



**THURBER** ENGINEERING LTD.

**DETAILED FOUNDATION INVESTIGATION REPORT  
ALDER CREEK EAST CULVERT REPLACEMENT  
HIGHWAY 17, UNSURVEYED TERRITORY  
THUNDER BAY DISTRICT, ONTARIO  
LATITUDE: 48.7199017°, LONGITUDE: -85.709616°**

**G.W.P. 6810-14-00, W.P. 6330-14-01, SITE No. 48E-075C**

**GEOCRES Number: 42C-46**

**Report**

to

**HATCH**

Date: December 18, 2018  
File: 15595



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**PART 1: FACTUAL INFORMATION**

**1. INTRODUCTION**

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the detailed design of the proposed replacement of the Alder Creek East Culvert on Highway 17, located west of the town of White River, in the Unsurveyed District of Thunder Bay, Ontario. Thurber previously completed a preliminary foundation investigation at the culvert site in 2018.

The purpose of this investigation was to explore the subsurface conditions at the culvert location and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by Hatch to carry out this detailed foundation investigation under the Ministry of Transportation Ontario (MTO) Agreement Number 6016-E-0008.

The preliminary investigations were previously conducted by Thurber and Golder Associates and are described below:

- Preliminary Foundation Investigation and Design Report, Alder Creek East Culvert Replacement, Highway 17, Unsurveyed Territory, Thunder Bay District, Ontario, GEOCRES Number 42C-43, prepared by Thurber Engineering Ltd., dated September 11, 2018.
- Preliminary Foundation Investigation and Design Report, Alder Creek E. Culvert, Site No. 48E-75/C, Highway 17, District of Thunder Bay, Unsurveyed Territory, Ministry of Transportation, Ontario, G.W.P 6330-14-00" Geocres No. 42C-37, prepared by Golder Associates, dated October 30, 2015.

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The borehole logs from Thurber's previously completed preliminary investigation are included in this report. The Record of Borehole sheets and Borehole Locations and Soil Strata drawing from the Golder report have been enclosed in Appendix E of this report for reference, and the subsurface information presented in that report was incorporated in the current report, as appropriate. It should be noted that Golder is solely responsible for the subsurface information provided in the Preliminary Foundation Investigation Report. The borehole logs from the Golder report should be included in the tender documents.

## **2. SITE DESCRIPTION**

The site is located along Highway 17, approximately 39 km west of the town of White River, Ontario. Highway 17 generally runs in an east-west direction at the culvert site. Dunc Lake is located south of Highway 17 and Alder Creek East flows northerly from Dunc Lake.

Based on the Ontario Structure Inspection Manual (OSIM) prepared by MTO on November 20, 2014, the existing culvert is a corrugated steel pipe arch that is 3.9 m wide, 2.1 m high and 27.2 m long. The culvert barrel is in poor condition with medium corrosion on the bottom half of the culvert and rusted bolts. The culvert is sagging by approximately 0.2 m at the centre of the culvert and has excessive deformations at the outlet.

The estimated culvert invert is at approximate Elevation 324.1 m at the inlet (north) and 323.8 m at the outlet (south). The existing road grade at the culvert location is at approximate Elev. 327.4 m. The height of fill above the culvert is approximately 1.0 m to 1.5 m. The elevation of the water flowing through the culvert on May 20, 2014, was reported at approximately 325.1 m.

The area on either side of the creek near the inlet and outlet of the culvert is vegetated with tall grass, and shrubs. Photographs in Appendix D show the culvert and the surrounding area.

The site lies within the physiographic region known as the Wawa Subprovince of the Superior Province of the Canadian Shield. Based on OGS Map 2545, titled "Bedrock Geology of Ontario", dated 1991, the bedrock is of the Archean age and consists of intrusive rocks, mainly massive to foliated granodiorite and granite. The subsoils on site generally consist of an alluvial plain comprised mainly of sand and glacial till with a predominantly sand to silty sand matrix.

## **3. INVESTIGATION PROCEDURES**

The current investigation and field testing program was carried out between July 23 and August 1, 2018, and consisted of drilling and sampling three (3) boreholes, designated as Boreholes



18-15 to 18-17, to depths of between 8.6 m and 10.5 m below existing ground surface. Borehole 18-15 was drilled at the inlet of the existing culvert near the locations of the proposed cofferdam. Boreholes 18-16 and 18-17 were drilled within the paved portion of the Highway, approximately 10 m east and 10 m west, respectively, of the existing culvert, for temporary roadway protection measures and for the proposed diversion pipe.

The previous preliminary investigation completed by Thurber was carried out between July 14 and September 14, 2017, during which time four boreholes denoted as Boreholes 17-07 to 17-10 were advanced to depths of 3.7 and 15.2 m at selected locations at the culvert site. In order to investigate the depth and extent of peat near the culvert, additional peat probes were also conducted near the inlet and outlet of the culvert during Thurber's preliminary investigation.

The Record of Borehole sheets for the boreholes from the current and previous preliminary investigations are included in Appendix A. The approximate locations of the boreholes from both investigations are shown on the Borehole Locations and Soil Strata Drawings included in Appendix C.

Four boreholes were previously drilled at this location and recorded within the October 30, 2015 report by Golder Associates. These boreholes (denoted as AL-1 to AL-4) were advanced to depths between 6.4 and 11.8 m. Based on a review of the Golder Borehole Locations and Soil Strata drawing, and topographic information provided by Hatch (Plan E-484854-17-1), the ground surface Elevations at Boreholes AL-1 and AL-4 have been re-interpreted as 325.1 m and 325.5 m respectively.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were estimated from topographic drawings provided to Thurber by Hatch. The boreholes from the current investigation were drilled using a truck-mounted drill rig for Boreholes 18-16 and 18-17, and a portable Hilti drill and tripod equipment for Borehole 18-15. The boreholes were advanced using wash boring techniques to depths between 8.6 m and 10.5 m. In all boreholes, soil samples were obtained at selected intervals using a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT), or from auger cuttings for surficial material.

The field investigation was supervised on a full-time basis by a member of Thurber's technical staff who directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.



The groundwater level was measured within the open boreholes completed by Thurber upon completion of drilling. The boreholes were backfilled in general accordance with Ontario Regulation 903, as amended by Regulation 128/03.

Details of the borehole completion are summarized as follows:

Borehole Number	Borehole Depth / Base Elevation (m)	Completion Details
18-15	8.6/316.9	Borehole backfilled with filter sand and bentonite holeplug to surface.
18-16	10.5/316.8	Borehole caved to 3.4 m then backfilled with bentonite holeplug to 2.4 m, sand to 0.2 m, then asphalt to surface.
18-17	9.8/317.7	Borehole caved to 7.6 m then backfilled with bentonite holeplug to 3.0 m, sand to 0.2 m, then asphalt to surface.
17-07	15.2/310.1	Borehole backfilled with bentonite holeplug and cuttings to surface
17-08	3.7/323.8	Borehole backfilled with cuttings to 0.1 m, then cold patch asphalt to surface
17-09	3.7/323.9	Borehole backfilled with cuttings to 0.1 m, then cold patch asphalt to surface
17-10	3.7/323.9	Borehole backfilled with cuttings to 0.1 m, then cold patch asphalt 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 distribution analyses (hydrometer and/or sieve). Laboratory testing results are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the



potential for corrosion associated with the structure, a sample of the native silt, and a sample of the surface water from the lake upstream of the existing culvert were collected during Thurber's preliminary investigation and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters. The results of the analytical testing are summarized in this report and also presented in Appendix B.

## **5. DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and Appendix E. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the subsurface conditions encountered in these boreholes beneath the asphalt and sand to silty sand embankment fill consisted of native sand to silt deposits overlying a sand and silt till. Peat was also encountered at the ground surface in the boreholes near the culvert inlet and outlet. Descriptions of the individual strata are presented below.

### **5.1 Asphalt**

Asphalt was encountered at the surface in Boreholes AL-2, AL-3, 17-08, 17-09, 17-10, 18-16 and 18-17. The thickness of the asphalt ranged from 100 mm to 325 mm.

### **5.2 Silty Sand to Sand Fill**

Silty sand to sand with some silt fill, containing trace gravel to becoming gravelly and trace clay, was encountered below the pavement structure in Boreholes AL-2, AL-3, 17-08 to 17-10, 18-16, and 18-17. The fill was approximately 2.2 m to 4.7 m thick and extended to Elevations 325.2 m to 322.7 m.

SPT 'N' values within the fill layer ranged from 9 to 93 blows per 0.3 m of penetration, indicating a loose to very dense relative density. Measured moisture contents within the fill varied between 4 percent and 16 percent.

The results of grain size distribution analyses carried out on samples of the sand to silty sand fill are presented on the Record of Borehole sheets included in Appendices A and E and on Figure B1 of Appendix B. The results of the grain size distribution analyses are summarized below:

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Soil Particle	Percentage (%)
Gravel	8 to 28
Sand	43 to 74
Silt	28 to 33
Clay	5 to 6
Silt and Clay	11 to 28

### 5.3 Peat

A layer of black silty to sandy peat was encountered as the surface layer in Boreholes 18-15, 17-07, AL-1 and AL-4. The layer ranged in thickness from 0.3 m to 2.7 m and extended to Elevations 322.4 m to 325.2 m.

Additional peat probes were conducted up to 25 m to the east and west of the culvert inlet and outlet. The depth of the assumed base of the peat varied from approximately 0.5 m to 1.5 m at the inlet, and 0.4 m to 1.3 m at the outlet. At both the inlet and outlet, the thickness of the peat decreased with increased distance from the culvert. The approximate locations of the peat probes are shown on the Borehole Locations and Soil Strata drawing in Appendix C. The depths to the assumed base of the pear are summarized in the following table:

Peat Probe Number	Approximate Location	Depth to Assumed Base of Peat (m)
P1	25 m West of Culvert Outlet	0.4
P2	15 m West of Culvert Outlet	0.9
P3	5 m West of Culvert Outlet	1.0
P4	5 m East of Culvert Outlet	1.3
P5	15 m East of Culvert Outlet	1.1
P6	25 m East of Culvert Outlet	0.8
P7	25 m West of Culvert Inlet	0.6
P8	15 m West of Culvert Inlet	1.3
P9	5 m West of Culvert Inlet	1.5
P10	5 m East of Culvert Inlet	1.4
P11	15 m East of Culvert Inlet	1.2
P12	25 m East of Culvert Inlet	0.5





SPT 'N' values within the peat ranged from 1 to 10 blows per 0.3 m of penetration, indicating a very soft to firm/compact consistency. Higher SPT 'N' values of 15 and 25 were also recorded but were likely due to frozen ground at the time of the Golder investigation. Moisture contents between 48 percent and 58 percent were measured in the peat.

#### **5.4 Sand to Silt**

Sand with some silt ranging to silt with trace sand, containing trace gravel, trace clay, and occasional cobbles was encountered in all boreholes at depths of between 0.3 m to 4.9 m (Elevations 325.2 m to 322.4 m). Where fully penetrated the sand to silt layer was approximately 2.3 m to 7.9 m thick and extended to depths of between 4.5 m and 10.2 m (Elevations 321.0 m to 316.6 m). Boreholes 17-08 to 17-10 and AL-1 were terminated within the sand to silt layer at depths of between 3.7 m and 8.2 m (Elevations 323.9 m to 316.9 m).

Boulders were encountered in the sand to silt layers in Boreholes 17-07, 18-15 and 18-16 at depths of between 5.2 m and 6.9 m. Where measured, the boulder diameters ranged from 0.6 m to 0.9 m.

The SPT 'N' values for the silt to sand ranged from 2 to 98 blows per 0.3 m penetration with typical values between 4 to 30 blows indicating a loose to compact condition. The silt to sand had a measured moisture content ranging from 6 percent to 36 percent. A higher moisture content of 60 percent was recorded in Borehole 18-15 and is likely due to the presence of organics.

The results of grain size distribution analyses carried out on selected samples of the sand to silt are presented on the Record of Borehole sheets included in Appendices A and E and on Figure B2 and B3 of Appendix B. The results of the grain size distribution analyses are summarized below:

<b>Soil Particle</b>	<b>Percentage (%)</b>
Gravel	0 to 12
Sand	2 to 82
Silt	38 to 95
Clay	0 to 8
Silt and Clay	17



## 5.5 Sand and Silt to Silty Sand Till

Sand and silt to silty sand till, containing trace clay to becoming clayey, trace to some gravel, and occasional cobbles, was encountered in Boreholes 18-15 to 18-17, 17-07, and AL-2 to AL-4 at depths of between 4.5 m to 10.2 m (Elevations 321.0 m to 316.6 m). These boreholes were terminated within the sand and silt to silty sand till at depths of between 6.4 m to 15.2 m (Elevations 319.1 m to 310.1 m).

The SPT 'N' values recorded in the sand and silt to silty sand till ranged from 8 to greater than 100 blows per 0.3 m penetration indicated a loose to very dense relative density. The sand and silt to silty sand till had a measured moisture content ranging from 8 percent to 16 percent.

The results of grain size distribution analyses and an Atterberg Limit carried out on selected samples of the sand and silt to silty sand till are presented on the Record of Borehole sheets included in Appendices A and E and on Figures B4 and B5 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 50
Sand	31 to 37
Silt	13 to 55
Clay	1 to 27

The results of Atterberg Limits testing are summarized below:

Index Property	Percentage (%)
Plastic Limit	11
Liquid Limit	21
Plasticity Index	10

The results of the Atterberg Limit test indicate the layer to be of low plasticity with group symbols CL.

## 5.6 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. The groundwater levels are summarized below:



Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
18-15	August 1, 2018	0.7	324.8	Open borehole
18-16	July 24, 2018	2.0	325.3	Open borehole
18-17	July 23, 2018	2.4	325.1	Open borehole
17-07	September 12, 2017	0.3	325.0	Open borehole
17-08	June 14, 2017	2.1	325.4	Open borehole
17-09	June 14, 2017	2.4	325.2	Open borehole
17-10	June 14, 2017	Dry	Dry	Open borehole
AL-01	April 7, 2015	1.0	324.1	Open borehole
AL-02	March 17, 2015	2.9	324.7	Open borehole
AL-03	March 17, 2015	3.0	324.2	Open borehole
AL-04	April 7, 2015	0.8	324.7	Open borehole

The creek water level on May 20, 2014 was reported to be Elev. 325.1 m upstream and downstream of the outlet.

The groundwater levels above are short-term readings, and seasonal fluctuations of the groundwater levels are to be expected. In particular, 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 native silt from Borehole 17-07 and a sample of the creek water were submitted for analytical testing of corrosivity parameters and sulphate during the preliminary investigation. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



**Table 6.1 – Analytical Test Results**

Parameter	Units (Soil)	Units (Water)	Test Results	
			17-07, SS#6, 4.6 m – 5.2 m	Alder Creek East
			(Silt)	(Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	mg/L	mg/L	1000	23
Sulphate	mg/L	mg/L	73	1.5
pH	No unit	No unit	8.60	7.90
Electrical Conductivity	µS/cm	µS/cm	1090	170
Resistivity	Ohms.cm	Ohms.cm	910	5880
Redox Potential	mV	mV	196	291

## 7. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained subsurface utility clearances prior to drilling.

Downing Drilling of Hawkesbury, Ontario and OGS of Almonte, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the current field investigation. The field investigation was supervised on a full-time basis by Mr. Liam Steers and Mr. Ryan McCourt of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

Thurber obtained the northing and easting coordinates and ground surface elevations from measurements taken in the field relative to the topographic plans provided by Hatch. The coordinate system MTM NAD83 Zone 14 was used for these boreholes.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory. Interpretation of the field data and preparation of this report was carried out by Mr. Cory Zanatta, P.Eng. and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



Thurber Engineering Ltd.



Cory Zanatta, P.Eng.  
Geotechnical Engineer



Mark Farrant, P.Eng.  
Geotechnical Engineer



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



## **Appendix A**

### **Record of Borehole Sheets**

## SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

### 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

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

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

NOTE: Hierarchy of Soil Strength Prediction

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



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

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level  
 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 <sub>L</sub> < 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 <sub>L</sub> < 30%).
		CI	Inorganic clays of medium plasticity, silty clays. (30% < W <sub>L</sub> < 50%).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS W <sub>L</sub> > 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			



# RECORD OF BOREHOLE No 18-15

1 OF 1

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 625.4 E 399 727.7 ORIGINATED BY LS  
DIST Thunder Bay HWY 17 BOREHOLE TYPE Wash Boring COMPILED BY MP  
DATUM Geodetic DATE 2018.07.31 - 2018.08.01 LATITUDE LONGITUDE CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
325.5	GROUND SURFACE							20	40	60	80	100							
0.0	<b>PEAT</b> , silty to sandy, trace gravel, trace organics, trace rootlets Soft Brown Moist		1	SS	3		325												
325.2																			
0.3																			
	<b>SILT</b> and <b>SAND</b> , trace gravel, trace organics, trace clay Loose to Compact Brown Moist to Wet		2	SS	9														4 53 39 4
			3	SS	24			324											
323.7																			
1.8	<b>SAND</b> , some silt, trace gravel Very Loose Brown to Grey Wet		4	SS	4			323											
	Some organics at 2.9m to 3.0m		5	SS	3														1 82 17 (SI+CL)
322.5			5B	SS															
3.0	<b>SILT</b> , trace to some sand, trace clay Compact Brown to Grey Wet		6	SS	18		322											0 8 85 7	
							321												
			7	SS	19														
							320												
	Boulder at 6.1m																		
319.3																			
6.2	<b>SILT</b> and <b>SAND</b> , clayey, trace gravel Very Stiff to Hard Grey Wet (TILL)		8	SS	20		319												
	Boulder at 7.6m						318												
			9	SS	180		317											0 37 36 27	
316.9																			
8.6	END OF BOREHOLE AT 8.6m ON CASING REFUSAL. WATER LEVEL AT 0.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH FILTER SAND AND BENTONITE HOLEPLUG TO SURFACE.																		

ONTMT452 MTO-15595 GPJ 2017TEMPLATE(MTO).GDT 11/1/18

# RECORD OF BOREHOLE No 18-16

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 639.5 E 399 742.6 ORIGINATED BY BRM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE LONGITUDE CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
327.3	GROUND SURFACE												
0.0	ASPHALT (100mm)												
327.0	Gravelly <b>SAND</b> , some silt Very Dense Brown Moist (FILL)		1	SS	77		327						28 61 11 (SI+CL)
0.3	Silty <b>SAND</b> , with gravel to some gravel, trace clay Very Dense Brown Moist (FILL)		2	SS	60		326						
			3	SS	60		325						24 43 28 5
324.9							324						
2.4	<b>SILT</b> , some peat, some sand, trace gravel Compact to Dense Black to Brown Wet		4	SS	29		323						
			5	SS	16		322						
							321						
322.1			6	SS	34		320						
5.2	<b>BOULDER</b>						319						
321.2							318						
6.1	<b>SAND</b> and <b>SILT</b> , some gravel, trace clay Compact to Very Dense Grey Wet		7	SS	24								
			8	SS	98								12 41 39 8
319.1													
8.2	<b>SAND</b> and <b>SILT</b> , some clay to clayey, trace gravel, occasional cobbles and boulders Very Dense Dark Grey Moist (TILL)												
			9	G									

Continued Next Page

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

# RECORD OF BOREHOLE No 18-16

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 639.5 E 399 742.6 ORIGINATED BY BRM  
 DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing COMPILED BY MP  
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE LONGITUDE CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
316.8			10	SS	50/		317									4 34 37 25	
10.5	END OF BOREHOLE AT 10.5m. WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE CAVED TO 3.4m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4m, SAND TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.				0.100												

# RECORD OF BOREHOLE No 18-17

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 640.0 E 399 719.5 ORIGINATED BY BRM  
DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing COMPILED BY MP  
DATUM Geodetic DATE 2018.07.23 - 2018.07.23 LATITUDE LONGITUDE CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>P</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
327.5	GROUND SURFACE															
0.0	ASPHALT (100mm)		1	SS												
0.1	Silty SAND, some gravel, trace clay Very Dense to Compact Light Brown to Grey Moist (FILL)		2	SS	80											17 55 28 (SI+CL)
			3	SS	20											
325.2																
2.3	SILT and SAND, trace gravel, trace clay Compact to Loose Brown to Grey Wet		4	SS	19											6 47 39 8
			5	SS	4											
			6	SS	5											
321.4																
6.1	SILT, trace sand, trace clay Loose Grey Wet		7	SS	9											0 2 91 7
319.9																
7.6	Silty SAND, some gravel, trace clay Compact Grey Moist (TILL)		8	SS	19											
			9	SS	17											
317.7																
9.8	END OF BOREHOLE AT 9.8m.															

Continued Next Page

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

## METRIC

[illegible]

# RECORD OF BOREHOLE No 17-07

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 650.8 E 399 721.8 ORIGINATED BY TTB  
 HWY 17 BOREHOLE TYPE Hilti Portable/Wash Boring/Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.09.12 - 2017.09.14 CHECKED BY NLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%) w <sub>P</sub> w      w <sub>L</sub>				GR	SA	SI	CL		
325.3	GROUND SURFACE					▽															
0.0	<b>PEAT</b> , silty, trace sand, trace clay Compact Brown Wet		1	SS	10		325														
324.5																					
0.8	Silty <b>SAND</b> , trace gravel Compact Grey Wet		2	SS	10		324							○							
			3	SS	13									○							
323.1																					
2.2	<b>SILT</b> , trace to some sand, trace clay, trace gravel, occasional cobbles Compact Grey Wet		4	SS	25		323							○							
			5	SS	22		322							○				0	2	91	7
								321													
			6	SS	14									○							
								320													
	Trace clay																				
			7	SS	19	319							○				0	17	75	8	
318.4																					
6.9	<b>BOULDER</b>		1	GS		318															
317.8																					
7.5	<b>SILT</b> , some sand, trace gravel Compact Grey Wet		8	SS	14	317							○								
316.6			2	GS																	
8.7	<b>SILT</b> and <b>SAND</b> , trace to some clay, trace gravel, occasional cobbles and boulders Very Dense (TILL)																				
			9	SS	100/ 0.100	316							○								

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 17-07

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 650.8 E 399 721.8 ORIGINATED BY TTB  
 HWY 17 BOREHOLE TYPE Hilti Portable/Wash Boring/Coring COMPILED BY AN  
 DATUM Geodetic DATE 2017.09.12 - 2017.09.14 CHECKED BY NLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								20 40 60 80 100									20 40 60		
Continued From Previous Page																			
310.1 15.2	<b>SILT</b> and <b>SAND</b> , trace to some clay, trace gravel, occasional cobbles and boulders Very Dense Grey Moist (TILL)						315								6 34 38 22				
			10	SS	100/ 0.125														
			3	GS															
			11	SS	50/ 0.025														
			4	GS															
			12	SS	100/ 0.050														
			13	SS	50/ 0.0														
			END OF BOREHOLE AT 15.2m. BOREHOLE OPEN AND WATER LEVEL AT 0.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

# RECORD OF BOREHOLE No 17-08

1 OF 1

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 638.7 E 399 742.7 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
327.5	GROUND SURFACE																
0.0	ASPHALT: (300mm)																
327.2																	
0.3	SAND, some silt, trace gravel Brown Moist (FILL)		1	GS													
324.7																	
2.8	SAND and SILT, trace clay, trace peat Compact Dark Brown Wet		2	GS												0 56 38 6	
			1	SS	12												
323.8																	
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.																

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 17-09

1 OF 1

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 640.6 E 399 752.6 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>P</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE								
327.6	GROUND SURFACE							20	40	60	80	100				
0.0	ASPHALT: (325mm)															
327.3																
0.3	Silty SAND, trace gravel, trace clay Brown Moist to Wet (FILL)		1	GS			327									8 53 33 6
			2	GS			326									
							325									
324.6																
3.0	SAND and SILT, trace gravel Dense Grey Wet		1	SS	31											
323.9																
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.															

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

# RECORD OF BOREHOLE No 17-10

1 OF 1

METRIC

W.P. 6330-14-01 LOCATION Alder Creek East Culvert, MTM NAD 83 Zone 14 N 5 398 642.3 E 399 762.4 ORIGINATED BY ES  
 HWY 17 BOREHOLE TYPE Solid Stem Augers COMPILED BY AB  
 DATUM Geodetic DATE 2017.07.14 - 2017.07.14 CHECKED BY NLB

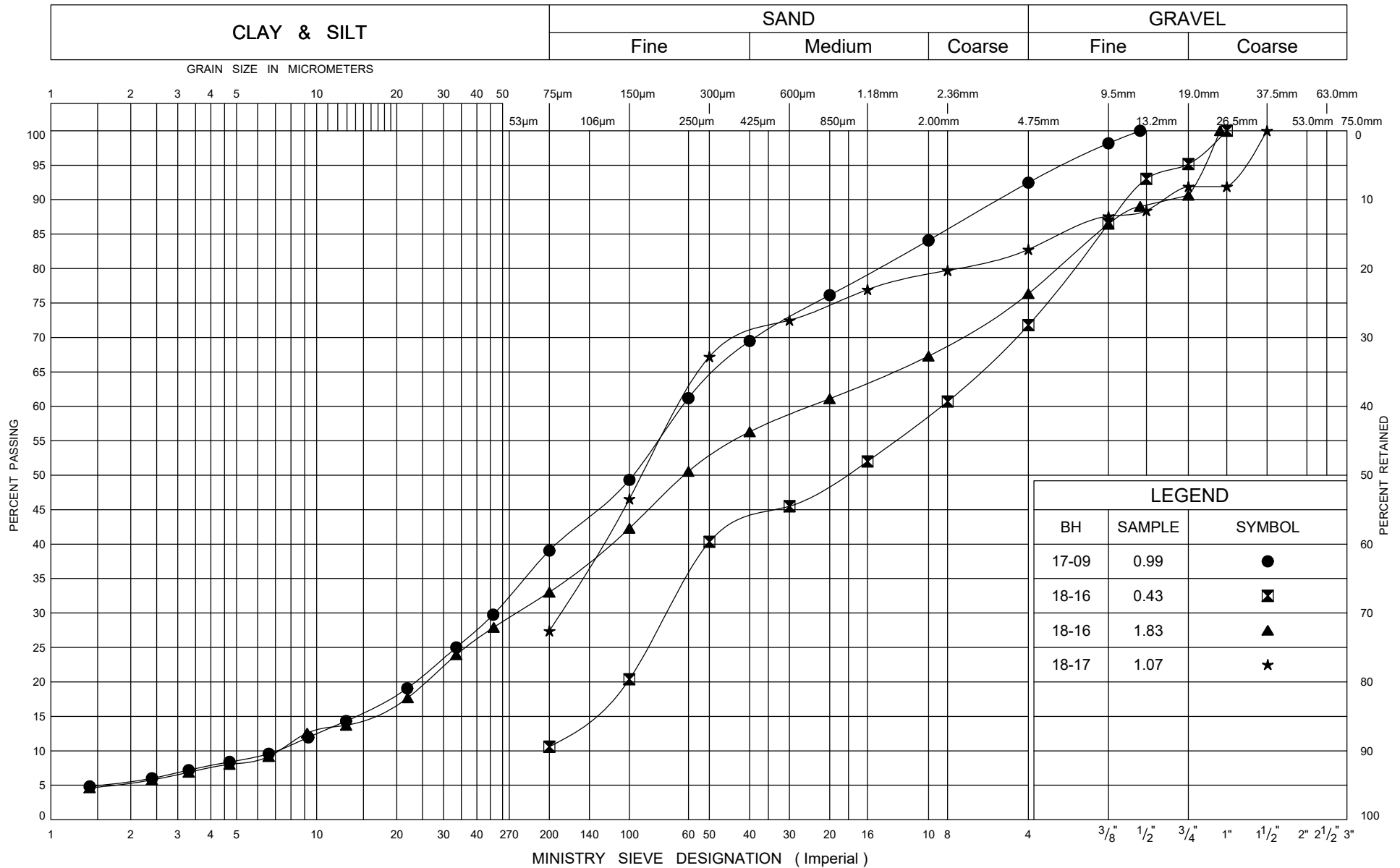
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							PLASTIC LIMIT w <sub>P</sub> NATURAL MOISTURE CONTENT w      LIQUID LIMIT w <sub>L</sub>			
327.6	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT: (300mm)																	
327.3																		
0.3	SAND, some silt, trace gravel Brown Moist (FILL)		1	GS			327											
							326											
324.9							325											
2.7	SAND and SILT, trace clay, occasional cobbles Dense Grey to Brown Wet		2	GS														
			1	SS	42													0 55 38 7
323.9							324											
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.																	

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



## **Appendix B**

### **Laboratory Test Results**



Ministry of  
Transportation

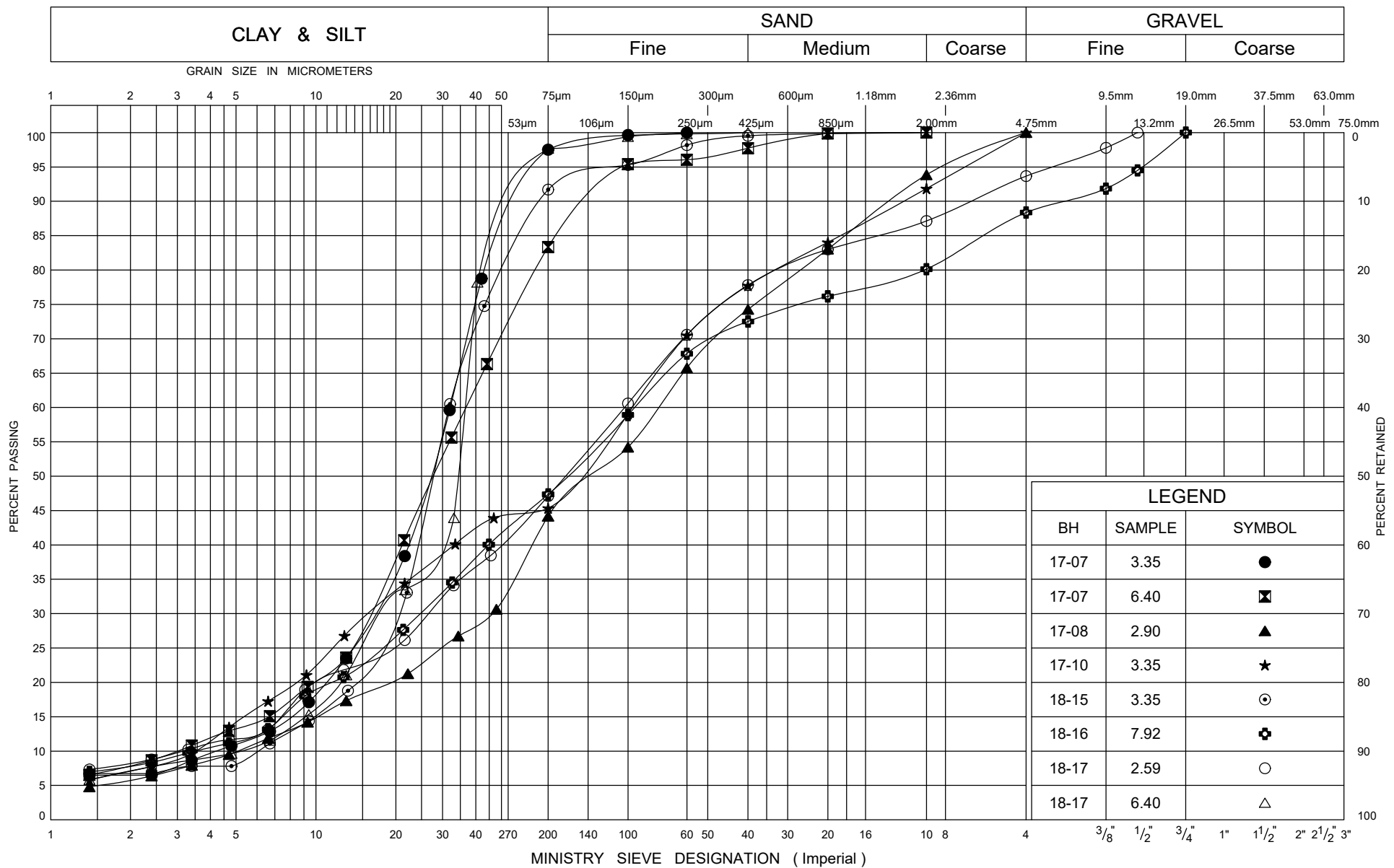
## GRAIN SIZE DISTRIBUTION

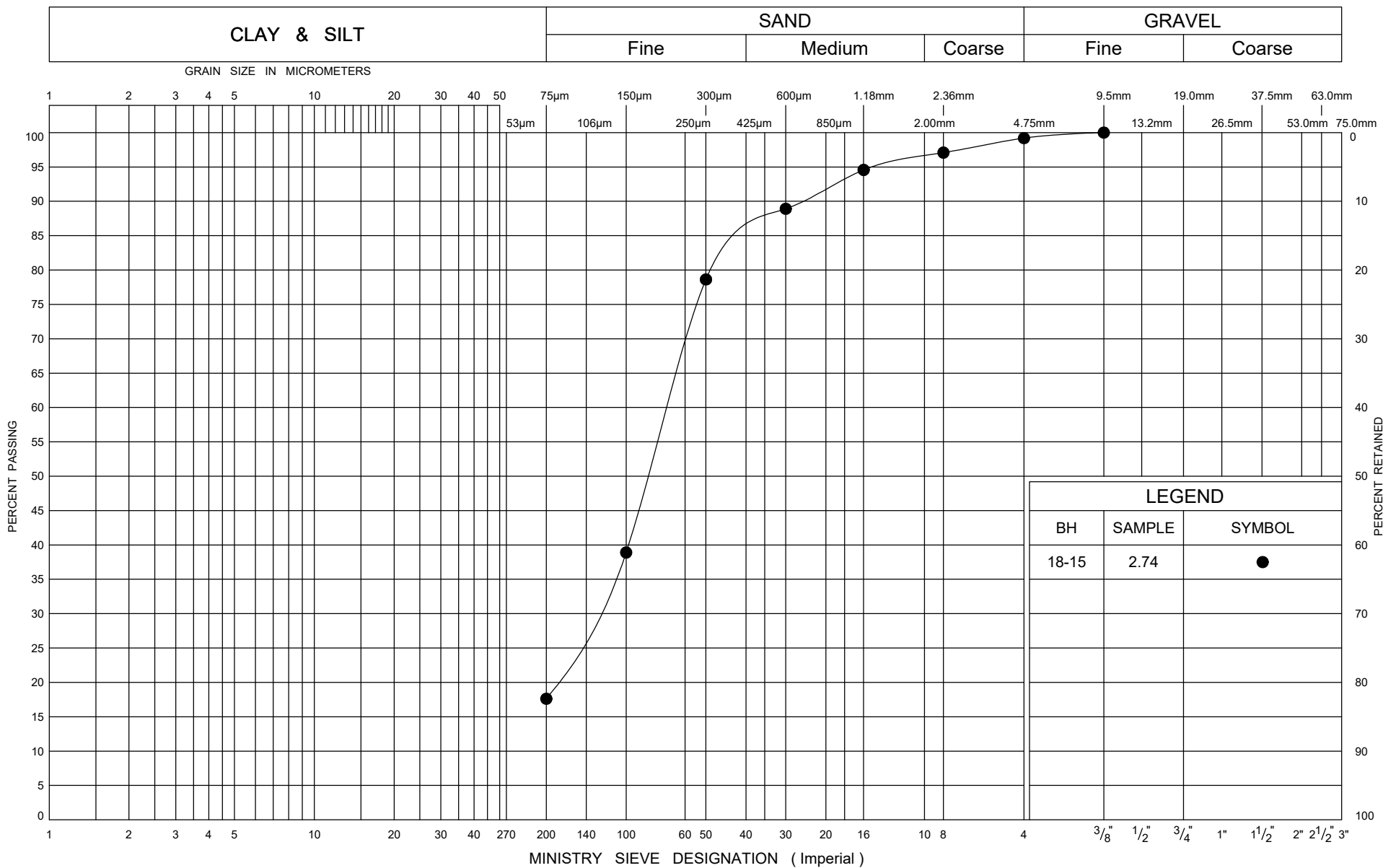
Silty SAND to Silty SAND FILL

FIG No B1

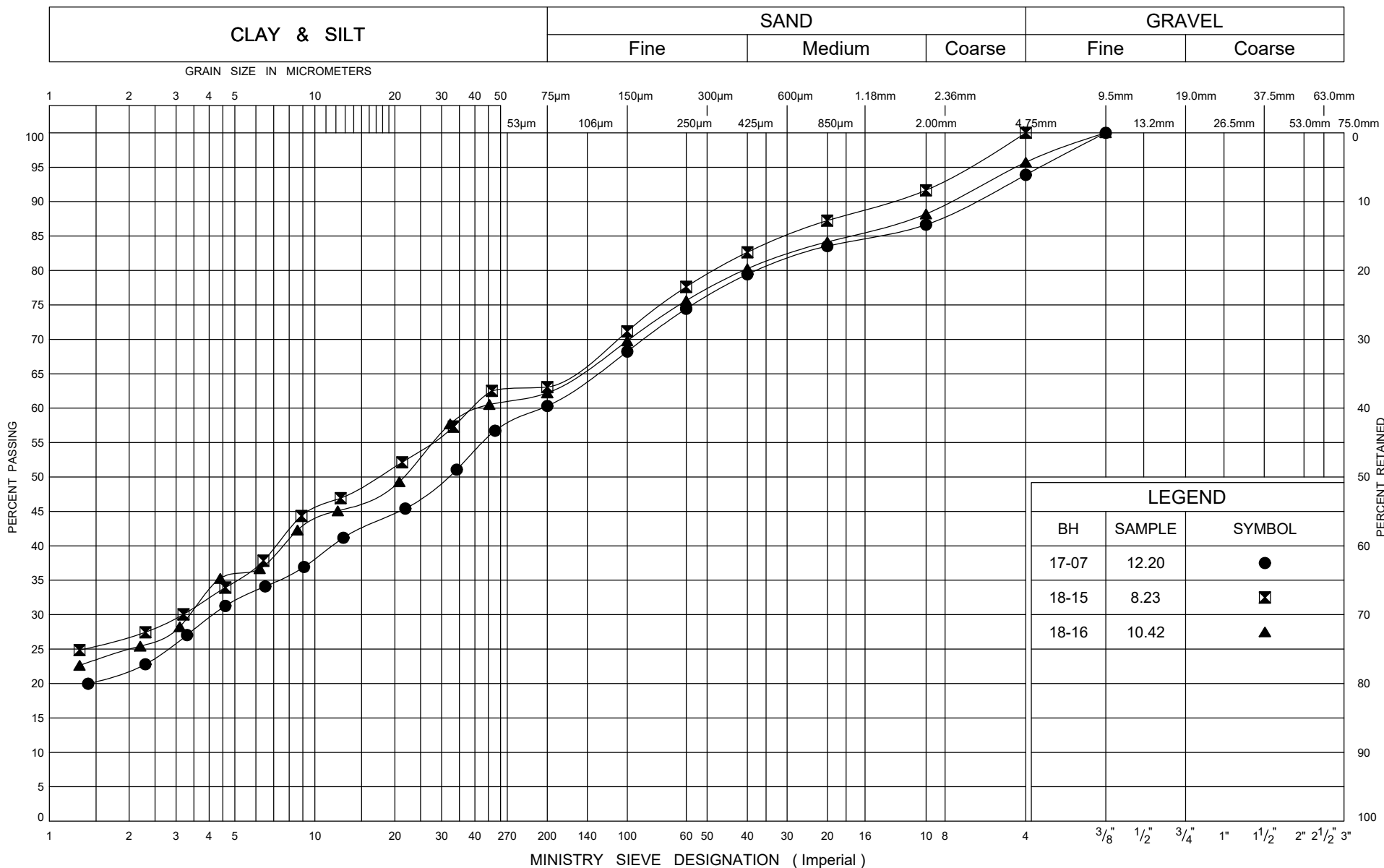
W P 6330-14-01

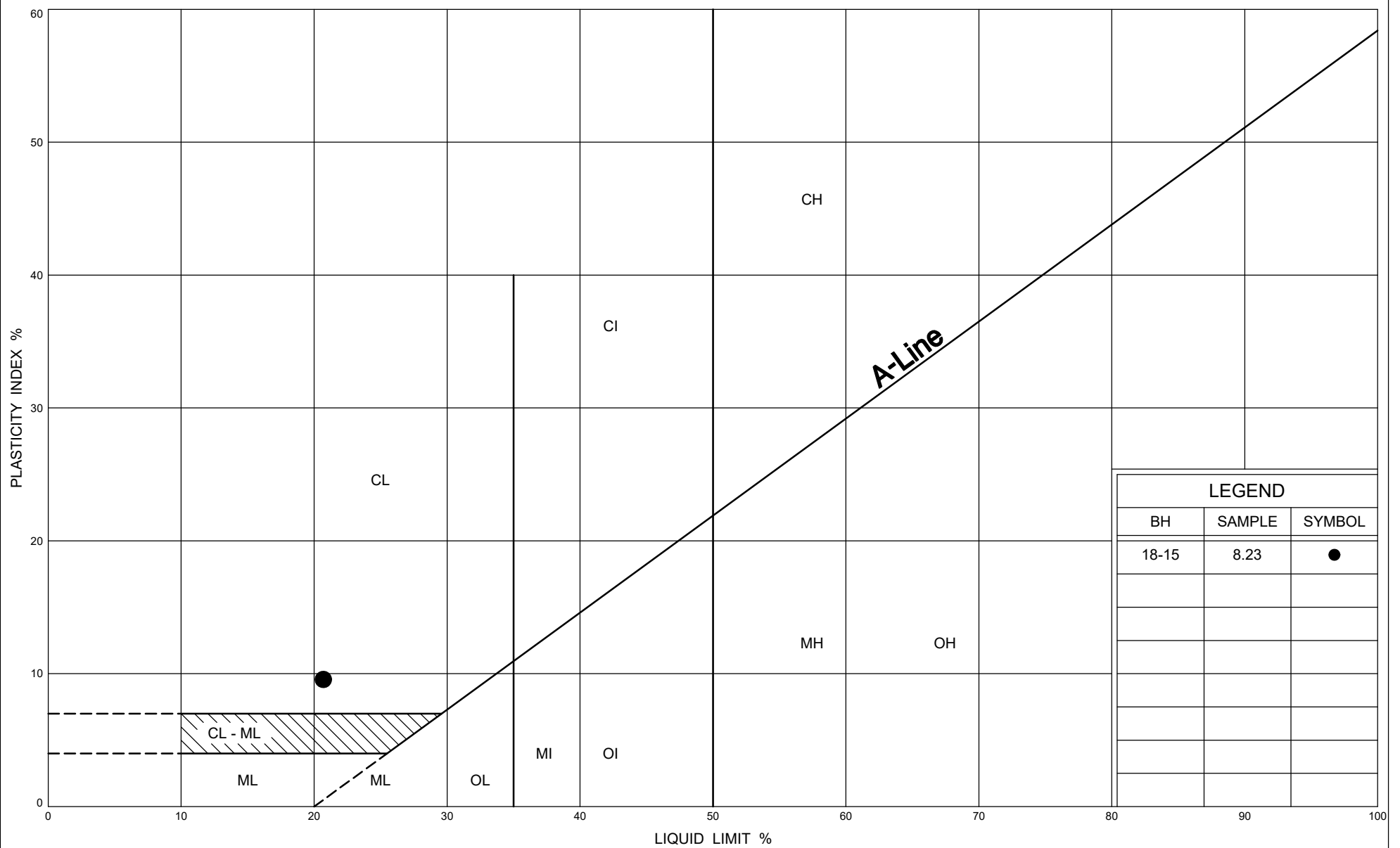
Alder Creek East Culvert





# GRAIN SIZE DISTRIBUTION SAND





LEGEND		
BH	SAMPLE	SYMBOL
18-15	8.23	●







## FINAL REPORT

CA14723-OCT17 R1

15595

Prepared for

**Thurber Engineering Ltd.**

## First Page

## CLIENT DETAILS

Client                   Thurber Engineering Ltd.

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

Contact               Mark Farrant

Telephone            905-829-8666 x 228

Facsimile             

Email                  mfarrant@thurber.ca

Project                15595

Order Number        

Samples               Soil (1)

## 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        CA14723-OCT17

Received              10/25/2017

Approved             11/02/2017

Report Number       CA14723-OCT17 R1

Date Reported        11/02/2017

## COMMENTS

Temperature of Sample upon Receipt: 6 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





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## RESULTS

Sample Number 5  
Sample Name BH-7, SS#6,  
15'-17'  
Sample Matrix Soil  
Sampled By Mark Farrant  
Sample Date 24/10/2017

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

## | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-27

Corrosivity Index	none	1	14
Soil Redox Potential	mV	-	196
Resistivity (calculated)	ohms.cm	-9999	910

## Anions by IC

## Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Chloride	µg/g	0.4	1000
Sulphate	µg/g	0.4	73

## Carbon/Sulphur

## Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Sulphide	%	0.02	< 0.02
----------	---	------	--------

## Conductivity

## Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Conductivity	uS/cm	2	1090
--------------	-------	---	------

## Moisture

## Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

Moisture Content	%	0.1	15.0
------------------	---	-----	------

## pH

## Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

pH	no unit	0.05	8.60
----	---------	------	------

## HOLDING TIME SUMMARY

Sample Name	QC Batch Reference	Sample Number	Sampled	Received	Extracted/ Prepared	Analysed	Holding Time	Approved
-------------	--------------------	---------------	---------	----------	---------------------	----------	--------------	----------

BH-7, SS#6, 15'-17'	NA	5	10/24/2017	10/25/2017	10/31/2017	10/31/2017		10/31/2017
---------------------	----	---	------------	------------	------------	------------	--	------------

## Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

BH-7, SS#6, 15'-17'	DIO0421-OCT17	5	10/24/2017	10/25/2017	10/27/2017	10/27/2017	11/21/2017	10/31/2017
---------------------	---------------	---	------------	------------	------------	------------	------------	------------

## Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

BH-7, SS#6, 15'-17'	ECS0041-OCT17	5	10/24/2017	10/25/2017	10/27/2017	10/27/2017	11/07/2017	10/30/2017
---------------------	---------------	---	------------	------------	------------	------------	------------	------------

## Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

BH-7, SS#6, 15'-17'	EWL0401-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	11/21/2017	10/30/2017
---------------------	---------------	---	------------	------------	------------	------------	------------	------------

## Moisture

Method: CCME Tier 1 | Internal ref.: ME-CA-[ENV]GC-LAK-AN-010

BH-7, SS#6, 15'-17'	GCM0415-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	12/23/2017	10/31/2017
---------------------	---------------	---	------------	------------	------------	------------	------------	------------

## pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

BH-7, SS#6, 15'-17'	EWL0401-OCT17	5	10/24/2017	10/25/2017	10/26/2017	10/26/2017	10/31/2017	10/30/2017
---------------------	---------------	---	------------	------------	------------	------------	------------	------------



FINAL REPORT

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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	DIO0421-OCT17	µg/g	0.4	<0.4	1	20	100	80	120	95	75	125
Sulphate	DIO0421-OCT17	µg/g	0.4	<0.4	5	20	96	80	120	94	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	ECS0041-OCT17	%	0.02	<0.02	ND	20	109	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	EWL0401-OCT17	uS/cm	2	< 2	0	10	99	90	110	NA		



QC SUMMARY

pH  
Method: SM 4500 | Internal ref.: ME-CA-IENVIEWL-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	EWL0401-OCT17	no unit	0.05	NA	1		100			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.

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

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-- End of Analytical Report --



## Certificate of Analysis

SGS Canada Inc.  
185 Concession St. Box 4300  
Lakefield, Ont., Canada, K0L 2H0



Client  
SGS LIMS Number  
Analysis Package:

Attention: Mark Farrant  
Project#: 15595  
Thurber Engineering Ltd  
CA13437-JUL17  
Corrosivity

Sample ID	Unit	Analysis Start Date	Analysis Approval Date	Alder Creek East
<b>Sample Date/Time</b>				
Temperature Upon Receipt	°C			21.0
Corrosivity Index	NA	01-Jun-17	01-Jun-17	
Redox Potential	mV	29-May-17	30-May-17	291
Sulphide	mg/L	01-Jun-17	01-Jun-17	<0.006
% Moisture (wet wt)	NA	30-May-17	01-Jun-17	
pH	units	30-May-17	31-May-17	7.90
Chloride	mg/L	31-May-17	01-Jun-17	23
Sulphate	mg/L	31-May-17	01-Jun-17	1.5
Conductivity	µS/cm	30-May-17	31-May-17	170
Resistivity (calculated)	ohms.cm	30-May-17	01-Jun-17	5880

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

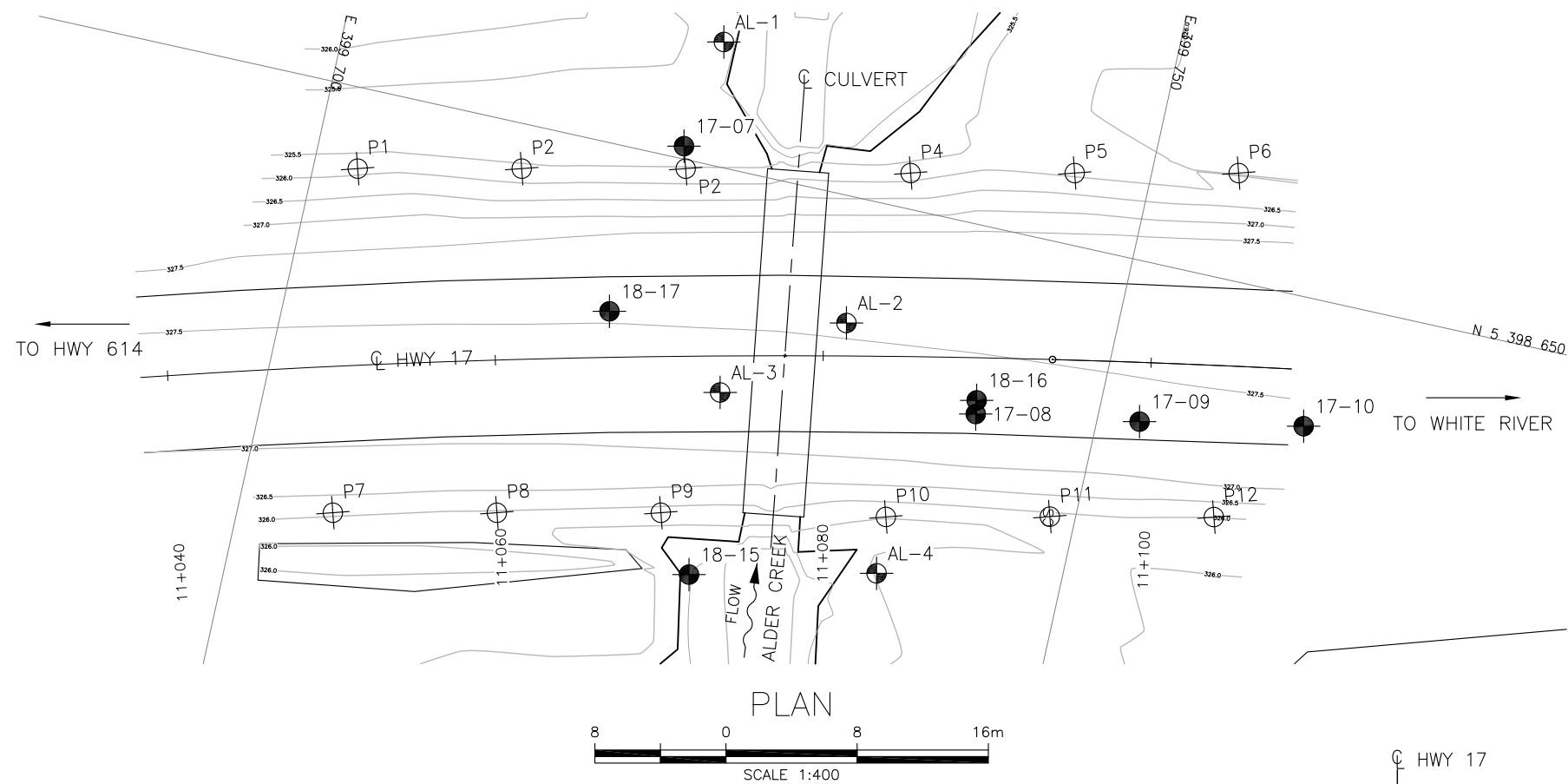
Deanna Edwards B.Sc., C.Chem  
Project Specialist  
Environment, Health and Safety

Data reported represents the sample submitted to SGS. Reproduction of this analytical report in full or in part is prohibited without prior written approval. Please refer to SGS General Conditions of Services located at [http://www.sgs.com/terms\\_and\\_conditions\\_service.htm](http://www.sgs.com/terms_and_conditions_service.htm).  
(Printed copies are available upon request.). Test Method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.



## **Appendix C**

### **Borehole Locations and Soil Strata Drawing**



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



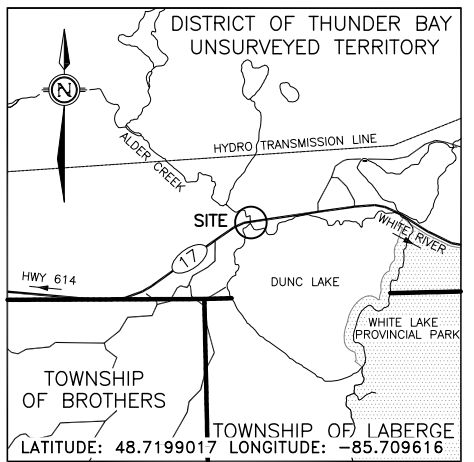
CONT No  
WP No 6330-14-01

HIGHWAY 17  
ALDER CREEK EAST  
CULVERT  
BOREHOLE LOCATIONS AND SOIL STRATA

**HATCH**



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

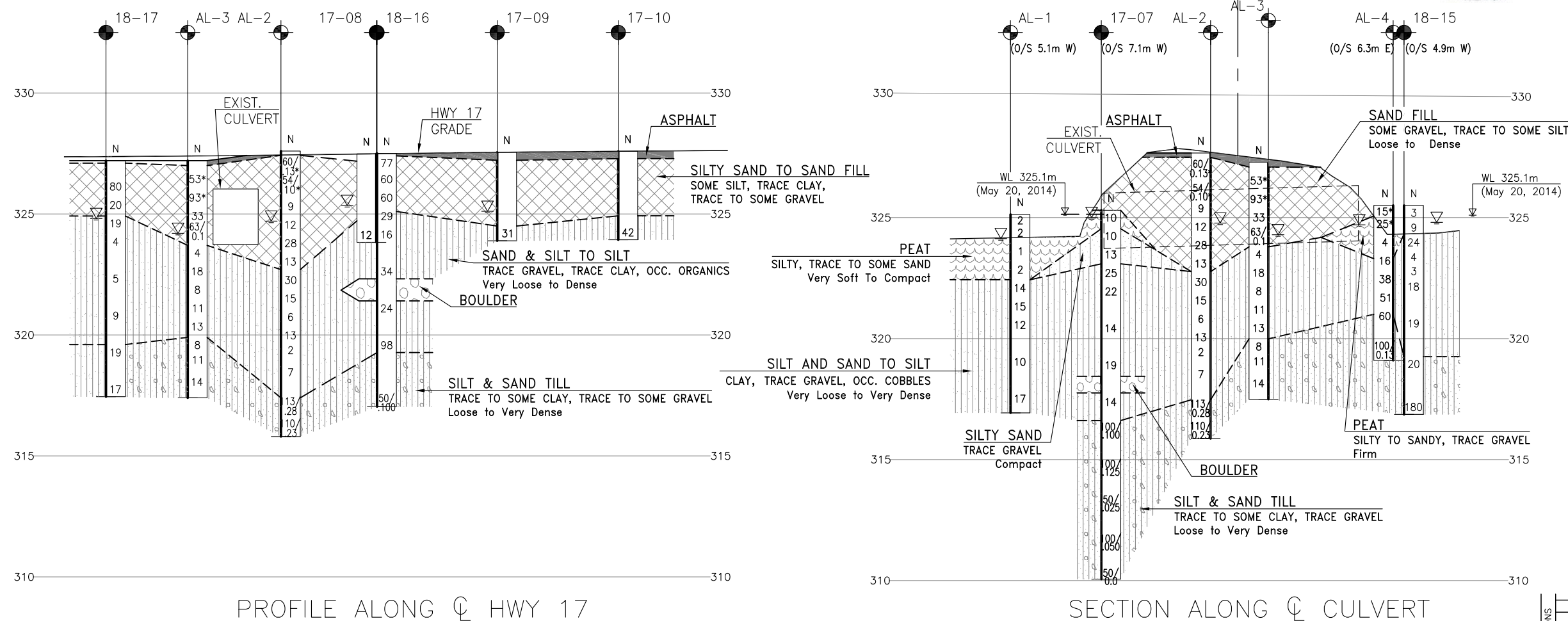
●	Borehole
⊕	Borehole (Previous Investigation)
⊗	Peat Probe
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
⬇	Head Artesian Water
⬇	Piezometer
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-07	325.3	5 398 650.8	399 721.8
17-08	327.5	5 398 638.7	399 742.7
17-09	327.6	5 398 640.4	399 752.6
17-10	327.6	5 398 642.3	399 762.4
18-15	325.5	5 398 625.4	399 727.7
18-16	327.3	5 398 639.5	399 742.6
18-17	327.5	5 398 640.0	399 719.5
AL-1	325.1	5 398 657.5	399 722.8
AL-2	327.6	5 398 642.4	399 733.8
AL-3	327.2	5 398 636.6	399 727.2
AL-4	325.5	5 398 627.9	399 738.9

-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 14.
- \* Re-interpreted from original borehole logs.

GEOCRES No.



PROFILE ALONG Q HWY 17

SECTION ALONG Q CULVERT



H 1:400

V 1:200

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	NLB	CHK MEF	CODE
DRAWN	AN	CHK NLB	SITE
LOAD	DATE	DEC 2018	
STRUCT	DWG	1	



## **Appendix D**

### **Site Photographs**



**Photo 1: Culvert outlet looking south (May 17, 2017)**





**Photo 2: Culvert inlet looking north (May 17, 2017)**



**Photo 3: Road approach looking west (May 17, 2017)**





**Photo 4: Road approach looking east (May 17, 2017)**





**Photo 5: Looking west on north side of road (outlet) (June 26, 2017)**





**Photo 6: Looking east on north side of road (outlet) (June 26, 2017)**





**Photo 7: Looking east on south side of road (inlet) (June 26, 2017)**





**Photo 8: Looking west on south side of road (inlet) (June 26, 2017)**



## **Appendix E**

### **Factual Data from 2015 Golder Foundation Investigation Report**

PROJECT 1411523			RECORD OF BOREHOLE No AL-1			1 OF 1 METRIC											
G.W.P. 6330-14-00			LOCATION N 5398657.5; E 399722.8			ORIGINATED BY MR											
DIST _____ HWY 17			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY MT											
DATUM GEODETIC			DATE April 7, 2015			CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m <sup>3</sup>	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	20 40 60					
325.9	GROUND SURFACE																
0.0	Silty PEAT, trace to some sand Very soft Black Wet		1	SS	2		325										
			2	SS	2		324										
			3	SS	1		323										
323.2			A	SS	2		322										
2.7	SILT to Sandy SILT Compact Grey Wet		4	SS	2		321										
			5	SS	14		320										
			6	SS	15		319										
			7	SS	12		318										
			8	SS	10												
			9	SS	17												
317.7	END OF BOREHOLE																
8.2	Note: 1. Water level at a depth of 1.0 m below ground surface (Elev. 324.9 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

PROJECT 1411523		<b>RECORD OF BOREHOLE No AL-2</b>				1 OF 1 <b>METRIC</b>							
G.W.P. 6330-14-00		LOCATION N 5398642.4; E 399733.8				ORIGINATED BY RI							
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers				COMPILED BY MT							
DATUM GEODETIC		DATE March 17, 2015				CHECKED BY SEMP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)			
327.6	GROUND SURFACE							20 40 60 80 100	20 40 60				
0.0	ASPHALT (180 mm)												
0.2	Sand, some gravel, trace to some silt (FILL) Loose to compact Brown to grey Frozen* to wet		1	SS	60/ 0.13*		327						14 74 (12)
			2	SS	54/ 0.10*		326						
			3	SS	9		325						
			4	SS	12		324						
	Augers grinding on inferred cobbles below 3.8 m depth.		5	SS	28		323						
322.7			6A	SS	13		322						0 55 44 1
4.9	Sandy SILT to SILT and SAND, trace gravel, trace clay Very loose to compact Grey Wet  Trace organics in Sample 6B.		7	SS	30		321						
			8	SS	15		320						
			9	SS	6		319						2 28 68 2
			10	SS	13		318						
			11	SS	2		317						
			12	SS	7		316						
317.4			13	SS	113/ 0.28								
10.2	SILT and SAND, some gravel, some clay (TILL) Very dense Grey Wet		14	SS	110/ 0.23								12 31 41 16
315.8													
11.8	END OF BOREHOLE  Note:  1. Water level at a depth of 2.9 m below ground surface (Elev. 324.7 m) upon completion of drilling.												

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

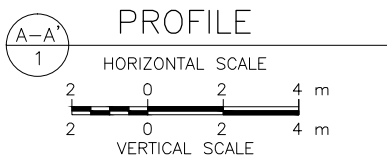
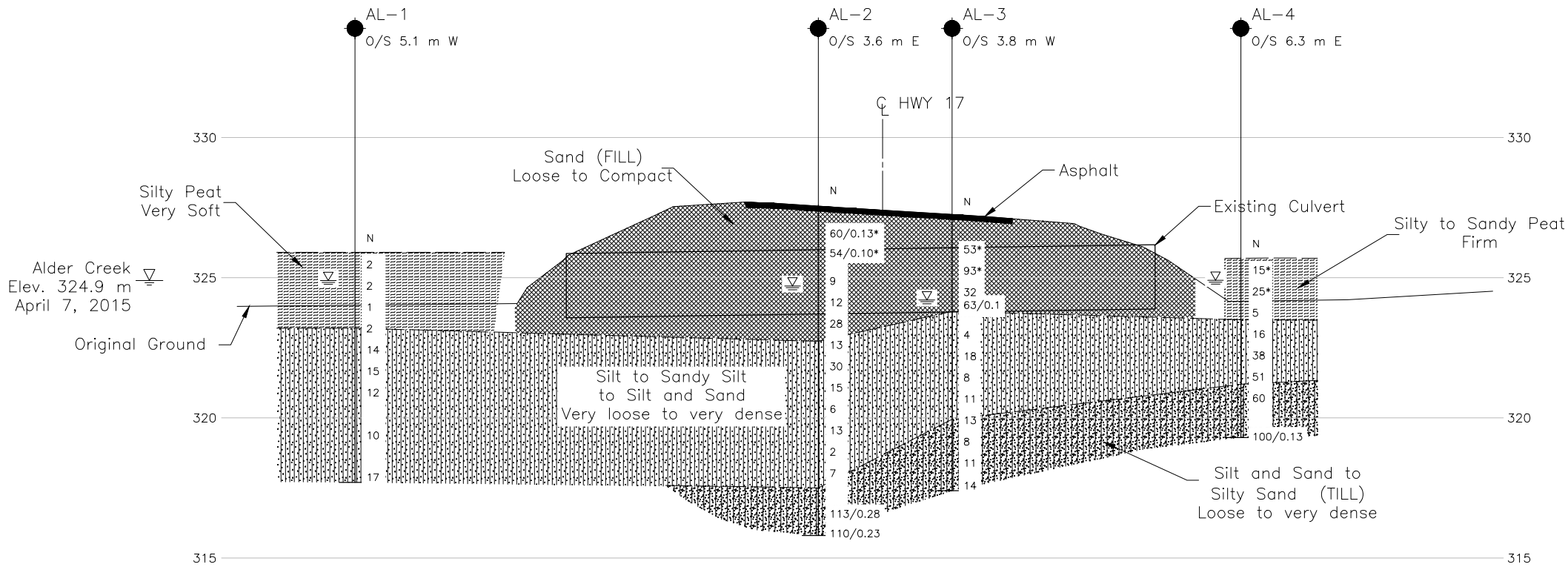
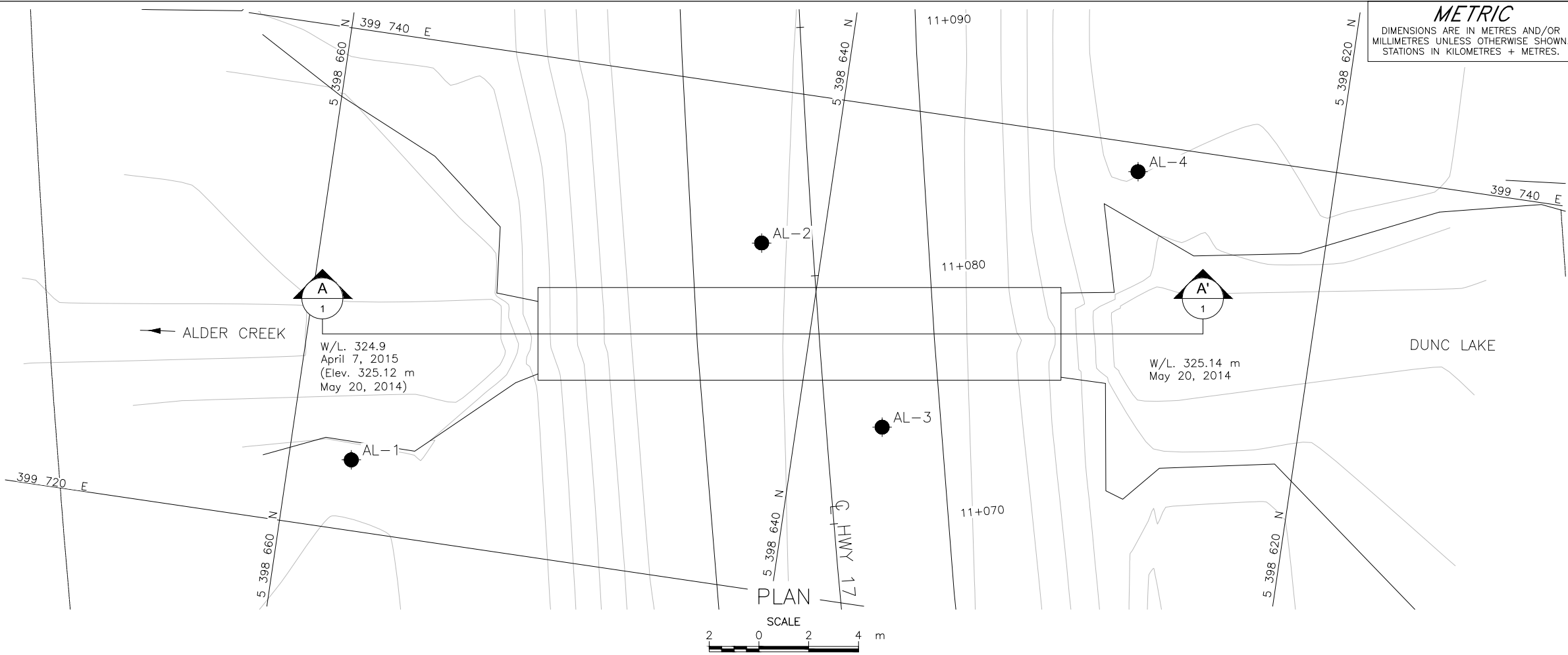
PROJECT 1411523			RECORD OF BOREHOLE No AL-3			1 OF 1 METRIC											
G.W.P. 6330-14-00			LOCATION N 5398636.6; E 399727.2			ORIGINATED BY RI											
DIST _____ HWY 17			BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers			COMPILED BY MT											
DATUM GEODETIC			DATE March 17, 2015			CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%)			γ	GR SA SI CL
327.2	GROUND SURFACE							20 40 60 80 100									
0.0	ASPHALT (190 mm)																
0.2	Sand, some gravel, some silt (FILL) Dense Brown Frozen* to wet		1	SS	53*		327										
	Augers grinding on inferred cobbles below 1.5 m depth.		2	SS	93*		326										12 74 (14)
			3	SS	33		325										
			4	SS	63/0 1		324										
323.7	SILT to SILT and SAND, trace gravel, trace clay Loose to compact Grey Wet		5	SS	4		323										
			6	SS	18		322										
			7	SS	8		321										0 8 90 2
			8	SS	11		320										
319.9	SILT and SAND, trace to some gravel, trace clay (TILL) Loose to compact Grey Wet		9	SS	13		319										
			10	SS	8		318										7 36 55 2
			11	SS	11												
			12	SS	14												
317.4	END OF BOREHOLE																
9.8	Note: 1. Water level at a depth of 3.0 m below ground surface (Elev. 324.2 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:



PROJECT 1411523		RECORD OF BOREHOLE No AL-4				1 OF 1 METRIC											
G.W.P. 6330-14-00		LOCATION N 5398627.9; E 399738.9				ORIGINATED BY MR											
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I. D. Hollow Stem Augers				COMPILED BY MT											
DATUM GEODETIC		DATE April 7, 2015				CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	20 40 60	W <sub>p</sub> W W <sub>L</sub>						
325.7	GROUND SURFACE																
0.0	Silty to Sandy PEAT, trace gravel, trace wood Firm Black to dark brown Frozen* to wet		1	SS	15*		325										
			2	SS	25*												
			3	SS	5		324										
323.5	SILT and SAND Compact to very dense Grey Wet  Trace to some gravel below 3.0 m depth.  Augers grinding on inferred cobbles below 3.8 m depth.		4	SS	16		323									0 56 44 0	
2.2			5	SS	38		322										
			6	SS	51												
321.2	Gravelly SILTY SAND, trace clay (TILL) Very dense Grey Wet  One large piece of gravel on 19 mm sieve in Sample 7.		7	SS	60		321									50 36 13 1	
4.5							320										
319.3	END OF BOREHOLE		8	SS	100/0.13												
6.4	Note:  1. Water level at a depth of 0.8 m below ground surface (Elev. 324.9 m) upon completion of drilling.																

SUD-MTO 001 1411523.GPJ GAL-MISS.GDT 26/10/15 DATA INPUT:

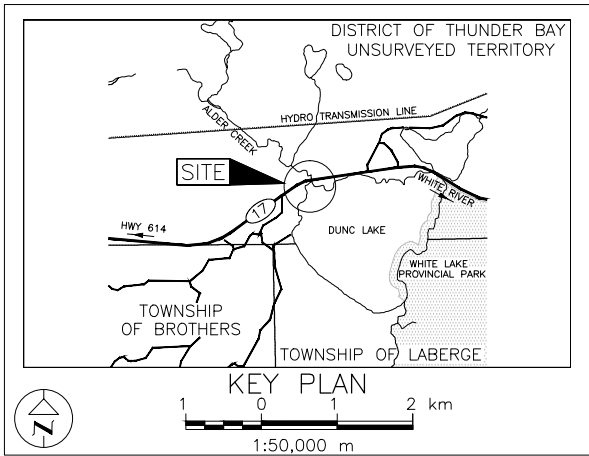


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
MILLIMETRES UNLESS OTHERWISE SHOWN.  
STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 6330-14-00

HIGHWAY 17  
ALDER CREEK CULVERT STA 11+078  
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



LEGEND			
	Borehole		
N	Standard Penetration Test Value		
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)		
	WL upon completion of drilling		

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
AL-1	325.9	5398657.5	399722.8
AL-2	327.6	5398642.4	399733.8
AL-3	327.2	5398636.6	399727.2
AL-4	325.7	5398627.9	399738.9

**NOTES**

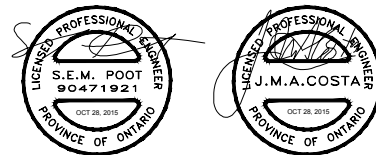
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

**REFERENCE**

Base plans provided in digital format by MTO, drawing file no. E484854171, received FEB 20, 2015.



NO.	DATE	BY	REVISION
Geocres No. 42C-37			
HWY. 17	PROJECT NO. 1411523		DIST. .
SUBM'D. AC	CHKD. .	DATE: 10/22/2015	SITE: 48E-75/C
DRAWN: JJL/TB	CHKD. SEMP	APPD. JMAC	DWG. 1