



THURBER ENGINEERING LTD.



**FOUNDATION INVESTIGATION REPORT
WHITEWOOD CREEK CULVERTS REPLACEMENT
TOWNSHIP OF O'CONNOR, DISTRICT OF THUNDER BAY, ONTARIO
SITE No. 48W-311/C
HIGHWAY 595**

ASSIGNMENT NO. 6015-E-0023

**GEOCRES Number: 52A-228
W.O.# 2017-11029**

Report

to

MINISTRY OF TRANSPORTATION ONTARIO

Lat: 48.359102

Long. -89.700311

Date: August 2, 2017
File: 17840

TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1.	INTRODUCTION	1
2.	SITE DESCRIPTION	1
3.	INVESTIGATION PROCEDURES	2
4.	LABORATORY TESTING	4
5.	DESCRIPTION OF SUBSURFACE CONDITIONS	4
5.1	Asphalt	5
5.2	Topsoil	5
5.3	Fill	5
5.4	Silt/Clayey Silt	6
5.5	Silty Clay	6
5.6	Cobbles/Fractured Bedrock	7
5.7	Bedrock	7
5.8	Groundwater Conditions	8
6.	CORROSIVITY AND SULPHATE TEST RESULTS	8
7.	MISCELLANEOUS	10

APPENDICES

Appendix A	Record of Borehole Sheets
Appendix B	Geotechnical and Analytical Laboratory Test Results
Appendix C	Selected Site Photographs
Appendix D	Borehole Locations and Soil Strata Drawing

**FOUNDATION INVESTIGATION REPORT
WHITEWOOD CREEK CULVERTS REPLACEMENT
TOWNSHIP OF O'CONNOR, DISTRICT OF THUNDER BAY, ONTARIO
SITE No. 48W-311/C
HIGHWAY 595**

ASSIGNMENT NO. 6015-E-0023

**GEOCRES Number: 52A-228
W.O.# 2017-11029**

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed replacement of the Whitewood Creek twin Culvert on Highway 595, located in the Township of O'Connor, District of Thunder Bay, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the twin culvert area and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, record of borehole sheets, laboratory test results, and a written description of the subsurface conditions encountered at the site.

Thurber was retained by the Ministry of Transportation Ontario (MTO) to carry out this foundation investigation under the MTO Retainer Agreement Number 6015-E-0023.

2. SITE DESCRIPTION

The Whitewood Creek Culverts site is located on Highway 595, in the Township of O'Connor approximately 4.3 km south of Highway 590, and approximately 8 km north of Highway 588, in the District of Thunder Bay, Ontario. The key plan showing the general location of the site is presented on the Borehole Locations and Soil Strata drawing in Appendix D.

Highway 595 runs in the general north-south direction with the culverts perpendicular to the centreline of the highway. The Whitewood Creek is a tributary of the Kaministiquia River and the stream flowing through the creek is from west to east at the site.

The terrain in the culvert area is gently undulating and forested outside of the right-of-way. The

existing culvert is a twin Corrugated Steel Pipe (CSP) culvert approximately 35 m in length. The Structural Inspection Report (SIR) prepared by McCormick Rankin, a member of MMM Group and dated January 2014 indicated that the culverts are in fair to good conditions apart from accumulation of debris build-up at the north and south outlets and minor damages at the edges of both outlets due to past debris removal activities.

The invert elevation of the existing culverts was indicated at about Elevation 278.0 m at the inlet and about Elevation 277.8 m at the outlet. The stream water level was reported to be at about Elevation 278.5 m at the upstream and about Elevation 277.6 m at the downstream on August 2015. At the culvert location, the highway embankment grade is at approximately Elevation 282.0 m. The depth of cover over the existing culvert is approximately 1.8 m to 2.0 m.

Photographs in Appendix C show the general nature of the site and the existing culvert.

Based on published geological information, the culvert lies close to the border of glaciolacustrine plain (including deposits of silts and clays with minor sands) and silty clay to silt deposit of glacial tills. The bedrock at the site consists of rocks of Gunflint Formation.

3. INVESTIGATION PROCEDURES

The field investigation and testing program for this project was specified in the Terms of Reference. The field work was carried out on April 6, 7, 12 and 30, 2017 during which time four (4) boreholes designated as Boreholes 17-01 to 17-04 were advanced at the site. Boreholes 17-01 and 17-04 were advanced adjacent to the inlet and outlet of the culverts and Boreholes 17-02 and 17-03 were advanced through the highway embankment just south and north of the culverts, respectively.

Utility clearances were obtained prior to the start of drilling. A rubber tire buggy mounted drill rig and a track-mounted CME 75 drill rig were used to advance the boreholes at the site using hollow stem augers. An NQ core barrel was used to obtain 3 m of rock core in Boreholes 17-02 and 17-03.

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) procedures as per ASTM D1586. Dynamic Cone Penetration Test (DCPT) was also conducted adjacent to Boreholes 17-01 and 17-02 from the ground surface to refusal. Where bedrock was cored, rock quality (i.e., TCR, SCR, RQD, weathering and strength indices), discontinuity characteristics and classification

data were recorded in the field based on visual inspection of the recovered rock cores upon extraction from the core barrel. The bedrock was sequentially photographed and selected samples were properly packed and transported to our laboratory for strength testing (point load index).

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The site supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes throughout the drilling operations. One standpipe piezometer using 19 mm diameter PVC pipes was installed within the overburden in Borehole 17-01 to permit monitoring of the groundwater levels at the site. The piezometer was decommissioned and the borehole was back filled on April 30, 2017. All other boreholes were backfilled on completion of drilling in general accordance with Ontario Regulation 903, as amended.

The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided by the MTO. The coordinate system MTM NAD 83, Zone 14 was used for the boreholes. The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D. The borehole coordinates, ground surface elevations, drilled depths and the completion details are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole Number	Coordinates (MTM NAD 83, Zone 14)		Ground Surface Elevation (m)	Borehole Depth (m)	Completion Details
	Northing (m)	Easting (m)			
17-01	5,357,870.4	326,991.7	279.5	9.8	Standpipe piezometer was installed in the borehole. After removal of the piezometer, the borehole was backfilled with bentonite holeplug and cuttings to ground surface.
17-02	5,357,859.8	327,005.1	282.5	16.2	Bentonite holeplug to 1.8 m, cuttings to 0.3 m then asphalt cold patch to ground surface.
17-03	5,357,869.7	327,009.5	281.8	15.7	Bentonite holeplug to 1.6 m, cuttings to 0.1 m then asphalt cold patch to ground surface.

Borehole Number	Coordinates (MTM NAD 83, Zone 14)		Ground Surface Elevation (m)	Borehole Depth (m)	Completion Details
	Northing (m)	Easting (m)			
17-04	5,357,857.8	327,020.0	278.5	11.0	Bentonite holeplug and cuttings to ground surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. Selected soil samples were also subjected to grain size distribution analyses (sieve and/or hydrometer). Selected bedrock core specimen were also subjected to point load strength index test. The results of the laboratory testing program are shown on the Record of Borehole sheets included in Appendix A and 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, two samples of the native soils near the invert level, and a sample of the surface water from the creek upstream of the existing culverts 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 of this report and are presented in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the "Borehole Locations and Soil Strata" drawing included in Appendix D. 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 must be recognized and expected that subsurface conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered in the boreholes consisted of embankment fill comprising of sand and gravel, sand, and/or pockets of silty clay overlying a native silt deposit which is in turn underlain by a deposit of silty clay. The silty clay is underlain by a relatively thin layer of cobbles (or fractured bedrock) over the bedrock. Descriptions of the individual strata are

presented below.

5.1 Asphalt

Boreholes 17-02 and 17-03 were drilled through the existing asphalt pavement on Highway 595. Asphalt thicknesses of 40 mm and 25 mm were measured at the two borehole locations, respectively. The thickness of asphalt may vary along the highway.

5.2 Topsoil

An approximately 50 mm thick layer of topsoil was encountered at the ground surface in Borehole 17-01. The topsoil thickness may vary in other areas of the site.

5.3 Fill

Fill was encountered below the topsoil in Borehole 17-01, below the asphalt in Boreholes 17-02 and 17-03 and from the ground surface in Borehole 17-04. The fill generally consisted of sand and gravel to gravelly sand at the borehole locations. Approximately 1 m thick layer of the clayey silt fill and 1.5 m thick layer of sand fill were encountered below the sand and gravel fill in Borehole 17-02. The fill was 2.2 m and 1.5 m thick in Boreholes 17-01 and 17-04 which were drilled at the inlet and outlet of the culverts. The fill was about 5.6 m and 4.7 m in Boreholes 17-02 and 17-03 which were drilled on Highway 595.

The relative density of the non-cohesive fill below the highway embankment was compact to very dense with the SPT-N values recorded from 19 blows per 0.3 m of penetration to 50 blows per 0.15 m of penetration. A single SPT-N value of 7 blows per 0.3 m of penetration was measured in the clayey silt fill indicating a firm consistency.

The relative density of the sand and gravel fill adjacent to the inlet and outlet of the culverts encountered in Boreholes 17-01 and 17-04 is loose to compact with SPT-N values recorded between 4 blows and 16 blows per 0.3 m of penetration.

The results of grain size analyses conducted on selected samples of the fill are presented on the Record of Borehole sheets included in Appendix A, and on Figure B1 in Appendix B.

The results are summarized in the following table:

Soil Particle	Percentage (%)	
	Sand and Gravel	Gravelly Sand
Gravel	37 and 39	30
Sand	45 and 49	62
Silt and Clay	12 and 18	8

The measured moisture content of the fill materials ranged between 3% and 24%.

5.4 Silt/Clayey Silt

A deposit of grey silt with some clay to clayey silt was encountered underlying the fill in all boreholes advanced at the site. The silt extended to depths of 2.2 m to 8.7 m below existing ground surface (base elevation ranging from 273.8 m to 276.3 m). The deposit was compact to very dense, or stiff to hard, as indicated by SPT 'N' values between 12 and 51 blows per 0.3 m of penetration. The measured moisture content of the silt ranged between 18% and 22%.

The results of grain size analysis and one Atterberg Limits test conducted on a sample of silt/clayey silt deposit are presented on the Record of Borehole sheets included in Appendix A and on Figures B2 and B3 in Appendix B.

The results are summarized in the following table:

Soil Particle	Percentage (%)
Gravel	0
Sand	0
Silt	78 to 85
Clay Size Fines	15 to 22
Measured Limit	Percentage (%)
Liquid Limit	25.6
Plastic Limit	18.7

5.5 Silty Clay

A deposit of grey silty clay was encountered below the silt layer in all four boreholes extending to depths of 12.6 m and 12.3 m (Elevations 269.9 m and 269.5 m) in Boreholes 17-02 and 17-03, respectively. Boreholes 17-01 and 17-04 were terminated in the silty clay.

SPT 'N' values within the silty clay ranged between 26 blows per 0.3 m of penetration and 100 blows per 0.125 m of penetration indicating a very stiff to hard consistency. The measured moisture content of the silty clay ranged between 12% and 31%.

The results of grain size distribution analyses and Atterberg Limits tests conducted on selected samples of the silty clay are presented on the Record of Borehole sheet included in Appendix A and on Figures B4 and B5 in Appendix B. The results are summarized in the following table:

Soil Particle	Percentage (%)
Gravel	0
Sand	0
Silt	50 to 64
Clay Size Fines	36 to 50
Measured Limit	Percentage (%)
Liquid Limit	33 and 42
Plastic Limit	20

The results of the Atterberg Limits testing indicate that the silty clay has a low to intermediate plasticity with group symbol CL to CI.

5.6 Cobbles/Fractured Bedrock

Cobbles/fractured bedrock with a thickness of 0.3 m to 0.6 m was encountered below the silty clay at depths of 12.6 m and 12.3 m in Boreholes 17-02 and 17-03, respectively. This layer was encountered just above the bedrock.

5.7 Bedrock

Borehole 17-04 was terminated at a depth of 11.0 m (Elevation 267.5 m) due to refusal to further auger penetration on probable bedrock.

Bedrock was encountered at depths of approximately 13.2 m and 12.6 m (Elev. 269.3 m and Elev. 269.2 m) in Boreholes 17-02 and 17-03, respectively. The bedrock was proven in Boreholes 17-02 and 17-03 by coring approximately 3 m in both boreholes. The bedrock is generally described as grey diabase, greenish grey in colour. Total Core Recovery (TCR) in the bedrock ranged from 60% to 100% with Solid Core Recovery (SCR) ranging from 49% to 100%. The Rock Quality

Designation (RQD) determined from the recovered cores generally ranged from 40% to 100%, indicating a poor to excellent rock quality.

Point load strength index tests (PLT) were carried out on selected core samples. The axial and diametral point load strength index values (Is50) are presented in Appendix B. The interpreted average UCS values for each core run of the bedrock ranged between 94 MPa and 162 MPa based on correlations with the PLT, indicating the bedrock at the site is strong to very strong.

5.8 Groundwater Conditions

A standpipe piezometer was installed in Borehole 17-01 on April 12, 2017 and a groundwater level reading was taken in the piezometer on April 30, 2017. The groundwater levels measured in the open borehole and in the piezometer are summarized in Table 5.1 below.

Table 5.1 – Groundwater Measurements

Borehole	Date	Piezometer Installation		Water Level (m)		Remark
		Screen Depth/Elevation (m)	Screened Deposit	Depth	Elevation	
17-01	April 12, 2017	6.7 to 9.8 / 272.8 to 269.8	Silty Clay	1.9	277.6	Open borehole
	April 30, 2017			2.2	227.3	Piezometer

The groundwater level should be assumed to reflect the local creek water level. Water level measurements in the creek were reported on the MTO Site Plan Drawing, E-1078-595-4, which reported measurements of Elevation 278.5 m at the inlet and 277.6 m at the outlet in August 2015. The above groundwater levels 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 during spring and after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Two samples of the native soil from Boreholes 17-02 and 17-03, and a sample of the surface water from the creek were submitted for analytical testing of corrosivity parameters and sulphate content. 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		
			17-02, SS#6, 6.1 m – 6.7 m	17-03, SS#5, 4.6 m – 5.2 m	Whitewood Creek
			(Silt)	(Silt)	(Creek Water)
Sulphide	%	mg/L	0.05	<0.02	<0.006
Chloride	µg/g	mg/L	55	25	7.3
Sulphate	µg/g	mg/L	110	61	3.2
pH	No unit	No unit	8.68	8.55	7.46
Electrical Conductivity	µS/cm	µS/cm	157	109	129
Resistivity	Ohms.cm	Ohms.cm	6,370	9,170	7,750
Redox Potential	mV	mV	200	237	295

7. MISCELLANEOUS

Thurber obtained the coordinates and ground surface elevations of the boreholes from measurements taken in the field and relative to the topographic plans provided by the MTO.

RPM Drilling Inc. of Thunder Bay, Ontario supplied and operated the drilling, sampling and in-situ testing equipment for the field investigation. The field investigation was supervised on a full time basis by Mr. Amir Fereidouni and Ms. Eckie Siu of Thurber. Overall supervision of the field program was provided by Mr. Cory Zanatta, B.A.Sc. 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, EIT and Mr. Mehdi Mostakhdemi, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Cory Zanatta, B.A.Sc.
Geotechnical EIT



Mehdi Mostakhdemi, M.Sc., P.Eng.
Senior Geotechnical Engineer



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





Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽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.

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.

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Approximate Uniaxial Compressive Strength (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

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 % 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.

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			

RECORD OF BOREHOLE No 17-01

1 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 870.4 E 326 991.7 ORIGINATED BY ES
 HWY 595 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.04.12 - 2017.04.12 CHECKED BY CZ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div><div>W_P</div><div>W</div><div>W_L</div></div> <div>WATER CONTENT (%)</div>	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
279.5	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL: (50 mm) SAND and GRAVEL , some silt, trace roots and rootlets Loose to Compact Brown Moist (FILL) Trace clay		1	GS										
			1	SS	8									37 45 18 (SI+CL)
			2	SS	16									
277.3														
2.2	SILT , some clay Dense Grey Moist		3	SS	32									0 0 78 22
			4	SS	46									
274.9														
4.6	Silty CLAY Hard Brown Moist (CI)		5	SS	44									
			6	SS	38									0 0 58 42
	Occasional silt lenses		7	SS	40									
			8	SS	39									
269.8														
9.8	END OF BOREHOLE AT 9.8 m.													

Continued Next Page

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

RECORD OF BOREHOLE No 17-01

2 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 870.4 E 326 991.7 ORIGINATED BY ES
 HWY 595 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.04.12 - 2017.04.12 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														
	Continued From Previous Page																					
	<p>GROUND WATER LEVEL AT 1.9 m UPON COMPLETION.</p> <p>Standpipe piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen.</p> <p>PIEZOMETER REMOVED ON APRIL 30, 2017. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.</p> <p>DCPT STARTED ABOUT 1.4 m NORTH OF THE BOREHOLE AT A DEPTH OF 0.9 m DUE TO NEAR SURFACE BOULDERS AND ENDED AT A DEPTH OF 5.0 m DUE TO REFUSAL.</p> <p>WATER LEVEL READINGS</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH(m)</th> <th>ELEV.(m)</th> </tr> </thead> <tbody> <tr> <td>2017.04.30</td> <td>2.2</td> <td>277.3</td> </tr> </tbody> </table>	DATE	DEPTH(m)	ELEV.(m)	2017.04.30	2.2	277.3															
DATE	DEPTH(m)	ELEV.(m)																				
2017.04.30	2.2	277.3																				

ONTMT4S MTO-17840.GPJ 2015TEMPLATE(MTO).GDT 5/31/17

RECORD OF BOREHOLE No 17-02

1 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 859.8 E 327 005.1 ORIGINATED BY ES
 HWY 595 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.04.06 - 2017.04.06 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
282.5	GROUND SURFACE							20 40 60 80 100		20 40 60				
0.0	ASPHALT: (40 mm)		1	GS			282							
	SAND and GRAVEL, trace to some fines Dense Brown Moist (FILL)		1	SS	33									39 49 12 (SI+CL)
	Occasional cobbles		2	SS	30		281							
			3	SS	34		280							
279.4														
3.1	Clayey SILT, some sand, trace gravel Firm Brown Moist (FILL)		4	SS	7		279							
278.4														
4.1	SAND, trace silt, trace clay Compact Brown Wet (FILL)		5	SS	19		278							
276.9							277							
5.6	Clayey SILT Hard Grey (CL-ML)		6	SS	51		276							0 0 82 18
	Trace sand		7	SS	41		275							
273.8							274							
8.7	Silty CLAY Hard Grey Moist (CI)		8	SS	31		273							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

ONTMT4S MTO-17840 GPJ 2015TEMPLATE(MTO).GDT 5/31/17

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-03

1 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 869.7 E 327 009.5 ORIGINATED BY ES
 HWY 595 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2017.04.07 - 2017.04.07 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				W _P W W _L				WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE											
281.8	GROUND SURFACE							20	40	60	80	100		20	40	60				
0.0	ASPHALT: (25 mm)																			
	SAND, some gravel to gravelly, trace fines Dense to Very Dense Brown Moist (FILL)		1	GS									○							
			1	SS	55								○							
	Occasional cobbles		2	SS	51								○							
			3	SS	33								○							
			4	SS	50/ 0.150								○							

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17-04

1 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 857.8 E 327 020.0 ORIGINATED BY AHF
 HWY 595 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.04.30 - 2017.04.30 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			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)			GR	SA		SI	CL				
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
278.5	GROUND SURFACE																				
0.0	SAND and GRAVEL , trace silt Loose Brown Wet (FILL)		1	GS			278														
			1	SS	4																
277.0							277														
1.5	SILT , some clay, trace fine sand Compact Grey Moist		2	SS	19												0	0	85	15	
276.3							276														
2.2	Silty CLAY Hard to Very Stiff Grey Moist		3	SS	73																
			4	SS	66		275														
							274														
			5	SS	49																
							273														
			6	SS	40		272											0	0	61	39
							271														
			7	SS	26																
							270														
			8	SS	26		269														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17-04

2 OF 2

METRIC

W.P. _____ LOCATION Whitewood Creek N 5 357 857.8 E 327 020.0 ORIGINATED BY AHF
 HWY 595 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.04.30 - 2017.04.30 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									
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
Continued From Previous Page																	
267.5			9	SS	40/ 0.075												
11.0	END OF BOREHOLE AT 11.0 m DUE TO AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

ONTMT4S MTO-17840.GPJ 2015TEMPLATE(MTO).GDT 5/31/17

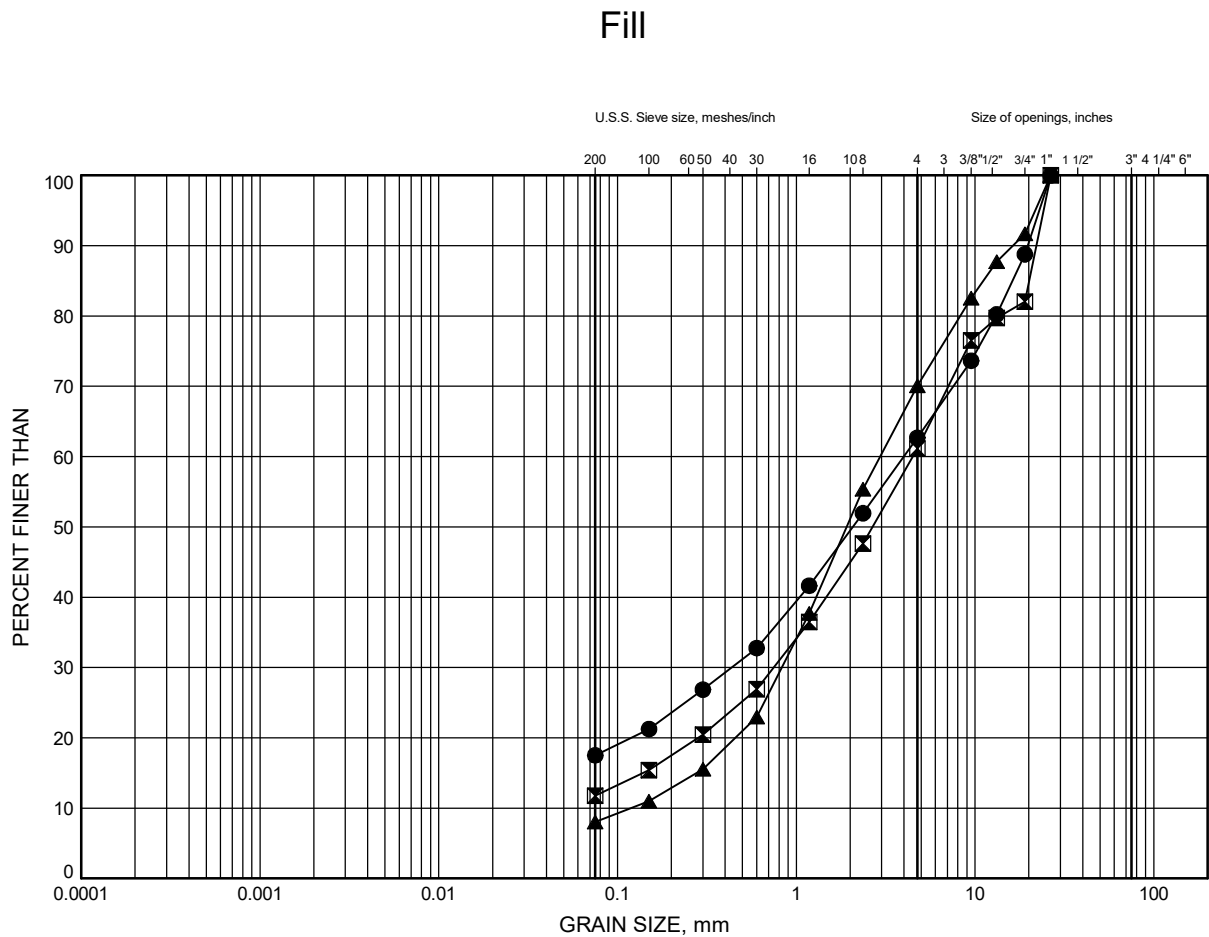


Appendix B

Geotechnical and Analytical Laboratory Test Results

Whitewood Creek GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	1.1	278.5
⊠	17-02	1.1	281.4
▲	17-03	1.8	280.0

Date May 2017
W.P. _____

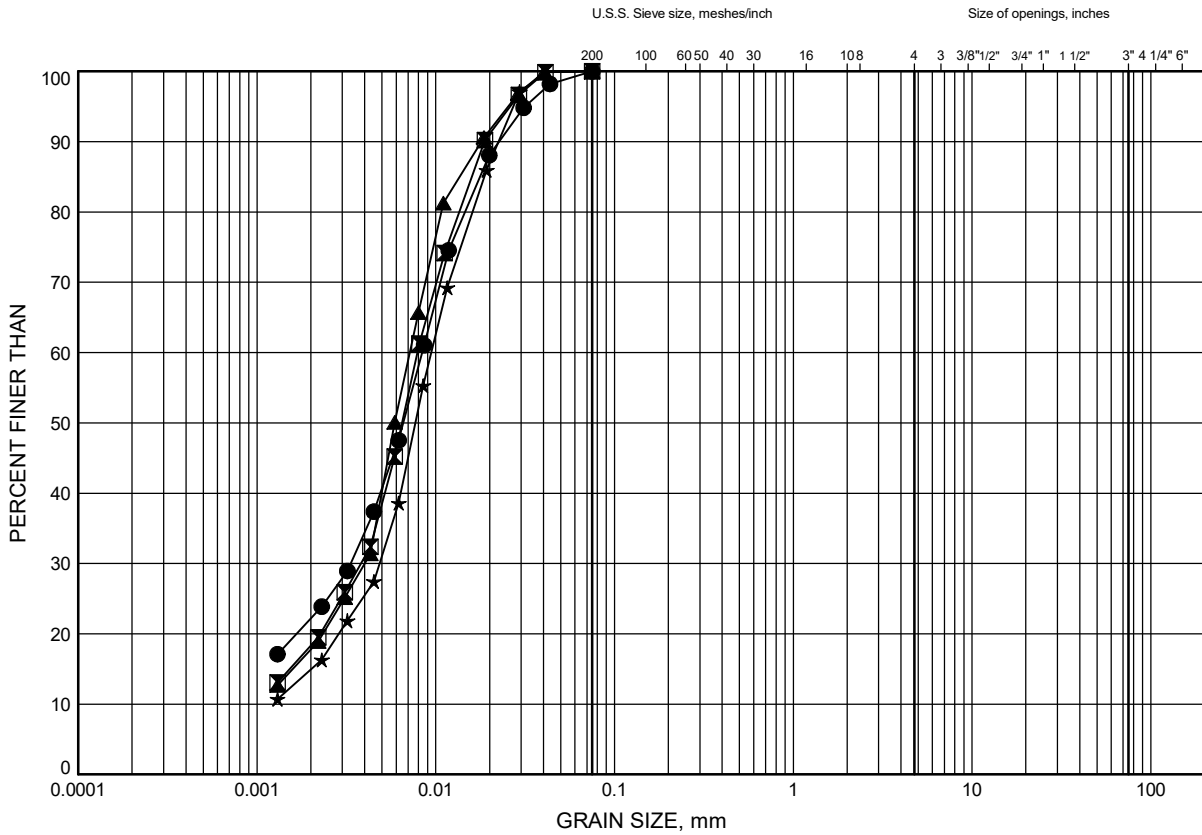


Prep'd MFA
Chkd. MM

Whitewood Creek GRAIN SIZE DISTRIBUTION

FIGURE B2

Silt / Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	2.6	276.9
⊠	17-02	6.4	276.1
▲	17-03	4.9	277.0
★	17-04	1.8	276.7

Date May 2017
W.P. _____

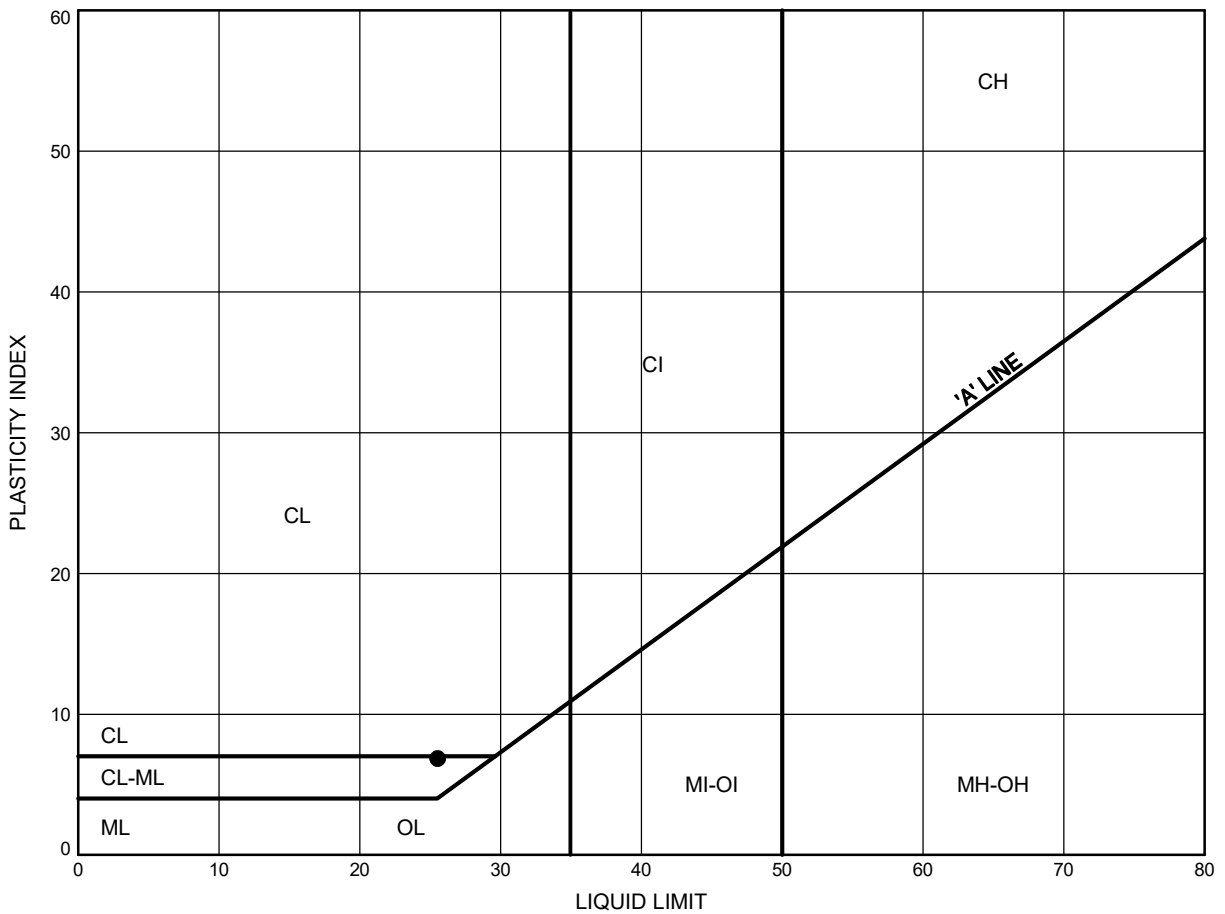


Prep'd MFA
Chkd. MM

Whitewood Creek ATTERBERG LIMITS TEST RESULTS

FIGURE B3

Silt / Clayey Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-02	6.4	276.1

Date May 2017
W.P.

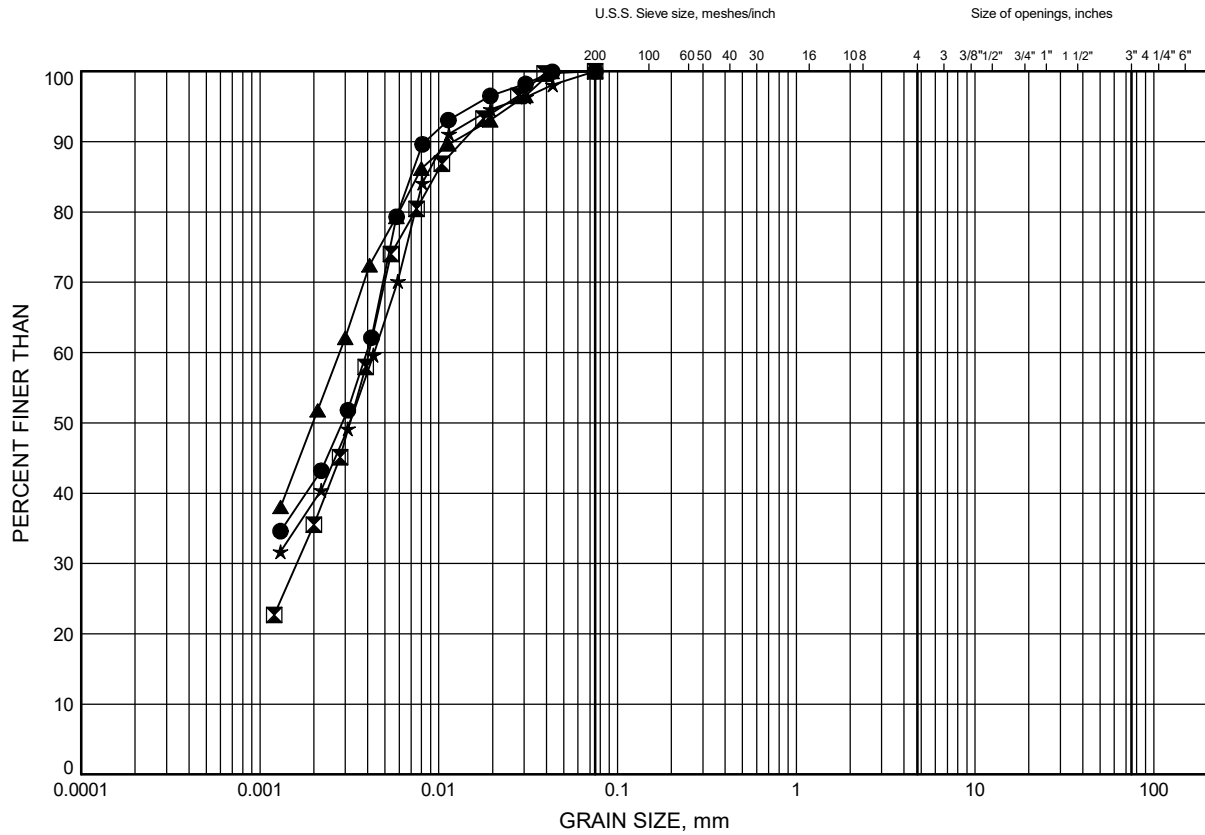


Prep'd MFA
Chkd. MM

Whitewood Creek GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	6.4	273.1
⊠	17-02	11.0	271.5
▲	17-03	9.4	272.4
★	17-04	6.4	272.1

Date May 2017
W.P.

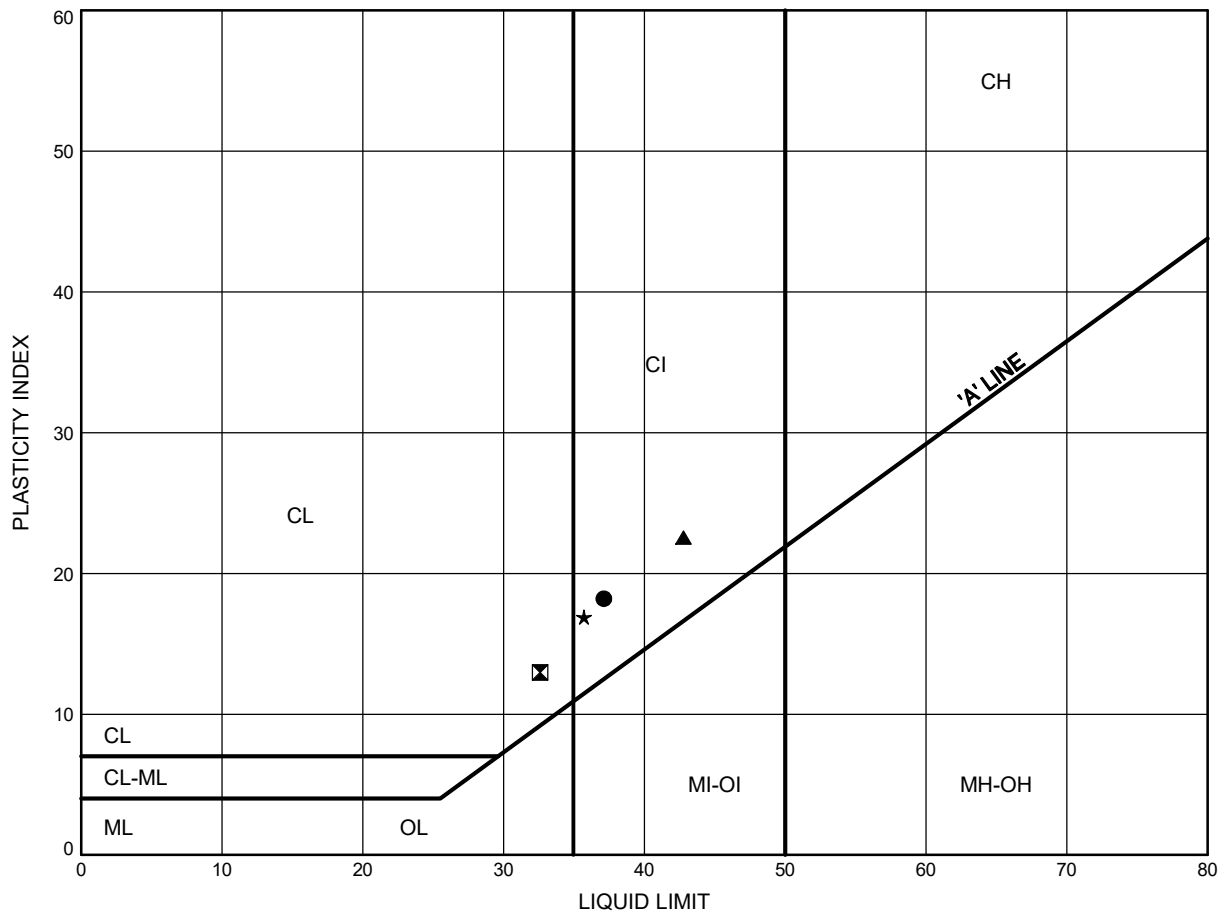


Prep'd MFA
Chkd. MM

Whitewood Creek ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-01	6.4	273.1
⊠	17-02	11.0	271.5
▲	17-03	9.4	272.4
★	17-04	6.4	272.1

Date May 2017
W.P. _____



Prep'd MFA
Chkd. MM



ASTM D5731-08

Date Drilled:	06-Apr-17
Date Tested:	01-May-17
Tester:	GA
Reviewed by:	CZ

[illegible]



ASTM D5731-08

Date Drilled:	07-Apr-17
Date Tested:	01-May-17
Tester:	GA
Reviewed by:	CZ

[illegible]

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840**Thurber Engineering Ltd.****Attn : Mark Farrant**

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

Phone: 905-829-8666 x 228
Fax:

19-April-2017

Date Rec. : 12 April 2017
LR Report: CA13544-APR17
Reference: 17840 Mark Farrant


Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: MDL	7: Whitewood Creek Culvert	8: Sitch Creek Culvert Hwy 588
Sample Date & Time						06-Apr-17 18:00	09-Apr-17 18:30
Temperature Upon Receipt [°C]					---	13.0	13.0
pH [no unit]	13-Apr-17	08:53	17-Apr-17	14:39	0.05	7.46	7.25
Conductivity [uS/cm]	13-Apr-17	08:53	17-Apr-17	14:39	2	129	90
Resistivity (calculated) [Ohms.cm]	17-Apr-17	16:09			---	7750	11100
Redox Potential [mV]	12-Apr-17	13:31	13-Apr-17	11:41	---	295	303
Chloride [mg/L]	12-Apr-17	16:30	13-Apr-17	12:41	0.04	7.3	3.0
Sulphate [mg/L]	12-Apr-17	16:30	13-Apr-17	12:41	0.04	3.2	3.0
Sulphide [mg/L]	13-Apr-17	10:15	17-Apr-17	10:30	0.006	< 0.006	< 0.006

Temperature of Sample upon Receipt: 13 degrees C
Cooling Agent Present: No
Custody Seal Present: No


Deanna Edwards, B.Sc, C.Chem
Project Specialist
Environmental Services, Analytical

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840**LR Report :** CA13544-APR17

Method Descriptions

Parameter	Units	SGS Method Code	Reference Method Code
Anions by IC	mg/L	ME-CA-[ENV]IC-LAK-AN-001	EPA300/MA300-Ions1.3
Conductivity	uS/cm	ME-CA-[ENV]EWL-LAK-AN-006	SM 2510
pH	no unit	ME-CA-[ENV]EWL-LAK-AN-006	SM 4500
Redox Potential	mV		SM 2580
Sulphide by SFA	mg/L	ME-CA-[ENV]SFA-LAK-AN-008	SM 4500



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 17840

LR Report : CA13544-APR17

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank				LCS / Spike Blank			Matrix Spike / Reference Material		
					RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
						%		Low	High		Low	High
Anions by IC - QCBatchID: DIO0140-APR17												
Chloride	0.04	mg/L	<0.04		4	20	100	80	120	104	75	125
Sulphate	0.04	mg/L	<0.04		2	20	98	80	120	107	75	125
Conductivity - QCBatchID: EWL0169-APR17												
Conductivity	2	uS/cm	2		3	10	97	90	110	NA		
pH - QCBatchID: EWL0169-APR17												
pH	0.05	no unit	NA		0		100			NA		
Redox Potential - QCBatchID: EWL0152-APR17												
Redox Potential	no	mV	NA		4	20	104	80	120	NA		
Sulphide by SFA - QCBatchID: SKA0110-APR17												
Sulphide	0.006	mg/L	<0.006		ND	20	81	80	120	NV	75	125



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Thurber Engineering Ltd

Attn : Cory Zanatta

2010 Winston Park Dr
Oakville, ON
L6H 5R7,

Phone: 905-829-8666 x 240

Fax:

Project : 17742/17840

24-May-2017

Date Rec. : 17 May 2017

LR Report: CA14528-MAY17

Reference: 17742/17840 Cory Zanatta

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: 17840 17-04 SS4	6: 17840 17-08 SS6	7: 17840 17-06 SS7	8: 17840 17-03 SS5
Sample Date & Time					15-May-17	15-May-17	15-May-17	15-May-17
Temperature Upon Receipt [°C]	---	---	---	---	10.0	10.0	10.0	10.0
Corrosivity Index [none]	24-May-17	13:45	24-May-17	13:45	7.5	4.5	7.5	4.0
Soil Redox Potential [mV]	18-May-17	19:36	19-May-17	14:01	139	152	272	237
Sulphide [%]	23-May-17	12:52	23-May-17	13:09	0.67	0.53	0.51	< 0.02
% Moisture (wet wt) [%]	23-May-17	10:42	23-May-17	10:44	19.3	19.8	9.9	17.9
pH [no unit]	19-May-17	14:44	24-May-17	13:14	8.73	8.22	8.51	8.55
Chloride [µg/g]	19-May-17	12:04	23-May-17	11:42	16	5.9	15	25
Sulphate [µg/g]	19-May-17	12:04	23-May-17	11:42	54	68	200	61
Conductivity [uS/cm]	19-May-17	14:44	24-May-17	13:14	76	92	173	109
Resistivity (calculated) [Ohms.cm]	19-May-17	14:44	24-May-17	13:14	13200	10900	5780	9170



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 17742/17840

LR Report : CA14528-MAY17

Analysis	9: 17840 17-02 SS6	10: 17840 17-07 SS7	11: 17792 17-03 SS3	12: 17792 17-02 SS4
Sample Date & Time	15-May-17	15-May-17	15-May-17	15-May-17
Temperature Upon Receipt [°C]	10.0	10.0	10.0	10.0
Corrosivity Index [none]	7.5	7.5	2.0	1.0
Soil Redox Potential [mV]	200	256	278	315
Sulphide [%]	0.05	0.39	< 0.02	< 0.02
% Moisture (wet wt) [%]	18.9	14.1	20.1	10.9
pH [no unit]	8.68	8.47	7.40	6.03
Chloride [µg/g]	55	59	260	66
Sulphate [µg/g]	110	200	8.3	32
Conductivity [uS/cm]	157	200	384	150
Resistivity (calculated) [Ohms.cm]	6370	5000	2600	6670

Temperature of Sample upon Receipt: 10 degrees C

Cooling Agent Present: Yes

Custody Seal Present: No

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

Deanna Edwards, B.Sc, C.Chem

Project Specialist

Environmental Services, Analytical



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 17742/17840

LR Report : CA14528-MAY17

Method Descriptions

Parameter	SGS Method Code
Anions by IC	ME-CA-[ENV]IC-LAK-AN-001
Carbon/Sulphur	ME-CA-[ENV]ARD-LAK-AN-020
Conductivity	ME-CA-[ENV]EWL-LAK-AN-006
Metals Prep	ME-CA-[ENV]ARD-LAK-AN-013
pH	ME-CA-[ENV]EWL-LAK-AN-001



SGS Canada Inc.

P.O. Box 4300 - 185 Concession St.

Lakefield - Ontario - KOL 2H0

Phone: 705-652-2000 FAX: 705-652-6365

Project : 17742/17840

LR Report : CA14528-MAY17

Quality Control Report

Inorganic Analysis												
Parameter	Reporting Limit	Unit	Method Blank				LCS / Spike Blank			Matrix Spike / Reference Material		
							RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)
					%	Low				High	Low	
Anions by IC - QCBatchID: DIO0347-MAY17												
Chloride	0.4	µg/g	<0.4		12	20	97	80	120	97	75	125
Sulphate	0.4	µg/g	<0.4		5	20	97	80	120	86	75	125
Carbon/Sulphur - QCBatchID: ECS0026-MAY17												
Sulphide	0.02	%	<0.02		ND	20	117	80	120			
Conductivity - QCBatchID: EWL0361-MAY17												
Conductivity	2	uS/cm	< 2		0	10	96	90	110	NA		
pH - QCBatchID: EWL0361-MAY17												
pH	0.05	no unit	NA		0		100			NA		



Appendix C

Selected Site Photographs



Photograph 1 – Whitewood Creek Culverts, East End (Outlet)

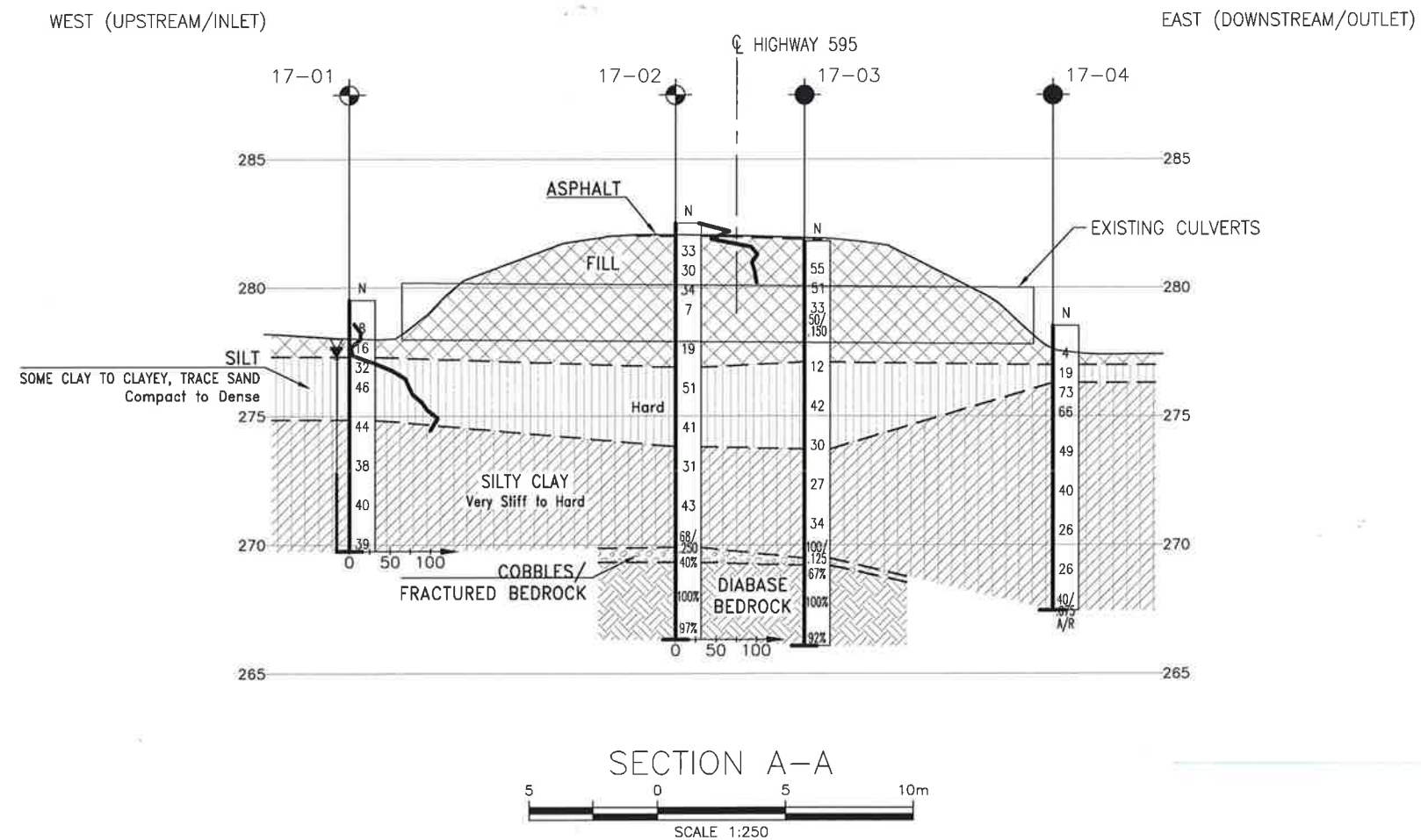
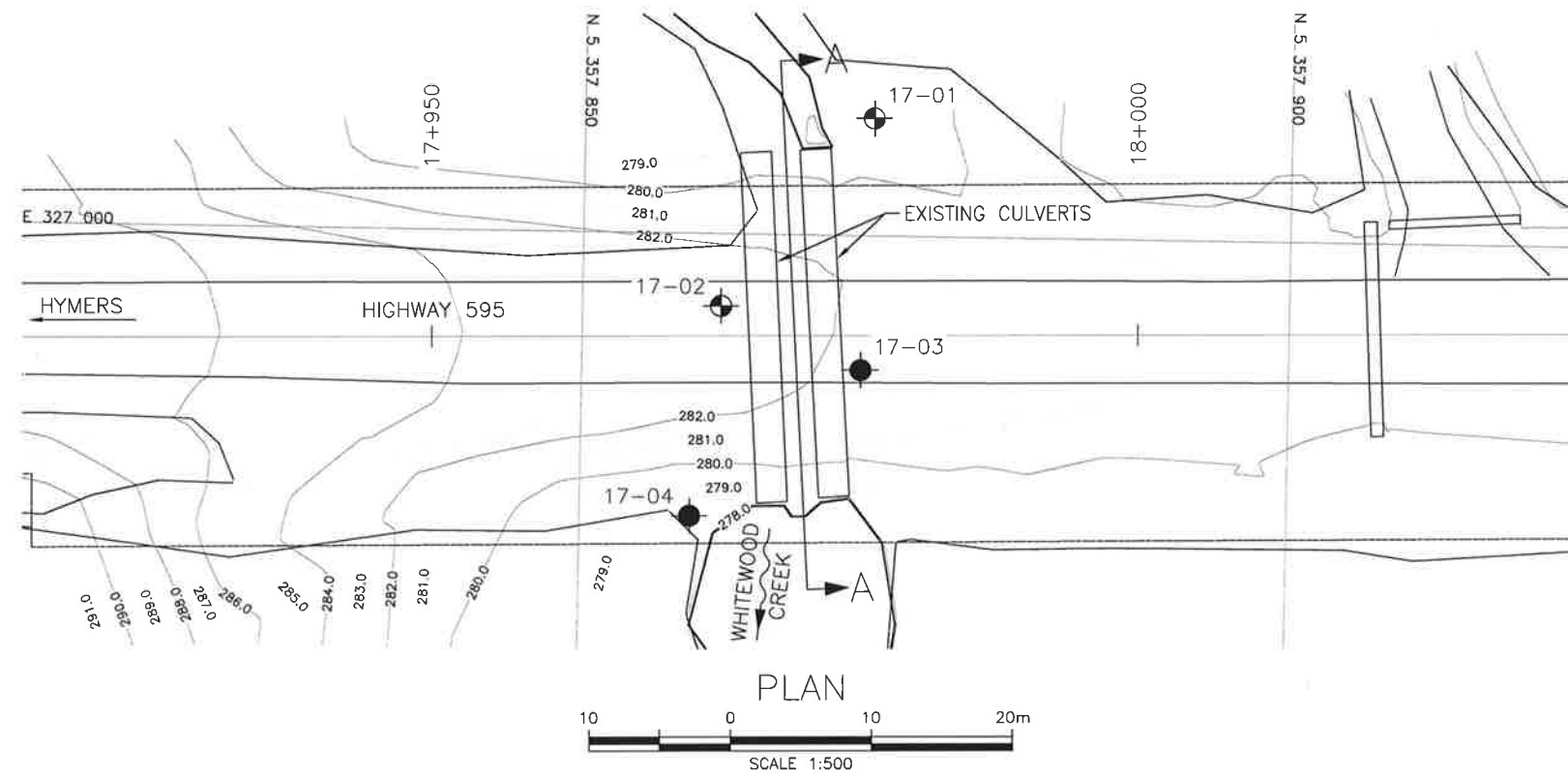


Photograph 2 – Whitewood Creek Culverts, West End (Inlet)



Appendix D

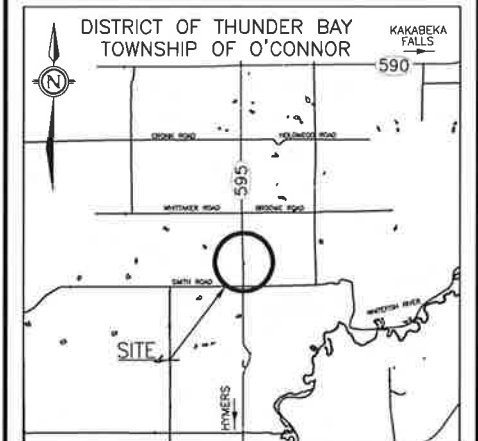
Borehole Locations and Soil Strata Drawing



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

CONT No
WP No

HIGHWAY 595
WHITEWOOD CREEK
CULVERTS
BOREHOLE LOCATIONS AND SOIL STRATA



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
17-01	279.5	5 357 870.4	326 991.7
17-02	282.5	5 357 859.8	327 005.1
17-03	281.8	5 357 869.7	327 009.5
17-04	278.5	5 357 857.8	327 020.0

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.

GEOCRES No. 52A-228



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