Rocio Palomeque**

Telephone **905-829-8666 x 263**

Facsimile

Email **rreyna@thurber.ca**

Project **11375**

Order Number

Samples **Soil (5)**

### LABORATORY DETAILS

Project Specialist **Deanna Edwards, B.Sc, C.Chem**

Laboratory **SGS Canada Inc.**

Address **185 Concession St., Lakefield ON, K0L 2H0**

Telephone **705-652-2000**

Facsimile **705-652-6365**

Email **deanna.edwards@sgs.com**

SGS Reference **CA14445-AUG18**

Received **08/16/2018**

Approved **08/23/2018**

Report Number **CA14445-AUG18 R1**

Date Reported **08/23/2018**

### COMMENTS

Temperature of Sample upon Receipt: 6 degrees C  
Cooling Agent Present.  
Custody Seal Present&intact.

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

### SIGNATORIES

Deanna Edwards, B.Sc, C.Chem



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Legend.....	7
Annexes.....	8-9



# FINAL REPORT

CA14445-AUG18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>Corrosivity Index</b>								
Corrosivity Index	none	1	4.0	4.0	6.5	4.0	4.5	
Soil Redox Potential	mV	-	246	362	187	205	169	
Sulphide	%	0.02	< 0.02	< 0.02	0.04	< 0.02	0.86	
pH	no unit	0.05	8.87	9.36	10.7	9.02	8.15	
Resistivity (calculated)	ohms.cm	-9999	3320	10500	4120	4070	4410	

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>General Chemistry</b>								
Conductivity	uS/cm	2	301	95	243	246	227	

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL	Result	Result	Result	Result	Result	
<b>Metals and Inorganics</b>								
Moisture Content	%	0.1	19.4	3.0	7.6	11.0	13.9	
Sulphate	µg/g	0.4	70	6.6	270	9.1	710	



# FINAL REPORT

CA14445-AUG18 R1

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Palomeque

Samplers: N/A

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9
Sample Name	RS16-03-SS4	RW7-01-SS3	RW1-04-SS2	NE16-10 SS4	EC16-08 SS3
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Sample Date	18/05/2018	05/06/2018	06/06/2018	27/04/2018	27/04/2018

Parameter	Units	RL	Result	Result	Result	Result	Result
Other (ORP)							
Chloride	µg/g	0.4	240	13	60	130	4.4

## QC SUMMARY

### Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0280-AUG18	µg/g	0.4	<0.4	2	20	96	80	120	97	75	125
Sulphate	DIO0280-AUG18	µg/g	0.4	<0.4	5	20	97	80	120	81	75	125

### Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0022-AUG18	%	0.02	<0.02	99	20	99	80	120			

### Conductivity

Method: SM 2510 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0253-AUG18	uS/cm	2	< 0.002	0	10	99	90	110	NA		

## QC SUMMARY

### pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0253-AUG18	no unit	0.05	NA	0		101			NA		

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

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

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

## LEGEND

---

### FOOTNOTES

**NSS** Insufficient sample for analysis.  
**RL** Reporting Limit.  
 ↑ Reporting limit raised.  
 ↓ Reporting limit lowered.  
**NA** The sample was not analysed for this analyte  
**ND** Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full. This report supersedes all previous versions.

-- End of Analytical Report --



SGS Environment,  
Health and Safety

Lakeland: 185 Concession St., Lakeland, ON K0L 2H0 Phone: 705-652-2000 Toll Free: 877-747-7658 Fax: 705-652-6365  
London: 657 Consortium Court, London, ON N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com

No: 00864  
Page 1 of 1

**Request for Laboratory Services and CHAIN OF CUSTODY**

**Laboratory Information Section - Lab Use only**

Received By: John Colli  
Received Date: 08/15/12 (mm/dd/yy)  
Received Time: 12:00 am (pm) (circle)

Received By (signature): [Signature]  
Custody Seal Present: Y / (N) (circle)  
Custody Seal Inact: Y / (N) (circle)

Cooling Agent Present: Y / (N) (circle)  
Temperature Upon Receipt (°C): 13.14, 12

LAB LIMS #: CA 14445 - 603  
Accession #: ACC18

**REPORT INFORMATION**

Company: Thorber Engineering Ltd.  
Contact: Rocio Palomeque Reyna  
Address: 103-2010 Winston Park Dr.  
Okville, ON L6H 5R7  
Phone: 905-829-8666 x260  
Fax: R. Reyna & Thorber, Ltd.  
Email: [Redacted]

**INVOICE INFORMATION**

Company:  (same as Report Information)  
Contact: \_\_\_\_\_  
Address: \_\_\_\_\_  
Phone: \_\_\_\_\_  
Email: \_\_\_\_\_

**PROJECT INFORMATION**

Quotation #: 11375 P.O. #: \_\_\_\_\_  
Project #: \_\_\_\_\_ Site Location/ID: \_\_\_\_\_  
**TURNAROUND TIME (TAT) REQUIRED**  
TAT's are quoted in business days (exclude statutory holidays & weekends).  
Samples received after 3pm or on weekends : TAT begins the next business day  
 Regular TAT (5-7days)  1 Day  2 Days  3-4 Days  
RUSH TAT (Additional Charges May Apply)  
PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION  
Specify Due Date: \_\_\_\_\_ Rush Confirmation ID: \_\_\_\_\_

DRINKING WATER SAMPLES (POTABLE WATER FOR HUMAN CONSUMPTION) MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

**ANALYSIS REQUESTED**

COMMENTS:  
Field Filtered (F)  
Preserved (P)

**REGULATIONS**

Regulation 153 (2011):  
 Table 1  Res/Park  Soil Texture:  
 Table 2  Ind/Com  Coarse  
 Table 3  Agrl/Other  Medium  
 Table  Fine

Other Regulations:  
 Reg 347/558 (3 Day min TAT)  
 PW/QO  M/MER  
 CCME  Other: \_\_\_\_\_

Sewer By-Law:  
 Sanitary  Storm  
 Municipality: \_\_\_\_\_

**RECORD OF SITE CONDITION (RSC)**  YES  NO

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	ANALYSIS REQUESTED		COMMENTS: Field Filtered (F) Preserved (P)
					YES	NO	
1 R516-03 - SGA	May 18, 2018		1	Soil			Corrosivity
2							
3 RW7-01 - S53	June 5, 2018		1	Soil			
4							
5 RWM-04 - S52	June 6, 2018		1	Soil			
6							
7 NE16-10 S54	April 24, 2018		1	Soil			
8							
9 EC16-08 S53	July 16, 2018		1	Soil			
10							

Observations/Comments/Special Instructions

Sampled By (NAME): \_\_\_\_\_ Signature: [Signature] Date: 08/15/2018 (mm/dd/yy) Pink Copy - Client  
 Relinquished by (NAME): \_\_\_\_\_ Signature: \_\_\_\_\_ Date: \_\_\_\_\_ (mm/dd/yy) Yellow & White Copy - SGS



# SAMPLE INTEGRITY REPORT

Project Number: 11375

ONTARIO REGULATION 153/04

SGS Sample ID: CA14445-Aug18

Date / Time Sampled: *see CoC*

Client Sample ID

ALL

### Sample Submission General Sample Integrity Violations

- Temperature >10 C upon receipt if not sampled same day
- No evidence of cooling trend initiated if sampled same day
- Chain of Custody not submitted
- Chain of Custody incomplete
- Chain of Custody not signed / dated
- Chain of Custody not a current version
- Bottles / Samples listed on CoC but not received
- Bottles / Samples received but not listed on the CoC
- Sample container received empty

### Sample Specific Sample Integrity Violations

Sample received past hold time	<input type="checkbox"/>						
Incorrect preservation (including no preservation where required)	<input type="checkbox"/>						
Headspace present in VOC vial (aqueous)	<input type="checkbox"/>						
Sample(s) received frozen	<input type="checkbox"/>						
Bottle(s) broken or damaged in transport	<input type="checkbox"/>						
Discrepancy between sample label and chain of custody	<input type="checkbox"/>						
Analysis requirements absent / unclear	<input type="checkbox"/>						
Missing or incorrect sample label(s)	<input type="checkbox"/>						
Inappropriate sample container used	<input type="checkbox"/>						
Insufficient number of bottles received	<input type="checkbox"/>						
Limited sample volume	<input type="checkbox"/>						
Insufficient sample volume	<input type="checkbox"/>						
Sample contains multiple phases	<input type="checkbox"/>						

### Sediment Log

Groundwater samples contain visible sediment / particulate	<input type="checkbox"/>						
Groundwater contains greater than 1cm of sediment / particulate matter in bottle	<input type="checkbox"/>						

### Additional Comments/Remarks:

No issues upon receipt

Initials:     KH



## **Appendix C**

### **Borehole Locations and Soil Strata Drawings**

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

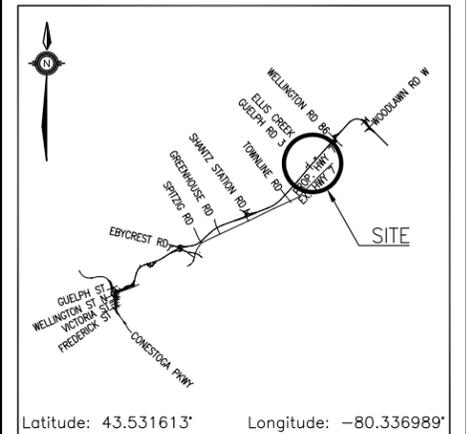
CONT No  
GWP No 408-88-00



HIGHWAY 7 - NEW  
ELLIS CREEK  
PROPOSED BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

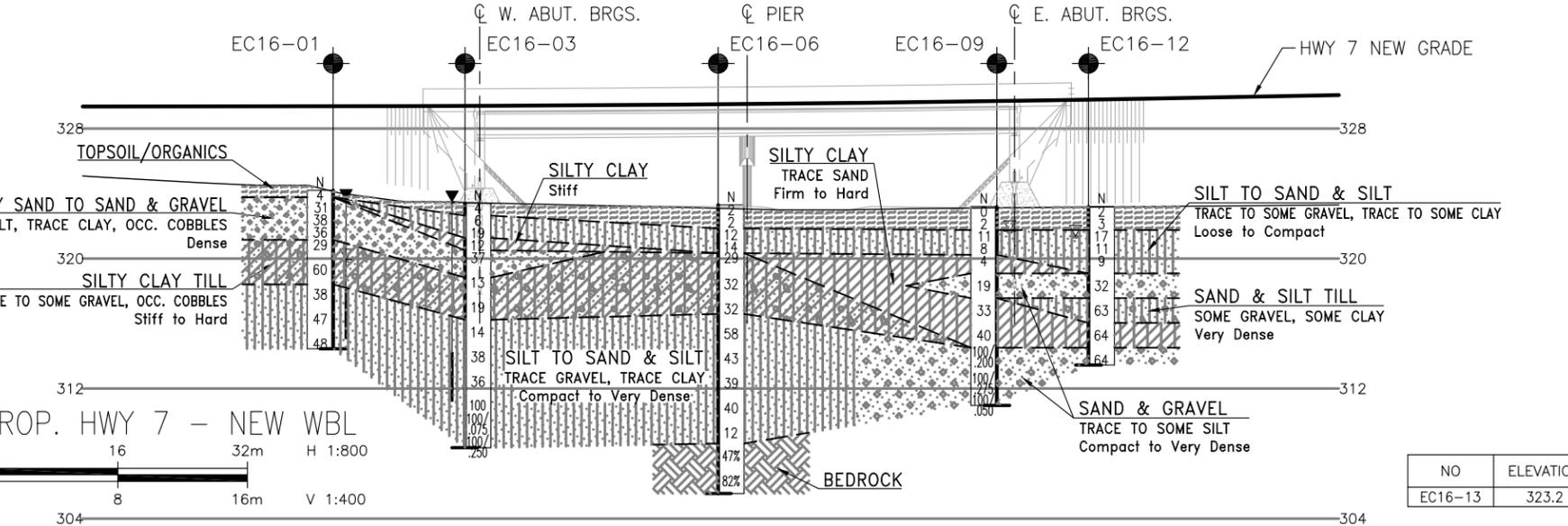
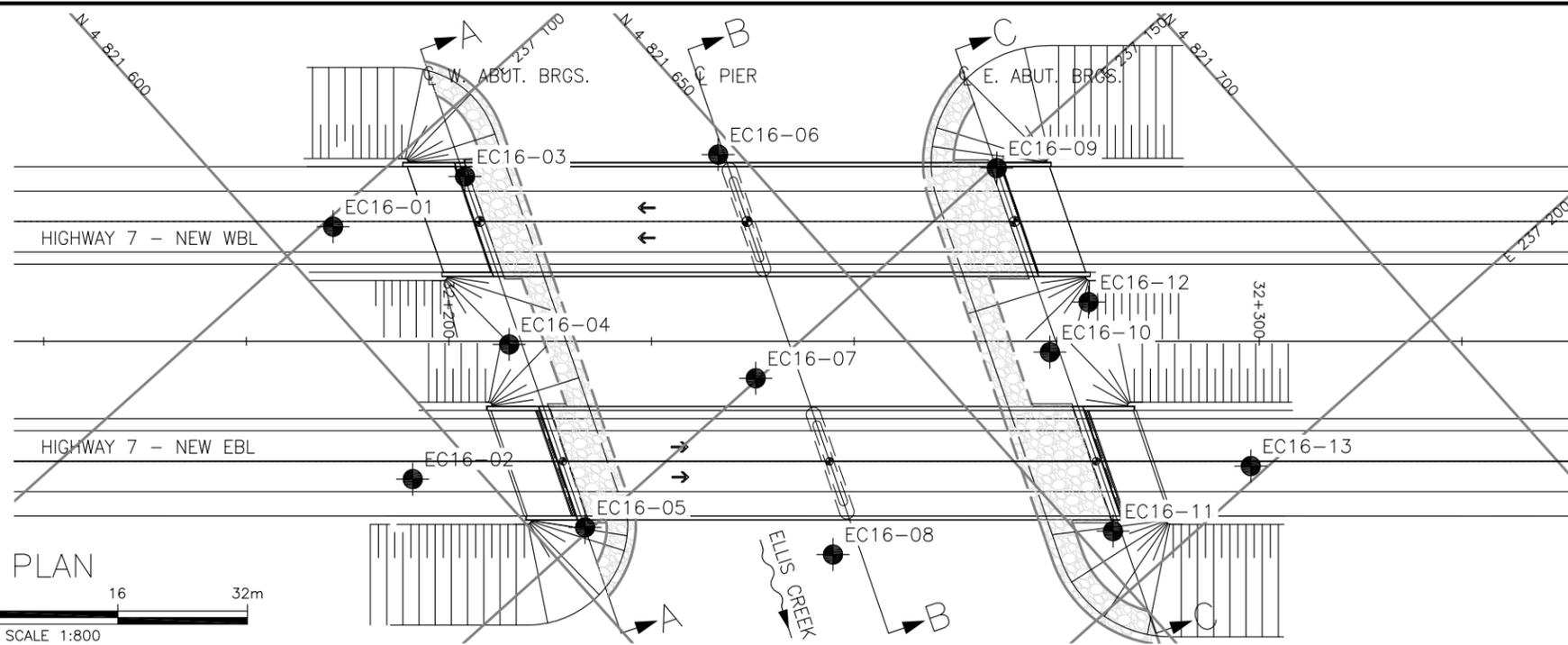
- Borehole (Current Investigation)
- Borehole (2008 Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ☼ Water Level
- ☼ Head Artesian Water
- ☼ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
EC16-01	324.2	4 821 606.7	237 101.1
EC16-02	323.9	4 821 593.3	237 130.8
EC16-03	323.4	4 821 622.9	237 107.3
EC16-04	323.3	4 821 613.2	237 126.4
EC16-05	323.1	4 821 605.1	237 149.4
EC16-06	323.3	4 821 648.0	237 126.2
EC16-07	323.3	4 821 633.1	237 149.8
EC16-08	323.1	4 821 625.7	237 172.3
EC16-09	323.2	4 821 672.5	237 150.3
EC16-10	323.0	4 821 662.3	237 171.6
EC16-11	323.3	4 821 653.4	237 193.2
EC16-12	323.2	4 821 669.9	237 170.2

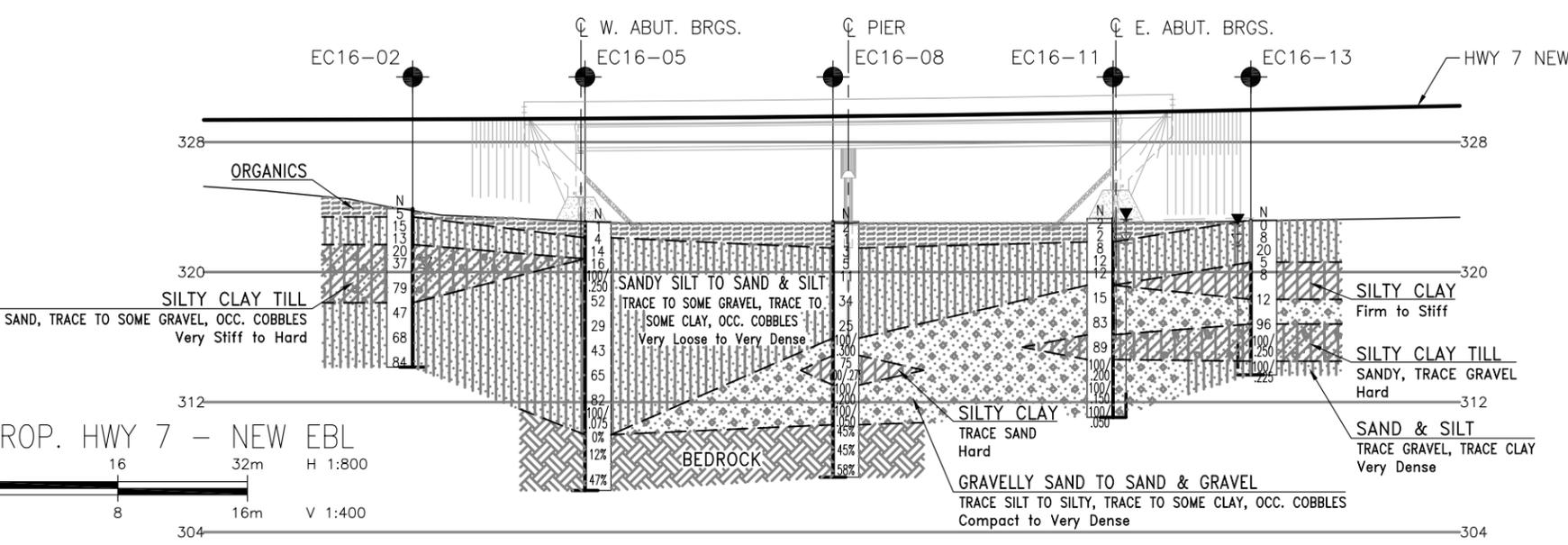
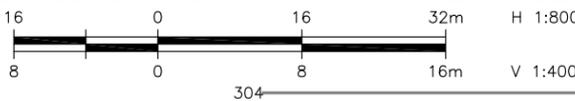
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

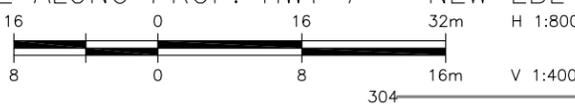
GEOCRES No. 40P9-59



PROFILE ALONG PROP. HWY 7 - NEW WBL



PROFILE ALONG PROP. HWY 7 - NEW EBL



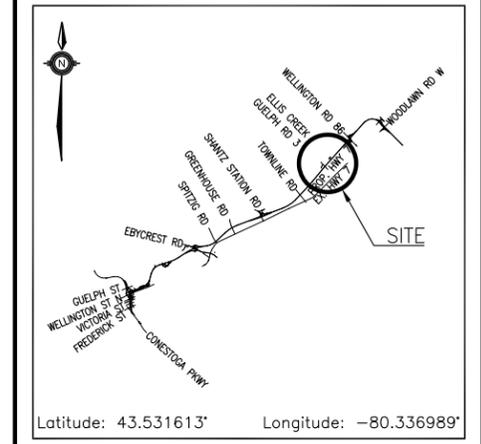
REVISIONS	DATE	BY	DESCRIPTION

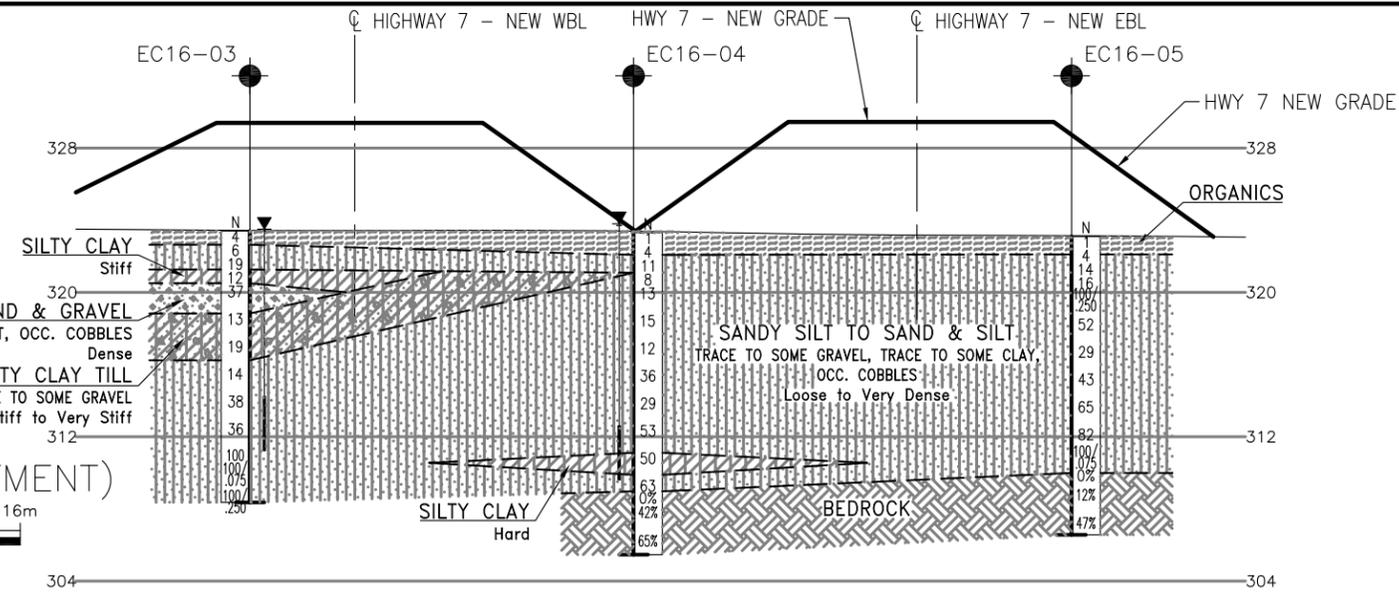
DESIGN	RPR	CHK	PKC	CODE	LOAD	DATE	MAY 2020
DRAWN	MFA	CHK	RPR	SITE	STRUCT	DWG	1

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

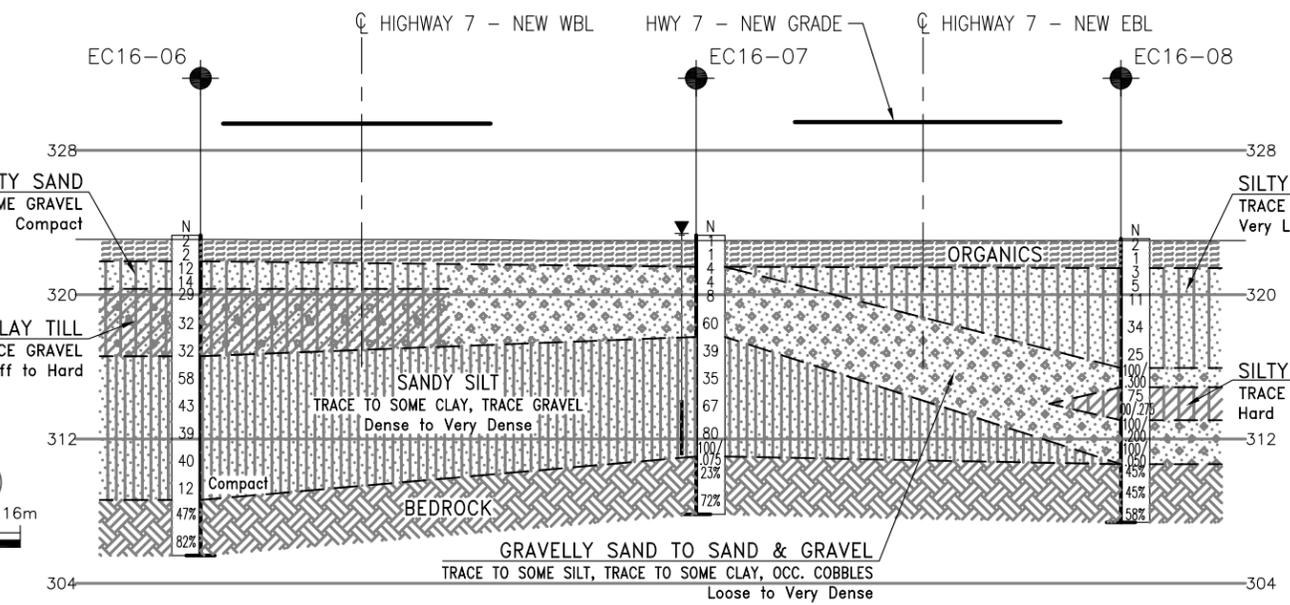
CONT No  
GWP No 408-88-00  
HIGHWAY 7 - NEW  
ELLIS CREEK  
PROPOSED BRIDGE  
BOREHOLE LOCATIONS AND SOIL STRATA



SECTION A-A (WEST ABUTMENT)

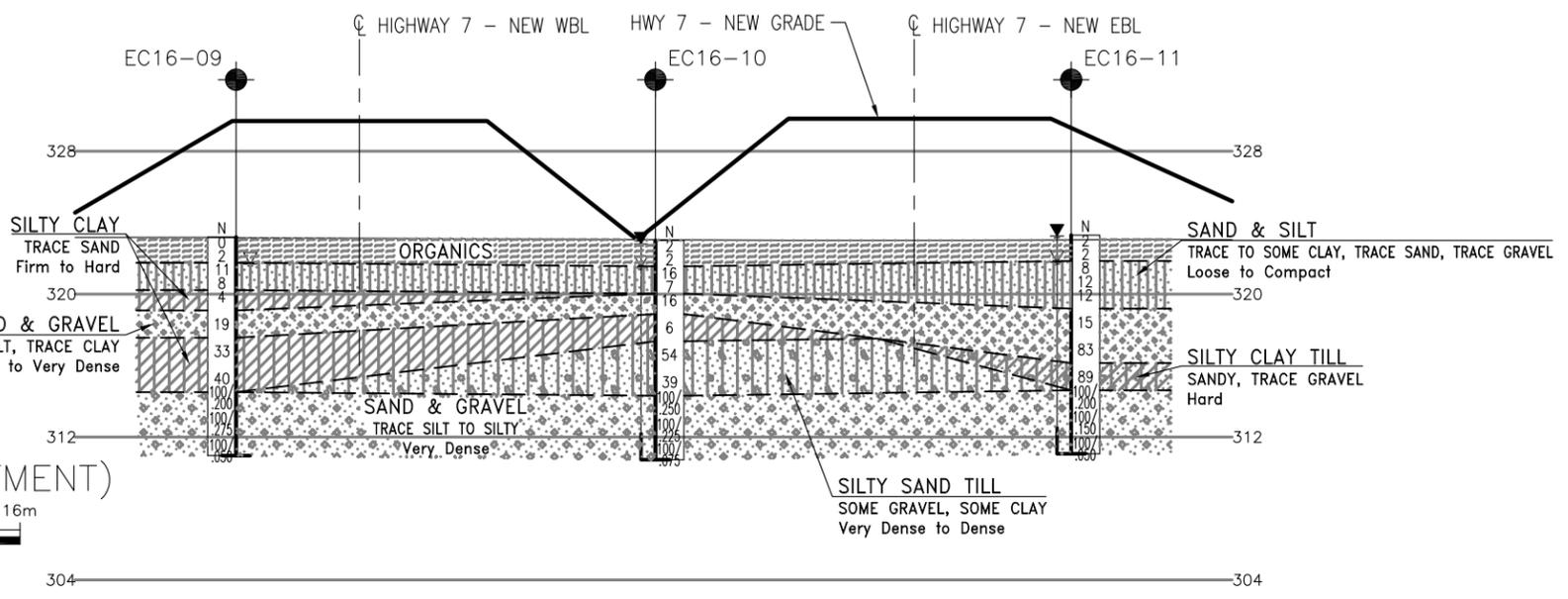
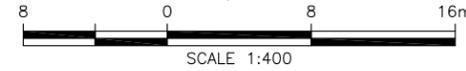


SECTION B-B (PIER)



NO	ELEVATION	NORTHING	EASTING
EC16-13	323.2	4 821 671.4	237 198.6

SECTION C-C (EAST ABUTMENT)



KEYPLAN  
LEGEND

- Borehole (Current Investigation)
- Borehole (2008 Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level
- ▽ Head Artesian Water
- ⊥ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
EC16-01	324.2	4 821 606.7	237 101.1
EC16-02	323.9	4 821 593.3	237 130.8
EC16-03	323.4	4 821 622.9	237 107.3
EC16-04	323.3	4 821 613.2	237 126.4
EC16-05	323.1	4 821 605.1	237 149.4
EC16-06	323.3	4 821 648.0	237 126.2
EC16-07	323.3	4 821 633.1	237 149.8
EC16-08	323.1	4 821 625.7	237 172.3
EC16-09	323.2	4 821 672.5	237 150.3
EC16-10	323.0	4 821 662.3	237 171.6
EC16-11	323.3	4 821 653.4	237 193.2
EC16-12	323.2	4 821 669.9	237 170.2

- NOTES-**
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
  - This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
  - Coordinate system is MTM NAD 83 Zone 10.

**GEOCREs No. 40P9-59**

REVISIONS	DATE	BY	DESCRIPTION