



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 7-NEW EBL AND WBL OVER HOPEWELL
CREEK HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

GEOCRES No. 40P9-57

Latitude 43.515747 °, Longitude -80.355691 °

Report

to

WSP

Date: April 28, 2020
Thurber File No: 11375



TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES.....	2
4.	LABORATORY TESTING.....	5
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	5
5.1	Topsoil.....	6
5.2	Recent alluvium.....	6
5.3	Sandy Silt	6
5.4	Sand and Gravel	7
5.5	Sandy Silt Till, Silty sand Till and Sand and Silt Till	7
5.6	Sand	9
5.7	Silty Clay Till.....	9
5.8	Groundwater Conditions.....	10
6.	CORROSIVITY AND SULPHATE TEST RESULTS.....	12
7.	MISCELLANEOUS	12

APPENDICES

Appendix A	Record of Borehole Sheets, Laboratory Test Results for Present Site Investigation and Analytical Laboratory Test Results
Appendix B	Record of Borehole Sheets and Laboratory Test Results for Previous Site Investigation
Appendix C	Borehole Locations and Soil Strata Drawing



**FOUNDATION INVESTIGATION REPORT
HIGHWAY 7-NEW EBL AND WBL OVER HOPEWELL CREEK
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00**

GEOCRES No. 40P9-57

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of two proposed bridges to carry Highway 7-New Eastbound lane and Westbound lane (EBL and WBL) over Hopewell Creek in the Regional Municipality of Waterloo, Ontario.

The purpose of the 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, a stratigraphic profile, 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 previous and current investigations.

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

Reference has been made to information on subsurface conditions contained in a previous foundation report prepared for this site during the preliminary design phase. The title of the report is:

- Preliminary, Foundation Investigation and Design Report, Highway 7 EBL and WBL over Hopewell Creek, Highway 7-New, Kitchener to Guelph, G.W.P. 408-88-00, Geocres No. 40P8-153, Report to Ministry of Transportation Ontario West Region, File: 15-64-17, dated November 10, 2009. (Reference 1).

2. SITE DESCRIPTION

At the site, the Highway 7-New alignment runs parallel to the existing Highway 7 alignment and 150 m to the north. The site lies approximately 6 km to the northeast of a developed area of the City of Kitchener.



The site lies within an area of farms and agricultural lands. There are farmsteads to the east and west sides of Hopewell Creek, and to the north of the existing Highway 7 alignment.

Hopewell Creek runs north to south and crosses the proposed Highway 7 alignment near station 25+840. The creek is approximately 9.0 m wide within the extent of the proposed structures.

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 and the occurrence of surface boulders is noted. 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.

3. INVESTIGATION PROCEDURES

A preliminary foundation investigation was carried out between May 26 and August 8, 2008. Four boreholes, 08-130 to 08-133, were drilled for the proposed Highway 7-New Eastbound Lane (EBL) and Westbound Lane (WBL) bridges. Boreholes 08-130 and 08-131 were drilled for the WBL bridge, and Boreholes 08-132 and 08-133 were drilled for the EBL bridge. One borehole was drilled at each bridge abutment of the possible one-span structure arrangements. The depths of the boreholes ranged from 12.2 m to 13.9 m (Elevations 301.3 to 299.6) and, to 26.0 m depth (Elevation 291.2) in Borehole 08-132. The Record of Borehole sheets for the boreholes drilled during the previous investigation are included in Appendix B. The elevations on the Record of Borehole sheets was updated since the preliminary report was issued based on new information obtained during the current investigation.

A detailed geotechnical investigation was conducted between July 28 to August 8, 2017, and November 28 to December 1, 2017. Nine boreholes (numbered HC16-01 to HC16-08 and RW-25) were drilled during the detailed investigation. Boreholes HC16-01 and HC16-02 were located at the proposed west approaches, and Boreholes HC16-07 and HC16-08 were located at the proposed east approaches. Boreholes HC16-03 to HC16-06 were drilled near the proposed west and east abutments of the Highway 7-New WBL and EBL structures. Borehole RW-25 was drilled near the north end of a proposed retaining wall, which extends north from the east abutment of the Highway 7-New WBL. The depths of the boreholes ranged from 3.1 m to 18.5 m (Elevations 311.0 to 297.9). The Record of Borehole sheets for the boreholes drilled during the present investigation are included in Appendix A.



The approximate locations of the boreholes from the previous and current investigations are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C. The coordinates and elevations of the current and previous boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendices A and B, respectively.

The ground surface elevations and coordinates of the recent 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, a track mounted D52 drill rig equipped with hollow-stem augers were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

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 for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling of the investigation are presented on the Record of Borehole sheets in Appendices A and B.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Four standpipe piezometers were installed in selected boreholes (08-130, 08-133, HC16-04 and HC16-05). Each piezometer consisted of a 25 mm diameter 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 3.1. Upon completion of the investigation and monitoring of the piezometers, the piezometers were decommissioned as per O.Reg. 903.



Table 3.1 – Borehole Completion Details

Foundation Unit		Borehole Number	Borehole Ground Surface Elevation	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
WBL	West Approach	HC16-01	314.6	9.8/304.8	None Installed	Borehole backfilled with auger cuttings to surface.
	West Abutment	08-130	314.3	13.8/300.5	13.4/300.9	25 mm diameter piezometer with 1.5 m slotted screen installed with sand filter to 11.6 m, holeplug from 11.6 m to 11.3 m, grout from 11.3 m to 0.2 m, then holeplug to ground surface.
		HC16-03	313.6	15.7/297.9	None Installed	Borehole backfilled with auger cuttings to surface.
	East Abutment	08-131	313.5	12.2/301.3	None Installed	Bentonite benseal to 0.3 m, then holeplug to ground surface.
		HC16-05	313.8	13.9/299.8	13.8/299.9	25 mm diameter piezometer with 3.0 m slotted screen installed with a sand filter to 9.1 m, bentonite holeplug from 9.1 m to ground surface.
	East Approach	HC16-07	314.1	9.1/305.0	None Installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
	Retaining Wall (north side)	RW16-25	312.9	12.4/300.5	None Installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
EBL	West Approach	HC16-02	317.4	6.4/311.0	None Installed	Borehole backfilled with auger cuttings to surface.
	West Abutment	08-132	317.2	26.0/291.2	None Installed	Borehole backfilled with grout to 0.6 m, then holeplug to ground surface.
		HC16-04	316.5	18.5/298.0	18.3/298.2	25 mm diameter piezometer with 3.0 m slotted screen installed with a sand filter to 13.7 m, holeplug from 13.7 m to 10.6 m, bentonite seal and auger cuttings from 10.6 m to ground surface.



Foundation Unit		Borehole Number	Borehole Ground Surface Elevation	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	East Abutment	08-133	313.5	13.9/299.6	13.9/299.6	25 mm diameter piezometer with 1.5 m slotted screen installed with a sand filter to 11.6 m, holeplug from 11.6 m to 11.3 m, bentonite seal from 11.3 m to 0.3 m, then holeplug to ground surface.
		HC16-06	313.4	13.9/299.6	None Installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
	East Approach	HC16-08	313.9	3.1/310.8	None Installed	Borehole backfilled with auger cuttings to surface.

4. LABORATORY TESTING

The 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 the laboratory testing of current and previous investigations are summarized on the Record of Borehole sheets in Appendices A and B, respectively and also presented on the figures included in Appendices A and B, respectively.

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 A.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendices A and B. Details of the encountered soil stratigraphy along the proposed alignment are presented in these appendices 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, the subsurface conditions encountered in the boreholes consisted of topsoil and/or



recent alluvium overlying silt, sand, sand and gravel layers, and both cohesive and cohesionless till deposits. Descriptions of the individual strata are presented below.

5.1 Topsoil

Topsoil was identified at ground surface in Boreholes 08-131, 08-133, HC16-01 to HC16-08 and RW16-05. The topsoil thickness ranged from 75 mm to 700 mm. Moisture content measured in the topsoil ranged from 25 percent to 83 percent.

The topsoil encountered in Borehole HC16-08 has some sand, some silt and trace gravel and has a compact state, based on an SPT 'N' value of 16 blows per 0.3 m of penetration.

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 Recent Alluvium

Dark brown to brown recent alluvium containing some silt, trace clay, trace sand and occasional organics was encountered surficially in Boreholes 08-130 and 08-132, and below the topsoil in Boreholes HC16-03 to HC16-05 and RW16-25. The alluvium thickness ranged from 0.5 m to 1.5 m.

The alluvium is in a very loose to loose state, based on SPT 'N' values of 2 to 8 blows per 0.3 m of penetration. An SPT 'N' value of 31 blows per 0.3 m of penetration, indicating a dense state, was measured in Borehole RW16-25. Moisture content ranged from 15 percent to 53 percent.

5.3 Sandy Silt

A layer of native dark brown to brown sandy silt containing trace gravel, trace clay and occasional organics, rootlets and cobbles, was encountered below the topsoil and recent alluvium in Boreholes 08-131, HC16-01, HC16-02 and HC16-04. The thickness of the sandy silt ranged from 1.2 m to 3.0 m.

The depth to the base of the sandy silt varied from 1.4 m to 1.5 m (Elevations 315.9 to 312.0) and was 4.4 m (Elevation 312.0) in Borehole HC16-04.

The sandy silt is described as loose to dense, based on SPT 'N' values ranging from 4 to 32 blows per 0.3 m of penetration. The moisture content of this layer ranged from 10 percent to 33 percent.



5.4 Sand and Gravel

A layer of brown sand and gravel containing trace to some silt, trace to some clay and occasional cobbles was contacted at depths ranging from 0.2 m to 1.5 m (Elevations 315.9 to 312.0) in all the boreholes, except in Borehole HC16-01. In Borehole HC16-04, the sand and gravel layer was contacted at 5.9 m depth (Elevation 310.5). The thickness of the sand and gravel ranged from 0.7 m to 4.9 m.

The depth to the base of the sand and gravel ranged from 1.4 m to 5.6 m (Elevations 314.4 to 307.3), and at 7.0 m (Elevation 309.5) in Borehole HC16-04.

A lower layer of sand and gravel was contacted in Borehole 08-132 at 15.7 m depth (Elevation 301.5). The thickness of the lower sand and gravel layer was 2.1 m. The depth to the base of the lower sand and gravel was at 17.8 m (Elevation 299.4).

SPT 'N' values in the sand and gravel layer ranged from 9 to 100 blows per 0.3 m of penetration, typically 20 to 47, indicating a loose to very dense state. An SPT 'N' value in the lower sand and gravel layer of 100 blows per 0.225 m was recorded, indicating a very dense state. Moisture contents ranged from 3 percent to 16 percent.

Grain size distribution test results from sand and gravel samples are presented on the Record of Borehole sheets and on Figures A1 and Figure B1 of Appendices A and B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	34 to 57
Sand	28 to 46
Silt & Clay	11 to 24

5.5 Sandy Silt to Silty Sand Till

A deposit of native brown to grey cohesionless till described as sandy silt till, silty sand till and sand and silt till containing trace to some gravel, trace to some clay and occasional cobbles was contacted at depths ranging from 1.4 m to 7.2 m (Elevations 314.4 to 305.7), except in Borehole HC16-04, 08-130, and 08-132. Where fully penetrated, the thickness of the cohesionless till ranged from 1.6 m to 5.3 m. The depth to the base of the upper cohesionless till, where fully penetrated, ranged from 3.0 m to 7.5 m (Elevations 311.6 to 306.1).



A lower layer of grey silty sand to sandy silt till containing some clay and trace to some gravel was contacted in Boreholes 08-132, HC16-03 and HC16-04 at depths ranging from 12.0 m to 17.8 m (Elevations 301.6 to 299.4).

Boreholes 08-131, 08-133, HC16-02, HC16-05 to HC16-08 and RW16-25 were terminated within the upper cohesionless till at depths ranging from 3.1 m to 13.9 m (Elevations 311.0 to 299.6). Boreholes 08-132, HC16-03 and HC16-04 were terminated within the lower cohesionless till at depths ranging from 15.7 m to 26.0 m (Elevations 298.0 to 291.2).

SPT 'N' values in the cohesionless till layer, generally ranged from 30 blows per 0.3 m of penetration to higher than 100 blows per 0.025 m of penetration indicating a dense to very dense relative density. SPT 'N' values of 6, 11, and 17 blows per 0.3 m of penetration were measured in Boreholes HC16-01 and HC16-03 indicating a loose to compact relative density. The measured moisture content varied from 5 percent to 21 percent.

Grain size distribution test results for cohesionless till samples are presented on the Record of Borehole sheets and on Figures A2, A3 and B4 of Appendices A and B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 18
Sand	28 to 60
Silt	18 to 55
Clay	6 to 18

Clayey zones were contacted in the sandy silt till near Elevation 306.6 in Borehole 08-133 and near Elevation 307.2 in Borehole 08-131. Atterberg Limits test results are presented on Figure B6 of Appendix B. The results of the laboratory tests are summarized as follows:

Liquid Limit	18
Plastic Limit	10

The above results show that the clayey zones within the cohesionless till are of low plasticity with a group symbol of CL-ML.

Glacial till layers typically contain cobbles and boulders which may account for some high blow counts and resistance to augering.



5.6 Sand

Brown to grey sand containing trace gravel to gravelly, trace to some silt, trace to some clay and occasional cobbles and boulders was encountered at depths ranging from 3.0 m to 6.1 m (Elevations 311.1 to 307.3) in Boreholes 08-130, 08-133, HC16-06, HC16-07 and RW16-25. The thickness of the sand layer ranged from 1.5 m to 2.6 m. The depth to the base of the sand ranged from 5.6 m to 7.6 m (Elevations 308.5 to 305.7).

SPT 'N' values in the sand ranged from 10 to 52 blows per 0.3 m of penetration, indicating a compact to very dense relative density. Moisture content ranged from 5 percent to 20 percent.

Grain size distribution test results for sand samples are presented on the Record of Borehole sheets and on Figures A4 and B2 of Appendices A and B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 22
Sand	63 to 90
Silt & Clay	9 to 23

5.7 Silty Clay Till

A native layer of brown to grey cohesive till described as silty clay till containing trace gravel, trace to with sand and occasional cobbles was encountered at depths ranging from 2.5 m to 7.5 m (Elevations 312.0 to 306.1) in Boreholes 08-130, 08-132, HC16-01, HC16-03 and HC16-04. Where fully penetrated, the thickness of the silty clay till ranged from 4.5 m to 12.2 m.

The depth to the base of the silty clay till, where fully penetrated, ranged from 12.0 m to 16.6 m (Elevations 301.6 to 299.8).

Boreholes 08-130 and HC16-01 were terminated within the silty clay till at 13.8 m and 9.8 m depth (Elevations 300.5 and 304.8), respectively.

SPT 'N' values in silty clay till generally ranged from 11 blows per 0.3 m of penetration to higher than 100 blows per 0.125 m of penetration, typically 20 to 79 blows, indicating a typically very stiff to hard consistency. The natural moisture contents generally lay in the range of 9 percent to 24 percent.



Grain size distribution test results for silty clay till samples are presented on the Record of Borehole sheets and on Figures A5 and B3 in Appendices A and B. The results of laboratory tests carried out on silty clay till samples were as follows:

Soil Particles	Silty Clay Till (%)
Gravel	0 to 3
Sand	10 to 31
Silt	38 to 55
Clay	25 to 46

The results of Atterberg Limits are presented on the Record of Borehole sheets and in Figures A6 and B5 included in Appendices A and B. The results of Atterberg Limits testing are summarized below:

Liquid Limit	26 to 38
Plastic Limit	13 to 16

The above results show that the silty clay till is of low to medium plasticity with group symbols of CL and CI.

Glacial tills inherently contain cobbles and boulders.

5.8 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 08-130, 08-133, HC16-04 and HC16-05 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized below, in Table 5.1.

Table 5.1 – Water Level Measurements

Foundation Unit		Borehole	Date	Water Level (m)		Comment
				Depth	Elevation	
WBL	West Approach	HC16-01	July 28, 2017	6.1	308.5	Open borehole



Foundation Unit		Borehole	Date	Water Level (m)		Comment
				Depth	Elevation	
	West Abutment	08-130	August 22, 2008	0.4*	314.7*	Piezometer
		HC16-03	August 2, 2017	3.0	310.6	Open borehole
	East Abutment	08-131	May 26, 2008	1.1	312.4	Open borehole
		HC16-05	December 1, 2017	2.4	311.4	Open borehole
			December 18, 2017	0.7*	314.5*	Piezometer
			December 21, 2017	0.7*	314.5*	Piezometer
EBL	East Approach	HC16-07	November 28, 2017	2.4	311.7	Open borehole
	Retaining Wall	RW16-25	November 30, 2017	2.4	310.5	Open borehole
	West Approach	HC16-02	July 28, 2017	0.0	317.4	Open borehole
	West Abutment	08-132	August 6, 2008	Dry	-	Open borehole
		HC16-04	July 31, 2017	6.1	310.4	Open borehole
			November 27, 2017	3.0	313.5	Piezometer
	East Abutment	08-133	July 15, 2008	0.7*	314.2*	Piezometer
			August 22, 2008	0.9*	314.4*	Piezometer
	East Approach	HC16-06	November 29, 2017	2.1	311.3	Open borehole
	East Approach	HC16-08	August 8, 2017	2.1	311.8	Open borehole

*Measured above ground surface (artesian conditions)

Available information indicates that the water level at Hopewell Creek is as follows:

- 2-year water level – Elevation 314.7
- 100-year water level – Elevation 315.9

The groundwater levels above are short-term readings, and seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the sand and gravel from Borehole HC16-05 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 A.

Table 6.1 – Analytical Test Results⁷

Parameter	Units (Soil)	Test Results
		HC16-05 SS 3 Depth 1.5 m
		(Soil Sample)
Sulphide	%	<0.02
Chloride	µg/g	71
Sulphate	µg/g	22
pH	No unit	9.06
Electrical Conductivity	µS/cm	128
Resistivity	Ohms.cm	7810
Redox Potential	mV	314

7. MISCELLANEOUS

Altech Drilling & Investigative Services of Elmira, Ontario supplied a D52 track-mounted drill rig for the current investigation 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 Group.

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

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical



laboratory testing was carried out by SGS Canada Inc.

Details of the previous investigation, conducted in 2008, are presented in Reference 1.

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

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, Ph.D., P.Eng
Geotechnical Engineer



Jason Lee, P.Eng.
Principal/Senior Geotechnical Engineer



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



Appendix A

Record of Borehole Sheets, Laboratory Test Results for Present Site Investigation and Analytical Laboratory Test Results (Current Investigation)

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 ⁽¹⁾ '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

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


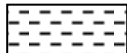



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	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	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<u>TERMS</u>		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.				
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.				
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.				
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 HC16-01

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 525.6 E 231 148.4 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.07.28 - 2017.07.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								20 40 60 80 100										
314.6	GROUND SURFACE																	
0.0	TOPSOIL: (100mm)																	
0.1	Sandy SILT , occasional organics, rootlets and topsoil Loose Brown Moist		1	SS	4		314											
			2	SS	6													
313.1																		
1.4	Sandy SILT , some clay, trace gravel Loose to Compact Brown Moist to Wet (TILL)		3	SS	6		313											
			4	SS	26		312										0	28 55 17
311.6																		
3.0	Silty CLAY , some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		5	SS	19		311											
							310											
	Grey		6	SS	17													
							309											
	Wet		7	SS	13		308											
			8	SS	19		307										3	16 45 36
							306											
	Hard		9	SS	30		305											
304.8																		
9.8	END OF BOREHOLE AT 9.8m.																	

Continued Next Page

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

RECORD OF BOREHOLE No HC16-01

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 525.6 E 231 148.4 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.07.28 - 2017.07.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	WATER LEVEL AT 6.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.													

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

RECORD OF BOREHOLE No HC16-02

1 OF 1

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 497.9 E 231 161.8 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.07.28 - 2017.07.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS ▽*	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
317.4	GROUND SURFACE													
0.0	TOPSOIL: (100mm)													
0.1	Sandy SILT , trace gravel, occasional organics Loose to Compact Brown Moist		1	SS	11		317							
			2	SS	9									
315.9							316							
1.4	SAND and GRAVEL Very Dense Brown Moist		3	SS	60									
			4	SS	63		315							
314.4														
3.0	Silty SAND , some gravel, some clay Compact Brown Moist (TILL)		5	SS	29		314							
							313							
	Very Dense		6	SS	79									
							312							
			7	SS	50/									
311.0					.100		311							12 48 28 12
6.4	END OF BOREHOLE AT 6.4m. WATER LEVEL AT SURFACE UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.													

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

RECORD OF BOREHOLE No HC16-03

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 540.9 E 231 154.8 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.08.02 - 2017.08.02 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
313.6	GROUND SURFACE												
0.0	TOPSOIL: (100mm)												
0.1	RECENT ALLUVIUM, some silt, some clay, occasional organics		1	SS	4		313						
312.9	Loose Dark Brown Moist												
0.7	SAND and GRAVEL Loose to Compact Brown Moist to Wet		2	SS	9		312						
			3	SS	11								
311.4							311						
2.2	Silty SAND, some gravel, some clay Very Dense to Compact Grey Wet (TILL)		4	SS	100								
	clayey zone		5	SS	17		310						
			6	SS	59		309						
							308						
			7	SS	11		307						
306.1							306						
7.5	Silty CLAY, some sand, trace gravel Hard to Very Stiff Grey Wet (TILL)		8	SS	47		305						
	Moist to Wet		9	SS	21		304						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No HC16-04

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 511.4 E 231 166.9 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.07.31 - 2017.08.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
316.5	GROUND SURFACE							20	40	60	80	100						
0.0 0.1	TOPSOIL: (75mm) RECENT ALLUVIUM, some silt, some clay, occasional organics Loose Dark Brown Wet		1	SS	7		316											
			2	SS	8													
315.0							315											
1.4	Sandy SILT, trace gravel, trace clay, occasional organics Compact to Dense Brown Moist		3	SS	18													
			4	SS	32		314											
			5	SS	28		313											
312.0							312											
4.4	Silty CLAY, with sand, occasional cobbles Hard Brown Moist (TILL)		6	SS	98		311											
310.5																		
5.9	SAND and GRAVEL, trace silt, trace clay Dense Grey Wet		7	SS	38		310											
309.5																		
7.0	Grey Wet		8	SS	100/ .100		309											
							308											
			9	SS	100/ .200		307											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

RECORD OF BOREHOLE No HC16-04

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 511.4 E 231 166.9 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.07.31 - 2017.08.01 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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
								20 40 60 80 100	20 40 60 80 100	W P W W L							
	Continued From Previous Page																
	Silty CLAY , some sand, trace gravel, occasional cobbles Hard to Very Stiff Grey Wet (TILL)		10	SS	40										0 14 53 33		
			11	SS	25												
			12	SS	68												
			13	SS	100/ .225												
299.8																	
16.6	Silty SAND , trace to some gravel, trace clay Very Dense Grey Wet (TILL)		14	SS	100/ .175												
298.0			15	SS	100/ .200												
18.5	END OF BOREHOLE AT 18.5m. WATER LEVEL AT 6.1m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.11.27 3.0 313.5																

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

METRIC[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

RECORD OF BOREHOLE No HC16-05

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 571.4 E 231 183.7 ORIGINATED BY OA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.12.01 - 2017.12.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page															
	SAND and SILT , some clay, trace gravel Very Dense Grey Wet (TILL)		10	SS	50/ 100		303									
			11	SS	100/ 225		302									
							301									
299.8			12	SS	100/ 200		300									6 42 38 14
13.9	END OF BOREHOLE AT 13.9m. WATER LEVEL AT 2.4m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.12.18 -0.7 314.5 Artesian 2017.12.21 -0.7 314.5 Artesian (frozen)															

ONTMT4S MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 3/16/18

RECORD OF BOREHOLE No HC16-06

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 541.5 E 231 201.0 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.11.29 - 2017.11.29 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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W P W W L									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)									
						20 40 60 80 100					20 40 60											
313.4	GROUND SURFACE																					
0.0	TOPSOIL: (200mm)																					
0.2	SAND and GRAVEL, trace to some silt and clay, occasional cobbles Loose to Very Dense Brown Wet		1	SS	4		313															
			2	SS	16																	
			3	SS	69																	
			4	SS	39				312													
			4	SS	39				311													
			5	SS	45				310													
309.3																						
4.1	SAND, some gravel, trace silt and clay Dense Grey Wet		6	SS	39		309															
							308															
			7	SS	45		307															
307.0																						
6.4	SAND and SILT, some clay, trace gravel Dense to Very Dense Grey Wet (TILL)																					
			8	SS	82		306															
							305															
			9	SS	100/ 250		304															

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No HC16-06

2 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 541.5 E 231 201.0 ORIGINATED BY OA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2017.11.29 - 2017.11.29 CHECKED BY RPR


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page							20	40	60	80	100					GR SA SI CL
	SAND and SILT, some clay, trace gravel Very Dense Brown Wet (TILL)						303										3 42 39 16
			10	SS	100/ .175												
	some gravel to gravelly Grey		11	SS	100/ .100		301										2 41 41 16
299.6			12	SS	100/ .150		300										
13.9	END OF BOREHOLE AT 13.9m. WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No HC16-07

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 570.5 E 231 202.0 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.11.28 - 2017.11.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								20 40 60 80 100							
314.1	GROUND SURFACE														
0.0	TOPSOIL: (150mm)														
0.2	SAND and GRAVEL, some silt and clay Compact to Dense Brown Wet occasional cobbles		1	SS	10										
			2	SS	38										
			3	SS	43										
			4	SS	47										
311.1															
3.0	SAND, some gravel to gravelly, some silt, some clay Dense to Compact Brown Wet		5	SS	34										
			6	SS	10										
308.5															
5.6	SAND and SILT, some clay, trace gravel Very Dense Grey Wet (TILL)		7	SS	73										
			8	SS	63										
	occasional cobbles														
305.0															
9.1	END OF BOREHOLE AT 9.1m UPON AUGER REFUSAL. WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND														

Continued Next Page

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

METRIC

[illegible]

RECORD OF BOREHOLE No HC16-08

1 OF 1

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 556.9 E 231 216.0 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2017.08.08 - 2017.08.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								20 40 60 80 100										
313.9	GROUND SURFACE																	
0.0	TOPSOIL , some sand, some silt, trace gravel Compact Black Moist		1	SS	16		313											
313.2																		
0.7	SAND and GRAVEL , trace silt, trace clay Dense Brown Moist		2	SS	37													
312.5																		
1.4			Silty SAND , some gravel, trace clay, occasional cobbles Very Dense Brown Moist to Wet (TILL)		3			SS	50/ 0.050	312								
			4	SS	50/ 0.100													
310.8	Auger grinding, slow augering		5	SS	50/		311											
3.1	END OF BOREHOLE AT 3.1m UPON AUGER REFUSAL. WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.				0.100													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No RW16-25

1 OF 2

METRIC

GWP# 408-88-00 LOCATION Hopewell Creek, MTM NAD 83 Zone 10: N 4 817 585.5 E 231 178.8 ORIGINATED BY OA
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2017.11.30 - 2017.11.30 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
312.9	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (200mm)																			
0.2	RECENT ALLUVIUM, some silt, some clay, occasional organics and rootlets		1	SS	31															
312.2	Dense Black Moist																			
0.7	SAND and GRAVEL, some silt and clay, occasional cobbles Compact to Very Dense Brown Moist		2	SS	22															
			3	SS	38															
			4	SS	31															
			5	SS	45															
			6	SS	73															
307.3																				
5.6	SAND, some gravel, trace silt and clay Compact Brown Wet		7	SS	11															
305.7																				
7.2	Silty SAND, some gravel, trace clay Very Dense Grey Wet (TILL)		8	SS	59															
			9	SS	86															

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

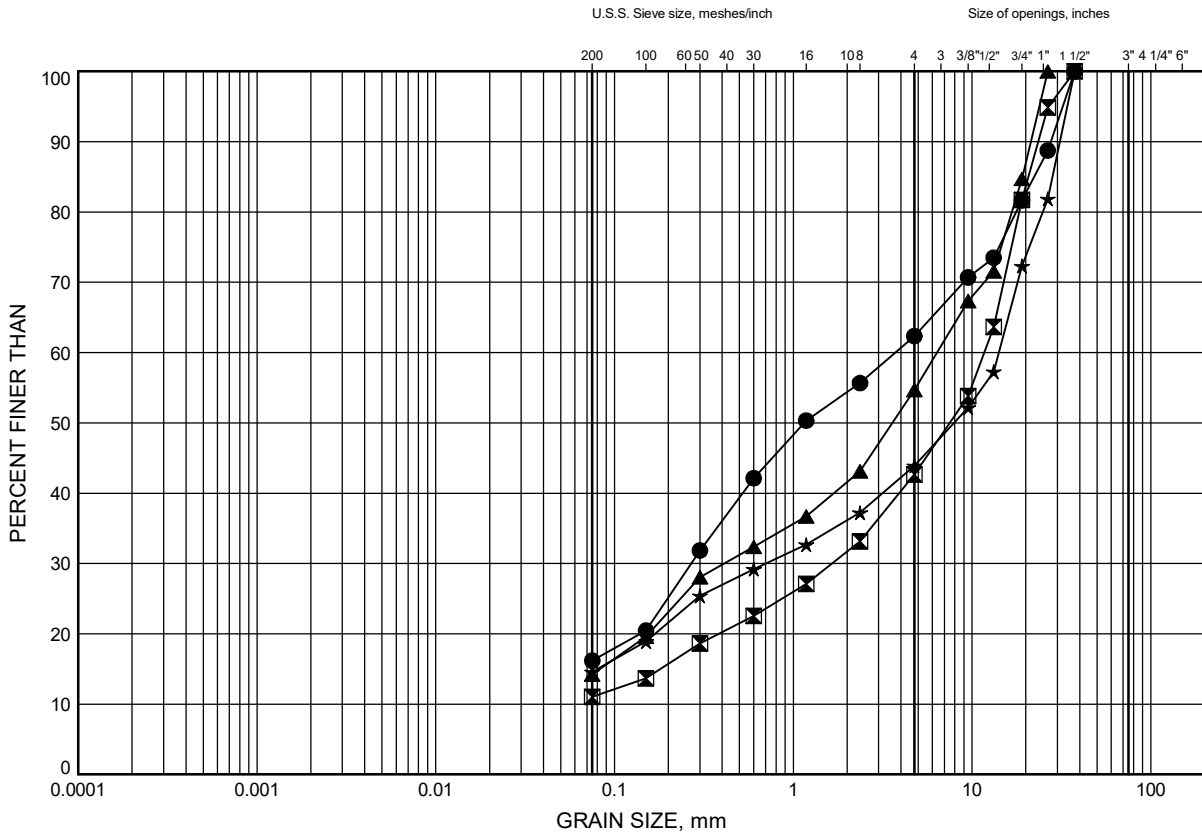
METRIC

[illegible]

Hopewell Creek GRAIN SIZE DISTRIBUTION

FIGURE A1

Sand and Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-05	3.4	310.4
⊠	HC16-06	2.6	310.9
▲	HC16-07	1.1	313.0
★	RW16-25	2.6	310.3

Date March 2018
GWP# 408-88-00

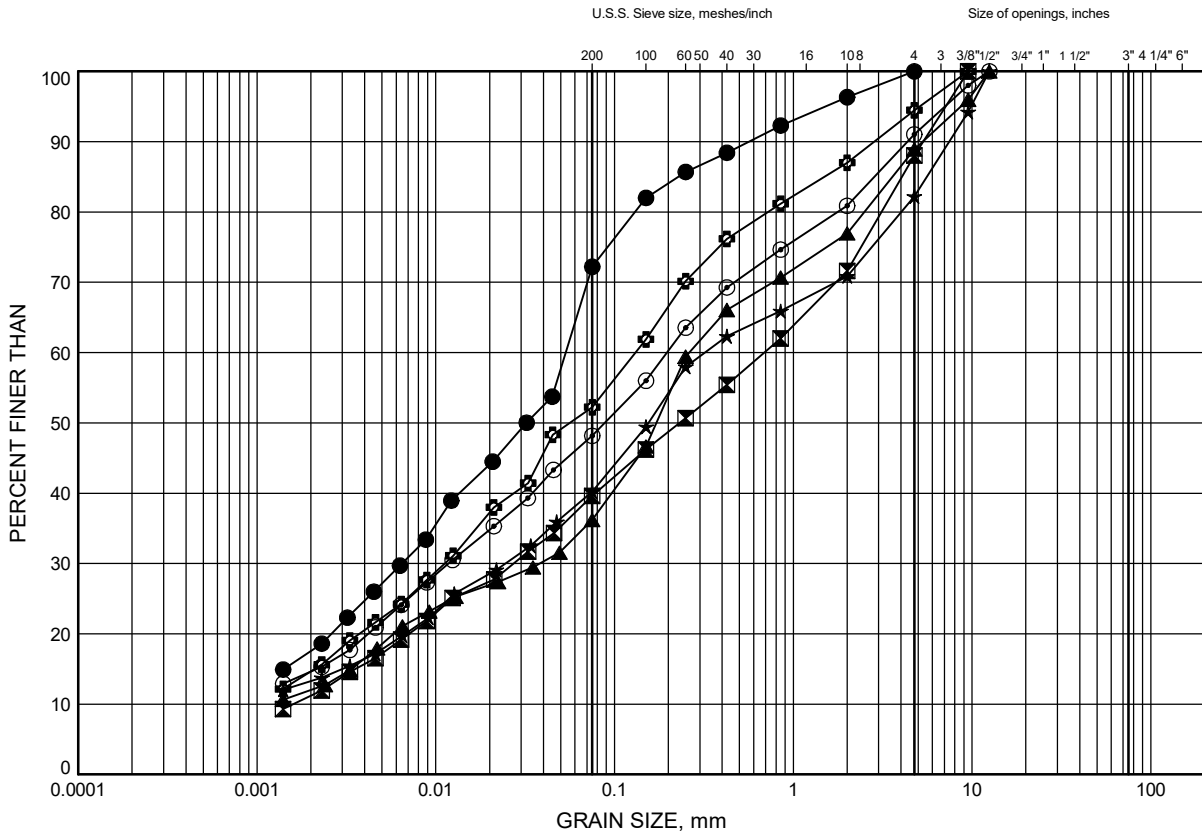


Prep'd MFA
Chkd. RPR

Hopewell Creek GRAIN SIZE DISTRIBUTION

FIGURE A2

Sandy Silt Till to Silty Sand Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-01	2.6	312.0
⊠	HC16-02	6.1	311.3
▲	HC16-03	4.9	308.7
★	HC16-03	14.0	299.6
⊙	HC16-05	9.4	304.3
⊕	HC16-05	13.8	300.0

Date March 2018

GWP# 408-88-00



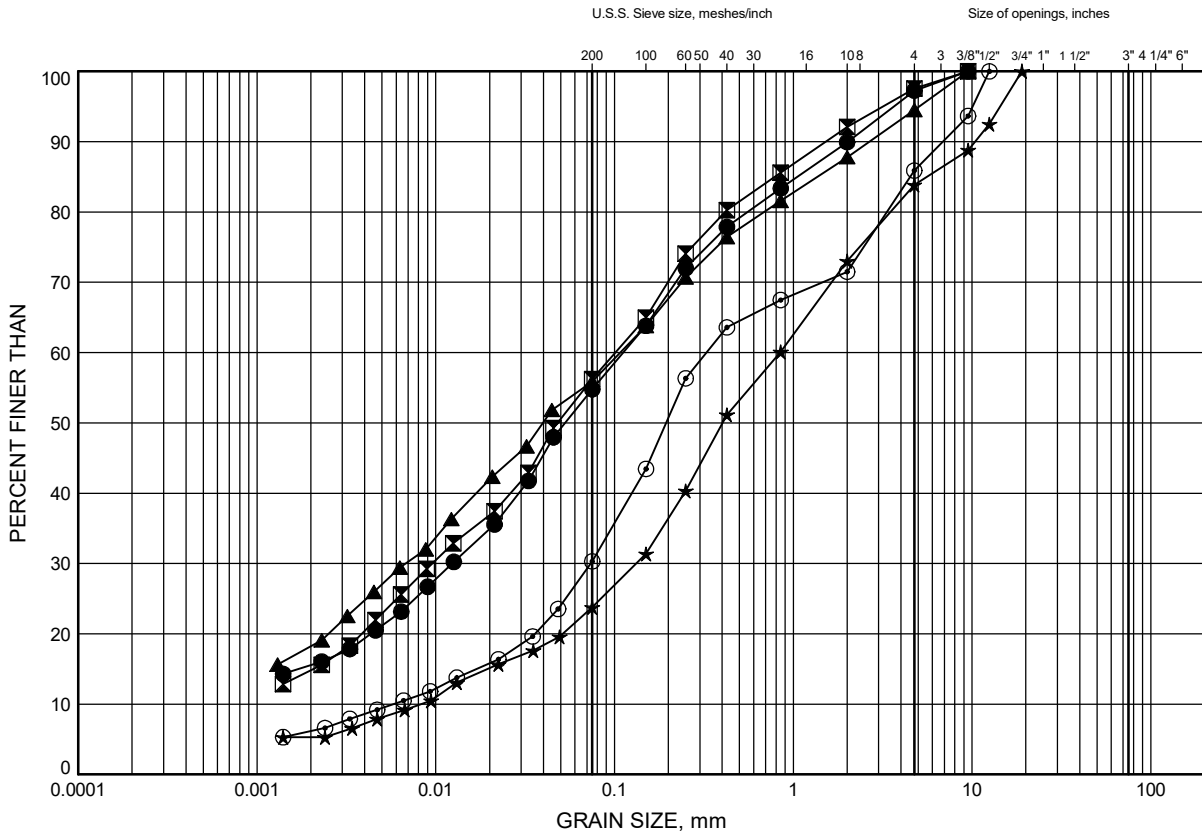
Prep'd MFA

Chkd. RPR

Hopewell Creek GRAIN SIZE DISTRIBUTION

FIGURE A3

Sandy Silt Till to Silty Sand Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-06	11.0	302.5
⊠	HC16-06	13.7	299.7
▲	HC16-07	7.9	306.2
★	HC16-08	2.6	311.3
⊙	RW16-25	11.0	301.9

Date March 2018

GWP# 408-88-00

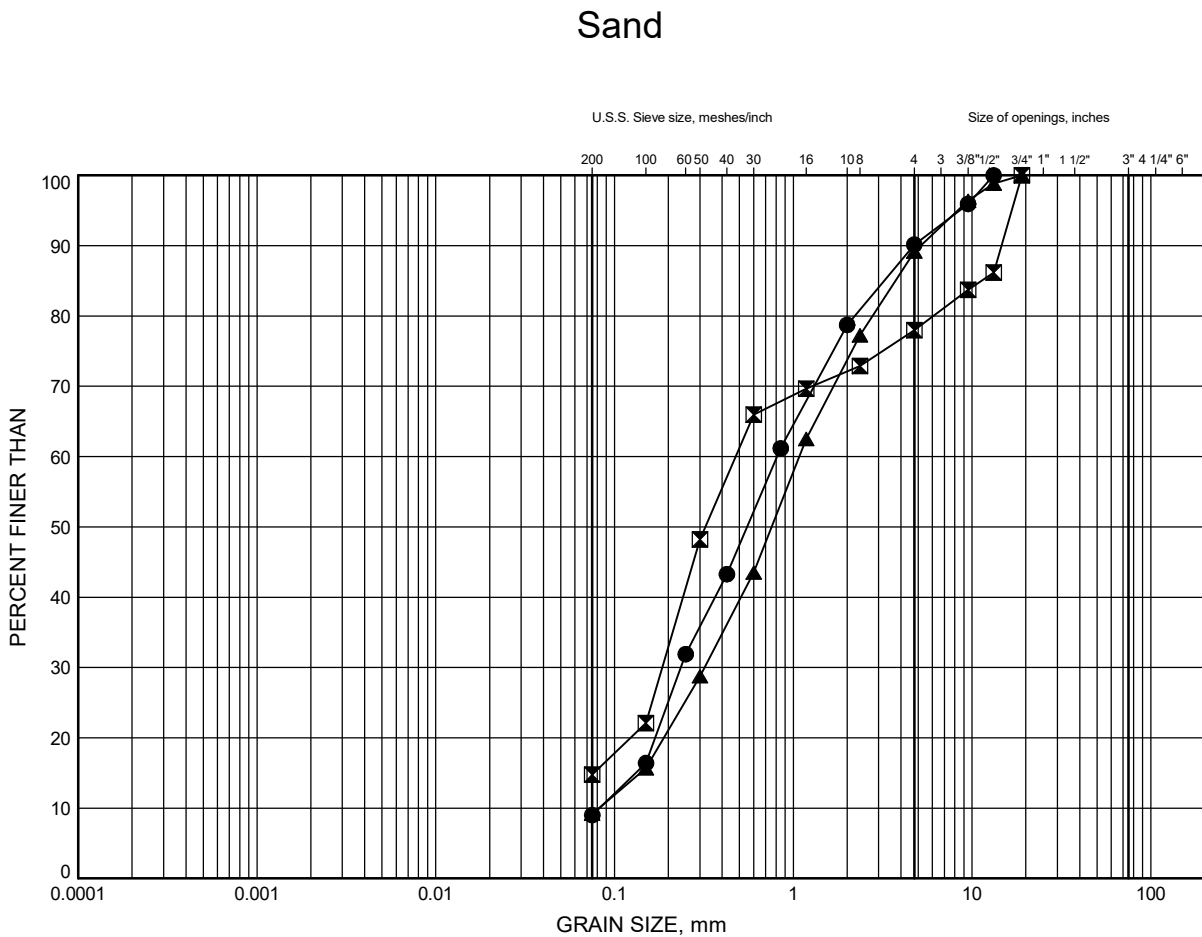


Prep'd MFA

Chkd. RPR

Hopewell Creek GRAIN SIZE DISTRIBUTION

FIGURE A4



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-06	4.9	308.6
⊠	HC16-07	3.4	310.7
▲	RW16-25	6.4	306.5

Date March 2018
GWP# 408-88-00

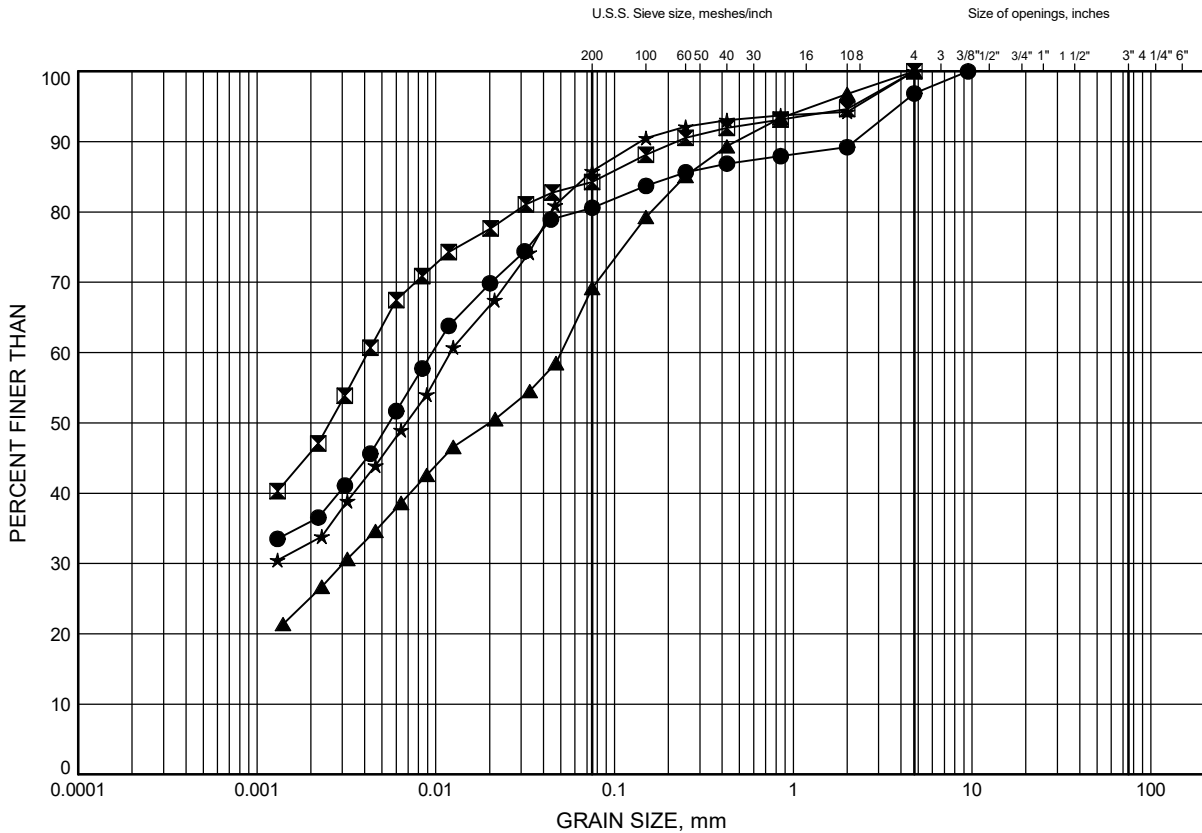


Prep'd MFA
Chkd. RPR

Hopewell Creek GRAIN SIZE DISTRIBUTION

FIGURE A5

Silty Clay Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-01	7.9	306.6
⊠	HC16-03	9.4	304.1
▲	HC16-04	4.9	311.6
★	HC16-04	11.0	305.5

Date March 2018

GWP# 408-88-00



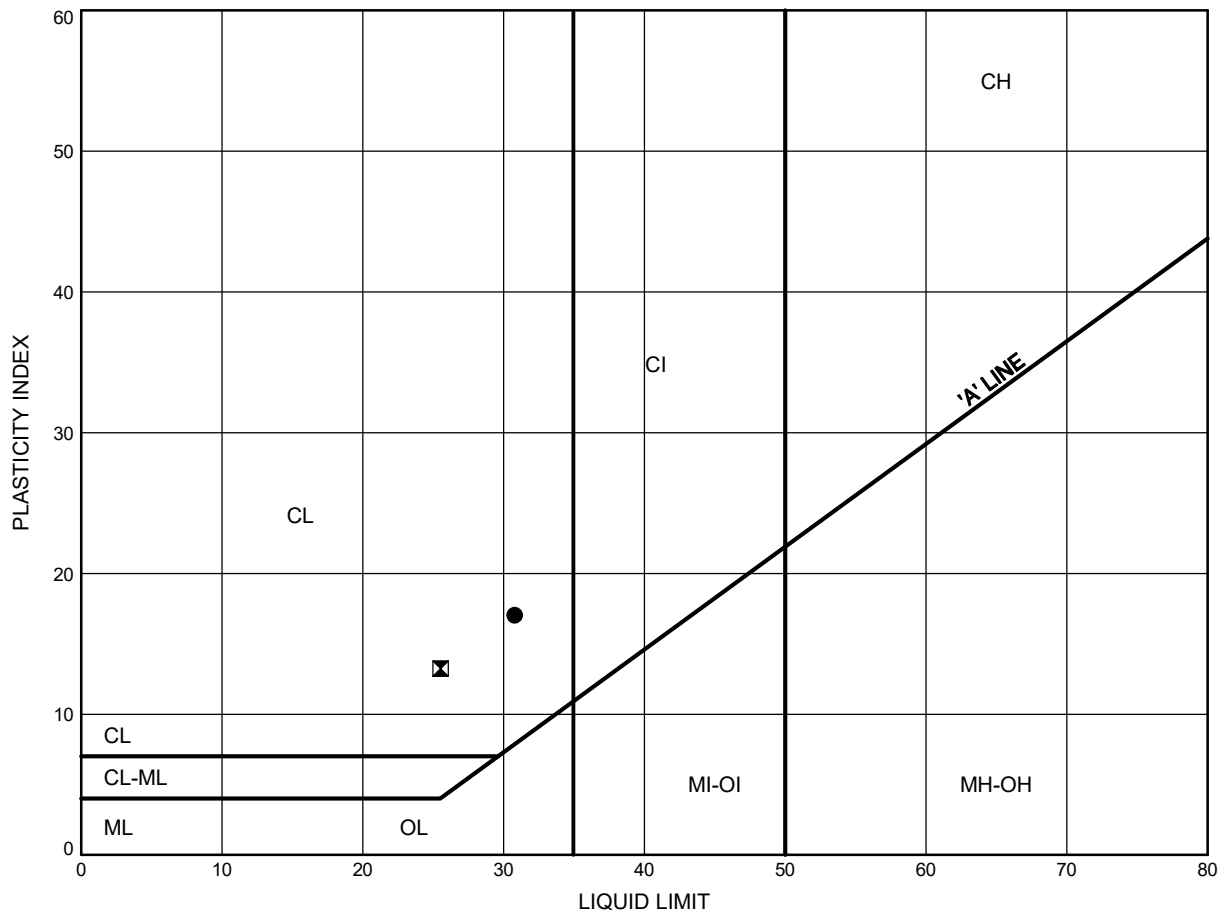
Prep'd MFA

Chkd. RPR

Hopewell Creek ATTERBERG LIMITS TEST RESULTS

FIGURE A6

Silty Clay Till



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	HC16-01	7.9	306.6
⊠	HC16-04	11.0	305.5

Date March 2018
GWP# 408-88-00



Prep'd MFA
Chkd. RPR



FINAL REPORT

CA14400-MAR18 R

11375

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client Thurber Engineering Ltd.

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

Contact Rocio Reyna

Telephone 905-829-8666 x 263

Facsimile

Email rreyna@thurber.ca

Project 11375

Order Number

Samples Soil (12)

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 CA14400-MAR18

Received 03/19/2018

Approved 03/23/2018

Report Number CA14400-MAR18 R

Date Reported 03/23/2018

COMMENTS

Temperature of Sample upon Receipt: 2 degrees C

Cooling Agent Present: Yes

Custody Seal Present: No

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





TABLE OF CONTENTS

First Page..... 1

Index..... 2

Results..... 3-5

QC Summary..... 6-7

Legend..... 8

Annexes..... 9-11



FINAL REPORT

CA14400-MAR18 R

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Reyna

Samplers: Kamil Feszak

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	BS16-04 SS4	GH16-04 SS8	RC16-02 SS3	CR04 SS3	EB 16-03 SS5	SP16-04 SS7	CV16-01 SS3	GRB16-10 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	21/03/2018							

Parameter	Units	RL	Result	Result	Result	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------	--------	--------	--------

Corrosivity Index

Corrosivity Index	none	1	4.0	3.0	4.0	4.0	3.0	5.5	4.0	4.0
Soil Redox Potential	mV	-	343	324	305	294	332	271	228	230
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.06	< 0.02	< 0.02
pH	no unit	0.05	9.08	8.73	8.47	8.63	8.60	8.49	8.78	9.14
Resistivity (calculated)	ohms.cm	-9999	3860	3390	4630	3950	6100	2800	7520	8470

PACKAGE: - Corrosivity Index (SOIL)

Sample Number	13	14	15	16
Sample Name	HC16-05 SS3	TR04-SS5	SH16-04 SS4	GRB16-21 SS4
Sample Matrix	Soil	Soil	Soil	Soil

Parameter	Units	RL	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------

Corrosivity Index

Corrosivity Index	none	1	4.0	4.0	3.0	4.0
Soil Redox Potential	mV	-	314	250	265	246
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	no unit	0.05	9.06	8.98	9.11	8.91
Resistivity (calculated)	ohms.cm	-9999	7810	10100	6940	8200



FINAL REPORT

CA14400-MAR18 R

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Reyna

Samplers: Kamil Feszak

PACKAGE: - General Chemistry (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	BS16-04 SS4	GH16-04 SS8	RC16-02 SS3	CR04 SS3	EB 16-03 SS5	SP16-04 SS7	CV16-01 SS3	GRB16-10 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	21/03/2018							

Parameter	Units	RL	Result	Result	Result	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------	--------	--------	--------

General Chemistry

Conductivity	uS/cm	2	259	295	216	253	164	357	133	118
--------------	-------	---	-----	-----	-----	-----	-----	-----	-----	-----

PACKAGE: - General Chemistry (SOIL)

Sample Number	13	14	15	16
Sample Name	HC16-05 SS3	TR04-SS5	SH16-04 SS4	GRB16-21 SS4
Sample Matrix	Soil	Soil	Soil	Soil

Parameter	Units	RL	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------

General Chemistry

Conductivity	uS/cm	2	128	99	144	122
--------------	-------	---	-----	----	-----	-----

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	BS16-04 SS4	GH16-04 SS8	RC16-02 SS3	CR04 SS3	EB 16-03 SS5	SP16-04 SS7	CV16-01 SS3	GRB16-10 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	21/03/2018							

Parameter	Units	RL	Result	Result	Result	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------	--------	--------	--------

Metals and Inorganics

Sulphate	µg/g	0.4	140	92	11	69	6.5	356	68	22
----------	------	-----	-----	----	----	----	-----	-----	----	----

PACKAGE: - Metals and Inorganics (SOIL)

Sample Number	13	14	15	16
Sample Name	HC16-05 SS3	TR04-SS5	SH16-04 SS4	GRB16-21 SS4
Sample Matrix	Soil	Soil	Soil	Soil

Parameter	Units	RL	Result	Result	Result	Result
-----------	-------	----	--------	--------	--------	--------

Metals and Inorganics

Sulphate	µg/g	0.4	22	2.4	15	11
----------	------	-----	----	-----	----	----



FINAL REPORT

CA14400-MAR18 R

Client: Thurber Engineering Ltd.

Project: 11375

Project Manager: Rocío Reyna

Samplers: Kamil Feszak

PACKAGE: - Other (ORP) (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	BS16-04 SS4	GH16-04 SS8	RC16-02 SS3	CR04 SS3	EB 16-03 SS5	SP16-04 SS7	CV16-01 SS3	GRB16-10 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	21/03/2018							

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result	Result
Other (ORP)											
Chloride	µg/g	0.4		34	50	12	71	4.8	7.6	13	67

PACKAGE: - Other (ORP) (SOIL)

Sample Number	13	14	15	16
Sample Name	HC16-05 SS3	TR04-SS5	SH16-04 SS4	GRB16-21 SS4
Sample Matrix	Soil	Soil	Soil	Soil

Parameter	Units	RL		Result	Result	Result	Result
Other (ORP)							
Chloride	µg/g	0.4		71	22	94	68

PACKAGE: - PHCs (SOIL)

Sample Number	5	6	7	8	9	10	11	12
Sample Name	BS16-04 SS4	GH16-04 SS8	RC16-02 SS3	CR04 SS3	EB 16-03 SS5	SP16-04 SS7	CV16-01 SS3	GRB16-10 SS4
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	21/03/2018							

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result	Result
PHCs											
Moisture Content	%	0.1		14.5	0.2	12.8	8.6	1.2	19.9	5.5	8.7

PACKAGE: - PHCs (SOIL)

Sample Number	13	14	15	16
Sample Name	HC16-05 SS3	TR04-SS5	SH16-04 SS4	GRB16-21 SS4
Sample Matrix	Soil	Soil	Soil	Soil

Parameter	Units	RL		Result	Result	Result	Result
PHCs							
Moisture Content	%	0.1		12.4	7.1	2.7	10.8



FINAL REPORT

CA14400-MAR18 R

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	DIO0288-MAR18	µg/g	0.4	<0.4	2	20	100	80	120	101	75	125
Sulphate	DIO0288-MAR18	µg/g	0.4	<0.4	15	20	98	80	120	96	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	ECS0025-MAR18	%	0.02	<0.02	ND	20	111	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	EWL0284-MAR18	uS/cm	2	< 2	1	10	99	90	110	NA		



FINAL REPORT

CA14400-MAR18 R

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	EWL0284-MAR18	no unit	0.05	NA	1		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. 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 --



Request for Laboratory Services and CHAIN OF CUSTODY

No:

Page 1 of 2

SGS Environmental Services - Lakefield: 185 Concession St., Lakefield, 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

Received By:

Enak Agsey
Received Date (mm/dd/yyyy): 03/15/2018 (mm/dd/yyyy)
Received Time: 11:00 AM

Received By (signature):

Custody Seal Present: ☒ NO
Custody Seal Intact: ☒ NO

Cooling Agent Present: ☒ ICE

Temperature Upon Receipt (°C): 7.0, 7.1, 7.2

LAB LIMS #:

REPORT INFORMATION

Company: *Thurber Eng.*

Contact: *Rocio Palomero Reyna*

Address: *103-2010 Winstonpark Dr.*

Oakville, ON

Phone: *905-829-8666 x260*

Fax:

Email: *rreynae@thurber.ca*

INVOICE INFORMATION

☒ (same as Report Information)

Company:

Contact:

Address:

Phone:

Email:

PROJECT INFORMATION

Quotation #:

Project #: *11375*

P.O. #:

Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7 days) TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 3pm or on weekends : TAT begins the next business day

☐ RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: Rush Confirmation ID:

REGULATIONS

Regulation 153 (2011):

☐ Table 1 ☐ Res/Park ☐ Soil Texture:

☐ Table 2 ☐ Ind/Com ☐ Coarse

☐ Table 3 ☐ Agri/Other ☐ Medium

☐ Table ☐ Fine

Other Regulations:

☐ Reg 347/558 (3 Day min TAT)

☐ PWQO ☐ MMER

☐ CCME ☐ Other:

☐ MISA

Sewer By-Law:

☐ Sanitary

☐ Storm

Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

SAMPLE IDENTIFICATION

DATE SAMPLED

TIME SAMPLED

OF BOTTLES

MATRIX

1 *TR-04 -SSS*

2 *SH16-0A SSS*

3 *GRB16-2 SSS*

4

5

6

7

8

9

10

ANALYSIS REQUESTED

COMMENTS:
Field Filtered (F)
Preserved (P)

Observations/Comments/Special Instructions

Sampled By (NAME): *KAMIL FESZAK*

Signature: *Kamil Feszak*

Date: *03/11/2018* (mm/dd/yyyy)

Pink Copy - Client

Relinquished by (NAME): *Sarah Hashidai*

Signature: *Sarah Hashidai*

Date: *03/11/2018* (mm/dd/yyyy)

Yellow & White Copy - SGS

Revision #: 1.0

Date of Issue: 01 June, 2014



Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environmental Services

- Lakefield: 185 Concession St., Lakefield, 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:

Page 2 of 2

Received By:

Enoch Forster

Received Date (mm/dd/yyyy): 03/17/2018

Received Time: 11:00 AM

Laboratory Information Section - Lab use only

Received By (signature):

Custody Seal Present: ☒

Custody Seal Intact: ☒

Cooling Agent Present: ☒

Temperature Upon Receipt (°C): 7.0, 7.1, 7.2

CA 14400-MAR-18

LAB LIMS #:

5x3

REPORT INFORMATION

Company: Thumber Eng.

Contact: Rogo Palomares Reyna

Address: 103-2010 Winston Dr. Oakville, ON

Phone: 905-824-8666

Fax: 905-824-8666

Email: preyna@thumber.ca

INVOICE INFORMATION

☒ (same as Report Information)

Company:

Contact:

Address:

Phone:

Fax:

Email:

PROJECT INFORMATION

Quotation #:

11375

P.O. #:

Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☐ Regular TAT (5-7 days) TAT's are quoted in business days (exclude statutory holidays & weekends).

Samples received after 3pm or on weekends : TAT begins the next business day

☐ RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: Rush Confirmation ID:

REGULATIONS

Regulation 153 (2011):

☐ Table 1 ☐ Res/Park ☐ Soil Texture:

☐ Table 2 ☐ Ind/Com ☐ Coarse

☐ Table 3 ☐ Agri/Other ☐ Medium

☐ Table 4 ☐ Fine

Other Regulations:

☐ Reg 347/558 (3 Day min TAT)

☐ PWQO ☐ MMER

☐ CCME ☐ Other:

☐ MISA

Sewer By-Law:

☐ Sanitary

☐ Storm

Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

SAMPLE IDENTIFICATION

1 B516-04 S54

2 B516-04 S58

3 RC16-02 S53

4 LR04 S53

5 EB16-03 S55

6 ~~EB16-03 S55~~

7 SP16-04 S57

8 CV16-01 S53

9 GRB16-10 S54

10 HC16-05 S53

DATE SAMPLED

March 21/2017

Oct 1/2017

Mar 1/2017

Dec 1/2016

Oct 1/2016

May 1/2017

June 1/2017

Dec 1/2017

Aug 1/2017

TIME SAMPLED

OF BOTTLES

MATRIX

Soil

Soil

Soil

Soil

Soil

Soil

Soil

Soil

Soil

Soil

ANALYSIS REQUESTED

COMMENTS:
Field Filtered (F)
Preserved (P)

Observations/Comments/Special Instructions

Sampled By (NAME): KAMIL FESZAK

Relinquished by (NAME): Sarah Hashemi

Signature:

Signature:

Date: 03/19/18 (mm/dd/yy)

Date: (mm/dd/yy)

Pink Copy - Client

Yellow & White Copy - SGS

Revision #: 1.0

Date of Issue: 01 June, 2014



SAMPLE INTEGRITY REPORT

Project Number: 11375

ONTARIO REGULATION 153/04

SGS Sample ID CA 14400 - MAR 18

Date / Time Sampled See CoFC

Client Sample ID See CoFC

ALL

Sample Submission General Sample Integrity Violations

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

Sample Specific Sample Integrity Violations

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

Sediment Log

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

Additional Comments/Remarks:

No issues upon receipt



Initials:

KH



Appendix B

Record of Borehole Sheets and Laboratory Test Results (Previous Investigation)

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 ⁽¹⁾ '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}



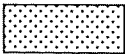


Shear Strength Determination by Pocket Penetrometer

- (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
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	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 (MPa) (psi)	Field Estimation of Hardness*
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.
		Weak	5.0 to 25.0 750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0 150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0 35 to 150	Indented by thumbnail

<u>TERMS</u>	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
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.
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 08-130

1 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 817 526.71 E 231 156.52 N 4 817 526.7 E 231 156.5 ORIGINATED BY ES
 HWY 7 - New BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
 DATUM Geodetic DATE 2008.08.07 - 2008.08.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
314.3	GROUND SURFACE							20 40 60 80 100					
0.0	RECENT ALLUVIUM trace gravel, some silt, trace clay, trace sand, occasional organics Loose Dark Brown Damp		1	SS	5		314						
313.0							313						
1.3	SAND and GRAVEL , some silt Very Dense Brown Moist to Wet		2	SS	80		312						
311.8			3	SS	50		311						
2.5	Sandy SILT , some clay, trace gravel Very Dense Brown Moist (TILL)		4	SS	45		310						
							309						
	occasional cobbles		5	SS	99		308						
	Clayey						307						
308.2			6	SS	49		306						
6.1	SAND , fine grained, trace silt, trace clay Dense Brown Moist						305						
	Spoon bouncing at 7.6m												
306.7			7	SS	50/ .125								
7.6	Silty CLAY , trace sand, trace gravel Hard Grey (TILL)		8	SS	79								

Continued Next Page

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

RECORD OF BOREHOLE No 08-130

2 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 817 526.71 E 231 156.52 N 4 817 526.7 E 231 156.5 ORIGINATED BY ES
 HWY 7 - New BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
 DATUM Geodetic DATE 2008.08.07 - 2008.08.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)					
							20	40	60	80	100	20	40	60			
	Continued From Previous Page																
	Silty CLAY , trace sand, trace gravel Hard Grey (TILL)		9	SS	105												
	some sand		10	SS	100/ .125												
300.5			11	SS	100/ .125												
13.8	END OF BOREHOLE AT 13.8m. Piezometer installation consists of 25mm diameter schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.08.22 0.4* 314.7 2009.04.23 0.7* 315.0 *Above ground level																

METRIC

W.P.	<u>408-88-00</u>	LOCATION	<u>N 4 817 555.39 E 231 188.29 N 4 817 555.4 E 231 188.3</u>	ORIGINATED BY	<u>SLL</u>
HWY	<u>7 - New</u>	BOREHOLE TYPE	<u>Hollow Stem Augers</u>	COMPILED BY	<u>WM</u>
DATUM	<u>Geodetic</u>	DATE	<u>2008.05.26 - 2008.05.26</u>	CHECKED BY	<u>RPR</u>

[illegible]

Continued Next Page

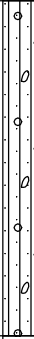
+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 08-131

2 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 817 555.39 E 231 188.29 N 4 817 555.4 E 231 188.3 ORIGINATED BY SLL
 HWY 7 - New BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.05.26 - 2008.05.26 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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _p W W _L 20 40 60				GR SA SI CL	
301.3	Continued From Previous Page Sandy SILT , trace clay, trace gravel Very Dense Grey Moist (TILL)		9	SS	100/ .175		303									○	4 42 47 7
302							302										
12.2	END OF BOREHOLE AT 12.2m. BOREHOLE OPEN TO 11.7m AND WATER LEVEL AT 1.1m ON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE BENSEAL TO 0.3m, THEN HOLEPLUG TO SURFACE.		10	SS	100/ .025												

RECORD OF BOREHOLE No 08-132

1 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 817 498.75 E 231 169.61 ORIGINATED BY WB/ES
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
 DATUM Geodetic DATE 2008.07.31 - 2008.08.06 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
317.2												
0.0	RECENT ALLUVIUM, some silt, trace clay, trace sand, occasional organics Dark Brown to Brown Damp Loose		1	AS			317					
			1	SS	5		316					
315.7												
1.5	SAND and GRAVEL, trace to some silt, trace clay Compact to Dense Brown Damp Auger grinding at 2.1m		2	SS	20		315					34 42 24 (SI+CL)
			3	SS	44							
			4	SS	28		314					
312.9							313					
4.3	Sandy SILT, trace to some clay, trace gravel Very Dense Brown Moist (TILL) Wet		5	SS	100/ 200		312					1 29 53 17
			6	SS	73		311					
310.2												
7.0	Silty CLAY, trace sand, trace gravel Hard Grey (TILL)		7	SS	32		310					
							309					
			8	SS	25		308					0 10 45 45

Continued Next Page

+ ³ , × ³ : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

ONTMT4S 6417R GPJ 9/18/08

RECORD OF BOREHOLE No 08-132

2 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 817 498.75 E 231 169.61 ORIGINATED BY WB/ES
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
 DATUM Geodetic DATE 2008.07.31 - 2008.08.06 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page													
	Silty CLAY , trace sand, trace gravel Hard Grey (TILL)		9	SS	11		307							
			10	SS	40		306							
			11	SS	51		304							
			12	SS	100/ 200		303							
301.5	Auger grinding at 15.5m						302							
15.7	SAND and GRAVEL , trace to some silt, trace clay Very Dense Grey Wet		13	SS	100/ 225		301							46 31 23 (SI+CL)
299.4			14	SS	70		300							
17.8	Sandy SILT , trace gravel, trace clay, cobbles and boulders Very Dense Grey Moist (TILL) Auger grinding at 18.6m						299							
							298							

ONTMT4S 6417R.GPJ 9/18/08

Continued Next Page

+ ³ , × ³ : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-132

3 OF 3

METRIC

G.W.P. 408-88-00 LOCATION N 4 817 498.75 E 231 169.61 ORIGINATED BY WB/ES
 HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
 DATUM Geodetic DATE 2008.07.31 - 2008.08.06 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 γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Sandy SILT, trace gravel, trace clay, presence of cobbles and boulders Very Dense Grey Moist (TILL)						297										
			15	SS	51		296										
							295										
			16	SS	100/ .075		294										
							293										
			17	SS	100/ .150		292										
291.2																	
26.0	END OF BOREHOLE AT 26.0m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 0.6m THEN HOLEPLUG TO SURFACE.		18	SS	100/ .125												

ONTMT4S 6417R.GPJ 9/18/08

RECORD OF BOREHOLE No 08-133

1 OF 2

METRIC

W.P. 408-88-00 LOCATION N 4 817 528.39 E 231 194.99 N 4 817 528.4 E 231 195.0 ORIGINATED BY SLL
 HWY 7 - New BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.05.26 - 2008.05.26 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _P	W			W _L	WATER CONTENT (%)	GR
313.5	GROUND SURFACE																		
0.0	TOPSOIL: (275mm)																		
313.2	Black																		
0.3	SAND and GRAVEL, trace to some silt, trace clay, occasional cobbles Dense to Very Dense Brown Moist		1	SS	35														
			2	SS	45														
			3	SS	90														
			4	SS	100														
309.8																			
3.7	SAND, some silt, trace gravel, trace clay Very Dense Brown Wet		5	SS	52														
307.9																			
5.6	Silty CLAY, some sand, trace gravel Hard Grey (TILL)		6	SS	48														
306.2																			
7.3	Sandy SILT, some clay, trace gravel Very Dense Grey (TILL)		7	SS	100/ .200														
			8	SS	69														

Continued Next Page

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

RECORD OF BOREHOLE No 08-133

2 OF 2

METRIC

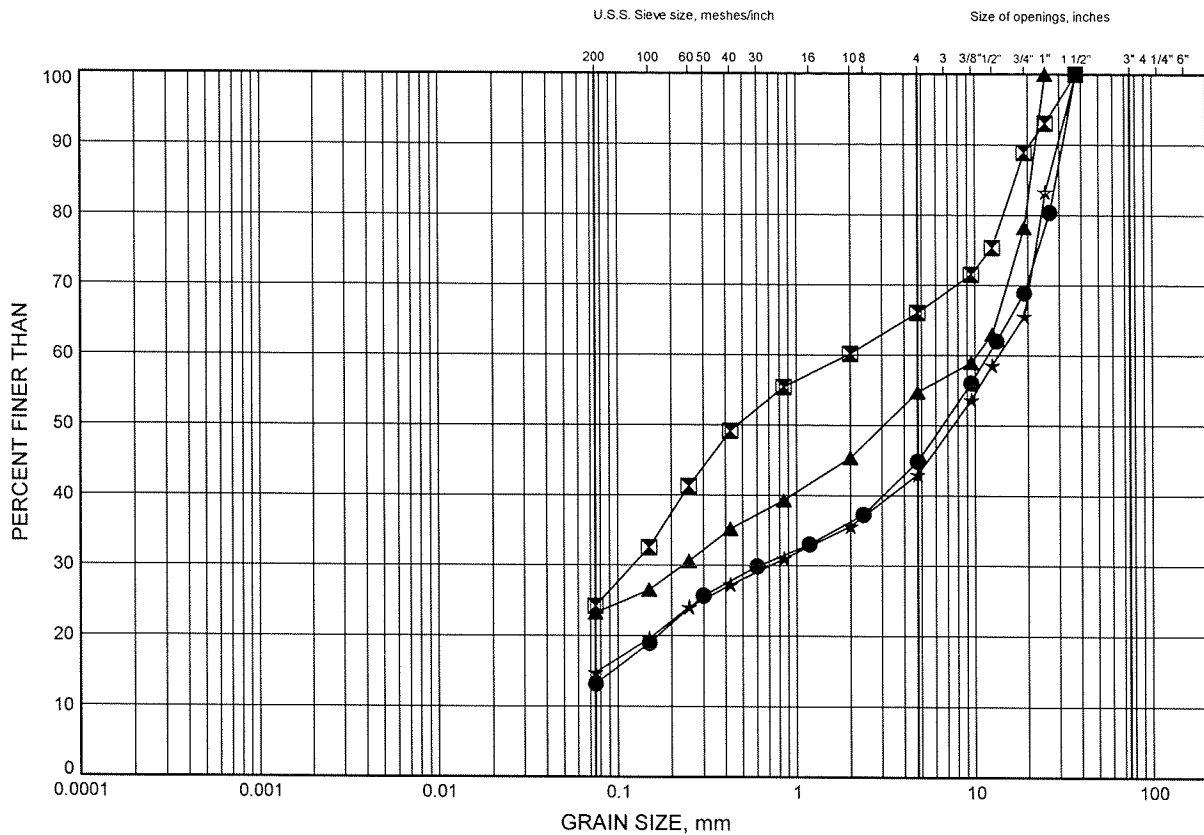
W.P. 408-88-00 LOCATION N 4 817 528.39 E 231 194.99 N 4 817 528.4 E 231 195.0 ORIGINATED BY SLL
 HWY 7 - New BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 2008.05.26 - 2008.05.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Sandy SILT , some clay, trace gravel Very Dense Grey (TILL)		9	SS	100/ .175		303										
							302										
			10	SS	100/ .100		301									9 43 39 9	
							300										
299.6			11	SS	100/ .100												
13.9	END OF BOREHOLE AT 13.9m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2008.07.15 0.7* 314.2 2008.08.22 0.9* 314.4 *Above ground level																

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B1

Sand and Gravel



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-131	2.59	312.50
⊠	08-132	1.83	315.39
▲	08-132	16.19	301.03
☆	08-133	2.59	313.38

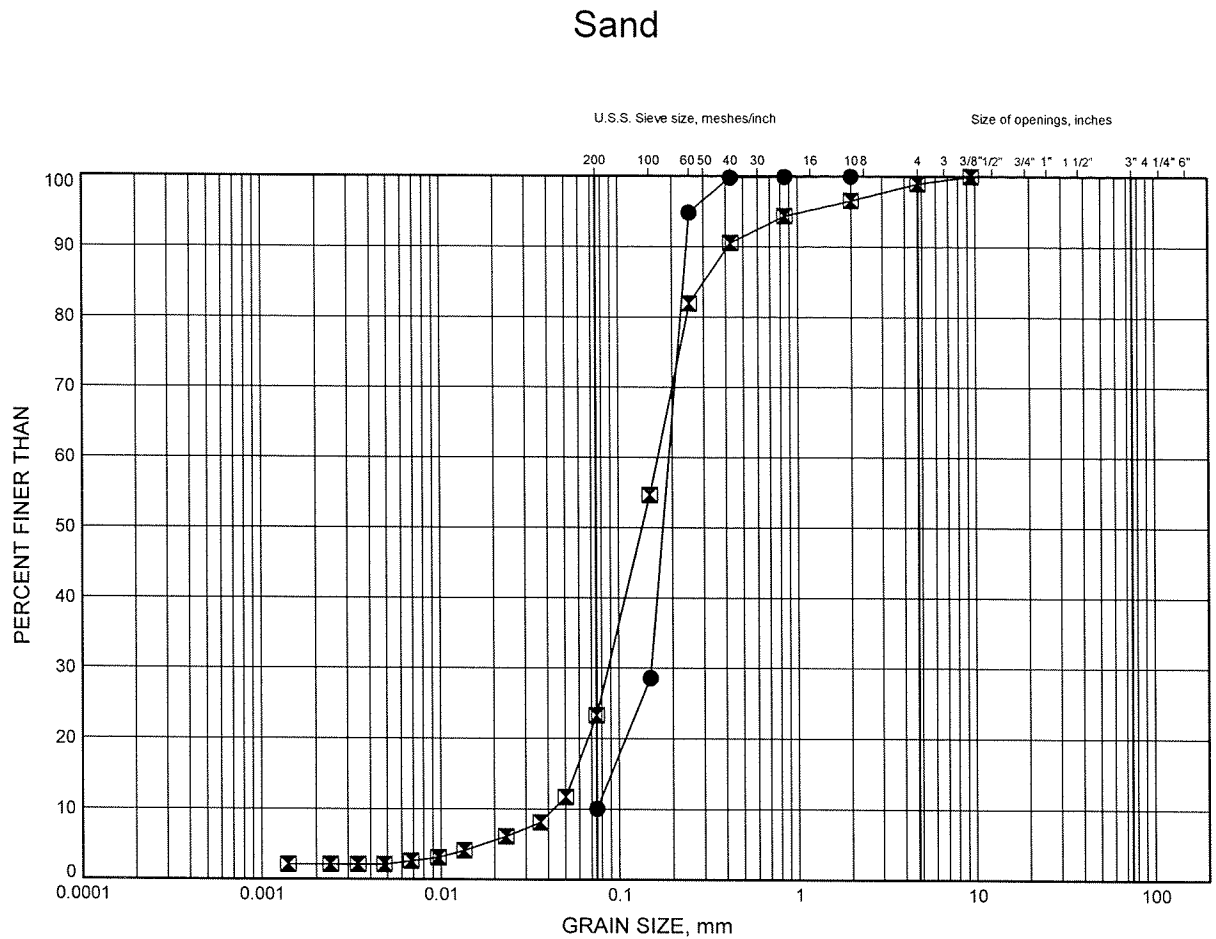
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/15/08

W.P.# 408-88-00
Prepared By MFA
Checked By RPR



Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B2



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-130	6.40	309.61
×	08-133	4.88	311.09

GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 9/15/08

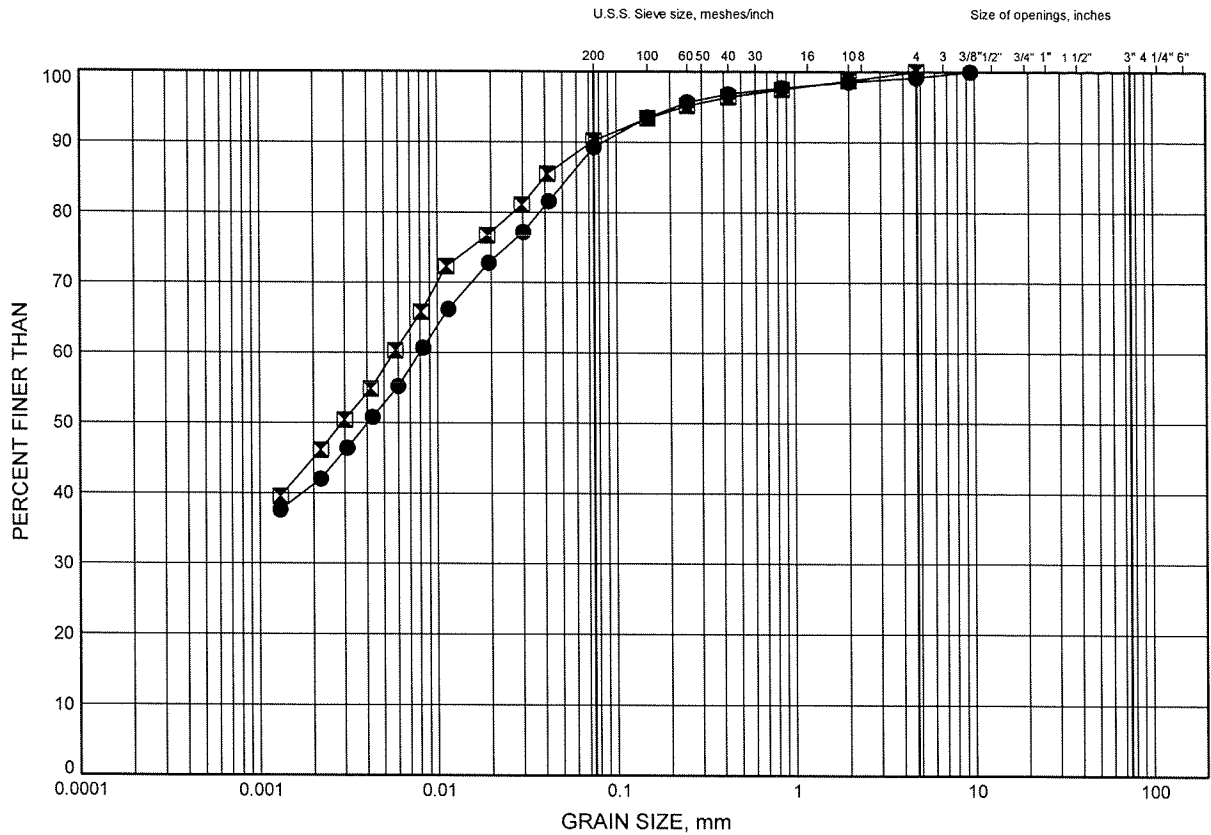
W.P.# 408-88-00
Prepared By MFA
Checked By RPR



Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty Clay Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-130	9.45	306.56
◻	08-132	9.45	307.77

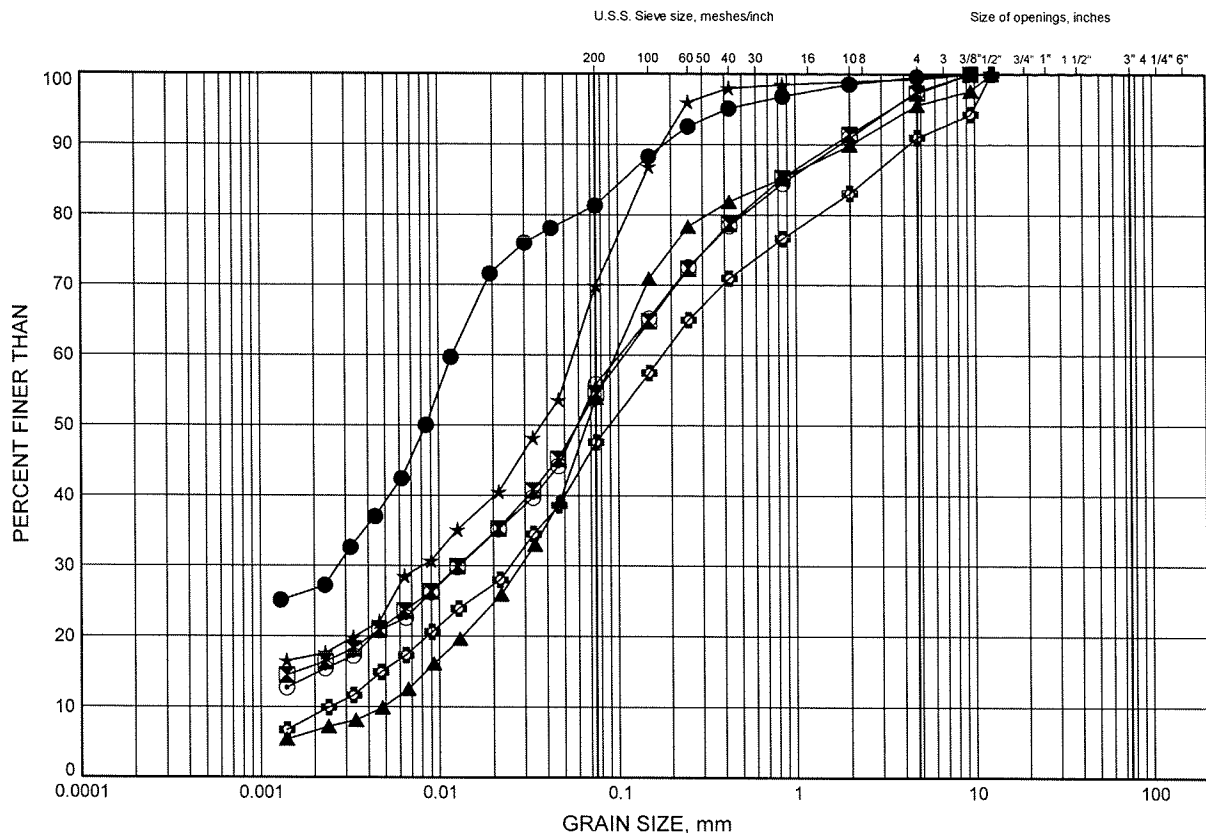


W.P.# 408-88-00
Prepared By MFA
Checked By RPR

Highway 7 - New GRAIN SIZE DISTRIBUTION

FIGURE B4

Sandy Silt Till



SILT and CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED	SAND			GRAVEL		

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-130	3.35	312.66
⊠	08-131	7.92	307.17
▲	08-131	10.83	304.26
☆	08-132	4.75	312.47
⊙	08-133	9.45	306.52
⊗	08-133	12.32	303.65



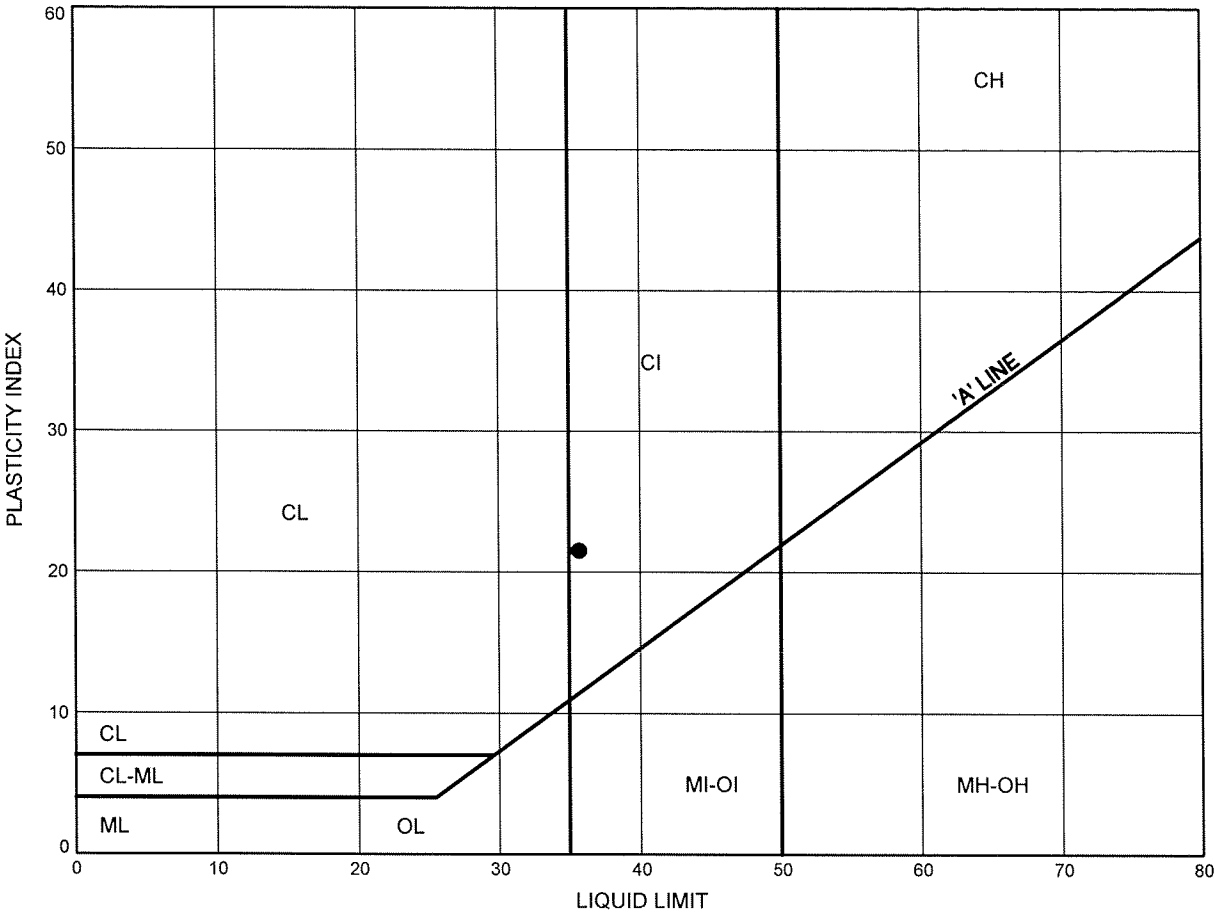
W.P.# 408-88-00
Prepared By MFA
Checked By RPR

Highway 7 - New

ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-132	9.45	307.77

Date September 2008
Project 408-88-00



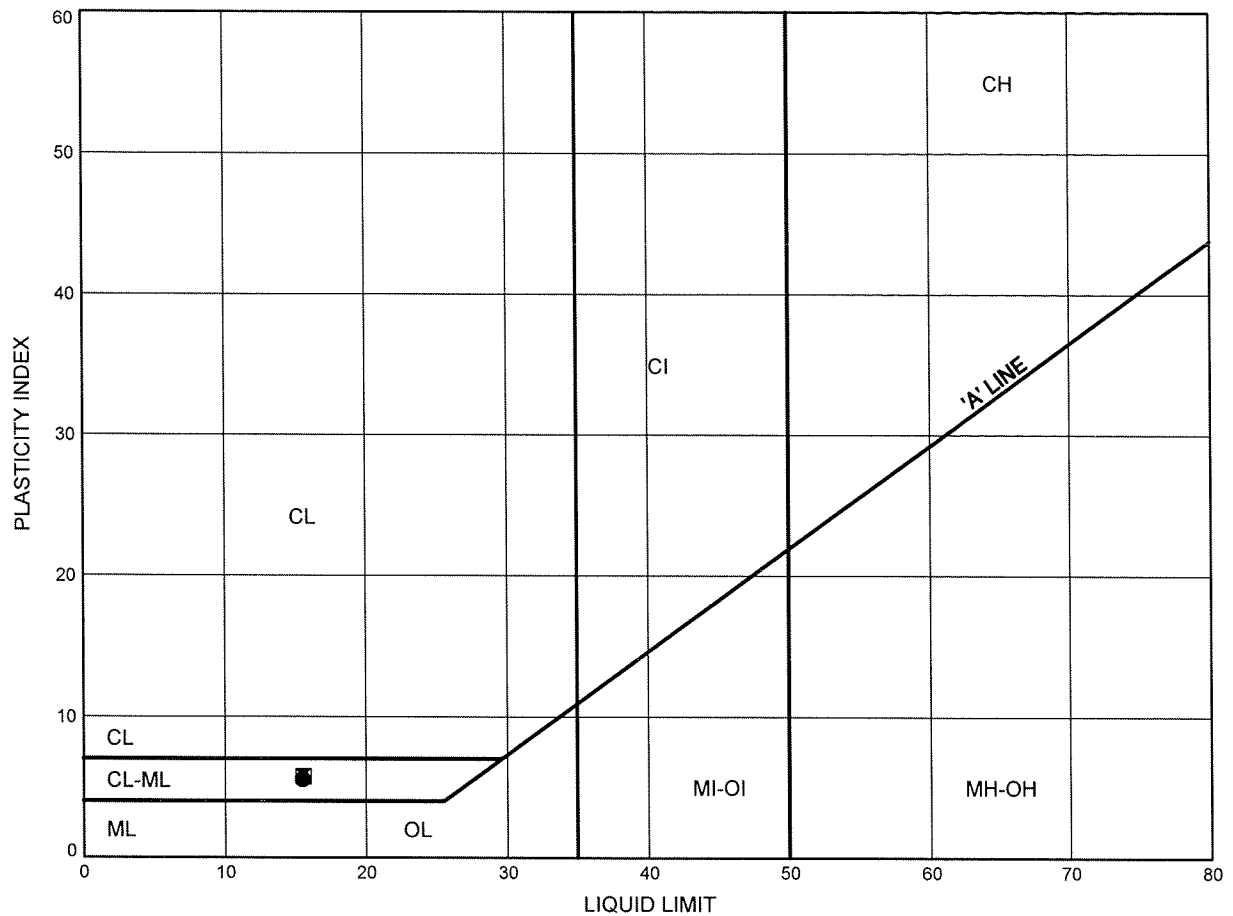
Prep'd MFA
Chkd. RPR

Highway 7 - New

ATTERBERG LIMITS TEST RESULTS

FIGURE B6

Sandy Silt Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-131	7.92	307.17
⊠	08-133	9.45	306.52

Date September 2008
 Project 408-88-00



Prep'd MFA
 Chkd. RPR



Appendix C

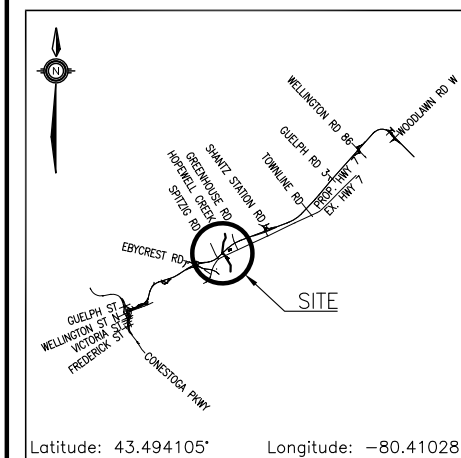
Borehole Locations and Soil Strata Drawing

CONT No
GWP No 408-88-00

SHEET

HIGHWAY 7
HOPEWELL CREEK
PROPOSED BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



Latitude: 43.494105°

Longitude: -80.410281°

KEYPLAN

LEGEND

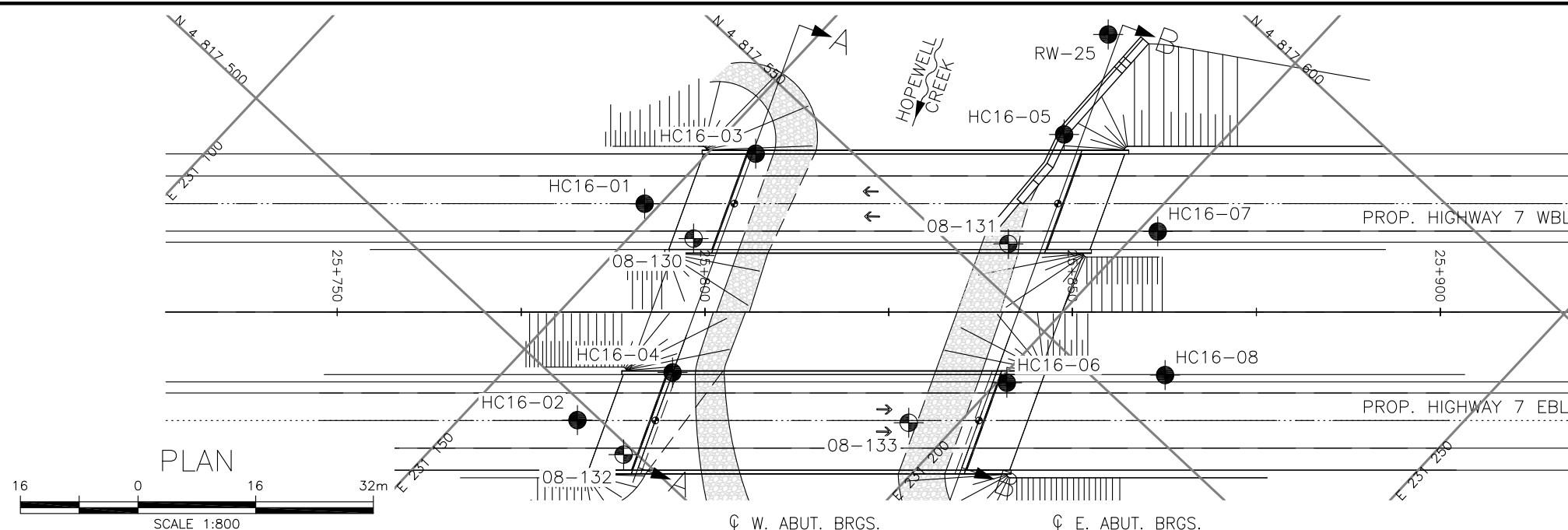
	Borehole (Current Investigation)
	Borehole (2008 Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HC16-01	314.6	4 817 525.6	231 148.4
HC16-02	317.4	4 817 497.9	231 161.8
HC16-03	313.6	4 817 540.9	231 154.8
HC16-04	316.5	4 817 511.4	231 166.9
HC16-05	313.8	4 817 571.4	231 183.7
HC16-06	313.4	4 817 541.5	231 201.0
HC16-07	314.1	4 817 570.5	231 202.0
HC16-08	313.9	4 817 556.9	231 216.0
RW-25	312.9	4 817 585.5	231 178.8
08-130	314.3	4 817 526.7	231 156.5
08-131	313.5	4 817 555.4	231 188.3
08-132	317.2	4 817 498.7	231 169.6

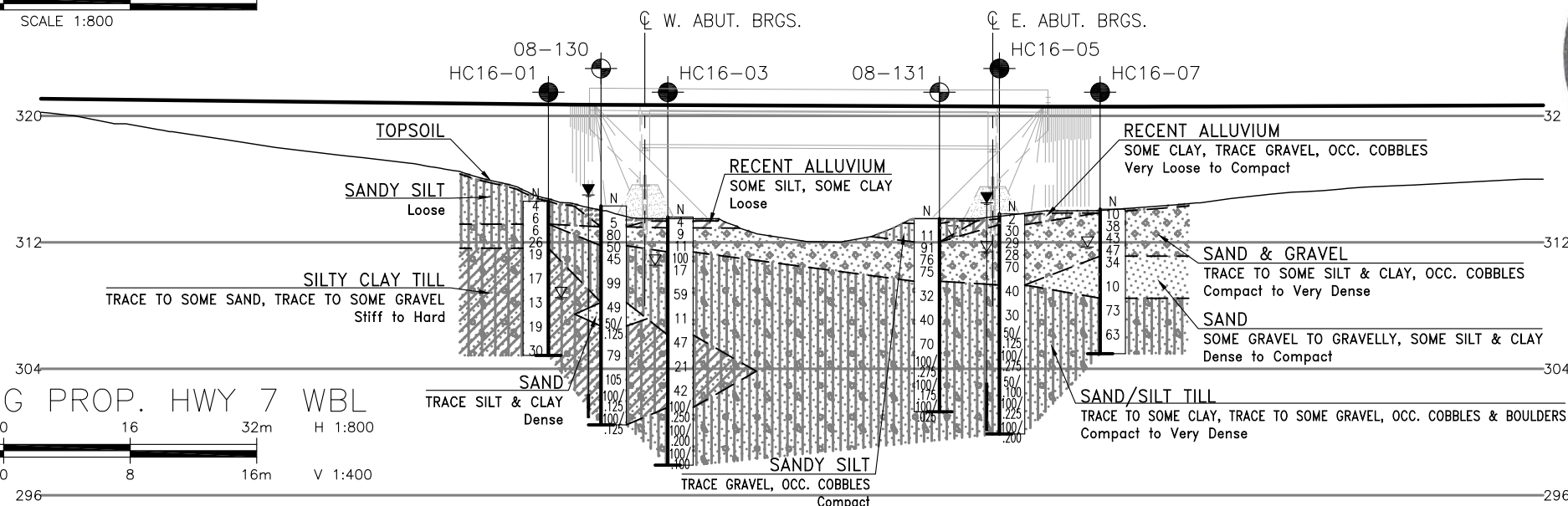
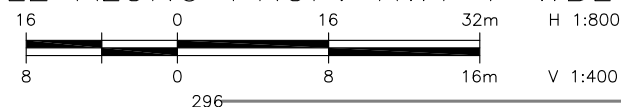
-NOTES-

- 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.

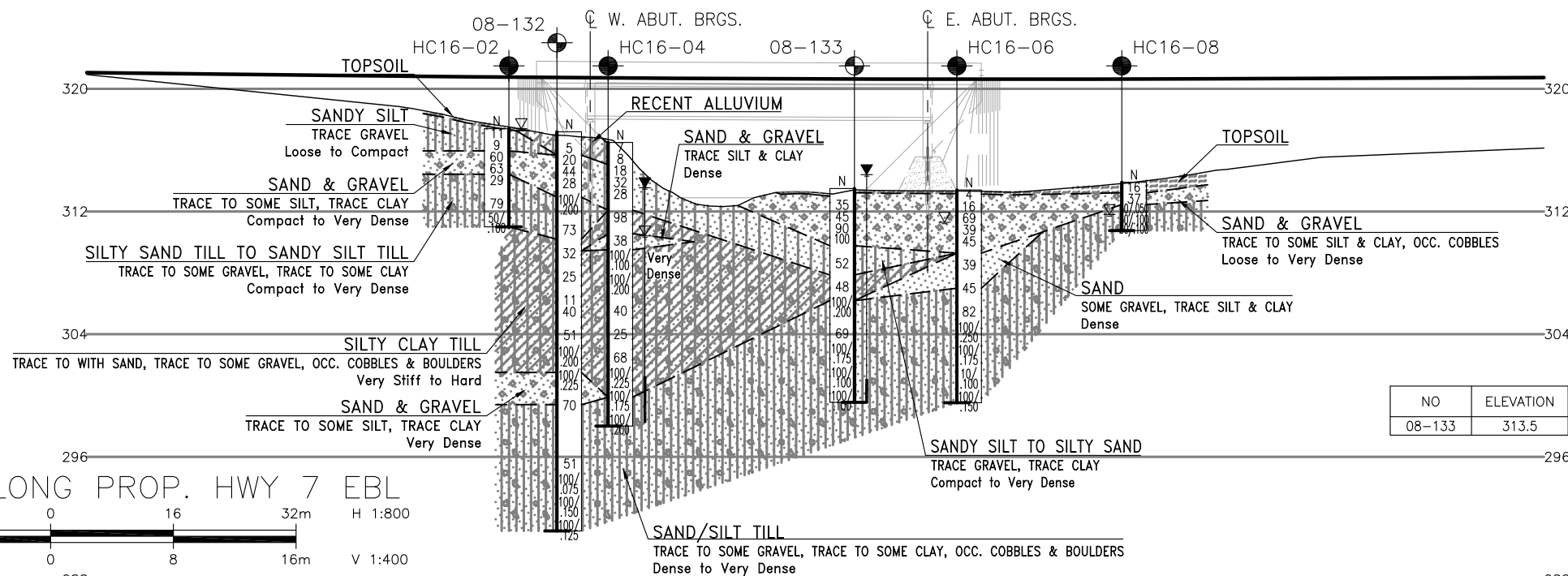
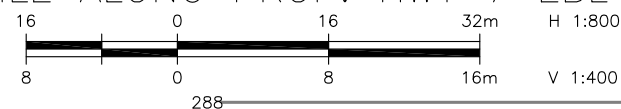
GEOCRES No. 40P9-57

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

PROFILE ALONG PROP. HWY 7 WBL

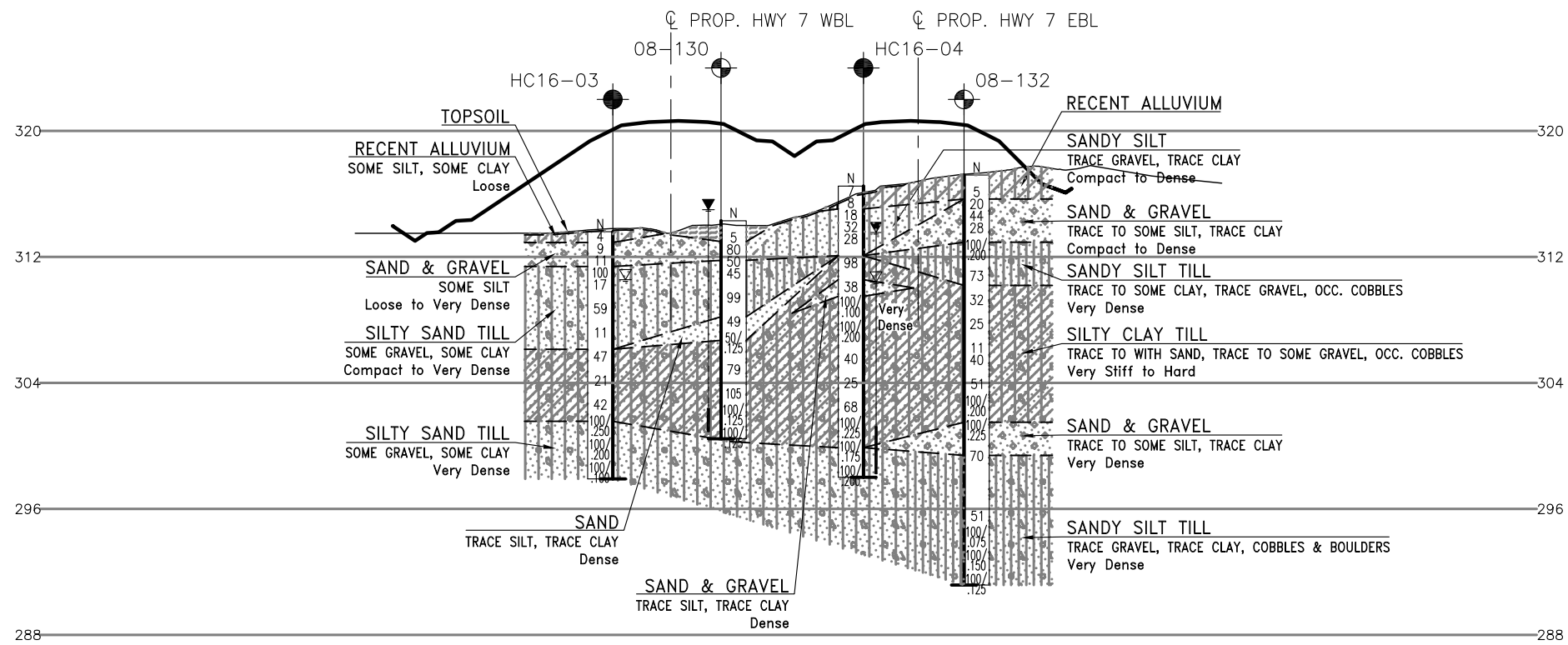


PROFILE ALONG PROP. HWY 7 EBL

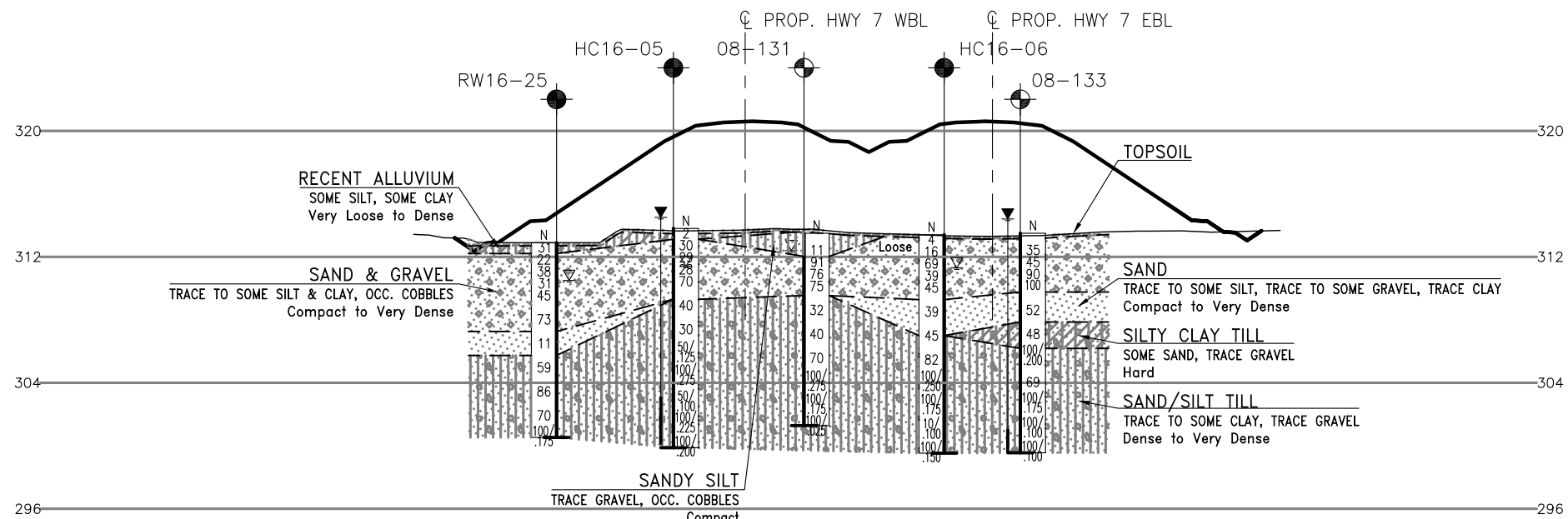
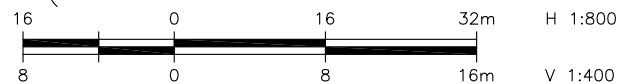


NO	ELEVATION	NORTHING	EASTING
08-133	313.5	4 817 528.4	231 195.0

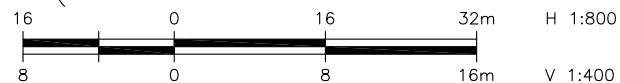
REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



SECTION A-A (WEST ABUTMENTS - WBL & EBL)



SECTION B-B (EAST ABUTMENTS - WBL & EBL)



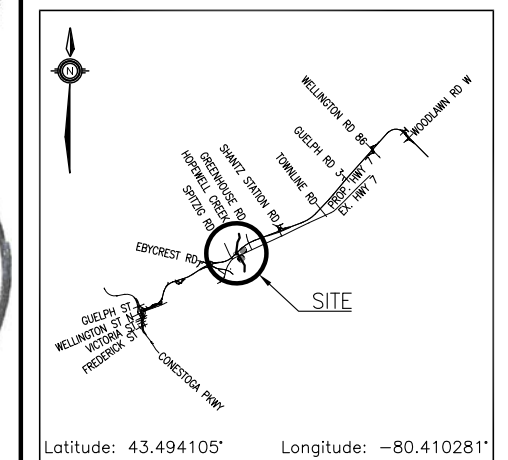
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
GWP No 408-88-00






HIGHWAY 7
HOPEWELL CREEK
PROPOSED BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



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
HC16-01	314.6	4 817 525.6	231 148.4
HC16-02	317.4	4 817 497.9	231 161.8
HC16-03	313.6	4 817 540.9	231 154.8
HC16-04	316.5	4 817 511.4	231 166.9
HC16-05	313.8	4 817 571.4	231 183.7
HC16-06	313.4	4 817 541.5	231 201.0
HC16-07	314.1	4 817 570.5	231 202.0
HC16-08	313.9	4 817 556.9	231 216.0
RW-25	312.9	4 817 585.5	231 178.8
08-130	314.3	4 817 526.7	231 156.5
08-131	313.5	4 817 555.4	231 188.3
08-132	317.2	4 817 498.7	231 169.6

-NOTES-

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

GEOCRES No. 40P9-57

NO	ELEVATION	NORTHING	EASTING
08-133	313.5	4 817 528.4	231 195.0

[illegible]