



THURBER ENGINEERING LTD.

**DETAILED FOUNDATION INVESTIGATION REPORT
GORGE CREEK CULVERT REPLACEMENT
HIGHWAY 11, UNSURVEYED TERRITORY
THUNDER BAY DISTRICT, ONTARIO
LATITUDE: 49.301882°, LONGITUDE: -88.098751°**

G.W.P. 6802-14-00, W.P. 6803-14-01 SITE No. 48C-182C

GEOCRES No: 52H-48

Report

to

HATCH

Date: November 12, 2018
File: 15595



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GEOCRES Number: 52H-48

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 Gorge Creek Culvert replacement. The Gorge Creek culvert is located on Highway 11, north of Nipigon, in Unsurveyed Territory, 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 6015-E-0008.

The preliminary investigation previously conducted by Thurber is described in the following report:

- Preliminary Foundation Investigation and Design Report, Gorge Creek Culvert Replacement, Highway 11, Unsurveyed Territory, Thunder Bay District, Ontario, GEOCRES Number 52H-43, prepared by Thurber Engineering Ltd.

The borehole logs from the preliminary investigation are included in this report.

2. SITE DESCRIPTION

The site is located along Highway 11, approximately 39 km North of Nipigon. The existing culvert allows Gorge Creek to flow in an east to west direction under Highway 11. Highway 11 generally



runs in a north-south direction at the culvert site. A pair of twin CSP culverts are located approximately 27 m north of the Gorge Creek Culvert on Highway 11.

Based on the Ontario Structure Inspection Manual (OSIM) prepared by MTO on November 20, 2014, the existing culvert is a cast in place, open footing, concrete culvert that is 6.1 m wide, 1.8 m high and 21.8 m long. The culvert barrel is in fair condition with some rust staining, delamination, spalling and exposed rebar at the inlet and outlet soffits.

The estimated culvert invert is at approximate Elevation 263.7 m at the inlet (east) and 263.6 m at the outlet (west). The existing road grade at the culvert location is at approximate Elev. 266.8 m, which indicates approximately 1 m of fill above the culvert. The elevation of the water flowing through the culvert on October 20, 2015 was reported to be approximately 264.9 m upstream of the inlet and 263.7 m downstream of the outlet.

The area on either side of the creek near the inlet and outlet of the culvert is vegetated with grass, shrubs and small trees, and the overall surrounding area is densely forested. A natural gas power plant is located approximately 750 m to the south of the culvert and an associated natural gas pipeline is located approximately 300 m the south east of the culvert. Photographs in Appendix D show the culvert and the surrounding area.

Based on published geological information, the site lies within an area of glaciofluvial outwash deposits of sand and gravel and is bounded by bedrock plains and knobs, and talus (rubble) to the east and west of the highway. The bedrock at the site consists of undifferentiated metasedimentary rocks.

3. INVESTIGATION PROCEDURES

The current investigation and field testing program was carried out between June 20 to July 10, 2018, and consisted of drilling and sampling five (5) boreholes, designated as Boreholes 18-10 to 18-14, to depths ranging from 6.7 m to 10.4 m below the existing ground surface. Dynamic Cone Penetration Tests (DCPTs) conducted at the base of Boreholes 18-11, 18-12 and 18-14 extended the boreholes to depths from 10.7 to 18.6 m. Boreholes 18-10 to 18-12 were drilled along the alignment of the existing twin CSP culverts located approximately 27 m north of the Gorge Creek Culvert. Boreholes 18-13 and 18-14 were drilled near the inlet and outlet of the existing Gorge Creek Culvert near the locations of the proposed cofferdams.

The previous preliminary investigation was carried out between August 23 and 25, 2017, during which time six (6) boreholes denoted as Boreholes 17-42 to 17-47 were advanced to depths of



between 3.5 m and 14.3 m below existing ground surface.

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 D.

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 track-mounted drill rig and wash boring techniques for Borehole 18-11 and a portable Hilti drill and tripod equipment using wash boring techniques for the Boreholes 18-10, 18-12, 18-13, and 18-14. Samples of the overburden soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). A Dynamic Cone Penetration Test (DCPT) was carried out at Boreholes 18-11, 18-12 and 18-14 to depths of between 10.7 m and 18.6 m.

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.

Piezometers were installed as part of the current investigation in Boreholes 18-10, 18-12, 18-13, and 18-14, and water level readings were taken throughout the investigation. The piezometers were decommissioned at the completion of the field investigation. The boreholes were backfilled in general accordance with Ontario regulation 903, as amended. A piezometer was also installed in Borehole 17-42 drilled during the preliminary investigation. Caving was noted in a number of boreholes in the sand and gravel soils.

Completion details of the boreholes are summarized in Table 3.1 below.



Table 3.1 -Borehole Completion Details

Borehole Number	Borehole, DCPT Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
18-10	9.8 / 255.3	9.8 / 255.3	Sand to 7.9 m then bentonite holeplug to surface.
18-11	18.6 / 248.5	None installed	Borehole caved to 3.5 m, then backfilled with bentonite holeplug to 0.3 m, then sand and gravel to 0.2 m, then asphalt cold patch to surface.
18-12	10.7 / 254.3	5.5 / 259.5	Borehole caved to 5.5 m then backfilled with sand to 3.7 m then bentonite holeplug to surface.
18-13	9.8 / 255.0	9.8 / 255.0	Sand to 7.3 m then bentonite holeplug to surface.
18-14	14.3 / 250.9	6.9 / 258.3	Borehole caved to 6.9 m, then backfilled with sand to 5.0 m then bentonite holeplug to surface.
17-42	14.3/251.1	13.7/251.7	Sand to 1.5 m then bentonite holeplug to surface
17-43	14.3/252.5	None Installed	Bentonite holeplug and cuttings to 0.9 m below surface, then dry cement to 0.2 m, then cold patch asphalt to surface
17-44	14.3/252.0	None Installed	Bentonite holeplug and cuttings to surface

Borehole Number	Borehole, DCPT Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
17-45	3.7/263.0	None Installed	Cuttings to 0.9 m below surface then dry cement to 0.2 m, then cold patch asphalt to surface
17-46	3.5/263.1	None Installed	Cuttings to 0.9 m below surface then dry cement to 0.2 m, then cold patch asphalt to surface
17-47	3.7/262.8	None Installed	Cuttings to 0.9 m below surface then dry cement to 0.2 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) and Atterberg Limits testing, where appropriate. 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, during the previous investigation, a sample of the existing native soil, and a sample of the surface water from the creek upstream of the existing culvert were collected. The samples were submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters and sulphate content. The results of the analytical testing are summarized in Section 6 and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A. 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 and gravel embankment soil consisted of native sand to sand and gravel deposits. Descriptions of the individual strata are presented below.

5.1 Asphalt

Boreholes 18-11, 17-43, 17-45, 17-46 and 17-47 were drilled through the paved section of Highway 11 and encountered a surface layer of asphalt that ranged in thickness from 150 mm to 200 mm.

5.2 Topsoil

Topsoil was encountered at the surface in Boreholes 18-10, 18-12, 18-13, and 18-14. The topsoil ranged in thickness from approximately 25 mm to 600 mm.

5.3 Fill

Fill was encountered below the asphalt at Boreholes 18-11, 17-43, 17-45, 17-46 and 17-47 and from the surface in for Boreholes 17-42 and 17-44. The fill layer varied from sand with trace silt and trace gravel to sand and gravel with trace to some silt. Occasional cobbles and boulders were noted in the fill. Where fully penetrated, the fill layer varied in thickness between 2.2 and 3.0 m and extended to depths of between 2.2 and 3.0 m (Elev. 263.2 to 264.1 m). Boreholes 17-45 to 17-47 were terminated within the fill at depths of 3.5 to 3.7 m (Elev. 262.8 to 263.1 m).

SPT 'N' values within the fill ranged from 11 to over 100 blows per 0.3 m of penetration, indicating a compact to very dense relative density. Moisture contents between 1 percent and 25 percent were measured in the cohesionless fill.

The results of grain size distribution analyses carried out on selected samples of the fill are presented on the Record of Borehole sheets included in Appendix A and on Figures B1 and B2 of Appendix B. The results of the grain size distribution analyses are summarized below:



Soil Particle	Percentage (%)
Gravel	9 to 43
Sand	51 to 82
Silt and Clay	2 to 12

5.4 Sand and Gravel to Gravelly Sand

Sand and Gravel, containing trace to some silt and occasional cobbles was encountered in Boreholes 18-11 to 18-14, and 17-43 at depths of approximately 0.1 m to 3.0 m (Elevations 264.9 m to 262.8 m). The sand and gravel layer was approximately 3.5 m to 5.7 m thick where fully penetrated and extended to depths of approximately 4.1 m to 8.7 m (Elevation 257.9 m to 263.8 m). Borehole 18-12 was terminated in the sand and gravel layer at a depth of 6.7 m (Elevation 258.3 m)

A lower layer of gravelly sand was encountered in Boreholes 18-13, 17-43, and 17-44 at depths of between approximately 9.1 m to 10.2 m (Elevations 256.6 m to 255.7 m). Where fully penetrated the lower gravelly sand layer was approximately 3.1 m thick and extended to a depth of approximately 13.3 m (Elevations 253.5 m to 253.0 m). Borehole 18-13 was terminated in the lower gravelly sand layer at a depth of 9.8 m (Elevations 255.0 m).

SPT 'N' values within the sand and gravel to gravelly sand layers ranged from 4 to over 100 blows per 0.3 m of penetration, indicating a very loose to very dense relative density although the deposits is generally compact. The higher blow counts may representative of the presence of cobbles. Measured moisture contents within this layer varied between 7 percent and 20 percent.

The results of grain size distribution analyses carried out on selected samples of the sand and sand and gravel to gravelly sand are presented on the Record of Borehole sheets included in Appendix A and on Figures B3 in Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	26 to 60
Sand	37 to 71
Silt and Clay	3 to 6



5.5 Sand

Sand layers, containing trace to some gravel, trace to some silt, occasional cobbles, and trace organics near the surface, were encountered in all boreholes, with the exceptions of Boreholes 17-45 to 17-47, at depths ranging between approximately 0.1 m to 8.7 m (Elevations 264.7 m to 258.4 m). Lower layers of sand were encountered in Boreholes 17-43 and 17-44 at depths of approximately 13.3 m (Elevations 253.5 m to 253.0 m). Where fully penetrated the sand layers ranged in thickness from 2.0 m to 7.2 m. Boreholes 18-10, 18-11, 18-14, and 17-42 to 17-44 were terminated in sand layers at depths of between 6.7 m to 14.3 m (Elevations 258.5 m to 251.1 m).

SPT 'N' values within the sand layers ranged from 1 to 70 blows per 0.3 m of penetration, indicating a loose to very dense relative density. The inconsistent and high blow counts may be representative of the presence of cobbles. Measured moisture contents within the sand deposit varied between 10 percent and 40 percent.

The results of grain size distribution analyses carried out on selected samples of the sand are presented on the Record of Borehole sheets included in Appendix A and on Figure B4 and B5 in Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 18
Sand	77 to 96
Silt and Clay	3 to 18

5.6 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 18-10, 18-12, 18-13, 18-14 and 17-42 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized below.

Table 5.1 – Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
18-10	July 6, 2018	0.7	264.4	Standpipe piezometer
	July 7, 2018	0.6	264.5	
	July 8, 2018	0.7	264.4	
	July 9, 2018	0.7	264.4	
18-11	June 20, 2018	2.4	264.7	Open borehole
18-12	July 8, 2018	1.3	263.7	Standpipe piezometer
	July 9, 2018	1.3	263.7	
	July 10, 2018	1.3	263.7	
18-13	July 5, 2018	1.0	263.8	Standpipe piezometer
	July 6, 2018	1.0	263.8	
	July 7, 2018	0.9	263.9	
18-14	July 10, 2018	1.3	263.9	Standpipe piezometer
	July 11, 2018	1.3	263.9	
17-42	August 27, 2017	1.0	264.4	Standpipe piezometer
17-43	August 25, 2017	3.0	263.8	Open borehole
17-44	August 24, 2017	1.8	264.5	Open borehole
17-45	August 23, 2017	2.4	264.3	Open borehole
17-46	August 23, 2017	Dry	Dry	Open borehole
17-47	August 23, 2017	2.1	264.4	Open borehole

The creek water level on October 20, 2015 was reported to be Elevation 264.9 m upstream of the inlet and 263.7 m 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 fill layer from Borehole 17-43 and a sample of the creek water were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.



Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results	
			17-43, SS#3, 1.5 m – 2.1 m	Gorge Creek
			(Silty Sand)	(Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	mg/L	mg/L	1100	0.57
Sulphate	mg/L	mg/L	21	1.5
pH	No unit	No unit	9.6	7.89
Electrical Conductivity	µS/cm	µS/cm	1150	107
Resistivity	Ohms.cm	Ohms.cm	867	9350
Redox Potential	mV	mV	230	261

7. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained subsurface utility clearances prior to drilling. Thurber estimated the northing and easting coordinates and ground surface elevations from measurements taken in the field relative to the topographic plans provided by Hatch.

OGS Inc. of Almonte, Ontario, and Downing Drilling of Hawkesbury, 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. Ryan McCourt and Ms. Judy Mei of Thurber. Overall supervision of the field program was provided by Mr. Mark Farrant, P.Eng. of Thurber.

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory. Analytical laboratory testing was carried out by SGS Canada Inc. 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.



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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 ⁽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

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


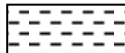



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (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 (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	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>						
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty Can be peeled by a pocket knife, crumbles under firm blows of geological pick. Indented by thumbnail	
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750		
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150		
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 18-10

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 259.4 E 224 860.6 ORIGINATED BY JM
DIST TB HWY 11 BOREHOLE TYPE Portable B Casing COMPILED BY AN
DATUM Geodetic DATE 2018.07.06 - 2018.07.06 LATITUDE 49.302100° LONGITUDE -88.099288° CHECKED BY CZ

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						WATER CONTENT (%) w _p w w _L					GR	SA
265.1	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (200mm) Stiff Moist		1	SS	15		265													
0.2	SAND, trace to some gravel, trace silt, some organice, trace rootlets, occasional cobbles Very Loose to Dense Brown Moist to Wet		2	SS	9		264													
	No organics below 1.7m		3	SS	3		263													
			4	SS	44		262													
	Very Loose Grey Wet		5	SS	2		261													
			6	SS	3		260													
			7	SS	4		259													
257.9							258													
7.2	SAND, some silt Compact Grey Moist to Wet		8	SS	13		257													
			9	SS	23		256													
255.3	END OF BOREHOLE AT 9.8m.																			
9.8																				

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 18-10

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 259.4 E 224 860.6 ORIGINATED BY JM
 DIST TB HWY 11 BOREHOLE TYPE Portable B Casing COMPILED BY AN
 DATUM Geodetic DATE 2018.07.06 - 2018.07.06 LATITUDE 49.302100° LONGITUDE -88.099288° CHECKED BY CZ

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																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.07.06 0.7 264.4 2018.07.07 0.6 264.5 2018.07.08 0.7 264.4 2018.07.09 0.7 264.4																

RECORD OF BOREHOLE No 18-11

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 267.5 E 224 872.6 ORIGINATED BY BRM
DIST TB HWY 11 BOREHOLE TYPE Wash Boring/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2018.06.20 - 2018.06.20 LATITUDE 49.302174° LONGITUDE -88.099126° CHECKED BY CZ

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							
267.1	GROUND SURFACE							20 40 60 80 100							
0.0	ASPHALT: (150mm)							20 40 60 80 100							
0.2	SAND and GRAVEL , trace silt, occasional cobbles and boulders Very Dense to Compact Brown Moist to Wet (FILL)		1	SS	99	▽	267								
			2	SS	36		266								
			3	SS	21		265								43 55 2 (SI+CL)
			4	SS	28		264								
264.1															
3.0	SAND and GRAVEL , trace silt Compact to Dense Grey Wet		5	SS	22		263								44 51 5 (SI+CL)
			6	SS	34		262								
							261								
			7	SS	5		260								
			8	SS	5		259								
258.4															
8.7	SAND , trace to some silt Very Loose Grey Wet		9	SS	4		258								

Continued Next Page

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

RECORD OF BOREHOLE No 18-11

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 267.5 E 224 872.6 ORIGINATED BY BRM
 DIST TB HWY 11 BOREHOLE TYPE Wash Boring/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2018.06.20 - 2018.06.20 LATITUDE 49.302174° LONGITUDE -88.099126° CHECKED BY CZ

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 (%)				
	Continued From Previous Page							20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _P W W _L				
								● QUICK TRIAXIAL × LAB VANE						
256.7							257							
10.4	End of sampling and start DCPT						256							
							255							
							254							
							253							
							252							
							251							
							250							
							249							
248.5														
18.6	END OF BOREHOLE AT 18.6m UPON DCPT REFUSAL. WATER LEVEL AT 2.4m. BOREHOLE CAVED TO 3.5m, THEN BACKFILLED WITH BENTONITE HOLEPLUG TO 0.3m, SAND AND GRAVEL TO 0.2m, THEN ASPHALT TO SURFACE.													

ONTMT452 MTO-15595 GPJ 2017TEMPLATE(MTO).GDT 7/27/18

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 18-12

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 274.0 E 224 883.4 ORIGINATED BY JM
 DIST TB HWY 11 BOREHOLE TYPE Portable B Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2018.07.07 - 2018.07.08 LATITUDE 49.302234° LONGITUDE -88.098978° CHECKED BY CZ

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							20	40	60	80	100															
254.3																											
10.7	END OF BOREHOLE AT 10.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH(m)</th> <th>ELEV.(m)</th> </tr> </thead> <tbody> <tr> <td>2018.07.08</td> <td>1.3</td> <td>263.7</td> </tr> <tr> <td>2018.07.09</td> <td>1.3</td> <td>263.7</td> </tr> <tr> <td>2018.07.10</td> <td>1.3</td> <td>263.7</td> </tr> </tbody> </table>	DATE	DEPTH(m)	ELEV.(m)	2018.07.08	1.3	263.7	2018.07.09	1.3	263.7	2018.07.10	1.3	263.7														
DATE	DEPTH(m)	ELEV.(m)																									
2018.07.08	1.3	263.7																									
2018.07.09	1.3	263.7																									
2018.07.10	1.3	263.7																									

RECORD OF BOREHOLE No 18-13

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 240.2 E 224 850.3 ORIGINATED BY JM
DIST TB HWY 11 BOREHOLE TYPE Portable B Casing COMPILED BY AN
DATUM Geodetic DATE 2018.07.05 - 2018.07.05 LATITUDE 49.301945° LONGITUDE -88.099420° CHECKED BY CZ

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _P W W _L WATER CONTENT (%)				GR	SA	SI	CL
264.8	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (25mm) SAND , trace to some silt, trace gravel, trace organics, occasional cobbles Very Loose to Compact Black-Brown Moist		1	SS	1									○						
			2	SS	8										○					
			3	SS	14										○					
262.8	SAND and GRAVEL , trace silt, trace organics, occasional cobbles Very Dense to Loose Grey-Brown Wet		4	SS	50/ 0.125									○						
2.0			5	SS	8									○	○					
	no organics below 4.0m		6	SS	8															
259.2	SAND , some silt, occasional cobbles Loose Grey Wet		7	SS	8										○					
5.6			8	SS	4										○	○				
255.7	Gravelly SAND , occasional cobbles Compact Grey Wet		9	SS	25										○					
9.1																				
255.0																				
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 18-13

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 240.2 E 224 850.3 ORIGINATED BY JM
 DIST TB HWY 11 BOREHOLE TYPE Portable B Casing COMPILED BY AN
 DATUM Geodetic DATE 2018.07.05 - 2018.07.05 LATITUDE 49.301945° LONGITUDE -88.099420° CHECKED BY CZ

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																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.07.05 1.0 263.8 2018.07.06 1.0 263.8 2018.07.07 0.9 263.9																

RECORD OF BOREHOLE No 18-14

1 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 238.7 E 224 905.3 ORIGINATED BY JM
DIST TB HWY 11 BOREHOLE TYPE Portable B Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2018.07.09 - 2018.07.10 LATITUDE 49.301919° LONGITUDE -88.098670° CHECKED BY CZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _P	W		W _L			
265.2	GROUND SURFACE																		
0.0	TOPSOIL: (600mm) Very Stiff Brown Moist		1	SS	19		265												
264.6																			
0.6	SAND and GRAVEL , trace silt, trace organics, occasional cobbles Very Dense to Loose Brown Moist to Wet		2	SS	37		264											51 44 5 (SI+CL)	
			3	SS	50/ 0.150														
			4	SS	28		263											40 55 5 (SI+CL)	
			5	SS	4		262												
261.1																			
4.1	SAND , trace to some silt, some gravel, occasional cobbles Compact Grey Wet		6	SS	16		261												
							260												
			7	SS	15		259												
258.5																			
6.7	End of sampling and start DCPT						258												
							257												
							256												

Continued Next Page

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

RECORD OF BOREHOLE No 18-14

2 OF 2

METRIC

W.P. 6330-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 238.7 E 224 905.3 ORIGINATED BY JM
 DIST TB HWY 11 BOREHOLE TYPE Portable B Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2018.07.09 - 2018.07.10 LATITUDE 49.301919° LONGITUDE -88.098670° CHECKED BY CZ

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							20 40 60 80 100																	
250.9							255																		
							254																		
							253																		
							252																		
							251																		
14.3	END OF DCPT AT 14.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH(m)</th> <th>ELEV.(m)</th> </tr> </thead> <tbody> <tr> <td>2018.07.10</td> <td>1.3</td> <td>263.9</td> </tr> <tr> <td>2018.07.11</td> <td>1.3</td> <td>263.9</td> </tr> </tbody> </table>	DATE	DEPTH(m)	ELEV.(m)	2018.07.10	1.3	263.9	2018.07.11	1.3	263.9															
DATE	DEPTH(m)	ELEV.(m)																							
2018.07.10	1.3	263.9																							
2018.07.11	1.3	263.9																							

RECORD OF BOREHOLE No 17-43

1 OF 2

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 244.2 E 224 873.4 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers/ Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2017.08.25 - 2017.08.25 LATITUDE 49.301965° LONGITUDE -88.099109° CHECKED BY NLB

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												
266.8	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (150mm)																			
0.2	SAND , trace silt, trace gravel Compact Brown Dry (FILL)		1	GS			266													
			1	SS	15															
			2	SS	27		265													
	No recovery		3	SS	11															
263.8							264													
3.0	SAND and GRAVEL , some to trace silt, with cobbles Compact to Very Dense Brown Wet		4	SS	24															
							263													
	No recovery		5	SS	163/ 0.250		262													
							261													
			6	SS	13		260													
259.6																				
7.2	SAND , some to trace silt, trace gravel Loose to Very Loose Brown Wet		7	SS	8		259													
			8	SS	2		258													
							257													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity


20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-43

2 OF 2

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 244.2 E 224 873.4 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Solid Stem Augers/Hollow Stem Augers/ Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2017.08.25 - 2017.08.25 LATITUDE 49.301965° LONGITUDE -88.099109° CHECKED BY NLB

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										
								20	40	60	80	100						
Continued From Previous Page												WATER CONTENT (%)						
256.6																		
10.2	Gravelly SAND , trace silt Loose Brown Wet		9	SS	4		256											
							255											
	No recovery		10	SS	5		254											
253.5																		
13.3	SAND , some silt, trace gravel Loose Grey Wet		11	SS	5		253											
252.5																		
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 3.7m AND WATER LEVEL AT 3.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.2m, THEN ASPHALT TO THE SURFACE.																	



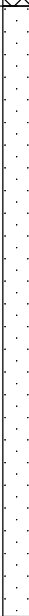

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-44

1 OF 2

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 249.7 E 224 887.9 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Washboring COMPILED BY AN
 DATUM Geodetic DATE 2017.08.24 - 2017.08.24 LATITUDE 49.302016° LONGITUDE -88.098911° 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 γ kN/m ³	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 _P w w _L				GR	SA	SI	CL	
266.3	GROUND SURFACE							20	40	60	80	100								
0.0	SAND and GRAVEL , some silt Very Dense Grey/Brown Wet (FILL)		1	SS	50/ 0.075		266													
			2	SS	100/ 0.075		265													
			3	SS	54		264													
			4	SS	34		263													
			5	SS	38		262													
263.3	occasional cobbles, occasional wood fragments Dense to Loose Brown Wet		6	SS	8		261													
			7	SS	5		260													
			8	SS	4		259													
259.3																				
7.0	SAND , some silt, trace gravel Loose Brown Wet		9	SS	7	257														

Continued Next Page

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

RECORD OF BOREHOLE No 17-44

2 OF 2

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 249.7 E 224 887.9 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Washboring COMPILED BY AN
 DATUM Geodetic DATE 2017.08.24 - 2017.08.24 LATITUDE 49.302016° LONGITUDE -88.098911° 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
	Continued From Previous Page							20 40 60 80 100								
256.1																
10.2	Gravelly SAND , trace silt Loose Brown Wet						256									
			10	SS	6											
							255									
			11	SS	9											
253.0																
13.3	SAND , some gravel, trace silt Very Loose Brown Wet						253									
			12	SS	3											12 84 4 (SI+CL)
252.0							252									
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 2.4m AND WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG SURFACE.															

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-44A

2 OF 2

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 249.7 E 224 887.9 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2017.08.24 - 2017.08.24 LATITUDE 49.302016° LONGITUDE -88.098911° CHECKED BY NLB



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						256										
							255										
							254										
							253										
252.0							252										
14.3	END OF DCPT AT 14.3m.																

RECORD OF BOREHOLE No 17-45

1 OF 1

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 223.5 E 224 877.0 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.08.23 - 2017.08.23 LATITUDE 49.301779° LONGITUDE -88.099056° CHECKED BY NLB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	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 _P w w _L				GR	SA	SI	CL
266.7	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (150mm)							20	40	60	80	100							
0.2	SAND and GRAVEL, trace to some silt Brown Dry to Wet (FILL)		1	GS			266							○					
			2	GS								○							
		Dense		1	SS	39								○					37 53 10 (SI+CL)
263.0																			
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 2.4m AND WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.2m, THEN ASPHALT TO THE SURFACE.																		

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-46

1 OF 1

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 213.6 E 224 878.8 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.08.23 - 2017.08.23 LATITUDE 49.301690° LONGITUDE -88.099029° 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 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 (%) W _p W W _L				
266.6	GROUND SURFACE																
0.0	ASPHALT: (150mm)																
0.2	SAND and GRAVEL trace to some silt Brown Dry (FILL)		1	GS			266									31 57 12 (SI+CL)	
			2	GS			265										
							264										
	Very Dense Wet		1	SS	148/ 0.225												
263.1	END OF BOREHOLE AT 3.5m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.2m, THEN ASPHALT TO THE SURFACE.																
3.5																	

RECORD OF BOREHOLE No 17-47

1 OF 1

METRIC

W.P. 6803-14-01 LOCATION Gorge Creek Culvert, MTM NAD 83 CSRS Zone 14 N 5 463 203.7 E 224 880.4 ORIGINATED BY TTB
 DIST HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.08.23 - 2017.08.23 LATITUDE 49.301602° LONGITUDE -88.099005° CHECKED BY NLB

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											
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
266.5	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (200mm)							20	40	60	80	100							
0.2	SAND and GRAVEL, trace to some silt Compact Brown Dry (FILL)		1	SS	25														
			1	GS															
	Very Dense		2	SS	55														
262.8																			
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN AND WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.2m, THEN ASPHALT TO THE SURFACE.																		

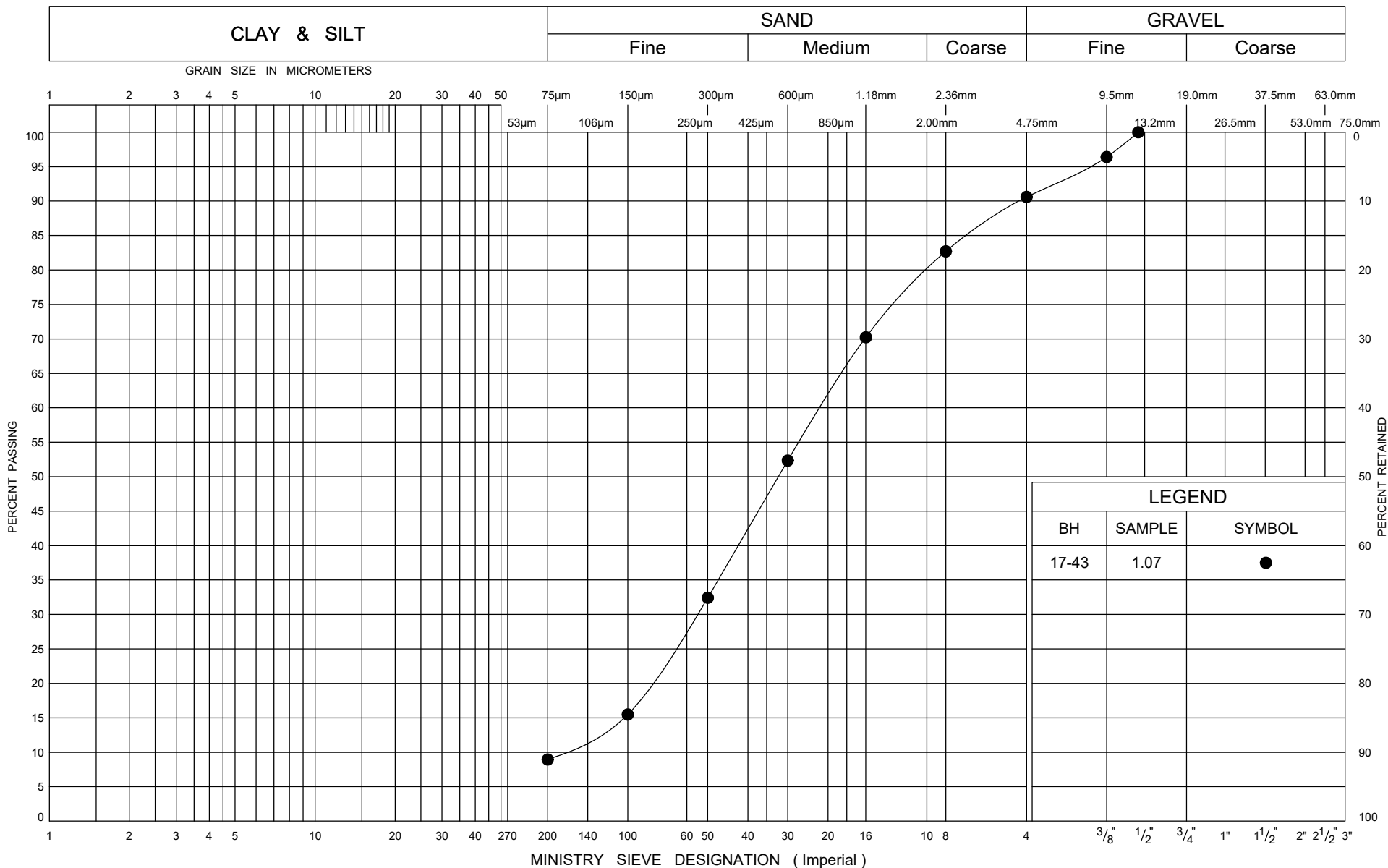
+³, ×³: Numbers refer to
Sensitivity

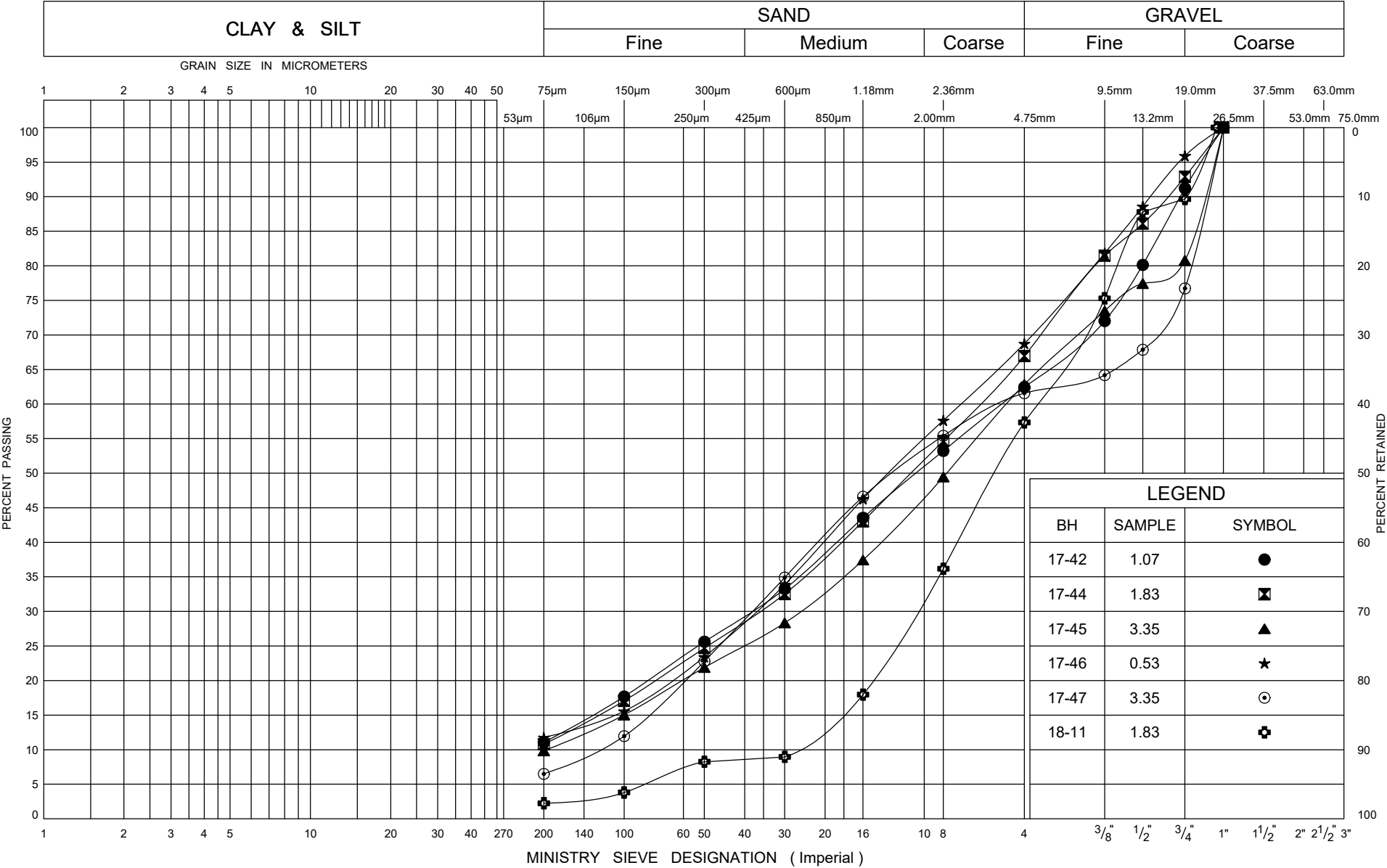
20
15
10
(%) STRAIN AT FAILURE

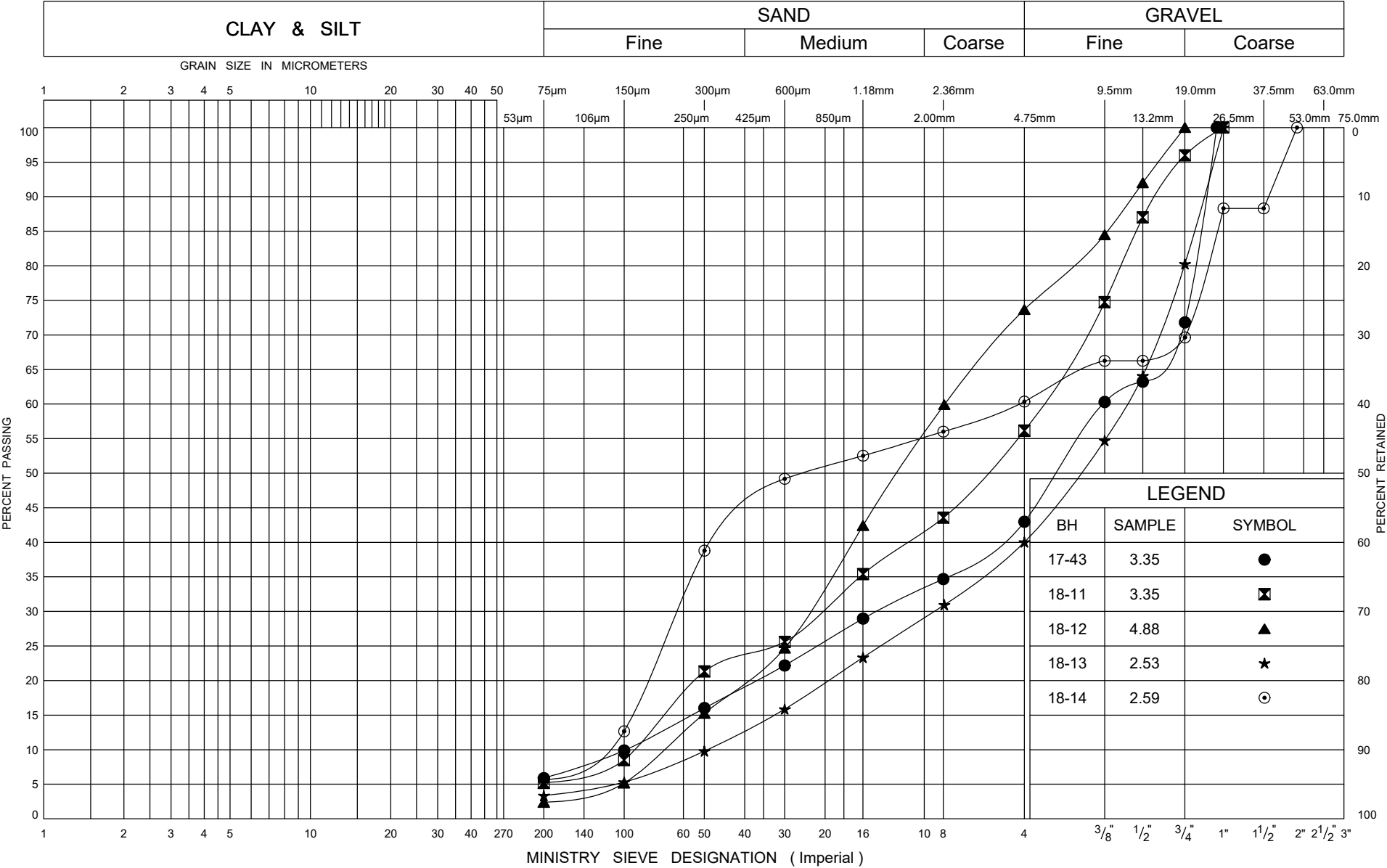


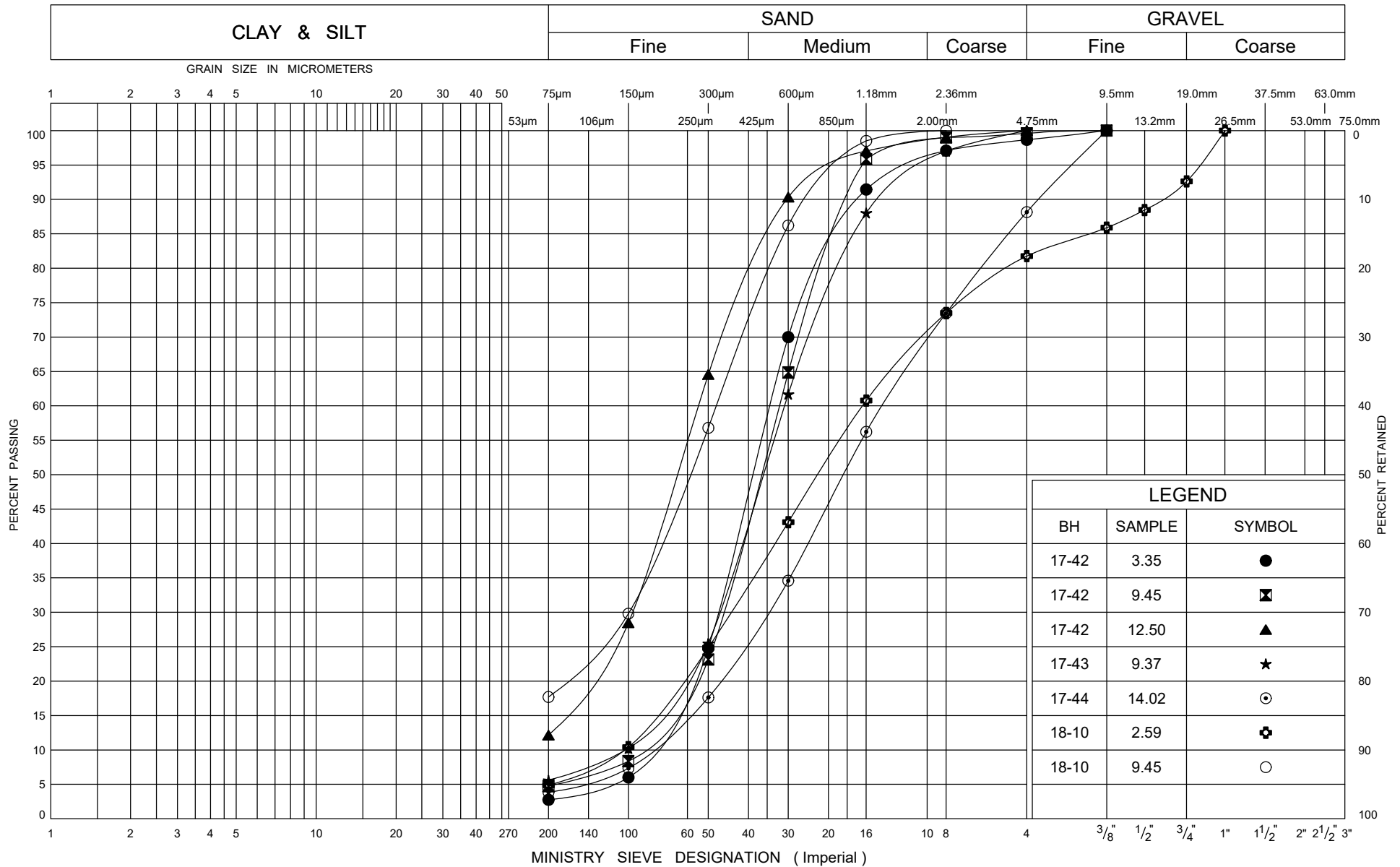
Appendix B

Laboratory Test Results









Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SAND

FIG No B4

W P 6330-14-01

Gorge Creek Culvert

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.
CA14253-SEP17
Corrosivity (Soil)

Sample ID Unit BH-43, SS#3, 5'-7'

Sample Date/Time 25-Aug-17

Moisture	%	4.7
pH	no unit	9.60
Corrosivity Index	none	13.0
Soil Redox Potential	mV	230
Sulphide	mg/L	<0.02
Chloride	mg/L	1100.0
Sulphate	mg/L	21
Conductivity	uS/cm	1150
Resistivity (calculated)	ohms.cm	867

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.
(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.



Client
SGS LIMS Number
Analysis Package:

Attention: Cory Zanatta
Project#: 15595, North Superior Lake Region
Thurber Engineering Ltd.
CA15829-AUG17
Corrosivity (Solution)

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

Sample ID Unit Gorge Creek

Sample Date/Time 23-Aug-17

Moisture	%	NA
pH	no unit	7.89
Corrosivity Index	none	NA
Redox Potential	mV	261
Sulphide	mg/L	<0.006
Chloride	mg/L	0.57
Sulphate	mg/L	1.5
Conductivity	uS/cm	107
Resistivity (calculated)	ohms.cm	9350

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

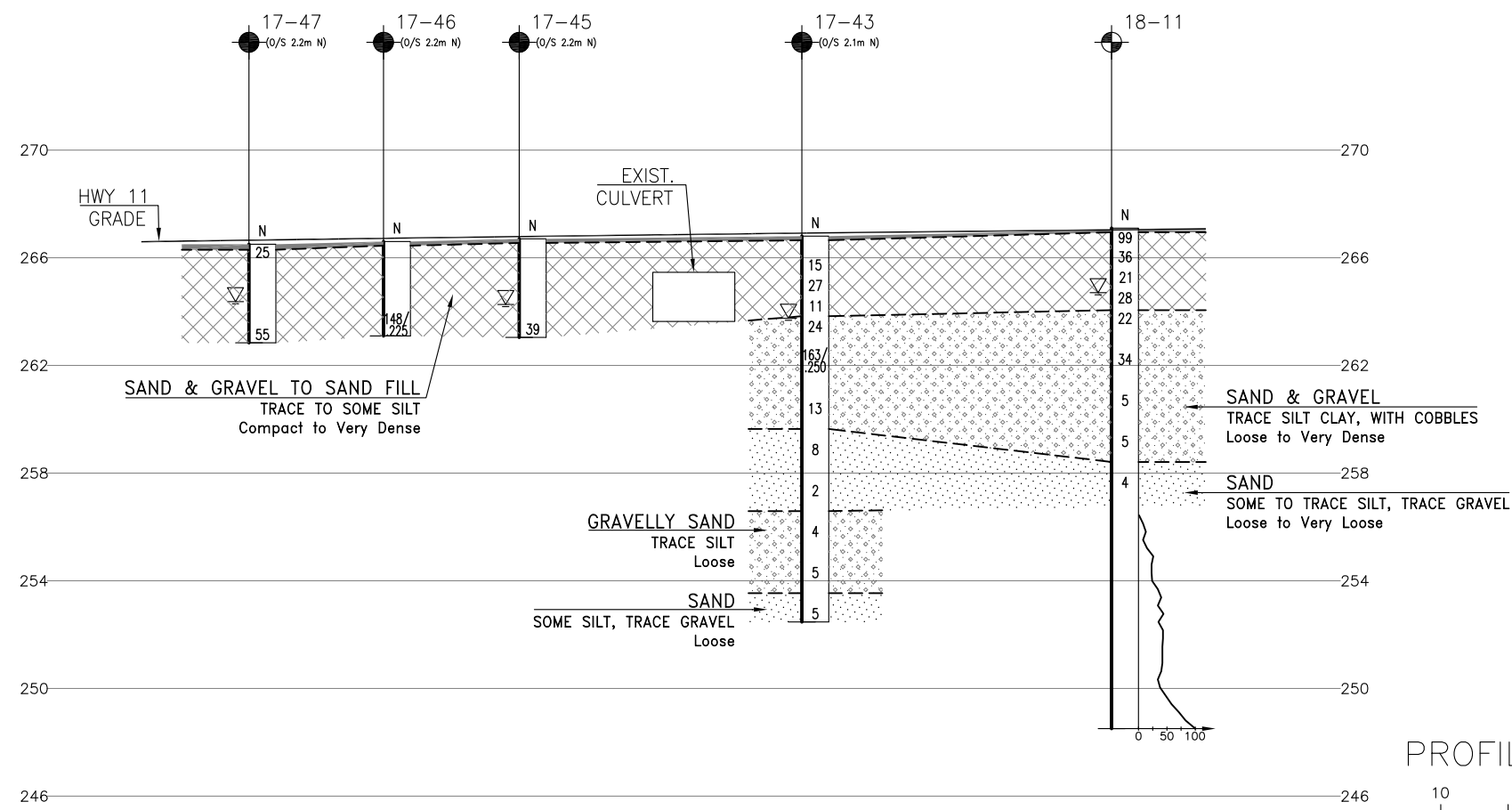
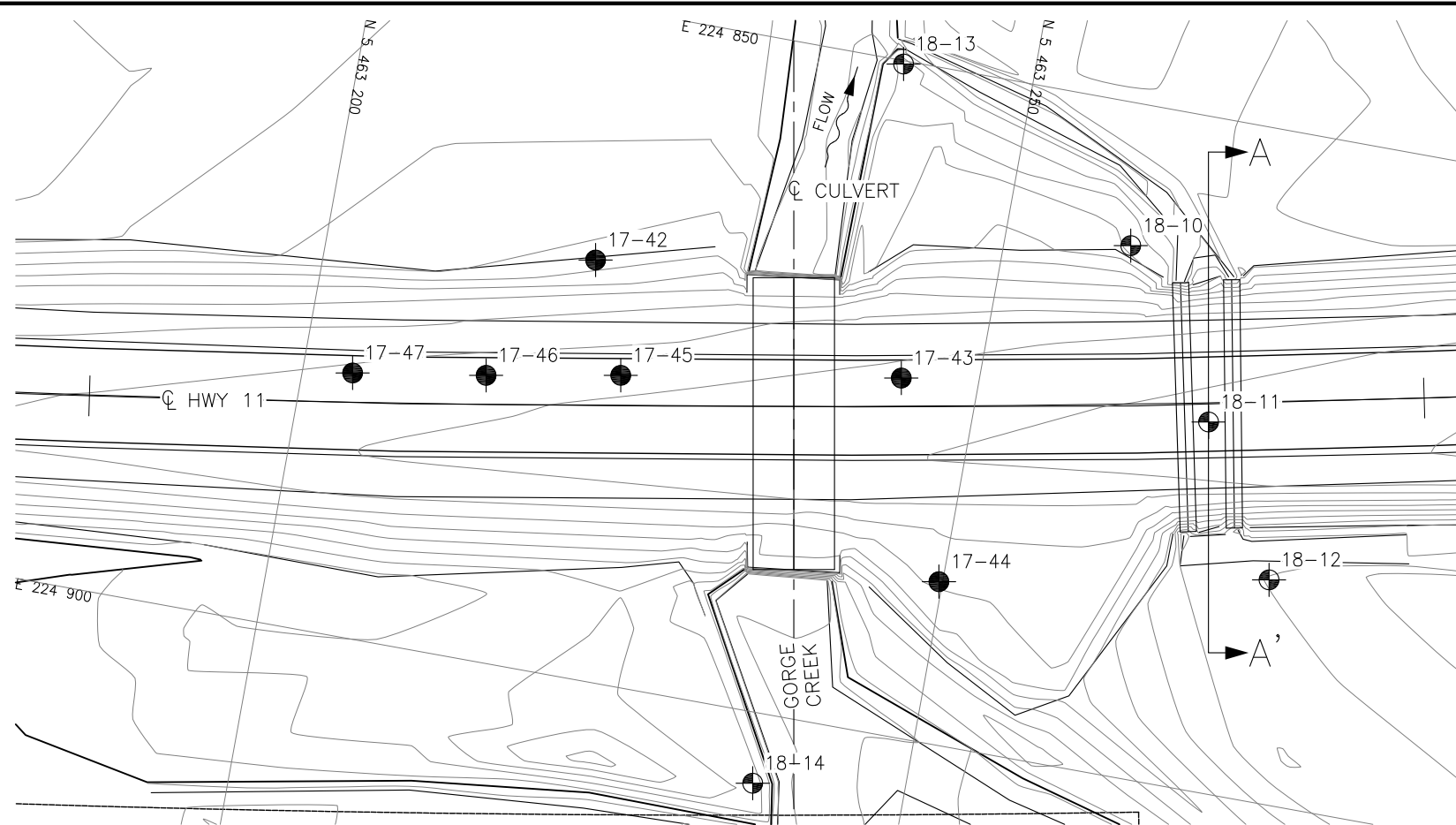
Deanna Edwards B.Sc., C.Chem
Project Specialist
Environment, Health and Safety

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.
(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.

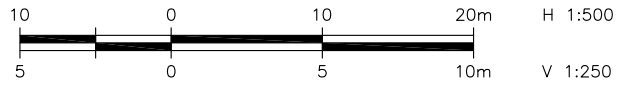


Appendix C

Borehole Locations and Soil Strata Drawing



PROFILE ALONG CL HWY 11



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



CONT No 2018-6015
WP No 6803-14-01

HIGHWAY 11
GORGE CREEK
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA I

THURBER ENGINEERING LTD.

SHEET
26

KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
17-42	265.4	5 463 220.1	224 868.8
17-43	266.8	5 463 244.2	224 873.4
17-44	266.3	5 463 249.7	224 887.9
17-45	266.7	5 463 223.5	224 877.0
17-46	266.6	5 463 213.6	224 878.8
17-47	266.5	5 463 203.7	224 880.4
18-10	265.1	5 463 259.4	224 860.6
18-11	267.1	5 463 267.5	224 872.6
18-12	265.0	5 463 274.0	224 883.4
18-13	264.8	5 463 240.2	224 850.3
18-14	265.2	5 463 238.7	224 905.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

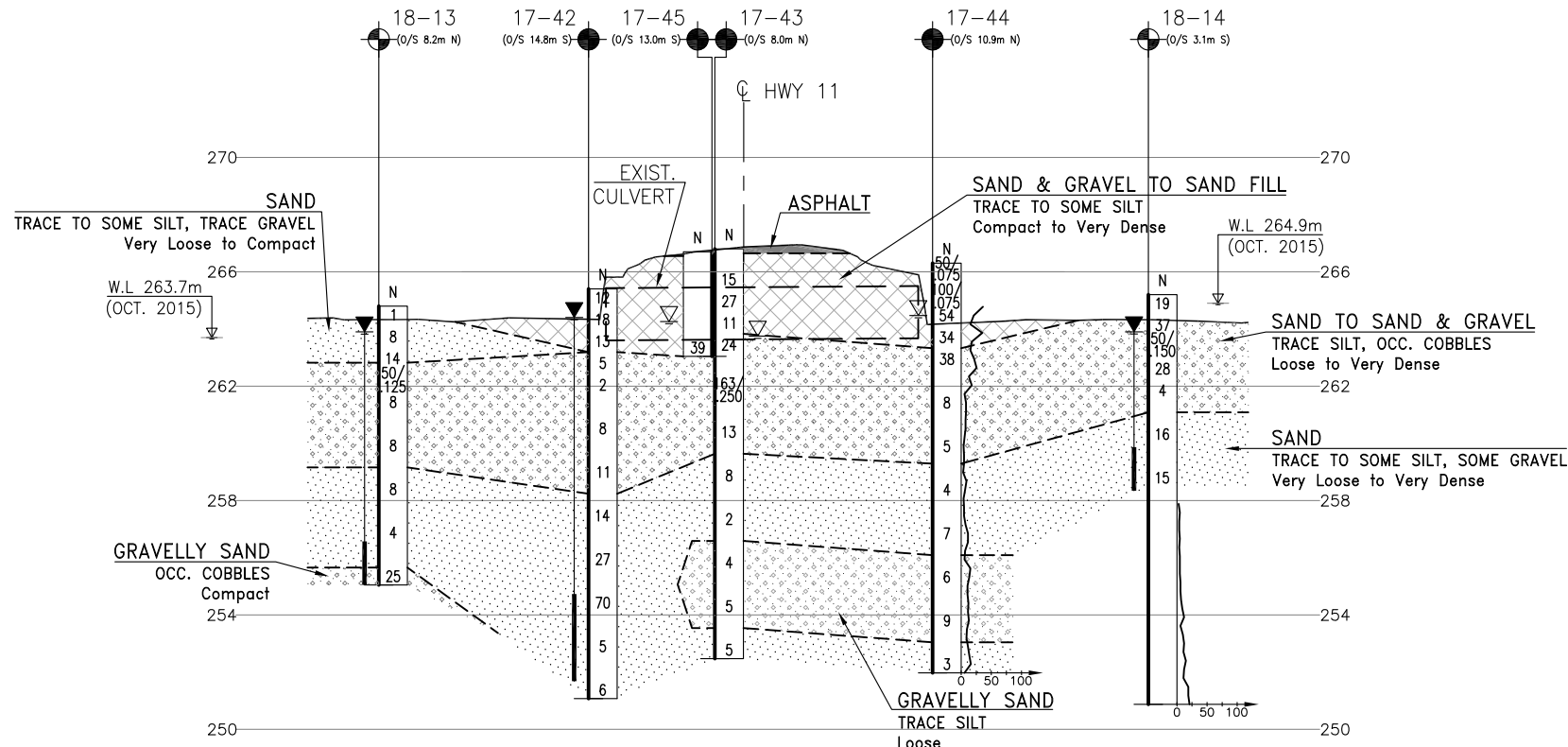
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

3) Coordinate system is MTM NAD 83 CSRS Zone 14.

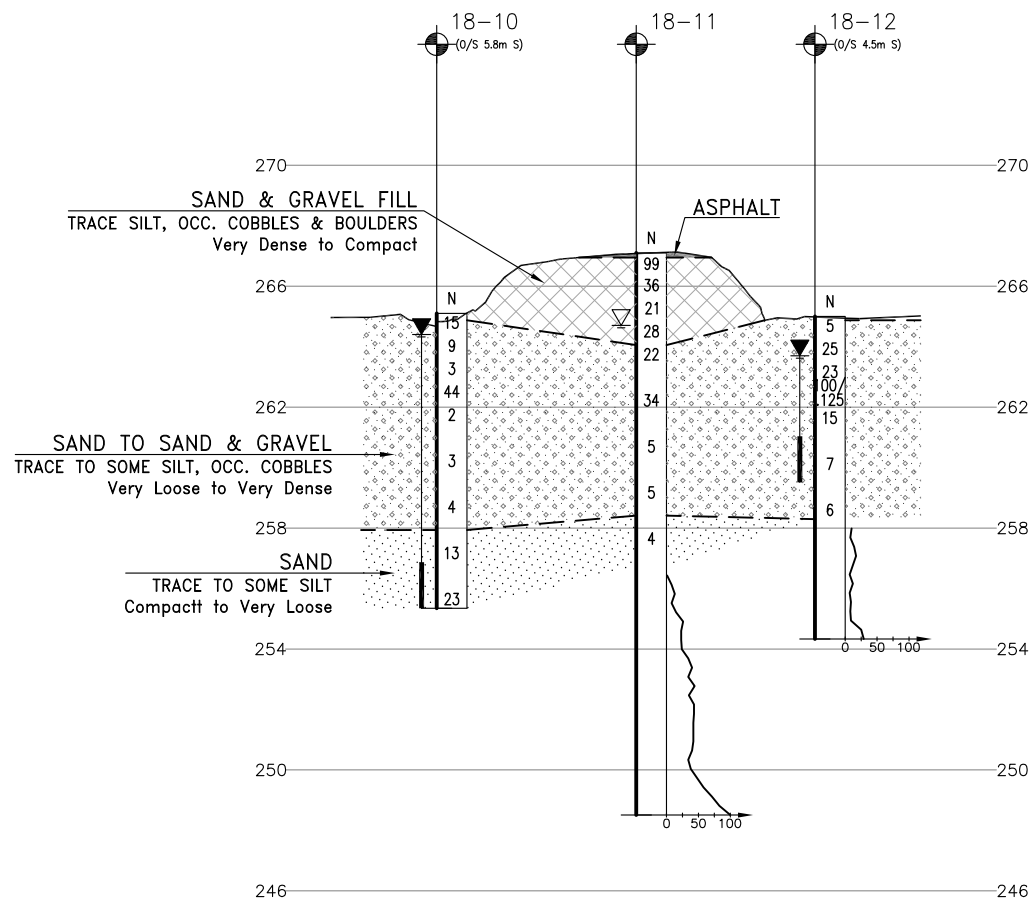
GEOCRES No. 52H-48

REVISIONS

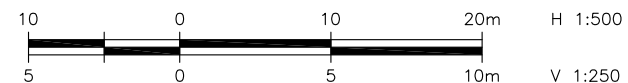
DATE	BY	DESCRIPTION
DESIGN	CZ	CHK MEF CODE LOAD DATE NOV 2018
DRAWN	AN	CHK CZ SITE 48C-182/C/STRUCT DWG 2



PROFILE ALONG CL CULVERT



PROFILE ALONG A-A'



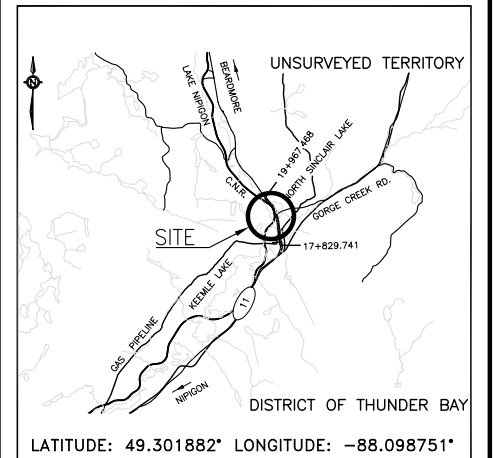
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No 2018-6015
WP No 6803-14-01

HIGHWAY 11
GORGE CREEK
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA II

SHEET
27

HATCH



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
17-42	265.4	5 463 220.1	224 868.8
17-43	266.8	5 463 244.2	224 873.4
17-44	266.3	5 463 249.7	224 887.9
17-45	266.7	5 463 223.5	224 877.0
17-46	266.6	5 463 213.6	224 878.8
17-47	266.5	5 463 203.7	224 880.4
18-10	265.1	5 463 259.4	224 860.6
18-11	267.1	5 463 267.5	224 872.6
18-12	265.0	5 463 274.0	224 883.4
18-13	264.8	5 463 240.2	224 850.3
18-14	265.2	5 463 238.7	224 905.3

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 CSRS Zone 14.

GEOCRES No. 52H-48

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CZ	CHK MEF	CODE
DRAWN	AN	CHK CZ	SITE 48C-182/C/STRUCT
			LOAD
			DATE
			NOV 2018
			DWG 3



Appendix D

Site Photographs



Photo 1: Road approach looking north. Taken May 15, 2017.



Photo 2: Road approach looking south. Taken May 15, 2017.



Photo 3: East embankment looking north (inlet). Taken June 27, 2017.



Photo 4: East embankment looking south (inlet). Taken June 27, 2017.



Photo 5: West embankment looking north (outlet). Taken June 27, 2017.



Photo 6: West embankment looking south (outlet). Taken June 27, 2017.



Photo 7: Culvert outlet looking southeast. Taken May 15, 2017.



Photo 8: Culvert inlet looking northwest. Taken May 15, 2017.