THURBER ENGINEERING LTD.

DETAILED FOUNDATION INVESTIGATION REPORT
CAMPROAD CREEK CULVERT REPLACEMENT
HIGHWAY 11, UNSURVEYED TERRITORY
THUNDER BAY DISTRICT, ONTARIO
LATITUDE: 49.584064º, LONGITUDE: -87.970042º

G.W.P. 6802-14-00, W.P. 6802-14-01, SITE No. 48C-179/C

GEOCRES Number: 42E-30

Report

to

HATCH

Date: November 12, 2018
File: 15595

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1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Camproad Creek Culvert on Highway 11, located in the Township of Summers, in the 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 investigation previously conducted by Thurber is described in the following report:

- Preliminary Foundation Investigation and Design Report, Camproad Creek Culvert Replacement, Highway 11, Unsurveyed Territory, Thunder Bay District, Ontario, GEOCRES Number 42E-29, 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 2 km south of the town of Beardmore, Ontario. The existing culvert allows Camproad Creek (also known as Warneford Creek) to flow in a westerly direction under Highway 11, where it meets Blackwater River to the west. Highway 11 generally runs in a north-south direction at the culvert site.

Based on the Ontario Structure Inspection Manual (OSIM) prepared by MTO on November 20, 2014, the existing culvert is a corrugated steel pipe culvert that has a diameter of 4.5 m and is 38.4 m long. The culvert barrel has rusting and section loss of the steel between the low and high water level, severe corrosion of joint laps and bolts, and deformation of the inlet and outlet of the culvert.

The grade level of Highway 11 at the existing culvert centreline is at an elevation of approximately 306.7 m. The invert elevation at the inlet (east) is 299.7 m and the invert elevation at the outlet (west) is 299.5 m. The elevation of the water flowing through the creek on November 7, 2015, was reported to be approximately 301.0 m upstream of the inlet and 299.4 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, and midsized trees, and the overall surrounding area is densely forested. On the east side of Highway 11, a paved highway rest area is located approximately 50 m south of the inlet and a cleared hydro corridor is located approximately 100 m north of the inlet. A railway corridor is located approximately 65 m west of the outlet. Photographs in Appendix D show the culvert and the surrounding area.

Based on published geological information, the site generally lies within an alluvial plain with sand and gravel deposits and is bounded by bedrock ridges to the east of the highway and west of Blackwater River. The bedrock at the site consists of mafic to intermediate metavolcanic rocks.

3. INVESTIGATION PROCEDURES

The current detailed field investigation for this project was carried out from June 20 to 22, 2018 and from July 12 to 18, 2018, and consisted of drilling and sampling four (4) boreholes, denoted as Boreholes 18-06 to 18-09, to depths ranging from 9.8 to 20.4 m below the existing ground surface. Boreholes 18-06 and 18-07 were located within the paved section of Highway 11 at the locations of proposed abutments for a temporary modular bridge, and Boreholes 18-08 and 18-09 were located near the inlet and outlet of the existing culvert near the locations of proposed cofferdams.

The previous preliminary investigation for this project was carried out between August 26 to 27 and between October 25 to 28, 2017, during which time seven (7) boreholes denoted as Boreholes 17-48 to 17-54 were drilled to depths of between 3.7 m and 14.3 m below the 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 are shown on the Borehole Locations and Soil Strata Drawing provided in Appendix C.

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. A truck-mounted CME 55 drill rig with NW casing was used to drill Boreholes 18-06 and 18-07, and a portable Hilti drill and tripod equipment using wash boring techniques was used to drill Boreholes 18-08 and 18-09. In all boreholes, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT). An NQ core barrel was used to advance Borehole 18-07 into bedrock. The results of the boreholes are presented on the Record of Borehole sheets in Appendix A.

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 and rock samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and in standpipe piezometers that were installed in Boreholes 18-06, 18-07, and 18-08. The boreholes in which no standpipe piezometers were installed were backfilled in general accordance with Ontario Regulation 903, as amended by Regulation 128/03. The piezometers were decommissioned upon completion of the field investigation in general accordance with Ontario Regulation 903, as amended by Regulation 128/03. Piezometers were also installed in Boreholes 17-48 and 17-50 during the preliminary investigation.

Details of the piezometer installations and borehole completion are summarized in Table 3.1 below.

Table 3.1 – Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
18-06	20.4 / 287.4	19.8 / 288.0	Sand to 18.0 m, then bentonite holeplug to 0.3 m, then sand and gravel to 0.15 m, then asphalt to surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
18-07	19.1 / 286.9	15.2 / 290.7	Bentonite holeplug to 15.3 m, then sand to 13.7 m, then bentonite holeplug to 0.3, then sand and gravel to 0.15 m, then asphalt to surface.
18-08	9.8 / 292.6	9.4 / 293.0	Borehole caved from 9.8 to 9.4 m, then sand to 7.6 m, then bentonite holeplug to surface.
18-09	9.8 / 292.1	None Installed	Borehole caved to 1.8 m, then bentonite holeplug and cuttings to surface.
17-48	14.3/297.0	13.7/287.6	Sand to 9.8 m then bentonite holeplug to surface
17-49	14.3/292.7	None Installed	Bentonite holeplug and cuttings to 0.9 m below surface, then concrete to 0.15 below surface and asphalt to surface
17-50	10.3/291.2	7.9/293.7	Bentonite and cuttings to 7.9 m, then sand to 4.7 m and cutting to surface
17-51	3.7/302.6	None Installed	Bentonite holeplug and cuttings to 0.9 m below surface, then concrete to 0.15 below surface and asphalt to surface
17-52	3.7/302.4	None Installed	Bentonite holeplug and cuttings to 0.9 m below surface, then concrete to 0.15 below surface and asphalt to surface
17-53	3.7/302.1	None Installed	Bentonite holeplug and cuttings to 0.9 m below surface, then concrete to 0.15 below surface and asphalt to surface
17-54	11.3/290.5	None Installed	Bentonite and cutting to surface.

It should be noted that caving occurred in Boreholes 18-08 and 18-09 in the silty soils.

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 point load testing on bedrock, 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 fill, and a sample of the surface water from the creek upstream of the existing culvert were collected 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. 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 consisted of asphalt and gravelly sand fill or sand and silt overlying varying thicknesses of sand, silt, sandy silt, which were underlain by metavolcanics bedrock. Descriptions of the individual strata are presented below.

5.1 Topsoil

Boreholes 18-08, 18-09 and 17-48 encountered 0.15 to 0.6 m of topsoil at the ground surface. At Borehole 17-48, the topsoil was mixed with sand and silt and trace gravel. An SPT ‘N’ value of 27 blows per 0.3 m of penetration was recorded in the topsoil / sand and silt mixture at Borehole 17-48, indicating a compact density. The moisture content was measured as 11 to 27 percent.

5.2 Asphalt

Boreholes 17-49, 17-51, to 17-53, 18-06 and 18-07 were drilled through the travelled lanes of Highway 11 and encountered a layer of asphalt that ranged in thickness from 125 mm to 225 mm.

5.3 Gravelly Sand to Sand and Gravel Fill

Embankment fill material was encountered below the asphalt in Boreholes 17-49, 17-51 to 17-53, 18-06 and 18-07. The fill ranged in thickness from 5.9 to 7.8 m in Boreholes 17-49, 18-06 and 18-07, and extended to depths of 6.1 to 8.0 m (Elevation 299.0 to 300.0 m). Boreholes 17-51 to 17-53 were terminated within the fill at a depth of 3.7 m each (Elevation 302.6 m to 302.1 m).

The fill ranged in composition from sand and gravel to sand with some gravel (typically gravelly sand) and contained occasional boulders and sandy silt zones.

Boreholes 17-51 to 17-53 were drilled to assess the existence and extent of any frost taper near the culvert. Based on the results of the field investigation, the granular base/subbase material extended below the frost penetration depth and a defined frost taper was not observed at the culvert location.

SPT 'N' values within the fill ranged from 8 to 123 blows per 0.3 m of penetration, indicating a loose to very dense relative density (typically compact to dense). Moisture contents between 4 percent and 19 percent were measured in the cohesionless fill.

The results of grain size distribution analyses carried out on selected samples of the gravelly sand to sand and gravel 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	17 to 51
Sand	37 to 77
Silt and Clay	3 to 19

5.4 Sand

A layer of native sand containing some silt, trace gravel, and trace to some organics was encountered below the topsoil in Boreholes 18-08 and 18-09. The sand layer was 0.6 to 1.3 m thick and extended to depths from 0.8 to 1.5 m (Elevation 300.4 to 301.6 m).

The sand ranged from very loose to dense, based on SPT 'N' values ranging from 3 to 47 blows per 0.3 m of penetration. Measured moisture contents within the sand deposit varied from 5 percent to 19 percent.

The results of a grain size distribution analysis test carried out on a selected sample of the sand is presented on the Record of Borehole sheets included in Appendix A and on Figure B3 of Appendix B. The results of the grain size distribution analysis are summarized below:

Soil Particle	Percentage (%)
Gravel	1
Sand	79
Silt	17
Clay	3

5.5 Sand and Silt

A sand and silt layer with some gravel and trace clay was encountered at the surface of Boreholes 17-50 and 17-54, and below the sand in Borehole 18-08. This layer ranged in thickness from 0.3 m to 4.6 m and extended to depths ranging from 2.4 to 4.6 m (Elevation 297.2 to 299.4 m).

SPT 'N' values within the sand and silt deposit ranged from 3 to 47 blows per 0.3 m of penetration, indicating a very loose to dense relative density. Measured moisture contents within the sand and silt deposit varied from 6 percent to 21 percent.

The results of grain size distribution analysis testing carried out on a selected sample of the sand and silt are presented on the Record of Borehole sheets included in Appendix A and on Figure B4 of Appendix B. The results of the grain size distribution analysis are summarized below:

Soil Particle	Percentage (%)
Gravel	11
Sand	44
Silt	39
Clay	6

5.6 Sand and Gravel to Gravelly Sand

A 0.8 to 2.1 m thick layer of sand and gravel to gravelly sand with trace to some silt, was encountered below the topsoil in Borehole 17-48 and below the sand in Boreholes 18-08 and 18-09. The sand and gravel to gravelly sand extended to depths of 2.3 to 2.7 m (Elevation 298.6 to 299.7 m).

SPT 'N' values within the sand and gravel to gravelly sand deposit ranged from 12 to 33 blows per 0.3 m of penetration, indicating a compact to dense relative density. Measured moisture contents varied between 2 percent and 12 percent.

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

Soil Particle	Percentage (%)
Gravel	24 to 43
Sand	49 to 64
Silt and Clay	6 to 12

5.7 Silt

The fill and upper native sand, sand and silt and gravelly sand layers were underlain by a thick deposit of silt containing trace sand to sandy, trace clay and trace gravel. Where fully penetrated, the silt deposit ranged from 5.3 to 10.5 m thick in Boreholes 17-48, 18-06, 18-07 and 18-09, and extended to depths from 7.6 to 18.3 m (Elevation 289.5 to 294.3 m). Boreholes 17-49, 17-50, 17-54 and 18-08 were terminated within the silt at depths ranging from 9.8 m to 14.3 m (Elevation 290.5 to 292.7 m).

SPT 'N' values within the silt deposit ranged from 3 to 58 blows per 0.3 m of penetration, indicating a very loose to very dense relative density (typically compact). Measured moisture contents within the silt deposit varied between 13 percent and 24 percent.

The results of grain size distribution analyses carried out on selected samples of the silt are presented on the Record of Borehole sheets included in Appendix A and on Figures B6 and B7 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 6
Sand	0 to 35
Silt	60 to 94
Clay	5 to 9

5.8 Sandy Silt

A layer of sandy silt with trace clay and trace gravel was encountered below the silt deposit in Boreholes 17-48, 18-06 and 18-09. These boreholes were terminated within the sandy silt layer at depths ranging from 9.8 to 20.4 m (Elevation 287.0 to 292.1 m).

The SPT ‘N’ values recorded in the sandy silt ranged from 8 to 59 blows per 0.3 m penetration indicating a loose to very dense relative density. The sandy silt had a measured moisture content ranging from 13 percent to 22 percent.

The results of grain size distribution analyses carried out on selected samples of the sandy silt are presented on the Record of Borehole sheets included in Appendix A and on Figure B8 of Appendix B. The results of the grain size distribution analysis are summarized below:

Soil Particle	Percentage (%)
Gravel	0 to 2
Sand	25 to 29
Silt	63 to 69
Clay	6

5.9 Lower Sand and Gravel

A 3.5 m thick lower layer of sand and gravel with trace silt was encountered below the silt in Borehole 18-07, overlying the bedrock. The lower sand and gravel extended to a depth of 16.2 m (Elevation 289.7 m). A 0.9 m thick layer of boulders was encountered within the sand and gravel at a depth of 14.6 to 15.5 m.

SPT ‘N’ values within the lower sand to gravel deposit ranged from 14 to 46 blows per 0.3 m of penetration, indicating a compact to dense relative density. Measured moisture contents within the sand and gravel deposit varied between 6 percent and 21 percent.

The results of a grain size distribution analyses carried out on a sample of the lower sand and gravel are presented on the Record of Borehole sheets included in Appendix A and on Figure B9 of Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Percentage (%)
Gravel	51
Sand	45
Silt and Clay	4

5.10 Bedrock

Metavolcanic bedrock was encountered in Borehole 18-07 at a depth of 16.2 m (Elevation 289.7 m). The bedrock was confirmed by coring 2.9 m. The bedrock was generally described as fresh. The borehole was terminated within the bedrock at a depth of 19.1 m (Elevation 286.9 m).

Total Core Recovery (TCR) in the bedrock was 100% with Solid Core Recovery (SCR) ranging from 65% to 85%. The Rock Quality Designation (RQD) determined from the recovered cores ranged from 9% to 68%, indicating very poor to fair quality (typically fair). Average unconfined compressive strengths (UCS) of the rock ranged between 12 to 149 MPa based on correlations with the point load tests (PLT), indicating that the rock ranged from weak to very strong.

The point load test results and photographs of the bedrock core are included in Appendix B.

5.11 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes 18-06 to 18-08, 17-48 and 17-50 to monitor the groundwater level at the site. The groundwater levels measured in the open boreholes and in the standpipe piezometers are summarized in Table 5.1 below.

Table 5.1 – Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
18-06	June 22, 2018 July 25, 2018	Dry 7.0	Dry 300.8	Standpipe piezometer
18-07	June 21, 2018 June 22, 2018 July 25, 2018	5.3 5.3 5.7	300.6 300.6 300.2	Standpipe piezometer
18-08	July 13, 2018 July 14, 2018	1.4 1.6	301.0 300.8	Standpipe piezometer
18-09	July 12, 2018	1.5	300.4	Open borehole
17-48	August 28, 2017	1.5	299.8	Standpipe piezometer
17-49	August 26, 2017	8.0	299.0	Open borehole
17-50	October 27, 2017 October 28, 2017	1.3 1.3	300.3 300.3	Standpipe piezometer
17-51	August 26, 2017	Dry	Dry	Open borehole
17-52	August 26, 2017	Dry	Dry	Open borehole
17-53	August 26, 2017	Dry	Dry	Open borehole
17-54	October 27, 2017	2.4	299.4	Open Borehole

The surface elevation of the water flowing through the creek on November 7, 2015, was reported to be approximately 301.0 m upstream of the inlet and 299.4 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 gravelly sand fill from Borehole 17-49, 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	
			17-49, SS#6, 4.6 m – 5.2 m (Fill)	Camproad Creek (Creek Water)
Sulphide	%	mg/L	<0.02	<0.006
Chloride	mg/L	mg/L	160	31
Sulphate	mg/L	mg/L	15	2.3
pH	No unit	No unit	9.65	7.91
Electrical Conductivity	µS/cm	µS/cm	322	243
Resistivity	Ohms.cm	Ohms.cm	3110	4120
Redox Potential	mV	mV	243	250

7. MISCELLANEOUS

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

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.

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. 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. 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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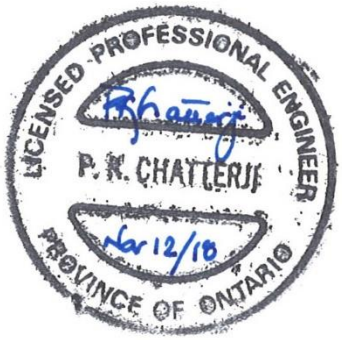
Thurber Engineering Ltd.

Mark Farrant, P.Eng.
Geotechnical Engineer



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

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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

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

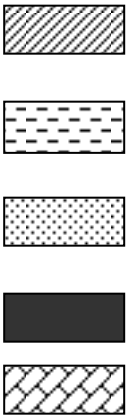
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 18-06 1 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 515.7 E 234 669.9 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing COMPILED BY MP

DATUM Geodetic DATE 2018.06.22 - 2018.06.22 LATITUDE 49.58432208 LONGITUDE -87.96993124 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.8	GROUND SURFACE										
0.0	**ASPHALT** (175mm)										
307.8	**GRAVEL**, some sand Very Dense Dark Brown Moist (FILL)		1	SS	100				○		
0.3	Gravelly **SAND**, some silt Very Dense Brown Moist (FILL)		2	SS	54		307		○		23 64 13 (SI+CL)
			3	SS	50/ 0.150		306		○		
304.8			4	SS	55		305		○		
3.0	Sandy **SILT**, trace gravel Compact Reddish Brown Wet (FILL)		5	SS	20		304		○		
304.0	**SAND** and **GRAVEL**, some silt Compact to Dense Brown Wet (FILL)		6	SS	37		303		○		50 37 13 (SI+CL)
			7	SS	13	▼	302		○		
300.0							301				
7.8	**SILT**, trace sand to sandy, trace clay Compact to Dense Grey Wet		8	SS	13		300		○		0 35 60 5
			9	SS	20		299		○		
							298				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 18-06 2 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 515.7 E 234 669.9 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing COMPILED BY MP

DATUM Geodetic DATE 2018.06.22 - 2018.06.22 LATITUDE 49.58432208 LONGITUDE -87.96993124 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
							297				
			10	SS	29				○		
							296				
			11	SS	19				○		0 4 90 6
							295				
							294				
			12	SS	24				○		
							293				
			13	SS	42				○		0 3 88 9
							292				
							291				
			14	SS	25				○		
289.5							290				
18.3	Sandy **SILT**, trace clay, trace gravel Very Dense Brown Moist		15	SS	59				○		
							289				
							288				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S2 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 8/10/18

Ministry of Transportation
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RECORD OF BOREHOLE No 18-06 3 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 515.7 E 234 669.9 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing COMPILED BY MP

DATUM Geodetic DATE 2018.06.22 - 2018.06.22 LATITUDE 49.58432208 LONGITUDE -87.96993124 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR	SA	SI	CL
	Continued From Previous Page													
287.4			16	SS	54				○		2	29	63	6
20.4	END OF BOREHOLE AT 20.4m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.06.22 Dry - 2018.07.25 7.0 300.8													

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 8/10/18

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RECORD OF BOREHOLE No 18-07 1 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 467.3 E 234 648.8 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP

DATUM Geodetic DATE 2018.06.20 - 2018.06.20 LATITUDE 49.58388376 LONGITUDE -87.9702138 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.9	GROUND SURFACE								
0.0	**ASPHALT**: (150mm)								
0.2 / 305.1	**SAND** and **GRAVEL**, trace silt Very Dense Dark Brown Moist (FILL)		1	SS	88				37 56 7 (SI+CL)
0.8	Gravelly **SAND**, trace silt Very Dense to Compact Brown Moist (FILL)		2	SS	45		305		
			3	SS	57		304		
			4	SS	11				21 76 3 (SI+CL)
302.5			5	SS	40		303		
3.4 / 301.5	Sandy **SILT** Dense Brown Moist (FILL)						302		
4.4 / 300.7	**BOULDER** (FILL)						301		
5.2	**SAND** and **GRAVEL** Compact Brown Wet (FILL)		6	SS	26	▼	300		
299.8									
6.1	**SILT**, trace sand, trace clay Compact to Dense Grey Wet		7	SS	37		299		
			8	SS	19		298		0 5 89 6
			9	SS	17		297		
							296		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 8/10/18

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RECORD OF BOREHOLE No 18-07 2 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 467.3 E 234 648.8 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP

DATUM Geodetic DATE 2018.06.20 - 2018.06.20 LATITUDE 49.58388376 LONGITUDE -87.9702138 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			10	SS	23		295		○		0 2 89 9
							294				
293.2			11	SS	22				○		
12.7	**SAND** and **GRAVEL**, trace silt Dense to Compact Dark Brown Wet						293				
			12	SS	46		292		○		51 45 4 (SI+CL)
291.3											
14.6	**BOULDER**						291				
290.4											
15.5			13	SS	14		290		○		
289.7										Fl	
16.2	**METAVOLCANIC BEDROCK,** greyish black, fresh, weak to very strong		1	RUN						3	RUN #1 TCR=100% SCR=65% RQD=9% UCS=12MPa (Average)
							289			2	
										7	
										8	
			2	RUN			288			4	RUN #2 TCR=100% SCR=85% RQD=68% UCS=145MPa (Average)
										3	
										1	
										2	RUN #3 TCR=100% SCR=67% RQD=67% UCS=149MPa (Average)
286.9			3	RUN			287			2	
19.1	END OF BOREHOLE AT 20.4m. WATER LEVEL AT 5.3m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen.										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 18-07 3 OF 3 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 467.3 E 234 648.8 ORIGINATED BY BRM

DIST Thunder Bay HWY 11 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY MP

DATUM Geodetic DATE 2018.06.20 - 2018.06.20 LATITUDE 49.58388376 LONGITUDE -87.9702138 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.06.21 5.3 300.6 2018.06.22 5.3 300.6 2018.07.25 5.7 300.2										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 18-08 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 507.1 E 234 632.4 ORIGINATED BY JM

DIST Thunder Bay HWY 11 BOREHOLE TYPE Wash Boring COMPILED BY MP

DATUM Geodetic DATE 2018.07.18 - 2018.07.18 LATITUDE 49.58424025 LONGITUDE -87.97044729 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
302.4	GROUND SURFACE										
0.0	**TOPSOIL**: (150mm)										
0.2	**SAND**, some silt, trace gravel, trace to some organics Loose Brown		1	SS	8		302				
301.6	Moist										
0.8	**SAND** and **GRAVEL** to Gravelly **SAND**, trace to some silt, occasional cobbles Compact to Dense Brown Moist		2	SS	27		301				43 49 8 (SI+CL)
			3	SS	33						
299.7			4	SS	27		300				24 64 12 (SI+CL)
2.7	**SAND** and **SILT**, some gravel Compact										
299.4	Brown to Grey Moist		5	SS	16		299				
3.0	**SILT**, some sand, trace clay, trace gravel Compact Grey Wet		6	SS	20		298				0 14 80 6
			7	SS	22		297				
			8	SS	18		296				
			9	SS	20		295				
292.6							294				
9.8	END OF BOREHOLE AT 9.8m.						293				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 8/10/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-08 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 507.1 E 234 632.4 ORIGINATED BY JM

DIST Thunder Bay HWY 11 BOREHOLE TYPE Wash Boring COMPILED BY MP

DATUM Geodetic DATE 2018.07.18 - 2018.07.18 LATITUDE 49.58424025 LONGITUDE -87.97044729 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	kN/m³	GR SA SI CL
	Continued From Previous Page										
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.5m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.07.13 1.4 301.0 2018.07.14 1.6 300.8										

ONTMT4S2 MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 8/10/18

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 18-09 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 496.3 E 234 689.6 ORIGINATED BY JM

DIST Thunder Bay HWY 11 BOREHOLE TYPE BW Casing COMPILED BY MP

DATUM Geodetic DATE 2018.07.12 - 2018.07.12 LATITUDE 49.5841493 LONGITUDE -87.96965436 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.9	GROUND SURFACE										
0.0	**TOPSOIL**: (150mm)										
0.2	**SAND**, some silt, trace gravel, trace to some organics, trace rootlets, trace clay Very Loose to Dense Brown Moist		1	SS	3						1 79 17 3
			2	SS	47		301				
300.4						▽					
1.5	**SAND** and **GRAVEL**, trace silt Dense Brown Moist to Wet		3	SS	31		300				
299.6											
2.3	**SILT**, trace sand, trace clay, trace gravel Compact Grey Wet		4	SS	21						0 9 85 6
			5	SS	15		299				
							298				
			6	SS	21		297				
							296				
			7	SS	17						
							295				
294.3											
7.6	Sandy **SILT**, trace clay Compact Grey Wet		8	SS	22		294				0 25 69 6
							293				
292.1			9	SS	12						
9.8	END OF BOREHOLE AT 9.8m.										

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

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RECORD OF BOREHOLE No 18-09 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 496.3 E 234 689.6 ORIGINATED BY JM

DIST Thunder Bay HWY 11 BOREHOLE TYPE BW Casing COMPILED BY MP

DATUM Geodetic DATE 2018.07.12 - 2018.07.12 LATITUDE 49.5841493 LONGITUDE -87.96965436 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE CAVED TO 1.8m AND WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

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RECORD OF BOREHOLE No 17-48 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 473.3 E 234 622.2 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers/Washboring COMPILED BY MP

DATUM Geodetic DATE 2017.08.27 - 2017.08.27 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.3	GROUND SURFACE										
0.0	**TOPSOIL**, mixed with sand and silt, trace gravel, trace rootlets Compact Brown		1	SS	27		301		○		
300.7 / 0.6	Moist										
	Gravelly **SAND**, trace silt, occasional cobbles and wood pieces Compact Brown Moist		2	SS	13		300		○		
			3	SS	20	▼			○		34 60 6 (SI+CL)
	Wet		4	SS	12		299		○		
298.6 / 2.7	**SILT**, trace to some sand, trace clay, trace gravel Compact to Loose Grey Wet		5	SS	13		298		○		6 16 71 7
			6	SS	14		297		○		
			7	SS	9		296		○		
			8	SS	17		295		○		0 0 94 6
			9	SS	16		294		○		
							293				
							292		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-48 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 473.3 E 234 622.2 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers/Washboring COMPILED BY MP

DATUM Geodetic DATE 2017.08.27 - 2017.08.27 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						291				
			10	SS	8				○		
289.6							290				
11.7	Sandy **SILT**, trace clay Compact to Loose Grey Wet		11	SS	16		289		○		
							288				
287.0			12	SS	8				○		0 29 65 6
14.3	END OF BOREHOLE AT 14.3m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.08.28 1.5 299.8						287				

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 3/6/18

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RECORD OF BOREHOLE No 17-49 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 497.5 E 234 659.9 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers/Washboring COMPILED BY MP

DATUM Geodetic DATE 2017.08.26 - 2017.08.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.0	GROUND SURFACE										
0.0	**ASPHALT**: (225mm)										
0.2	Gravelly **SAND**, trace to some silt Very Dense Brown Dry (FILL)		1	SS	123				○		
			2	SS	62		306		○		22 65 13 (SI+CL)
			3	SS	55		305		○		
	Becomonig compact		4	SS	24				○		
			5	SS	12		304		○		21 70 9 (SI+CL)
			6	SS	12		303		○		
	Switched to washboring		7	SS	10		302		○		
299.0			8	SS	50	▽	301		○		
8.0	**SILT**, trace to some sand, trace clay Very Dense to Compact Brown Wet						300				
	Becoming grey		9	SS	13		299		○		0 14 79 7
							298				

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$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 17-49 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 497.5 E 234 659.9 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers/Washboring COMPILED BY MP

DATUM Geodetic DATE 2017.08.26 - 2017.08.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			10	SS	24		296		○		
			11	SS	14		295		○		
			12	SS	16		294		○		0 0 94 6
292.7							293				
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 14.3m AND WATER LEVEL AT 8.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.9m, DRY CEMENT TO 0.15m AND COLD-PATCH ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 3/6/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-50 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 483.7 E 234 675.7 ORIGINATED BY JHP

HWY 11 BOREHOLE TYPE AB Casing/Hand Augers COMPILED BY MP

DATUM Geodetic DATE 2017.10.25 - 2017.10.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.5	GROUND SURFACE										
0.0	**SAND** and **SILT**, some gravel, trace clay, trace organics, occasional cobbles Loose to Dense Brown Wet		1	SS	10		301	○	○		
			2	SS	21			○	○		
			3	SS	20		300	○	○		
			4	SS	47			○	○		
299.1							299				
2.4	**SILT**, trace sand, trace clay Very Loose to Compact Grey Wet		5	SS	8			○	○		
			6	SS	3		298	○	○		0 2 91 7
			7	SS	15		297	○	○		
							296				
			8	SS	18			○	○		
							295				
			9	SS	19			○	○		0 0 91 9
							294				
							293				
			10	SS	25			○	○		
							292				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/31/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-50 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 483.7 E 234 675.7 ORIGINATED BY JHP

HWY 11 BOREHOLE TYPE AB Casing/Hand Augers COMPILED BY MP

DATUM Geodetic DATE 2017.10.25 - 2017.10.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
291.2											
10.3	END OF BOREHOLE AT 10.3m UPON REFUSAL. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.10.27 1.3 300.2 2017.10.28 1.3 300.2										

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-51 1 OF 1 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 480.1 E 234 650.7 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP

DATUM Geodetic DATE 2017.08.26 - 2017.08.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
306.3	GROUND SURFACE										
0.0	**ASPHALT**: (125mm)										
0.1	**SAND** and **GRAVEL**, trace silt Brown Dry (FILL)		1	GS			306 305		○		51 43 6 (SI+CL)
	Loose		1	SS	8		304 303		○		
302.6											
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.15m AND COLD-PATCH ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-52 1 OF 1 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 471.3 E 234 646.1 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP

DATUM Geodetic DATE 2017.08.26 - 2017.08.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
306.1	GROUND SURFACE										
0.0	**ASPHALT**: (225mm)						306				
0.2	**SAND**, some gravel, trace silt Brown Moist (FILL)		1	GS			305		○		
							304				
	Compact		1	SS	10		303		○		17 77 6 (SI+CL)
302.4											
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.15m AND COLD-PATCH ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-53 1 OF 1 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 462.3 E 234 641.6 ORIGINATED BY TTB

HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP

DATUM Geodetic DATE 2017.08.26 - 2017.08.26 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.8	GROUND SURFACE										
0.0	**ASPHALT**: (175mm)										
0.2	Gravelly **SAND**, some silt Brown Moist (FILL)		1	GS			305		○		25 56 19 (SI+CL)
							304				
							303				
	Compact		1	SS	13				○		
302.1											
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE BACKFILLED WITH CUTTINGS TO 0.9m, DRY CEMENT TO 0.15m AND COLD-PATCH ASPHALT TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 1/31/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-54 1 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 487.1 E 234 638.4 ORIGINATED BY JHP

HWY 11 BOREHOLE TYPE AB Casing/Hand Augers COMPILED BY MP

DATUM Geodetic DATE 2017.10.27 - 2017.10.28 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.8	GROUND SURFACE										
0.0	**SAND** and **SILT**, some gravel, trace clay Very Loose to Dense Brown Moist		1	SS	3		301		○		
			2	SS	14				○		11 44 39 6
			3	SS	11		300		○		
			4	SS	33	▽			○		
	Wet		5	SS	31		299		○		
			6	SS	24				○		
297.2							298				
4.6	**SILT**, trace sand, trace clay Compact to Very Dense Grey Wet		7	SS	24		297		○		0 4 88 8
			8	SS	35		296		○		0 4 90 6
			9	SS	58		295				
							294		○		
							293				
							292		○		

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 3/6/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 17-54 2 OF 2 METRIC

W.P. 6802-14-01 LOCATION Camproad Creek Culvert, MTM NAD 83 Zone 14 N 5 494 487.1 E 234 638.4 ORIGINATED BY JHP

HWY 11 BOREHOLE TYPE AB Casing/Hand Augers COMPILED BY MP

DATUM Geodetic DATE 2017.10.27 - 2017.10.28 CHECKED BY NLB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
							291				
290.5			10	SS	34				○		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 2.4m AND WATER LEVEL AT 2.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S MTO-15595.GPJ 2017TEMPLATE(MTO).GDT 3/6/18

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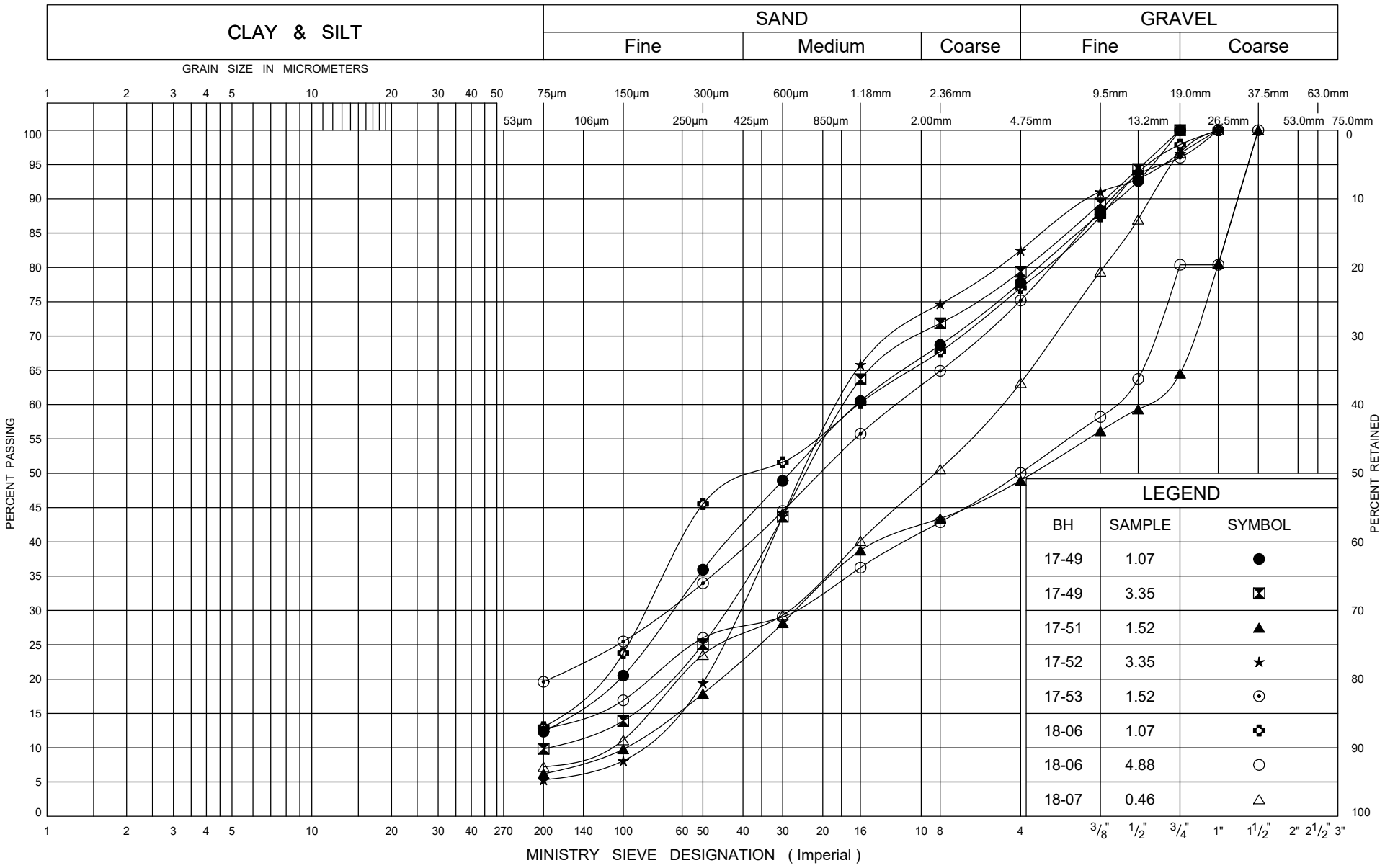
Appendix B

Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Gravelly SAND to SAND and GRAVEL FILL

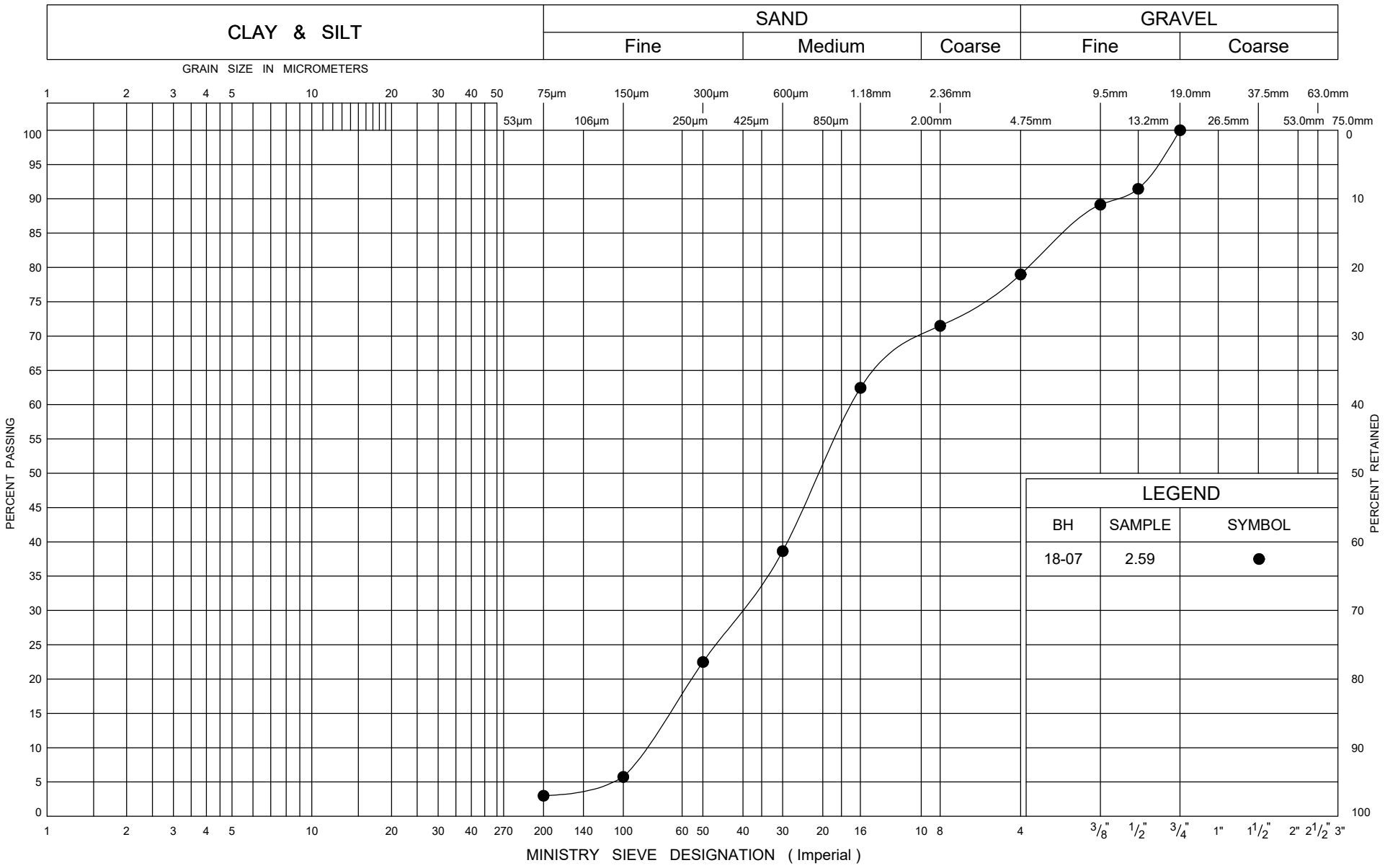
FIG No B1

W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Gravelly SAND to SAND and GRAVEL FILL

FIG No B2

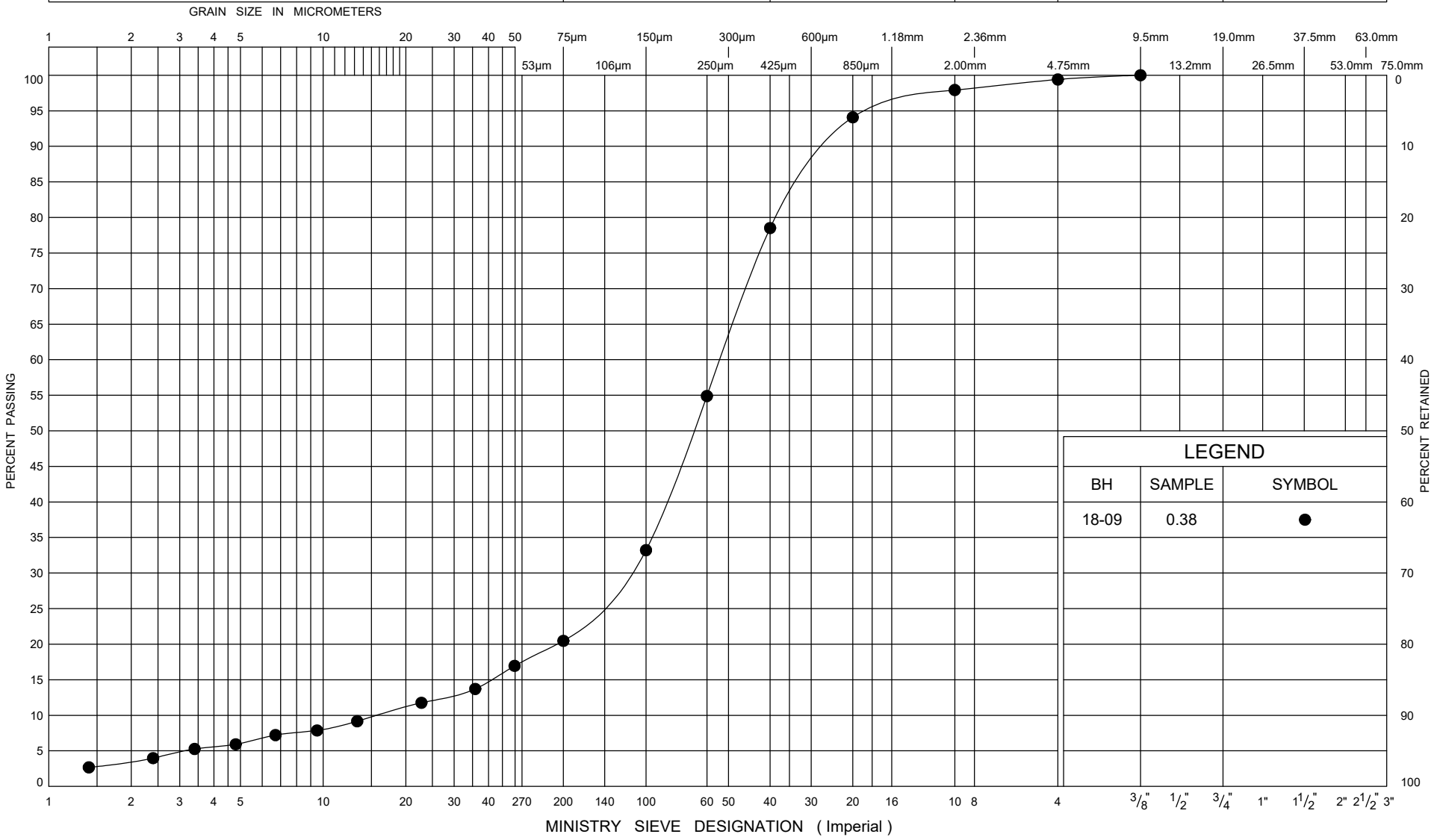
W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

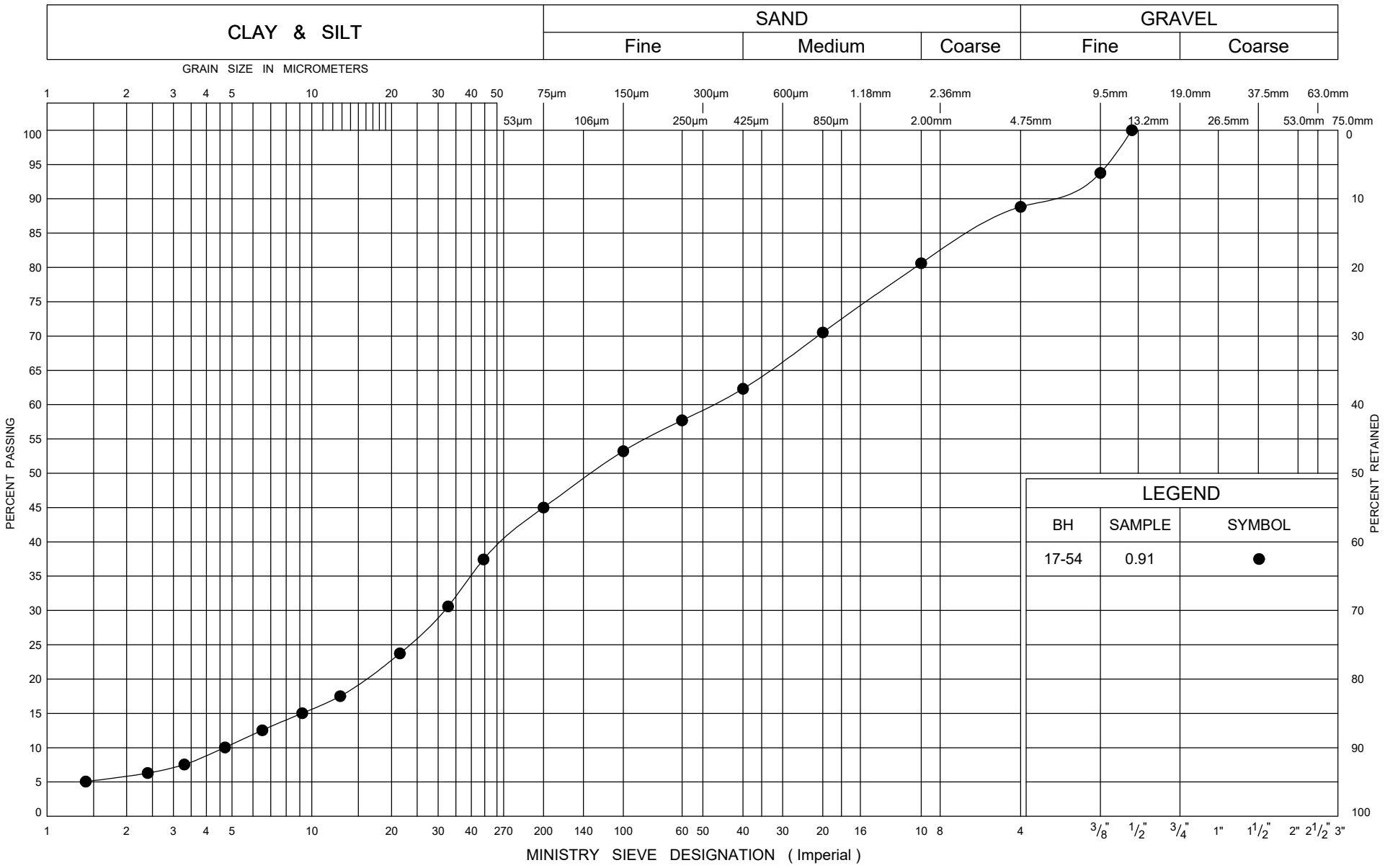
SAND

FIG No B3

W P 6802-14-01

Camproad Creek Culvert

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

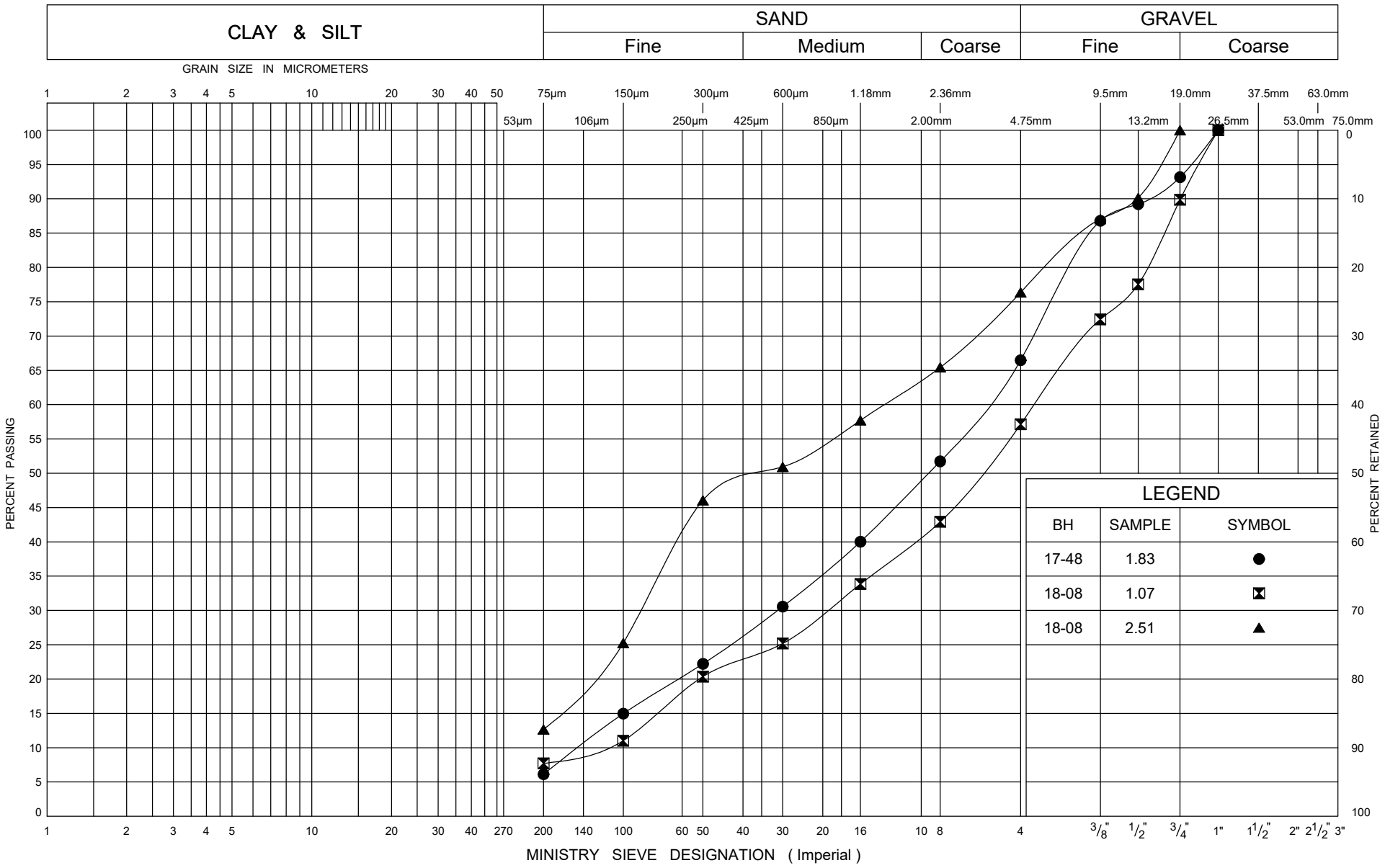
SAND and SILT

FIG No B4

W P 6802-14-01

Camproad Creek Culvert

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to Gravelly SAND

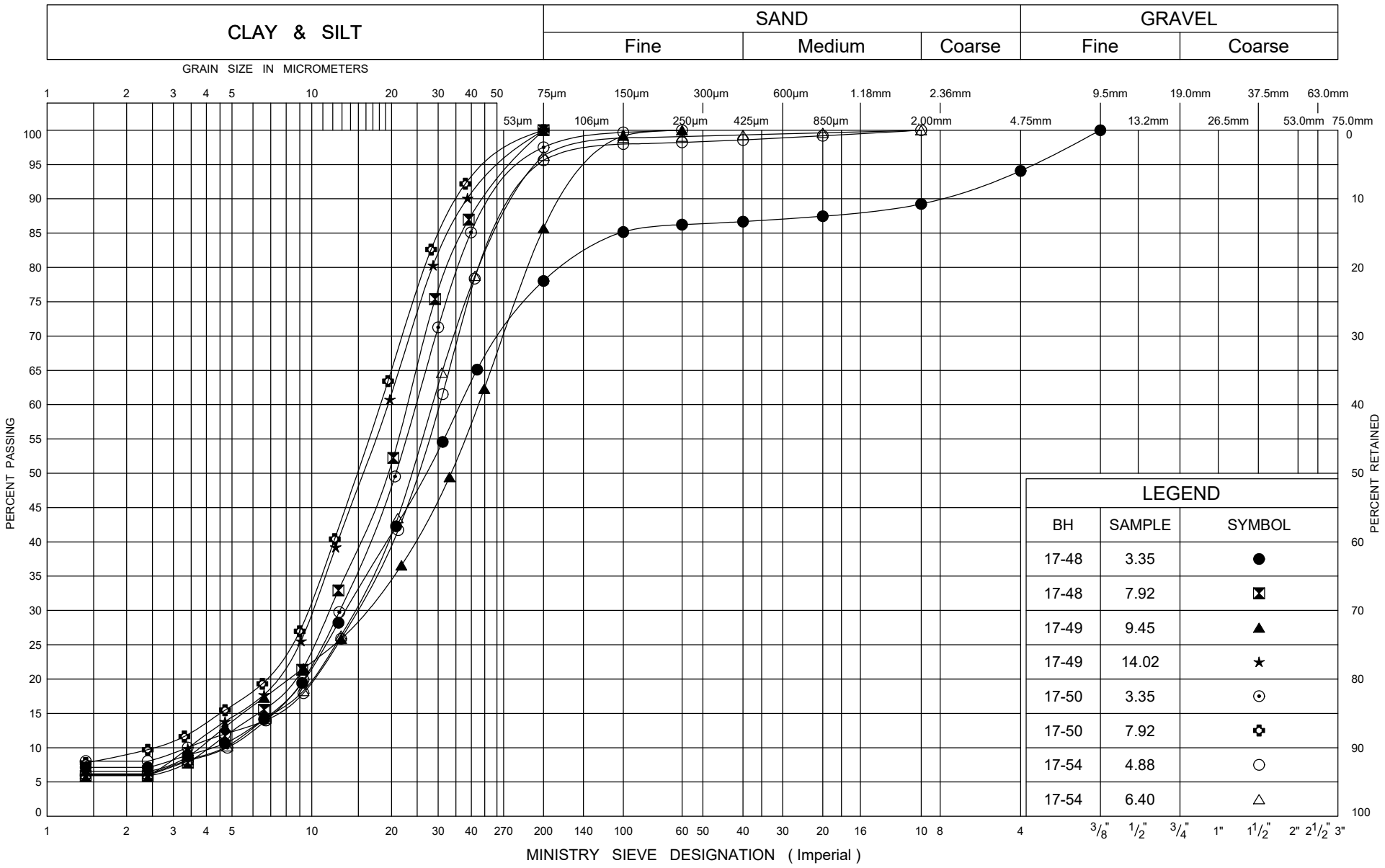
FIG No B5

W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

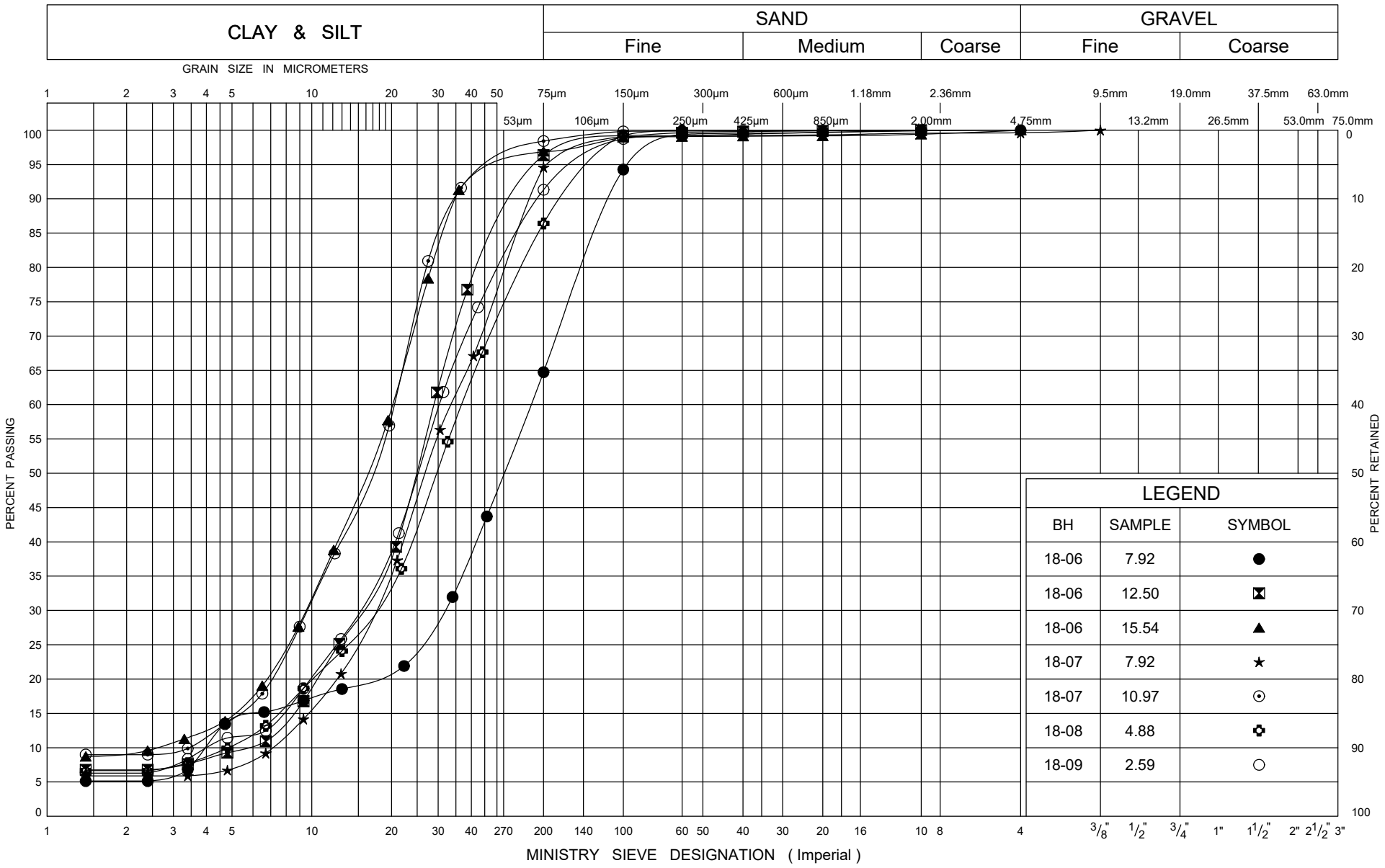
SILT

FIG No B6

W P 6802-14-01

Camproad Creek Culvert

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
18-06	7.92	●
18-06	12.50	⊠
18-06	15.54	▲
18-07	7.92	★
18-07	10.97	⊙
18-08	4.88	✿
18-09	2.59	○

Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SILT

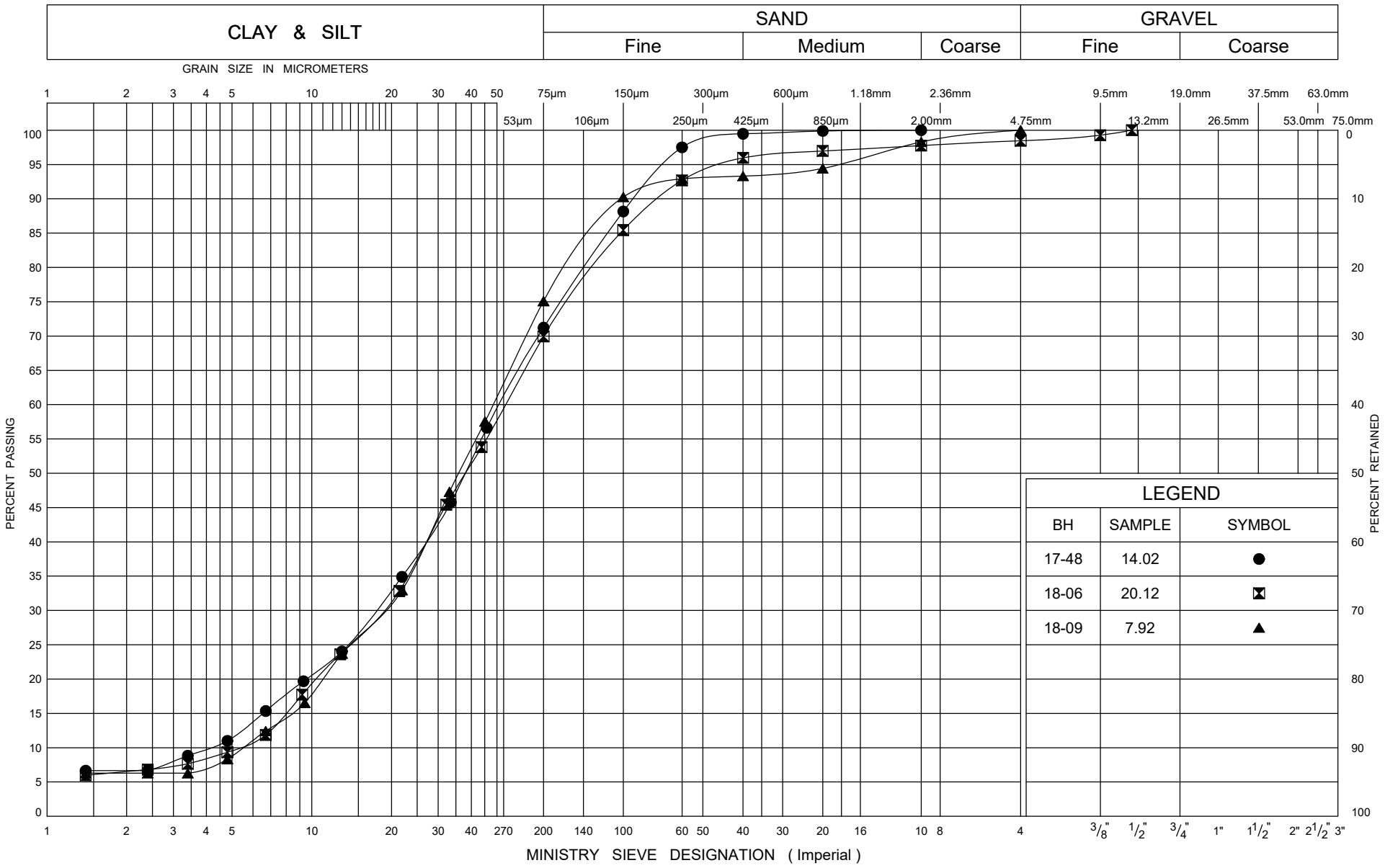
FIG No B7

W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Sandy SILT

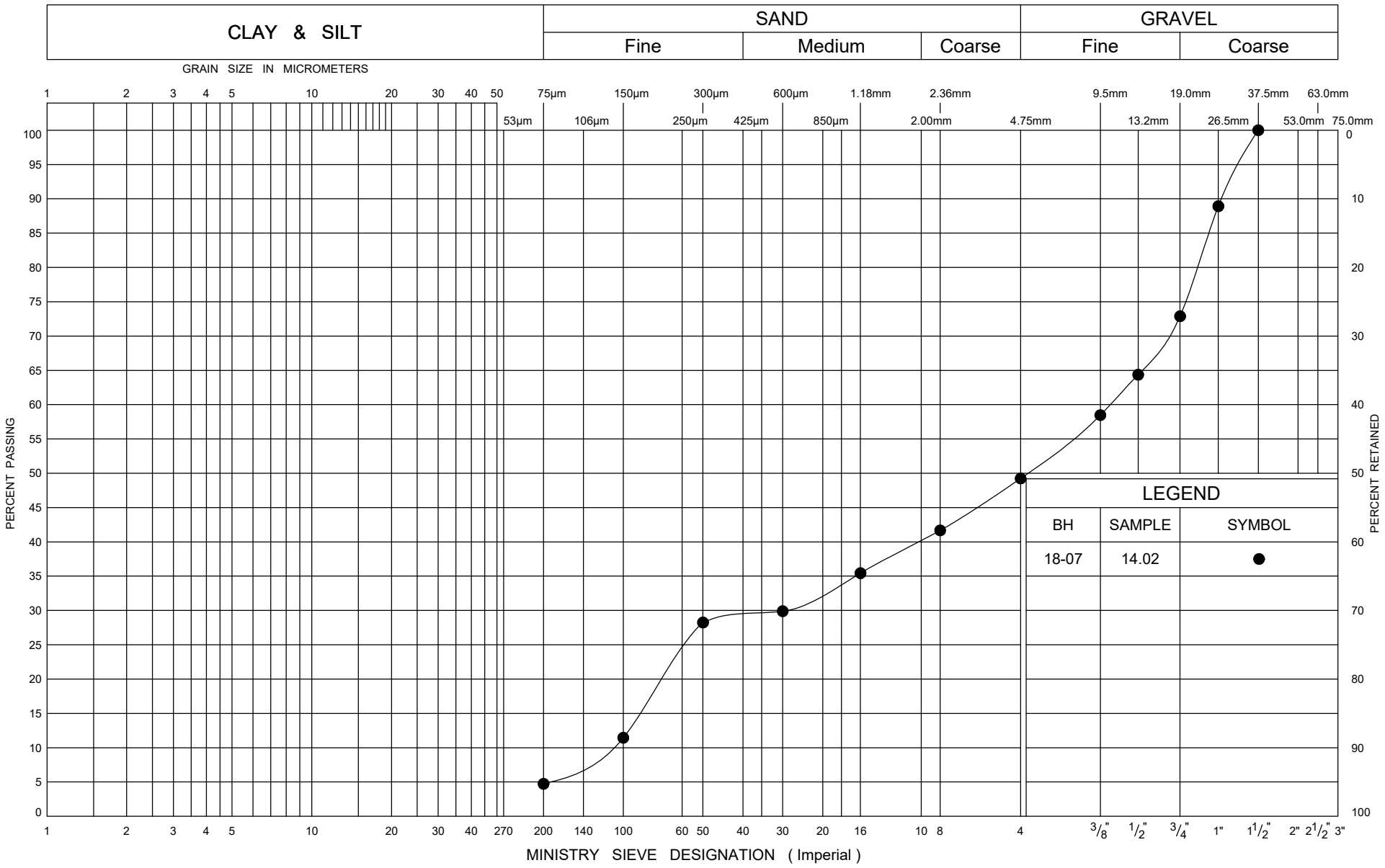
FIG No B8

W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

FIG No B9

W P 6802-14-01

Camproad Creek Culvert

ONTARIO MOT GRAIN SIZE MTO-15595.GPJ ONTARIO MOT.GDT 8/10/18

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	15595	**Date Drilled:**	June 20/18
Client:	HATCH	**Date Tested:**	July 5/18
Project Name:	amproad Creek Culvert Replacement	**Tester:**	RT
Core Size:	NQ **BH No :** 18-07	**Reviewed by:**	MEF

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	16.5	D	1.3	47.8	150.0	0.5	12.5	Metavolcanic	Weak
2	1	16.8	D	1.2	47.8	126.4	0.5	11.7	Metavolcanic	Weak
3	2	17.7	D	13.7	47.8	150.0	5.6	133.3	Metavolcanic	Very Strong
4	2	18.2	D	17.5	47.8	150.0	7.1	170.5	Metavolcanic	Very Strong
5	2	18.6	D	13.4	47.8	150.0	5.4	130.6	Metavolcanic	Very Strong
6	3	19.1	D	15.2	47.8	150.0	6.2	148.5	Metavolcanic	Very Strong
						RUN#1 AVG=		**12.1**		Weak
						RUN#2 AVG=		**144.8**		Very Strong
						RUN#3 AVG=		**148.5**		Very Strong

Photo 1: Borehole 18-07 Bedrock Core Sample

Certificate of Analysis

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

Attention: Mark Farrant
Project#: 15595

Client Thurber Engineering Ltd.
SGS LIMS Number CA14253-SEP17
Analysis Package: **Corrosivity (Soil)**

Sample ID	Unit	BH-49, SS#6, 15'-17'
Sample Date/Time		26-Aug-17
Moisture	%	3.5
pH	no unit	9.65
Corrosivity Index	none	3.0
Soil Redox Potential	mV	243
Sulphide	mg/L	<0.02
Chloride	mg/L	160
Sulphate	mg/L	15
Conductivity	uS/cm	322
Resistivity (calculated)	ohms.cm	3110

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

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

Certificate of Analysis

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

Attention: Cory Zanatta
Project#: North Superior Lake Area

Client Thurber Engineering Ltd.
SGS LIMS Number CA15830-AUG17
Analysis Package: Corrosivity (Solution)

Sample ID	Unit	Camproad Creek
Sample Date/Time		27-Aug-17
Moisture	%	NA
pH	no unit	7.91
Corrosivity Index	none	NA
Redox Potential	mV	250
Sulphide	mg/L	<0.006
Chloride	mg/L	31
Sulphate	mg/L	2.3
Conductivity	uS/cm	243
Resistivity (calculated)	ohms.cm	4120

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

THURBER

Appendix C

Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

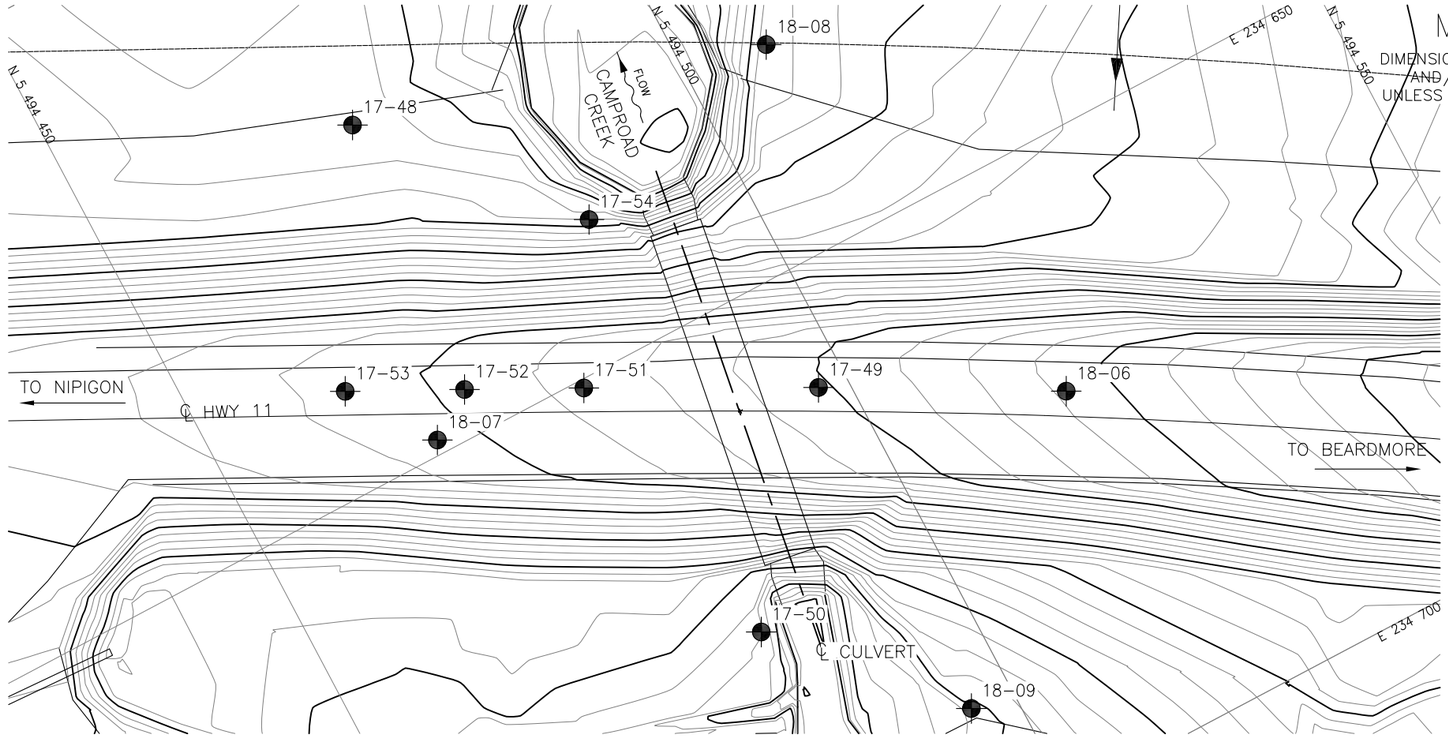
CONT No 2018-6015
WP No 6802-14-01

HIGHWAY 11
CAMPROAD CREEK
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA I

SHEET 11

HATCH

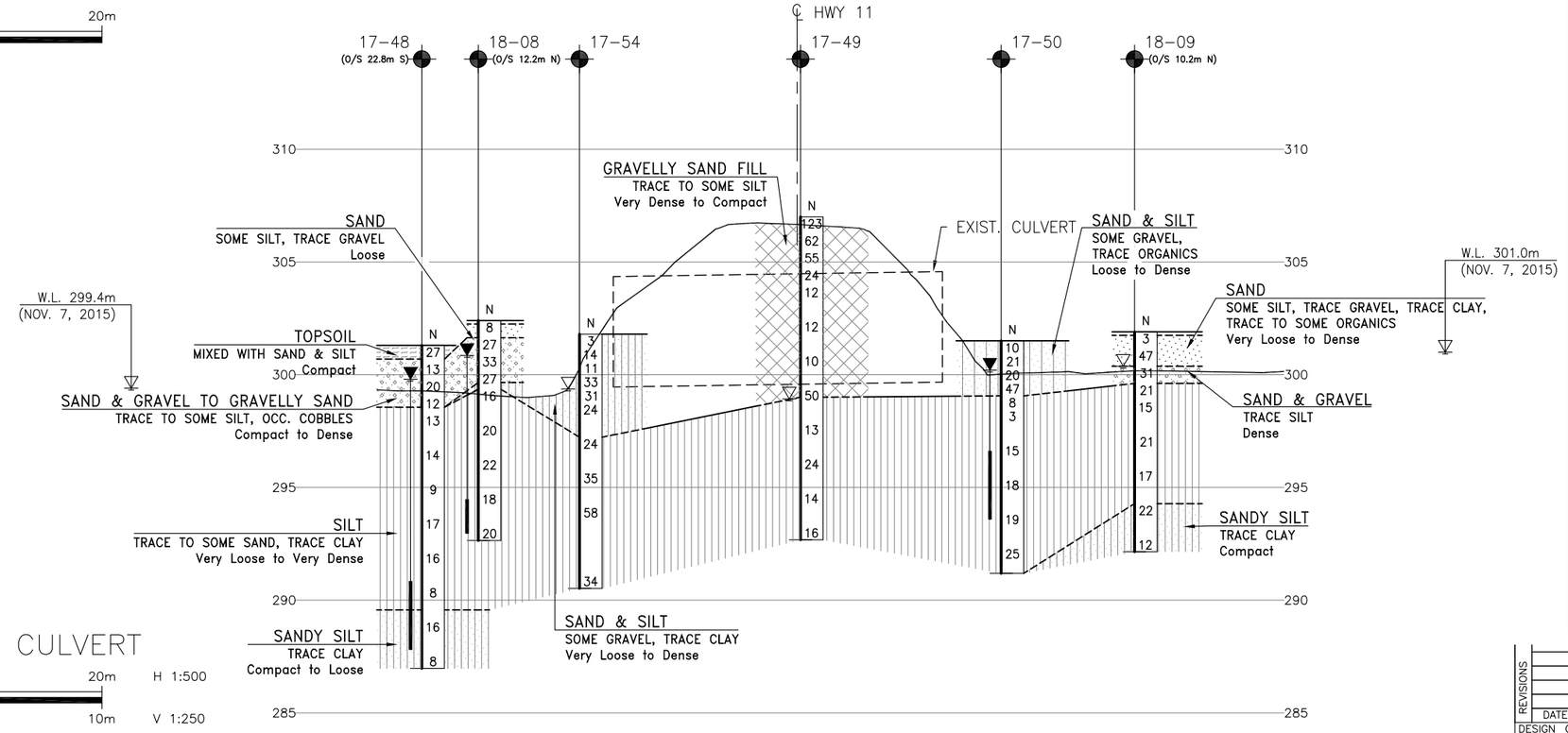
THURBER ENGINEERING LTD.



PLAN

10 0 10 20m

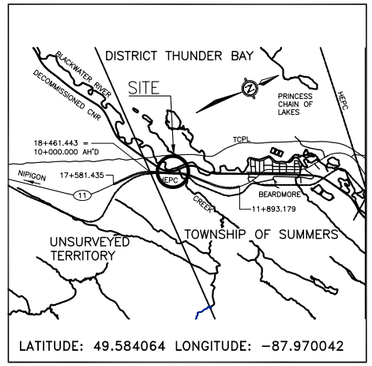
SCALE 1:500



SECTION ALONG ℄ CULVERT

10 0 10 20m H 1:500

5 0 5 10m V 1:250



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
17-48	301.3	5 494 473.3	234 622.2
17-49	307.0	5 494 497.5	234 659.9
17-50	301.5	5 494 483.7	234 675.7
17-51	306.3	5 494 480.1	234 650.7
17-52	306.1	5 494 471.3	234 646.1
17-53	305.8	5 494 462.3	234 641.6
17-54	301.8	5 494 487.1	234 638.4
18-06	307.8	5 494 515.7	234 669.9
18-07	305.9	5 494 467.3	234 648.8
18-08	302.4	5 494 507.1	234 632.4
18-09	301.9	5 494 496.3	234 689.6

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42E-30

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN CZ	CHK MEF	CODE	LOAD	DATE	NOV 2018
DRAWN AN	CHK MEF	SITE 48C-179/C	STRUCT	DWG 2	

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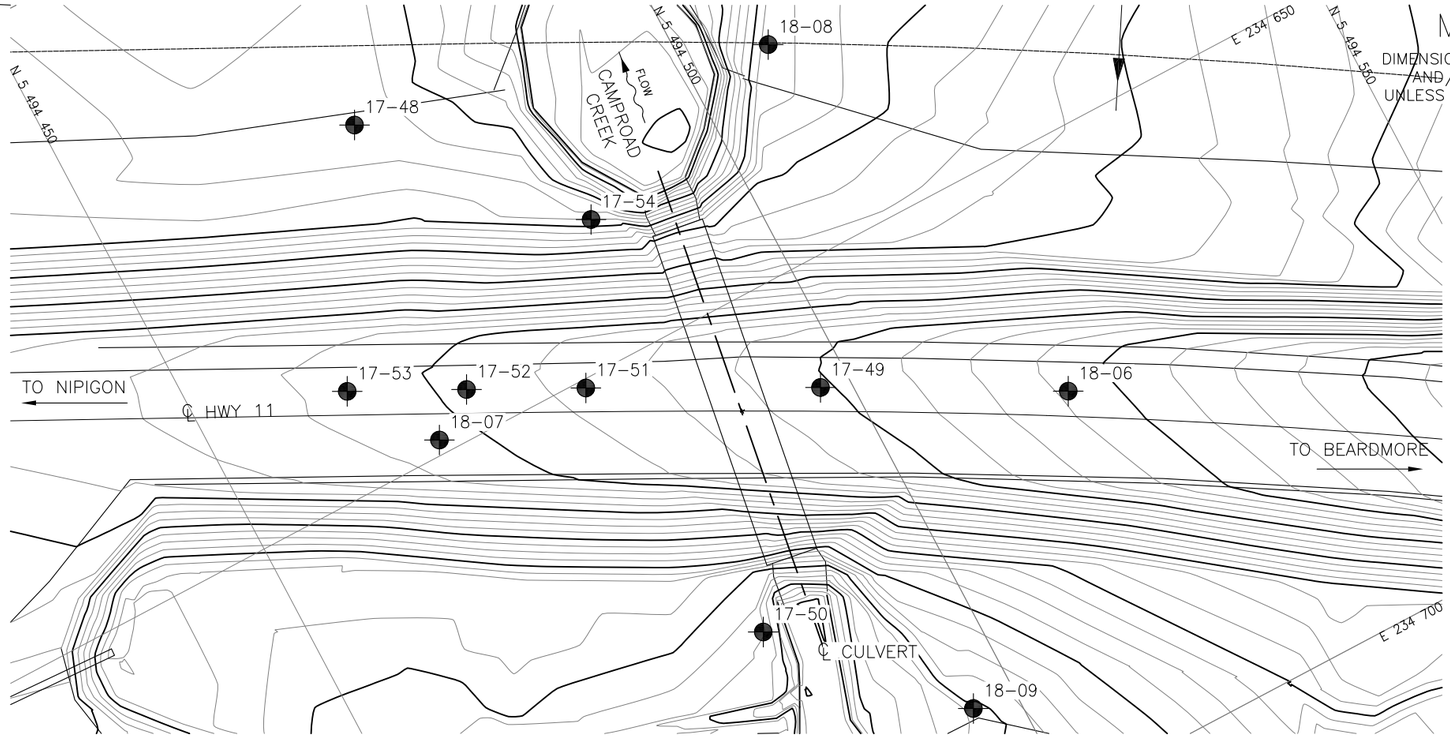
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

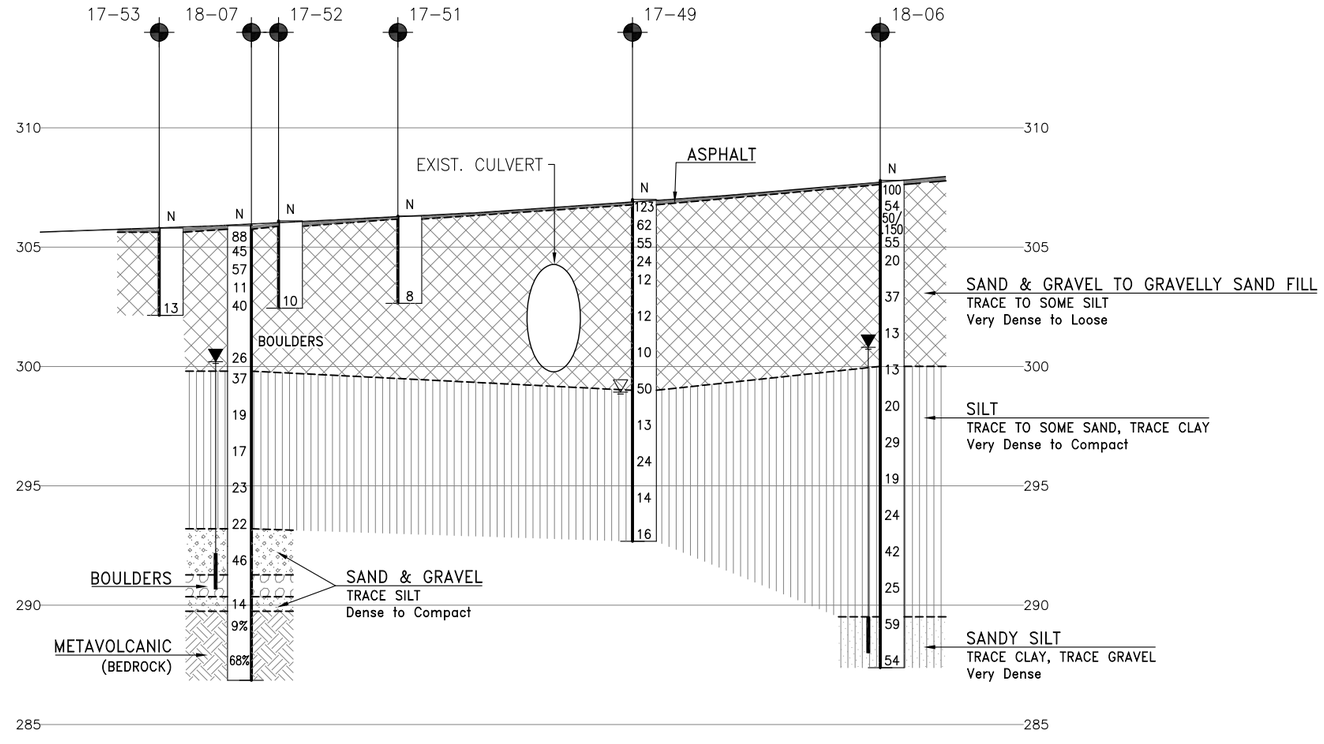
10 0 10 20m

SCALE 1:500

SECTION ALONG ℄ HWY 11

10 0 10 20m H 1:500

5 0 5 10m V 1:250



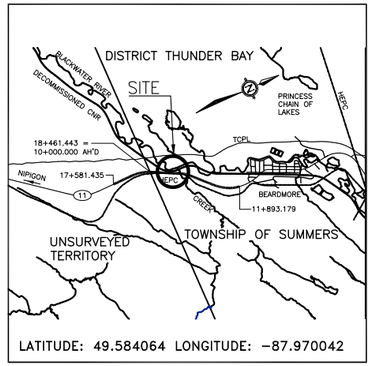
CONT No 2018-6015
WP No 6802-14-01

HIGHWAY 11
CAMPROAD CREEK
CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA II

SHEET 12

HATCH

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
17-48	301.3	5 494 473.3	234 622.2
17-49	307.0	5 494 497.5	234 659.9
17-50	301.5	5 494 483.7	234 675.7
17-51	306.3	5 494 480.1	234 650.7
17-52	306.1	5 494 471.3	234 646.1
17-53	305.8	5 494 462.3	234 641.6
17-54	301.8	5 494 487.1	234 638.4
18-06	307.8	5 494 515.7	234 669.9
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REVISIONS		
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DESIGN CZ	CHK MEF	CODE	LOAD	DATE	NOV 2018
DRAWN AN	CHK MEF	SITE 48C-179/C	STRUCT	DWG 3	

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THURBER

Appendix D

Site Photographs

Photo 1: Road approach looking north (taken June 27, 2017)

Photo 2: Road approach looking south (taken June 27, 2017)

Photo 3: Culvert inlet looking west (taken May 15, 2017)

Photo 4: Culvert barrel looking west (taken May 15, 2017)

Photo 5: Culvert outlet looking north (taken May 15, 2017)

Photo 6: East embankment looking south (inlet) (taken May 15, 2017)

Photo 7: East embankment looking north (inlet) (taken May 15, 2017)

Photo 8: West embankment looking south (outlet) (taken May 15, 2017)