

**FOUNDATION INVESTIGATION REPORT
BLANCHE RIVER BRIDGE REPLACEMENT
ROSEGROVE ROAD
NEW LISKEARD DISTRICT, ONTARIO
G.W.P. 5146-13-00, SITE NO. 47-085
Geocres Number: 42A-105**

**Report to:
MMM GROUP LIMITED**

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

Date: April 28, 2016
File: 19-5161-252

TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

1	INTRODUCTION	2
2	SITE DESCRIPTION	2
3	SITE INVESTIGATION AND FIELD TESTING	3
4	LABORATORY TESTING	4
5	DESCRIPTION OF SUBSURFACE CONDITIONS	5
5.1	Topsoil	5
5.2	Embankment Fill	5
5.3	Silty Clay with Sand	6
5.4	Sand	6
5.5	Varved Clayey Silt to Silty Clay.....	7
5.6	Silt to Sandy Silt	8
5.7	Gravel	9
5.8	Gravelly Sand Till.....	9
5.9	Sand	10
5.10	Water Levels.....	10
6	CORROSIVITY AND SULPHATE TEST RESULTS.....	11
7	MISCELLANEOUS	11

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Geotechnical and Analytical Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Borehole Locations and Soil Strata Drawing
Appendix E	Factual Data from 1972 Foundation Investigation Report, Geocres No.: 42A-23

FOUNDATION INVESTIGATION REPORT
BLANCHE RIVER BRIDGE REPLACEMENT
ROSEGROVE ROAD
NEW LISKEARD DISTRICT, ONTARIO
G.W.P. 5146-13-00, SITE NO. 47-085
Geocres Number: 42A-105

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the existing Blanche River Bridge on Rosegrove Road in the Township of Otto, New Liskeard District, Ontario.

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

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 5014-E-0024.

A 1972 internal report by the MTO Foundations Office (Geocres No. 42A-23) prepared for the then-proposed bridge replacement has been reviewed and the subsurface information incorporated in the preparation of this report. The Borehole Location Plan and Record of Borehole sheets from the 1972 report are enclosed in Appendix E for information.

2 SITE DESCRIPTION

The existing Blanche River Bridge is located on Rosegrove Road, southwest of the community of Kirkland Lake, approximately 3.5 km east of the intersection of Highway 11 and Rosegrove Road. The existing bridge is a three-span structure; the centre span consists of a steel bailey bridge and the two end spans consist of a timber deck supported on wooden rectangular timber beams supported on timber crib abutments. The total bridge length is approximately 30.5 m as per the RFP and the deck is 4 m wide as per the RFP. The existing structure was constructed in 1972 to replace the original bridge and the existing bridge is supported on timber piles.

Blanche River flows from north to south at the bridge location. The areas surrounding the bridge are covered with tall grass, shrubs and frequent trees. The local topography is of low relief with no visible bedrock outcrops.

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

Based on published geological information, the general area of the project is covered by glaciolacustrine sediments of clays and silts deposited during the Pleistocene period. These deposits are mostly varved clays, but massive clays are also present in some areas. Due to the different rates of seasonal deposition during various periods of glaciation, the lower zones of the deposits display typically much thicker varves than in the upper zones. Below the varved clays are glacial outwash deposits of silt, sand and gravel underlain by Precambrian alkalic intrusive rocks.

The soils in the immediate vicinity of the Blanche River have been influenced by the river and consist of modern alluvial deposits including sand, silt, gravel and organic material.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing program for this project was carried out in two segments. The first between June 12 and June 13, 2015 and the second between August 6 and August 8, 2015. The program consisted of drilling and sampling four boreholes (numbered BR-01 to BR-04) to depths ranging from 30.5 to 35.7 m below the existing ground surface or river level. Two boreholes were drilled through the approach embankment near the west and east bridge abutments (BR-01 and BR-04 respectively), and two boreholes were drilled in the river from a barge near the existing west and east bridge piers (BR-02 and BR-03 respectively). A Dynamic Cone Penetration Test (DCPT) was conducted below the sampled portion of Boreholes BR-01 and BR-02 to a depth of 37.9m and 35.4 m, respectively.

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by MMM Group Limited. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix D.

A track-mounted CME 45 hi-torque drill rig was used to advance the Boreholes BR-01 and BR-04 using hollow stem augers. A Diedrich D25 hi-torque track-mounted drill rig and a barge were used to advance BR-02 and BR-03 to a specified depth using casing/wash boring methods. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). Field vane shear testing using an MTO “N” size vane were carried out in very soft to soft cohesive soils.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A standpipe piezometer was installed in Borehole BR-01 to monitor the groundwater level after drilling. The piezometer was decommissioned after final water level reading. The boreholes were backfilled in general accordance with MOE Regulation 903. Completion details of the piezometer and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Boreholes	Borehole and DCPT Depth*/Elevation (m)	Piezometer Tip Depth/Elevation (m)	Completion Details
West Abutment	BR-01	37.9* / 235.7	35.1/ 238.5	Sand to 31.4 m, and bentonite holeplug and cuttings from 31.4 m to surface.
West Pier	BR-02	35.4** / 236.2	None installed	Bentonite holeplug from 34.7 m to surface of river bed.
East Pier	BR-03	34.8** / 236.8	None installed	Bentonite holeplug from 34.8 m to surface of river bed.
East Abutment	BR-04	30.5* / 244.1	None installed	Bentonite holeplug and cuttings from 30.5 m to surface.

Notes: *Borehole depth below existing ground surface

** Borehole Depth below river level at time of drilling

The results of the field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and plasticity testing (Atterberg Limits). The results of the geotechnical laboratory program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the existing native soil, and a sample of surface water from the river upstream of the bridge were collected. The samples were submitted to AGAT

Laboratories in Mississauga, Ontario for analytical testing of corrosivity parameters and sulphate. The results of the analytical testing are summarized in Section 6 below and are enclosed 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 in these sheets and on the “Borehole Locations and Soil Strata” drawing included in Appendix D. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It should be recognized that soil conditions may vary between and beyond the borehole locations.

The MTO Report prepared by the Foundations Office in 1972 describes a foundation investigation that was conducted at the then existing Blanche River Bridge for structure replacement. The locations of the boreholes from the 1972 report (Geocres No. 42A-23) and the Record of Borehole sheets are presented in Appendix E for information. The subsurface information documented in the MTO report was incorporated in the preparation of this report. In general, the information on subsurface conditions is consistent with the subsurface information obtained during the current investigation.

As determined in the current investigation, the soil stratigraphy at the west side of the river comprises a sand fill underlain by layers of silty clay and silty sand to approximately 5.6 m depth. These soils were further underlain by a very soft to stiff, varved clayey silt to silty clay extending to as much as 33.5 m depth. On the east side of the river, the varved clayey silt to silty clay was encountered immediately below the topsoil or thin river bed deposit and the clay extended to a depth of 25.7 m in Borehole BR-03. Adjacent Borehole BR-04 was terminated in this varved clay deposit at the depth of 30.5 m. The clayey silt to silty clay was underlain by a cohesionless deposit ranging in composition from a silt to gravel. A layer of gravelly sand till was encountered in one borehole (Borehole BR-02) at 33.3 m depth. More detailed description of the individual strata are presented below.

5.1 Topsoil

A thin layer of topsoil was encountered at the surface of Borehole BR-04, which was drilled adjacent to the existing roadway. The topsoil layer had a thickness of 75 mm at the borehole location. Topsoil thickness may vary in other areas of the site and this limited data should not be used for estimating purposes.

5.2 Embankment Fill

Embankment fill was encountered in Borehole BR-01, which was drilled adjacent to the bridge approach on the west side of the river. The fill consisted of brown sand with trace to some silt and gravel and trace organic inclusions at shallow depths including roots and rootlets. The thickness of the fill was 2.2 m with an underside elevation of 271.4.

SPT ‘N’ values recorded in the embankment fill ranged from 4 to 10 blows per 0.3 m penetration, indicating a loose to compact relative density. Moisture contents of the fill materials ranged from 3% to 15%.

5.3 Silty Clay with Sand

A layer of silty clay with sand was encountered in BR-01 beneath the embankment fill. The deposit was brown to grey in colour. Trace gravel and occasional oxidized silt seam were noted in this layer. This layer was 1.9 m thick with a base depth at 4.1 m (Elev. 269.5).

SPT ‘N’ values recorded in this layer were 3 and 6 blows per 0.3 m penetration indicating a soft to firm consistency. Moisture contents in this layer ranged between 19 and 25%. The results of grain size analyses conducted on a sample of this soil are presented in Figure B1, and Atterberg Limits test results are presented in Figure B10 in Appendix B. The results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	44
Silt	34
Clay	22
Soil Property	%
Liquid Limit	26
Plasticity Index	10

The results of the Atterberg Limits tests indicate that the silty clay is of low plasticity (CL).

5.4 Sand

A deposit of sand was encountered beneath the silty clay with sand layer in Borehole BR-01 and below the river bed in Boreholes BR-02 and BR-03. The thickness of the deposit ranged from 0.1 m to 1.5 m with the lower boundary between 1.9 m and 5.6 m (Elev. 269.7 to 268.0). The deposit contains predominantly sand with some silt, trace to some gravel, and trace clay. Wood fibres were noted in this deposit in the samples retrieved from the river bed.

SPT ‘N’ values recorded in this deposit varied between 1 and 2 blows per 0.3 m of penetration indicating a very loose relative density. Natural moisture contents of the deposit ranged from 35 to 51%.

The results of a grain size analyses conducted on a sample of the sand are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B2 of Appendix B. The results of the grain size analyses are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	73
Silt	17
Clay	10

5.5 Varved Clayey Silt to Silty Clay

A deposit of varved clayey silt to silty clay with trace sand was encountered in all boreholes drilled on site. The deposit underlies the sand in Boreholes BR-01, BR-02, and BR-03, and the topsoil in BR-04 and was typically grey in colour. In Boreholes BR-03 and BR-04, trace of organic inclusions (roots and rootlets) were noted at shallow depths. Occasional clay, silt and sand seams were noted at different depths in this deposit.

In Boreholes BR-02 and BR-03, a layer of very loose to loose silt with some clay and trace to some sand was encountered within the clayey silt / silty clay deposit. This layer ranged in thickness from 0.5 to 1.2 m with an underside between 19.6 m and 20.5 m depths (Elev. 252.0 and 251.1).

Where fully penetrated in Boreholes BR-01, BR-02, and BR-03, the clayey silt / silty clay was 23.8 m to 28.2 m thick and extended to depths of 25.7 m to 33.5 m (Elev. 245.9 to 240.1). Borehole BR-04 was terminated in this deposit at a depth of 30.5 m (Elev. 244.1).

The undrained in-situ vane shear strength was measured to be between 20 to 73 kPa. SPT 'N' values recorded in this deposit ranged from 0 (weight of rod or hammer) to 8 blows per 0.3 m penetration, typically ranging from 0 to 3 blows per 0.3 m of penetration. In conjunction with measured field vane shear strengths, the clayey silt / silty clay was found to have a soft to stiff consistency. Moisture contents in the clayey silt / silty clay ranged between 15% and 67% with most values ranging between 24 % and 51%. The grain size analyses conducted on samples are presented in Figure B3, B4, and B5, and Atterberg Limits test results are presented in Figure B11 and B12 in Appendix B. The results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	0 to 2
Silt	24 to 81
Clay	19 to 76
Soil Property	%
Liquid Limit	26 to 60
Plasticity Index	7 to 33

The results of the Atterberg Limits tests indicate that the plasticity of this deposit varies from low to high.

5.6 Silt to Sandy Silt

Deposits of sandy silt and silt were encountered in Borehole BR-01 and BR-03 underlying the varved clayey silt / silty clay deposit. Borehole BR-01 was terminated in the sandy silt at a depth of 35.7 m (Elev. 237.9). Where fully penetrated in BR-03, the deposit had a thickness of 6.1 m with the base at a depth of 31.8 m (Elev. 239.8). The deposits were grey in colour and contained trace to some clay.

SPT 'N' values recorded in these deposits varied between 9 and 21 blows per 0.3 m of penetration, indicating a loose to compact relative density. Natural moisture contents of the deposits ranged from 27% to 29%. The results of grain size analyses conducted on samples of the silt to sandy silt are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B6 of Appendix B. The results of the grain size analyses are summarized in the following table.

Soil Particles	Sandy Silt %	Silt %
Gravel	0	0
Sand	32	4
Silt	58	91
Clay	10	5

Below the sampled depth of Borehole BR-01, a DCPT was carried out to practical refusal (i.e., 100 blows per 0.3 m penetration) from a depth of 35.7 m to 37.9 m (Elev. 237.9 to 235.7).

5.7 Gravel

A layer of gravel with some sand and trace silt was encountered in BR-02 and BR-03. The deposit ranged in thickness from 1.6 to 2 m with the base between 33.3 m and 33.4 m depth (Elev. 238.3).

SPT 'N' values recorded in this layer were 26 and 28 blows per 0.3 m penetration, indicating a compact relative density. Moisture contents in this layer were measured at 5%. The results of grain size analysis conducted on a sample are presented in Figure B7. The results are summarized in the following table.

Soil Particles	%
Gravel	85
Sand	14
Silt & Clay	1

5.8 Gravelly Sand Till

A grey gravelly sand till containing some silt and clay was encountered in Borehole BR-02 underlying the gravel deposit. The borehole was terminated in the gravelly sand till layer at a depth of 34.7 m (Elev. 236.9).

SPT 'N' value recorded in this layer was 107 blows per 0.3 m penetration indicating a very dense relative density. The moisture content measured in this layer was 12%. The results of grain size analysis conducted on a sample of the till are presented in Figure B8. The results are summarized in the following table.

Soil Particles	%
Gravel	22
Sand	44
Silt & Clay	31

Below the sampled depth of Borehole BR-02, a DCPT was carried out to practical refusal (100 blows per 0.3 m) from a depth of 34.7 m to 35.4 m (Elev. 236.9 to 236.2).

5.9 Sand

A layer of brown sand containing trace silt was encountered in Borehole BR-03 underlying the gravel deposit. The borehole was terminated in the sand at a depth of 34.8 m (Elev. 236.8).

SPT 'N' values recorded in this layer ranged from 44 blows per 0.3 m penetration to 100 blows per 0.05 m penetration, indicating a dense to very dense relative density. Moisture content measured in this layer was 25%. The grain size analyses conducted on samples are presented in Figure B9. The results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	96
Silt & Clay	4

5.10 Water Levels

Where possible, water levels were monitored in the open boreholes during drilling operations. Boreholes BR-02 and BR-03 were drilled in the river, and wash boring methods were used to advance the boreholes; therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater levels. A standpipe piezometer was installed in one borehole to monitor the groundwater level after completion of drilling. The water levels measured in the piezometer and during drilling are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BR-01	July 14, 2015	2.8	270.8	In piezometer
	July 27, 2015	1.7	271.9	
BR-02	August 7, 2015	0	271.6*	Open borehole
BR-03	August 8, 2015	0	271.6*	Open borehole
BR-04	June 13, 2015	2.9	271.7	Open borehole

* Water level in the river

The topographic plan provided by MMM indicates the water level in Blanche River at Elev. 272.0 on May 29, 2015.

The water levels presented in Table 5.1 are short-term readings and seasonal fluctuations of the groundwater and river water levels are to be expected. In particular, the water level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 CORROSIVITY AND SULPHATE TEST RESULTS

A soil sample collected from the native clay and a sample of the water from the river 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	Units	Test Results	
	(Soil)	(Water)	BR-4 SS3 – Soil (1.5 m to 2.1 m)	Blanche River Water
Sulphide	%	mg/L	0.02	<0.05
Chloride	µg/g	mg/L	29	13.4
Sulphate	µg/g	mg/L	47	11.8
pH	pH Units	pH Units	7.98	7.44
Electrical Conductivity	mS/cm	µS/cm	0.222	-
Resistivity	ohm.cm	ohm.cm	4500	5880
Redox Potential	mV	mV	234	308
Langlier Index	-	-	-	-0.85
Total Hardness (as CaCO ₃)	-	mg/L	-	59.7
Total Dissolved Solids	-	mg/L	-	76
Alkalinity (as CaCO ₃)	-	mg/L	-	50

7 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber obtained the northing and easting coordinates and ground surface elevations from measurements taken in the field and relative to the topographic plans provided by MMM Group Limited.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a track-mounted CME-45 hi-torque drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes near the bridge abutments. Walker Drilling Limited of Utopia, Ontario supplied and operated a Diedrich D25 hi-torque drill rig and a barge to conduct the drilling, sampling and in-situ testing operations for the boreholes at the existing bridge piers. The drilling operations were supervised by Mr. Amir Fereidouni and Ms. Eckie Siu of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET. The report was prepared by Ms. Deanna Pizycki, EIT and Ms. Anna Piascik, P.Eng.

The report was reviewed by Mr. Alastair Gorman, P.Eng and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Deanna Pizycki
Apr 28/16

Deanna Pizycki, EIT
Geotechnical Engineer-in-Training



Alastair Gorman, P.Eng.
Senior Associate/Senior Geotechnical Engineer



Dr. P.K. Chatterji, Ph.D., 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
 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.

EXPLANATION OF ROCK LOGGING TERMS

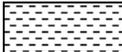
ROCK WEATHERING CLASSIFICATION

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		Field Estimation of Hardness*
	(MPa)	(psi)	
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 BR-01

1 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 626.6 E 374 167.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.12 - 2015.06.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
273.6	GROUND SURFACE													
0.0	SAND , trace to some silt, trace to some gravel, trace organics (roots and rootlets) Loose to Compact Brown Moist (FILL)		1	SS	7									
			2	SS	10									
			3	SS	4									
271.4	Silty CLAY and SAND , trace gravel, occasional oxidized silt seam Soft to Firm Brown to Grey		4	SS	6									
			5	SS	3									0 44 34 22
269.5	SAND , some silt, some gravel, trace clay Very Loose Grey Wet		6	SS	1									
268.0	Clayey SILT to silty CLAY , trace sand: (varved) Firm to Stiff Grey		7	SS	1									0 0 81 19
			8	SS	1									
			9	SS	1									

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-01

2 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 626.6 E 374 167.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.12 - 2015.06.13 CHECKED BY MEF

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								
							20	40	60	80	100	W _p	W	W _L		GR SA SI CL
	Continued From Previous Page															
			10	SS	1			3.6								
			11	SS	1			3.8								0 0 54 46
			12	SS	1			4.5								
			13	SS	1			2.5								
			14	SS	0			3.3								0 0 43 57
			15	SS	1			4.0								

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
5
0
5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BR-01

3 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 626.6 E 374 167.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.12 - 2015.06.13 CHECKED BY MEF

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						20 40 60 80 100									
			16	SS	0											
			17	SS	0											0 0 59 41
			18	SS	2											
			19	SS	4											0 0 75 25

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-01

4 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 626.6 E 374 167.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.12 - 2015.06.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page					20 40 60 80 100	20 40 60 80 100	20 40 60								
240.1			20	SS	2											
33.5	Sandy SILT, some clay Compact Grey Wet															
237.9			21	SS	21										0 32 58 10	
35.7	End of sampling at 35.7m and start of DCPT.															
235.7																
37.9	END OF BOREHOLE AND DCPT AT 37.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.06.14 2.8 270.8 2015.06.27 1.7 271.9															

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT_10/21/15

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

RECORD OF BOREHOLE No BR-02

2 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 618.7 E 374 186.7 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone/Dynamic Cone Penetration Test COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.06 - 2015.08.07 CHECKED BY MEF

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			20	40	60	80					
Continued From Previous Page																
			8	SS	2		261	8.0								
			9	SS	2		260									
							259	8.0								
			10	SS	2		258									
							257	9.0								
			11	SS	2		256									
							255	10.0								
			12	SS	3		254								0 0 46 54	
							253	8.0								
			13	SS	2		252									
							251	14.0								
			14	SS	4		250									
252.4							19.3									
	SILT, some clay, trace sand Very Loose Grey Wet															

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-02

4 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 618.7 E 374 186.7 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone/Dynamic Cone Penetration Test COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.06 - 2015.08.07 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
240.3														
31.3	GRAVEL , some sand, trace silt Compact Grey Wet		19	SS	28								85 14 1 (SI+CL)	
238.3														
33.3	Gravelly SAND , some silt, some clay Very Dense Grey Moist (TILL)													
236.9			20	SS	107								25 44 31 (SI+CL)	
34.7	End of sampling at 34.7m and start of DCPT.													
236.2	END OF BOREHOLE AT 35.4m UPON DCPT REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE OF CREEK BED.													

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

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

RECORD OF BOREHOLE No BR-03

1 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 625.1 E 374 200.6 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.07 - 2015.08.08 CHECKED BY MEF

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			20	40	60					
271.6	RIVER SURFACE														
0.0	WATER														
269.8															
1.8	SAND , some silt, trace clay, trace gravel, trace wood fibres Very Loose Brown Wet Clayey SILT to silty CLAY , trace sand, vavred Very Soft to Stiff Grey Occasional silt seams		1	SS	2										
			2	SS	1									0 0 66 34	
			3	SS	4									0 0 79 21	
			4	SS	3										
			5	SS	1									0 0 57 43	
			6	SS	3										
			7	SS	1										
			8	SS	1										

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-03

2 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 625.1 E 374 200.6 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.07 - 2015.08.08 CHECKED BY MEF

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			20	40	60					
Continued From Previous Page															
			9	SS	0		261	9.0							
							260								
			10	SS	2		259	7.0							
							258	8.0							
			11	SS	3		257								
							256	10.0							
			12	SS	8		255								
							254	6.0							0 0 50 50
							253	6.7							
			14	SS	6		252								
252.6															
19.1	SILT, some sand, some clay														
252.0	Loose														
	Grey														
19.6	Wet														

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-03

3 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 625.1 E 374 200.6 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.07 - 2015.08.08 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)						
						20	40	60	80	100	20	40	60			
	Continued From Previous Page															
	Silty CLAY to Clayey SILT , trace sand, occasional silt seams: (varved) Firm Grey		15	SS	2											
			16	SS	0											
			17	SS	7											
245.9																
25.7	SILT , some sand, trace clay Compact Grey Wet															
			18	SS	20										0 4 91 5	

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-03

4 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 625.1 E 374 200.6 ORIGINATED BY ES
 HWY Local / Rosegrove Rd. BOREHOLE TYPE NW Casing/Tricone COMPILED BY MFA
 DATUM Geodetic DATE 2015.08.07 - 2015.08.08 CHECKED BY MEF

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						20	40	60	80	100	W _p	W	W _L			
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
	occasional sand and clay seams		19	SS	9												
239.8	31.8 GRAVEL , some sand, trace silt Compact Grey Wet		20	SS	26												
238.3	33.4 SAND , trace gravel, trace silt Dense Brown Wet		21	SS	44												0 96 4 (SI+CL)
236.8	34.8 END OF BOREHOLE AT 34.8m UPON TRICONE REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE OF CREEK BED.		22	SS	100/ 0.050												

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

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

RECORD OF BOREHOLE No BR-04

2 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 619.6 E 374 214.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.13 - 2015.06.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page						20 40 60 80 100									
264			10	SS	0		3.8 +									0 0 53 47
263							5.7 +									
262			11	SS	1											
261							2.9 +									
260			12	SS	0											
259							3.3 +									0 0 39 61
258							2.9 +									
257			14	SS	1											
256							3.4 +									
255			15	SS	0											
							3.8 +									

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-04

3 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 619.6 E 374 214.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.13 - 2015.06.13 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page						20 40 60 80 100	20 40 60 80 100	20 40 60							
			16	SS	1											
							254	3.3								
							253									
							252									
			17	SS	0										0 0 61 39	
							251	2.6								
							250									
							249									
			18	SS	0											
							248									
							247	2.2								
							246									
			19	SS	1											
							245									

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

Continued Next Page

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

RECORD OF BOREHOLE No BR-04

4 OF 4

METRIC

GWP# 5146-13-00 LOCATION Blanche River Bridge N 5 321 619.6 E 374 214.8 ORIGINATED BY AHF
 HWY Local / Rosegrove Rd. BOREHOLE TYPE Solid Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2015.06.13 - 2015.06.13 CHECKED BY MEF

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			20	40	60	80	100					
	Continued From Previous Page																
244.1																	
30.5	END OF BOREHOLE AT 30.5m. WATER LEVEL AT 2.9m UPON COMPLETION.																

ONTMT4S_19-5161-252.GPJ_2015TEMPLATE(MTO).GDT 10/21/15

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

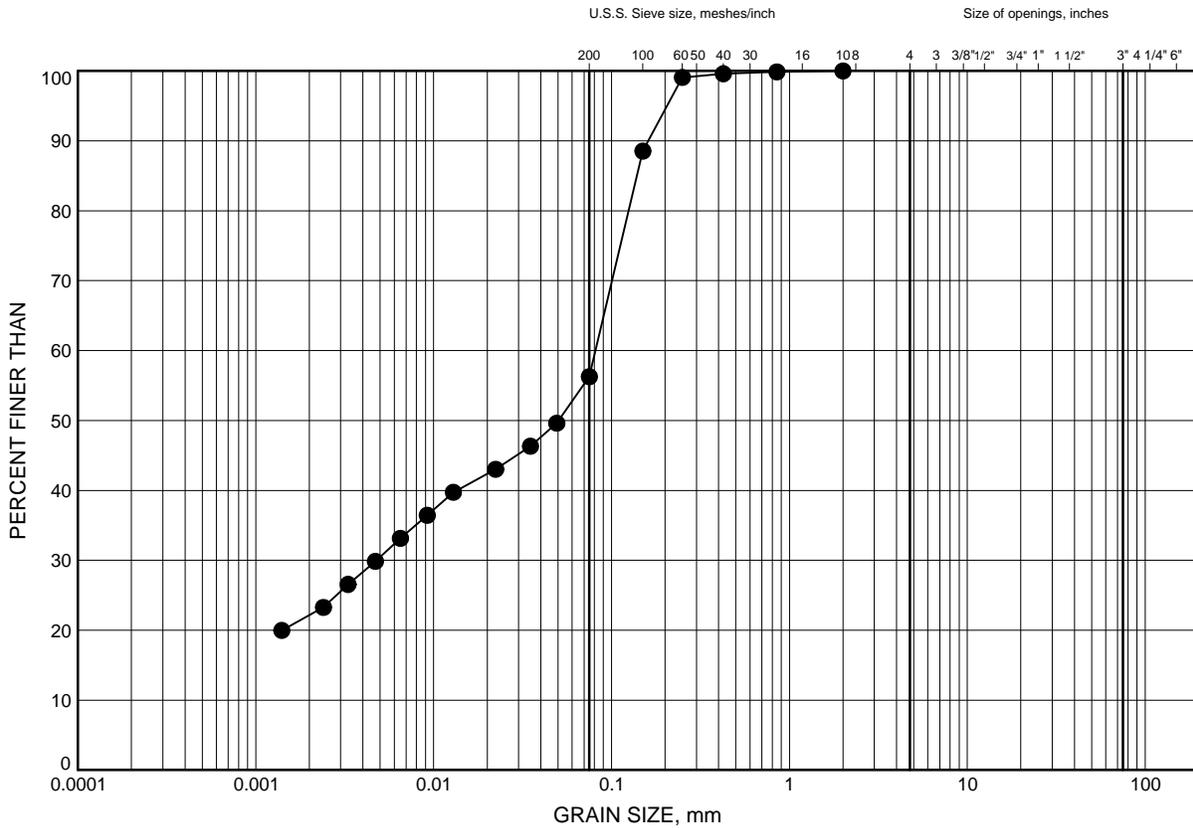
Appendix B

**Geotechnical and Analytical
Laboratory Test Results**

Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY and SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	3.35	270.25

Date .. October 2015 ..
GWP# .. 5146-13-00 ..

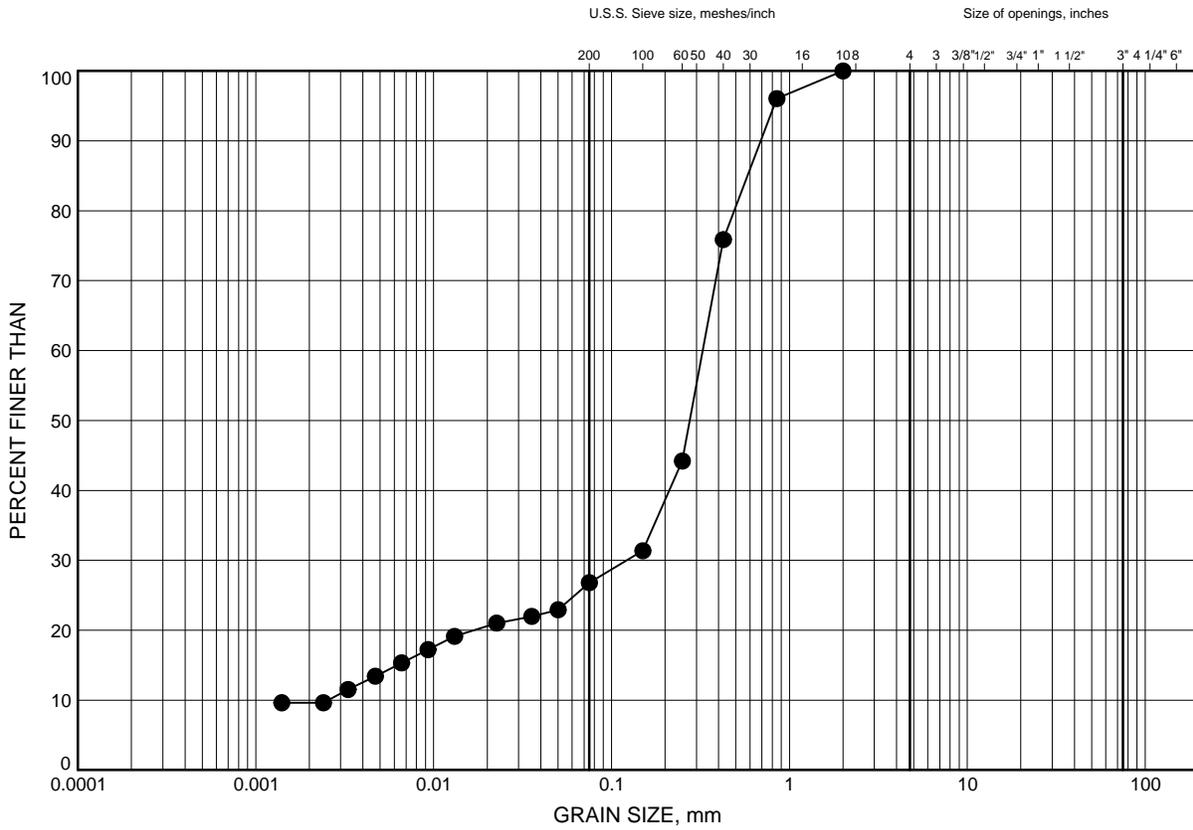


Prep'd .. AN ..
Chkd. .. AMP ..

Blanche River Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-02	2.54	269.10

Date: October 2015
GWP#: 5146-13-00



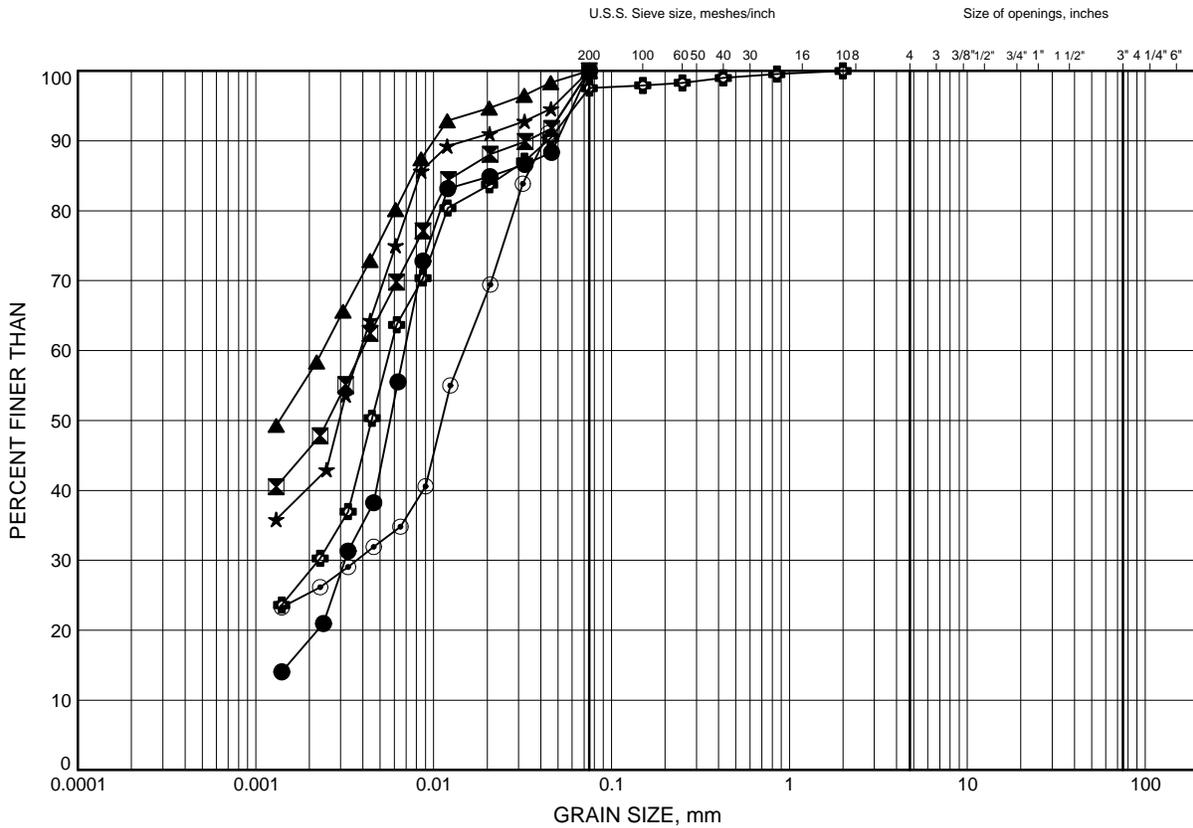
Prep'd: AN
Chkd.: AMP

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/5/15

Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3

Clayey SILT to Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	6.40	267.20
⊠	BR-01	12.50	261.10
▲	BR-01	17.07	256.53
★	BR-01	23.16	250.44
⊙	BR-01	29.26	244.34
⊕	BR-02	4.82	266.81

Date October 2015
GWP# 5146-13-00

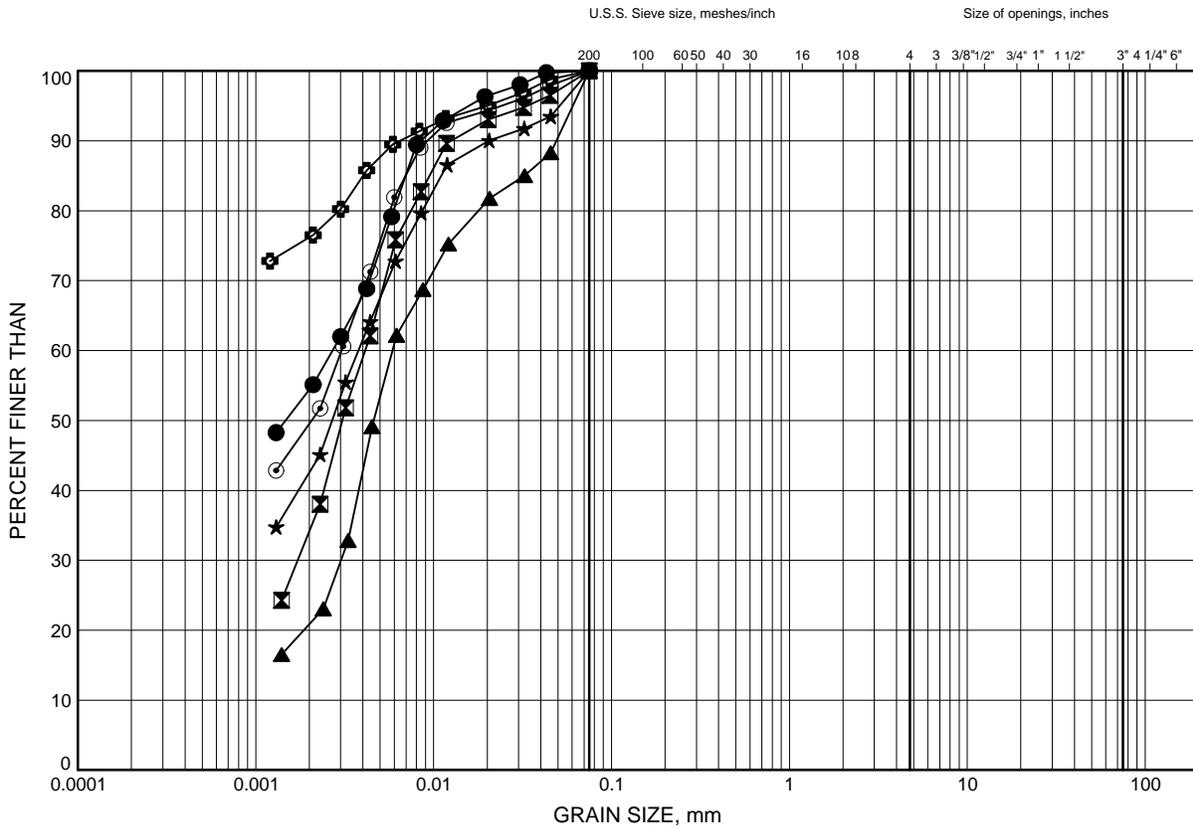


Prep'd AN
Chkd. AMP

Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B4

Clayey SILT to Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-02	16.25	255.38
⊠	BR-03	2.87	268.76
▲	BR-03	3.63	268.00
★	BR-03	5.16	266.48
⊙	BR-03	17.35	254.28
⊕	BR-04	1.07	273.53

Date October 2015
GWP# 5146-13-00

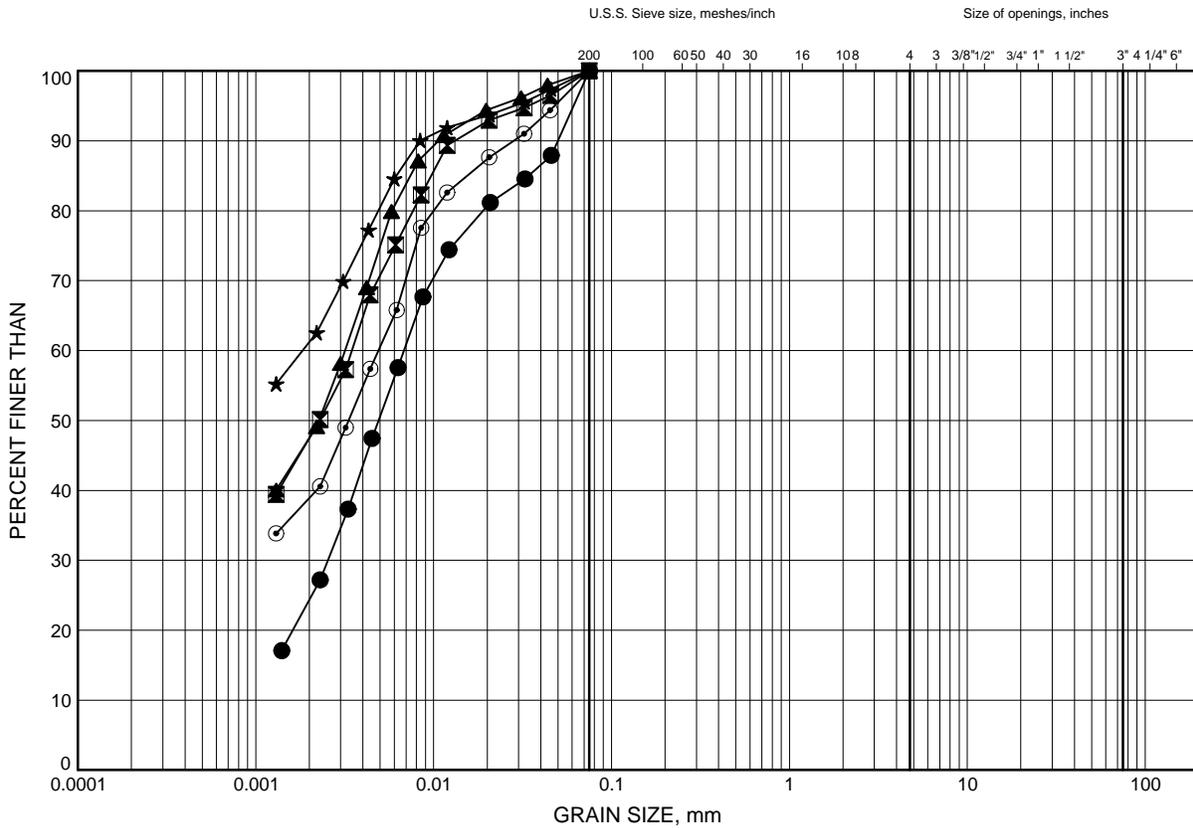


Prep'd AN
Chkd. AMP

Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B5

Clayey SILT to Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-04	4.88	269.72
⊠	BR-04	7.92	266.68
▲	BR-04	10.97	263.63
★	BR-04	15.54	259.06
⊙	BR-04	23.16	251.44

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/5/15

Date October 2015
GWP# 5146-13-00

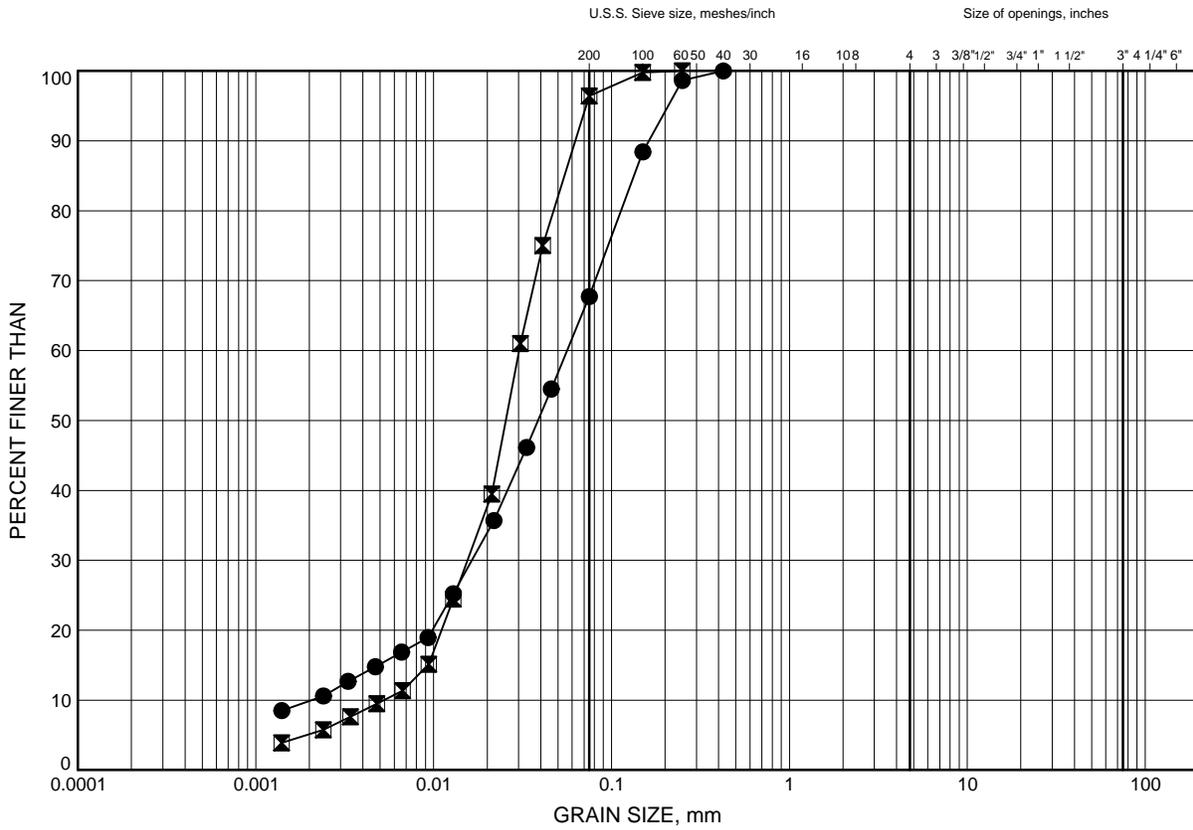


Prep'd AN
Chkd. AMP

Blanche River Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B6

SILT to Sandy SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	35.36	238.24
⊠	BR-03	28.02	243.62

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/5/15

Date .. October 2015 ..
GWP# .. 5146-13-00 ..

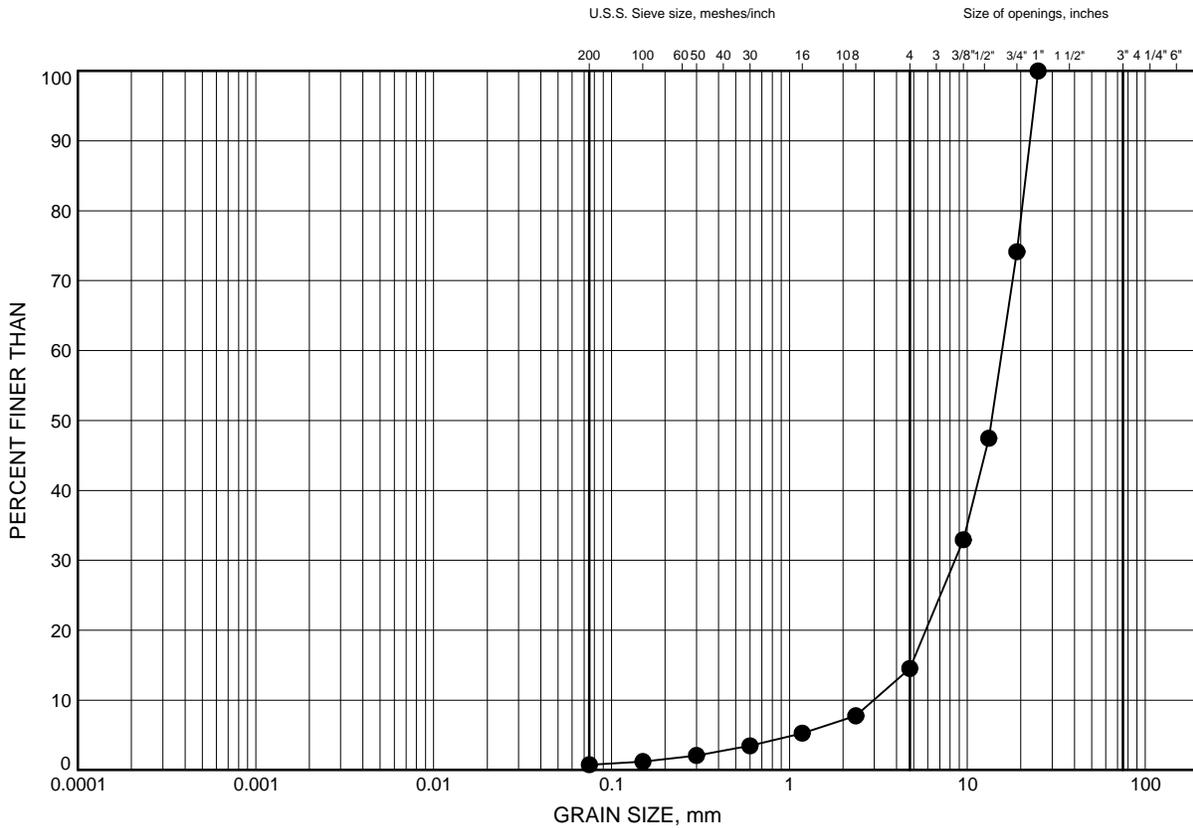


Prep'd .. AN ..
Chkd. .. AMP ..

Blanche River Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B7

GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-02	31.55	240.09

Date .. October 2015 ..
GWP# .. 5146-13-00 ..

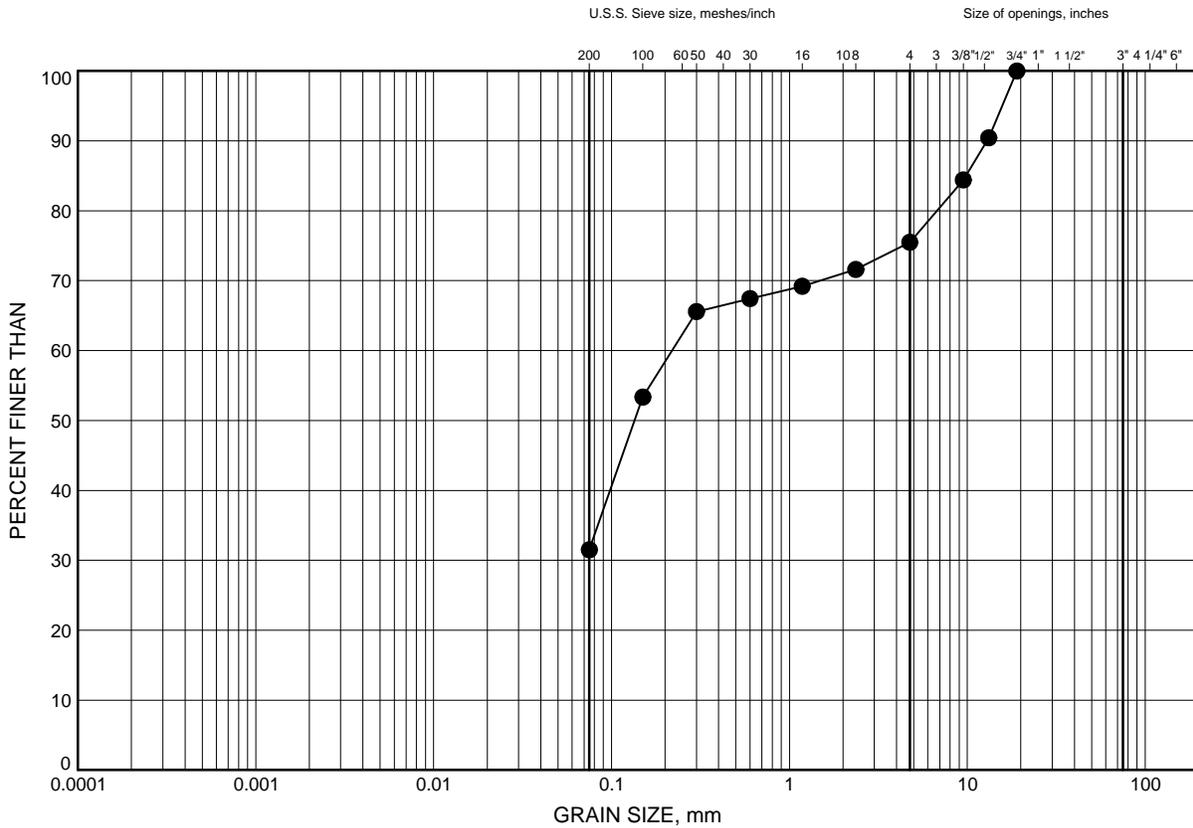


Prep'd .. AN ..
Chkd. .. AMP ..

Blanche River Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B8

Gravelly SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-02	34.52	237.12

Date .. October 2015 ..
 GWP# .. 5146-13-00 ..

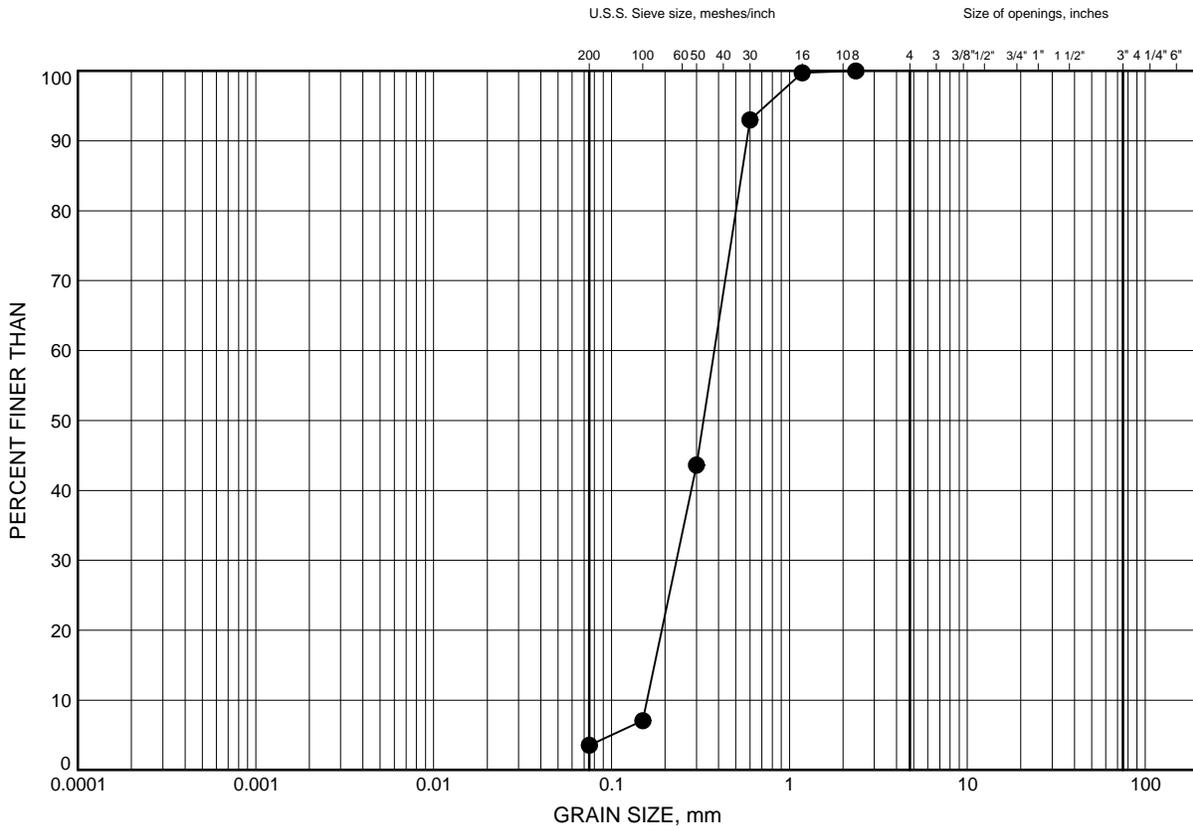


Prep'd .. AN ..
 Chkd. .. AMP ..

Blanche River Bridge
GRAIN SIZE DISTRIBUTION

FIGURE B9

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-03	34.13	237.51

Date .. October 2015 ..
GWP# .. 5146-13-00 ..



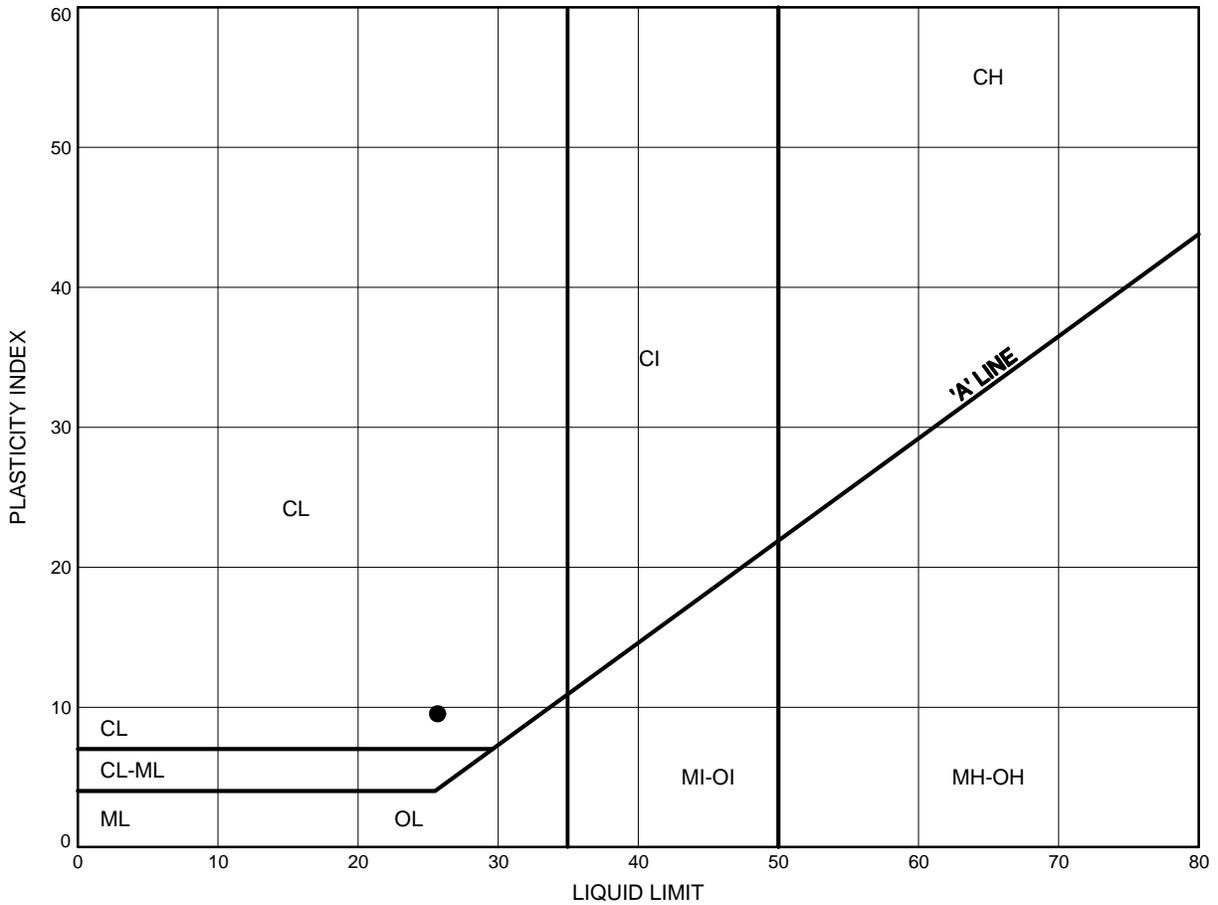
Prep'd .. AN ..
Chkd. .. AMP ..

GRAIN SIZE DISTRIBUTION - THURBER 19-5161-252.GPJ 10/5/15

Blanche River Bridge
ATTERBERG LIMITS TEST RESULTS

FIGURE B10

Silty CLAY and SAND



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	3.35	270.25

THURBALT 19-5161-252.GPJ 10/5/15

Date .. October 2015 ..
 GWP# .. 5146-13-00 ..

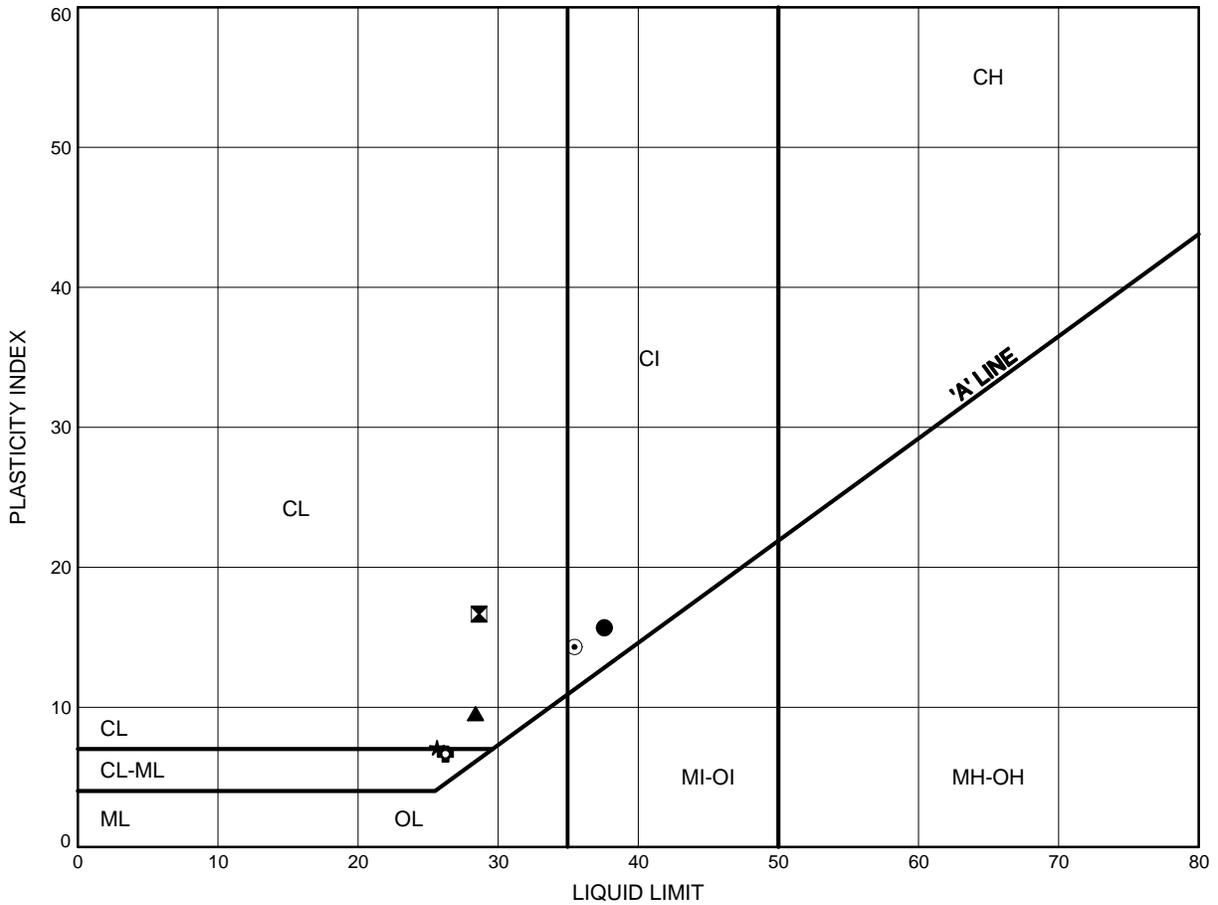


Prep'd .. AN ..
 Chkd. .. AMP ..

Blanche River Bridge
ATTERBERG LIMITS TEST RESULTS

FIGURE B11

Clayey SILT to Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	12.50	261.10
⊠	BR-01	17.07	256.53
▲	BR-01	23.16	250.44
★	BR-02	4.82	266.81
⊙	BR-02	16.25	255.38
⊕	BR-03	2.87	268.76

THURBALT 19-5161-252.GPJ 10/5/15

Date .. October 2015 ..
 GWP# .. 5146-13-00 ..

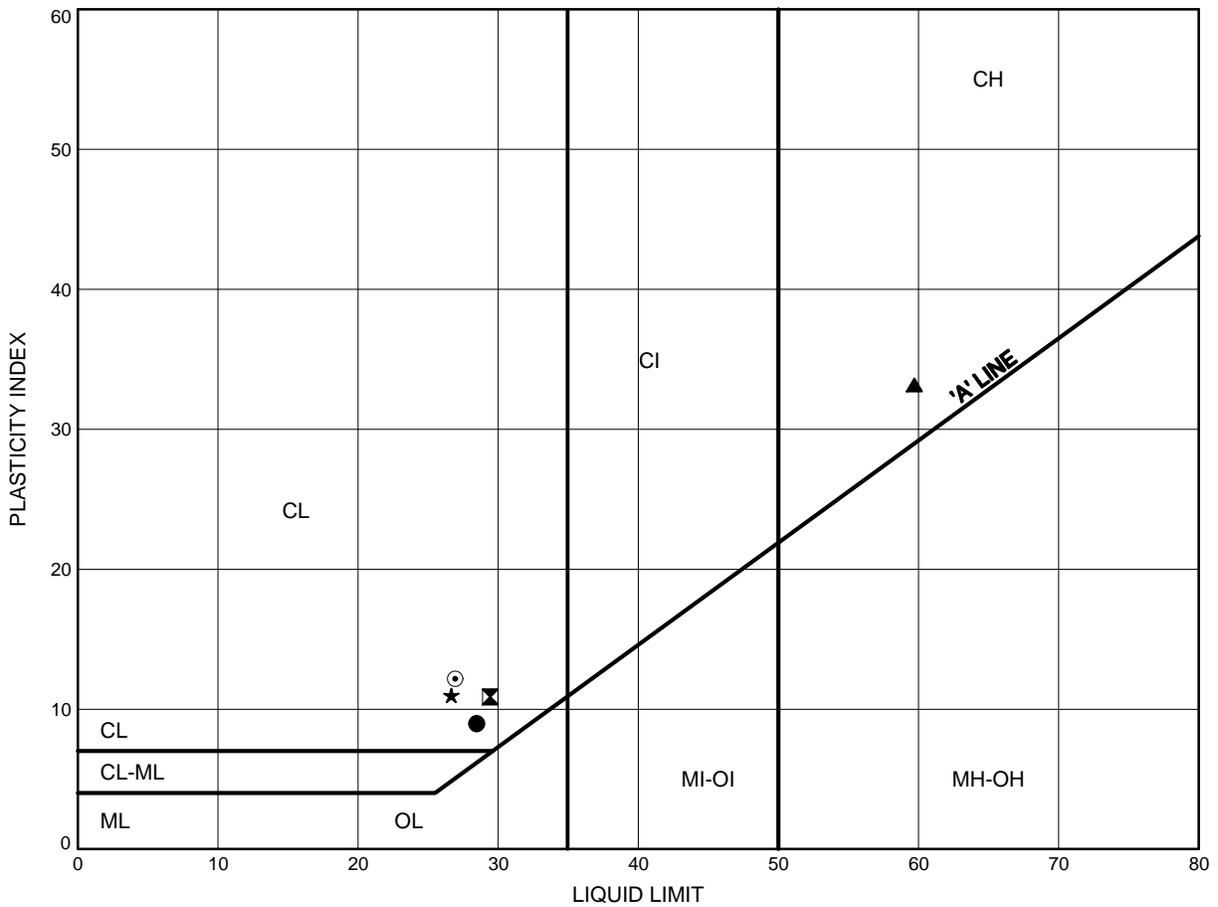


Prep'd .. AN ..
 Chkd. .. AMP ..

Blanche River Bridge
ATTERBERG LIMITS TEST RESULTS

FIGURE B12

Clayey SILT to Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-03	5.16	266.48
⊠	BR-03	17.35	254.28
▲	BR-04	1.07	273.53
★	BR-04	7.92	266.68
⊙	BR-04	10.97	263.63

THURBALT 19-5161-252.GPJ 10/5/15

Date ..October 2015.....
 GWP# 5146-13-00.....



Prep'd ..AN.....
 Chkd. ..AMP.....

**CLIENT NAME: THURBER ENGINEERING LTD
SUITE 103, 2010 WINSTON PARK DRIVE
OAKVILLE, ON L6H5R7
(905) 829-8666**

ATTENTION TO: Deanna Pizycki

PROJECT: Temiskaming Structures

AGAT WORK ORDER: 15T015408

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Sep 10, 2015

PAGES (INCLUDING COVER): 5

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

Certificate of Analysis

AGAT WORK ORDER: 15T015408

PROJECT: Temiskaming Structures

5835 COOPERS AVENUE
 MISSISSAUGA, ONTARIO
 CANADA L4Z 1Y2
 TEL (905)712-5100
 FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:

SAMPLED BY: DP

Corrosivity Package

DATE RECEIVED: 2015-09-04

DATE REPORTED: 2015-09-10

SAMPLE DESCRIPTION: BR-4 SS3 5'-7'

SAMPLE TYPE: Soil

DATE SAMPLED: 9/4/2015

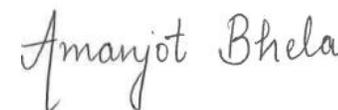
Parameter	Unit	G / S	RDL	6934351
Sulfide	%		0.01	0.02
Chloride (2:1)	µg/g		2	29
Sulphate (2:1)	µg/g		2	47
pH (2:1)	pH Units		NA	7.98
Electrical Conductivity (2:1)	mS/cm		0.005	0.222
Resistivity (2:1)	ohm.cm		1	4500
Redox Potential (2:1)	mV		5	234

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

6934351 * Sulphide analyses were performed at AGAT Laboratories Vancouver.

EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Certified By:



Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD
PROJECT: Temiskaming Structures
SAMPLING SITE:

AGAT WORK ORDER: 15T015408
ATTENTION TO: Deanna Pizycki
SAMPLED BY: DP

Soil Analysis																
RPT Date: Sep 10, 2015			DUPLICATE				Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Measured Value		Acceptable Limits			Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper	Lower		Upper	Lower		Upper	

Corrosivity Package

Sulfide	6934556		0.13	0.11	16.7%	< 0.01	97%	80%	120%							
Chloride (2:1)	6934351	6934351	29	33	12.9%	< 2	98%	80%	120%	92%	80%	120%	99%	70%	130%	
Sulphate (2:1)	6934351	6934351	47	48	2.1%	< 2	99%	80%	120%	103%	80%	120%	94%	70%	130%	
pH (2:1)	6934351	6934351	7.98	8.06	1.0%	NA	101%	90%	110%	NA			NA			
Electrical Conductivity (2:1)	6934351	6934351	0.222	0.230	3.5%	< 0.005	93%	90%	110%	NA			NA			
Redox Potential (2:1)	6934351	6934351	234	240	2.5%	< 5	103%	70%	130%	NA			NA			

Comments: NA signifies Not Applicable.

Certified By: _____

Amanjot Bhela



Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 15T015408

PROJECT: Temiskaming Structures

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:

SAMPLED BY: DP

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulfide			GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE



Certificate of Analysis

CLIENT NAME: THURBER ENGINEERING LTD
 PROJECT: 19-5161-252
 SAMPLING SITE:

AGAT WORK ORDER: 15T004153
 ATTENTION TO: Deanna Pizycki
 SAMPLED BY:

Inorganic Chemistry (Water)							
SAMPLE TYPE: Water		SAMPLE ID: 6825041		DATE RECEIVED: Aug 06, 2015			
DATE SAMPLED: Jul 28, 2015				DATE REPORTED: Aug 13, 2015			
SAMPLE DESCRIPTION: Blanche River							
PARAMETER	UNIT	RESULT	G / S	RDL	DATE ANALYZED	INITIAL	DATE PREPARED
pH	pH Units	7.44		NA	Aug 10, 2015	BP	Aug 10, 2015
Langelier Index		-0.85			Aug 11, 2015	SYS	Aug 11, 2015
Total Dissolved Solids	mg/L	76		20		AP	Aug 10, 2015
Alkalinity (as CaCO3)	mg/L	50		5	Aug 10, 2015	BP	Aug 10, 2015
Total Hardness (as CaCO3)	mg/L	59.7		0.5	Aug 11, 2015	SYS	Aug 11, 2015
Chloride	mg/L	13.4		0.10	Aug 07, 2015	JC	Aug 07, 2015
Sulphate	mg/L	11.8		0.10	Aug 07, 2015	JC	Aug 07, 2015
Sulphide	mg/L	<0.05		0.05	Aug 11, 2015	SN	Aug 11, 2015
Resistivity	ohms.cm	5880			Aug 10, 2015	SYS	Aug 10, 2015
Redox Potential	mV	308		5	Aug 12, 2015	BG	Aug 12, 2015

COMMENTS:

RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By: _____

Appendix C

Site Photographs



Photograph 1 – South Elevation, looking southeast



Photograph 2 – North Elevation, looking northwest



Photograph 3 – East Pier



Photograph 4 – West Pier



Photograph 5 –West Gabion Basket at West Abutment



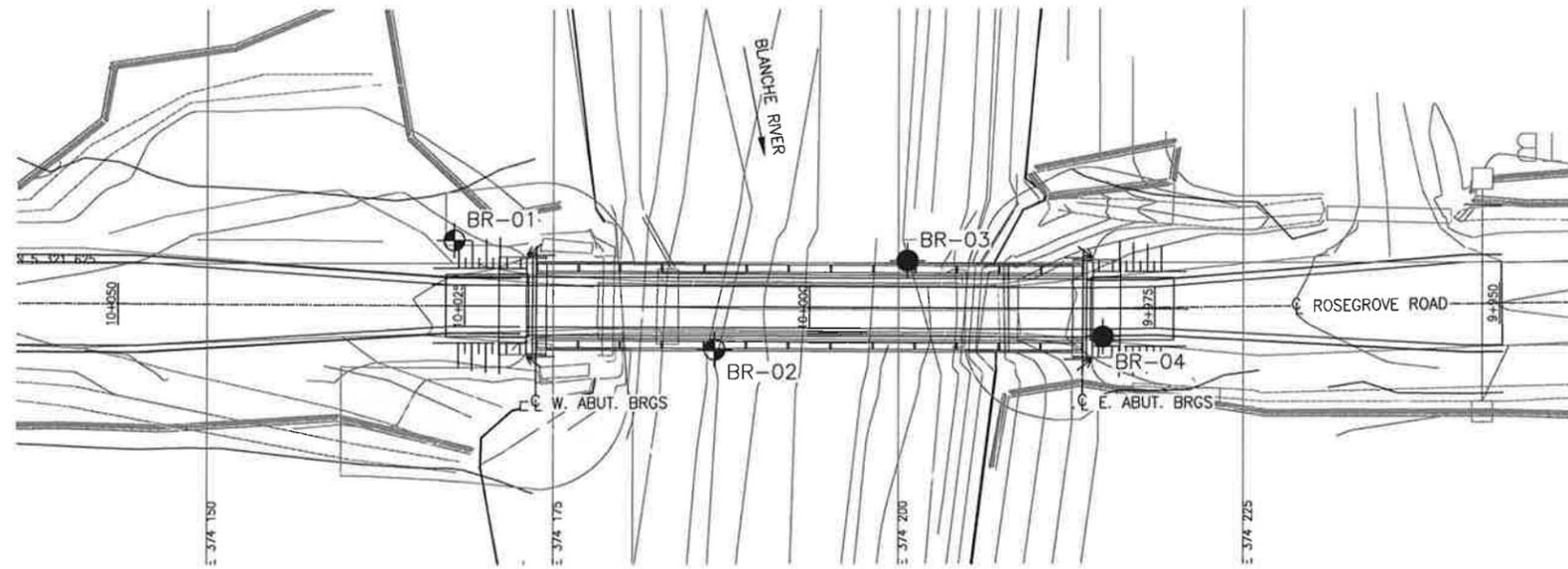
Photograph 6 – East Abutment/Timber Crib



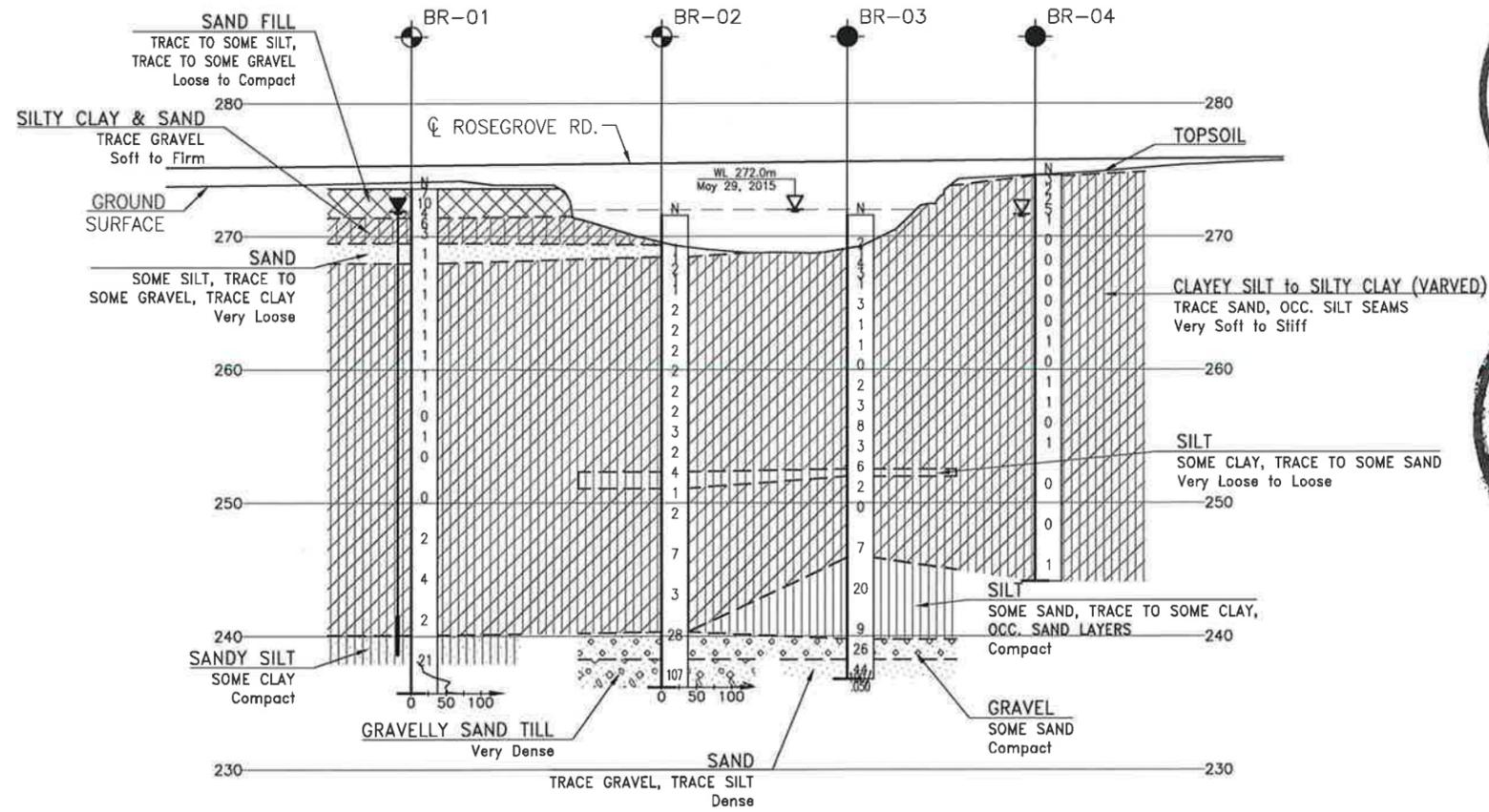
Photograph 7 – West approach looking east

Appendix D
Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION, ONTARIO



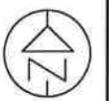
PLAN
SCALE 1:500



PROFILE ALONG ϕ ROSEGROVE ROAD
SCALE 1:500

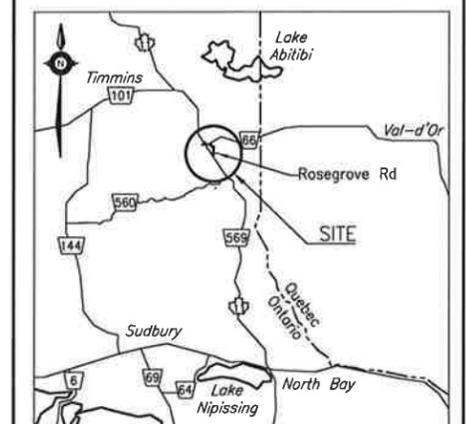
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 5146-13-00



BLANCHE RIVER
BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



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
BR-01	273.6	5 321 626.6	374 167.8
BR-02	271.6	5 321 618.7	374 186.7
BR-03	270.9	5 321 625.1	374 200.6
BR-04	274.6	5 321 619.6	374 214.8

-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. 42A-105



REVISIONS	DATE	BY	DESCRIPTION

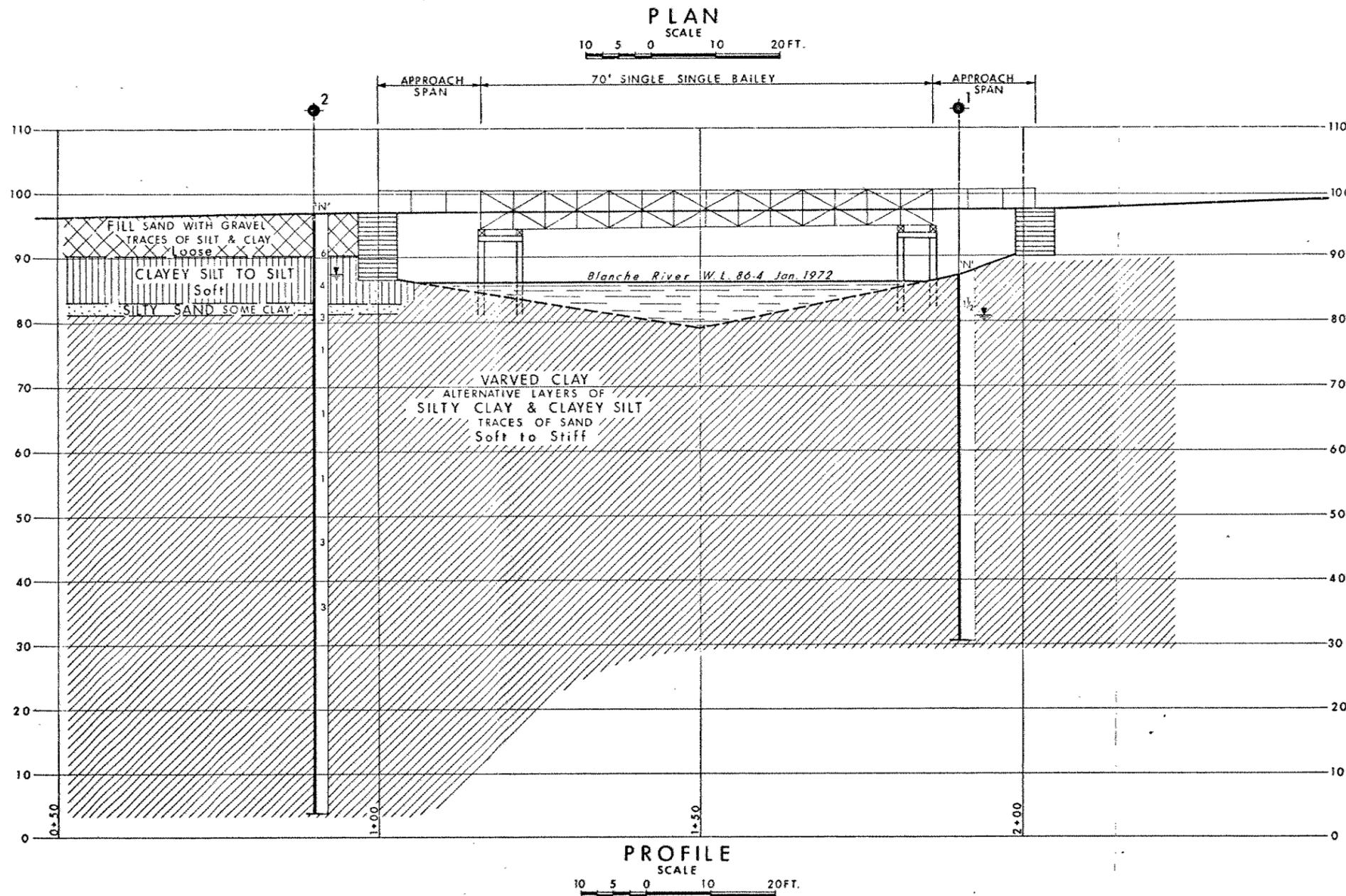
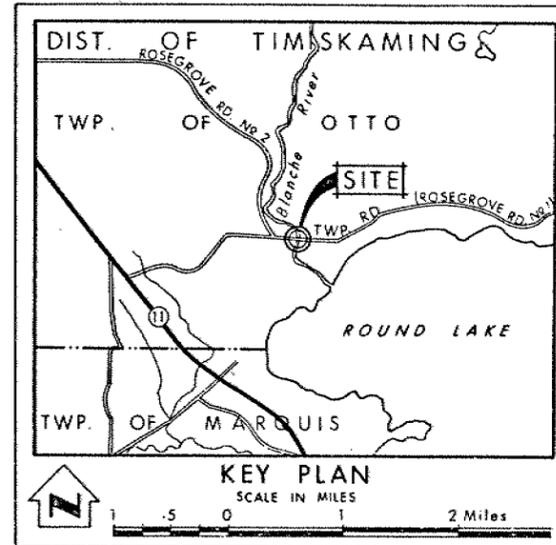
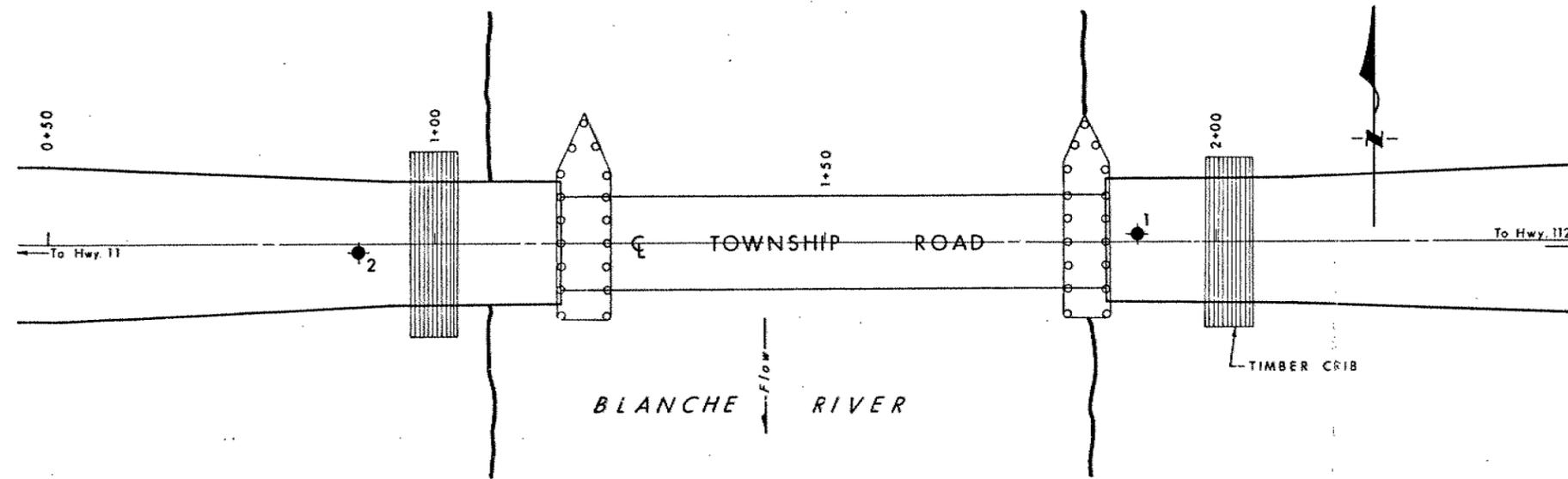
DESIGN	CHK	MEF	CODE	LOAD	DATE	APR 2016
DJP	MFA	CHK	DJP	SITE 47-085	STRUCT	DWG 1

FILENAME: H:\Projects\10\5146-13-00\252-Plan&Profile\BlancheRiverBridge.dwg
PLOTDATE: 4/16/2016 2:26 PM

Appendix E

Factual Data from 1972 Foundation Investigation Report

Geocres No.: 42A-23



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation, Jan. 1972		

NO.	ELEVATION	STATION	OFFSET
1	87.2	1+90	1' LT.
2	97.1	0+90	1' RT.

— NOTE —
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

BLANCHE RIVER

HIGHWAY NO. TOWNSHIP ROAD DIST. NO. 14
DIST. OF TIMISKAMING
TWP. OTTO LOT 5 CON. I & II

BORE HOLE LOCATIONS & SOIL STRATA

SUBWD P. P.	CHECKED	W.P. NO.	DRAWING NO.
DRAWN	CHECKED	JOB NO. 72-11008(R)	72-11008A
DATE April 4, 1972	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	CONT. NO.		

PRINCIPAL FOUNDATION ENGINEER

JOB 72-11008 (R) LOCATION Sta. 1 + 90 o/s 1' Lt.

ORIGINATED BY FP

W.P. M11 BORING DATE Jan. 12, 1972

COMPILED BY FP

DATUM Temporary BOREHOLE TYPE Cont. Flight Auger

CHECKED BY *SL*

SOIL PROFILE		STRAT. PLT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w _L PLASTIC LIMIT — w _P WATER CONTENT — w			BULK DENSITY Y P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS/FOOT		1000	2000	w _P	w	w _L				
87.2	Ground Level														
0.0	Varved Clay alternate layers of silty clay and clayey silt trace of sand Soft to Firm.		1	SS	1 1/2										
80														0 1 76 23 807	
70															108
60															112.5
50													107.5	0 1 57 42	
40														107	
30.7														112	
56.5	End of Borehole														

20
15 — 5 % STRAIN AT FAILURE
10

JOB 72-11008 (R)

LOCATION Sta. 0 + 90 o/s 1' Rt.

ORIGINATED BY PP

W.P. Nil

BORING DATE Jan. 12, 1972

COMPILED BY PP

DATUM Temporary

BOREHOLE TYPE Cont. Flight Auger

CHECKED BY *[Signature]*

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
						1000	2000	15	30	45			
97.1	Ground Level												
0.0	Sand with gravel traces of silt & clay.												
90.1	Loose (Fill)		1	SS	6								32 64 (4)
7.0	Clayey silt to silt		2	SS	4								87.4
83.1	Soft						+ 3.2						
81.3	Silty sand, some clay		3	SS	3		+ 8.0						0 65 25 10
15.8	Silty Clay		4	SS	1		+ 9.8						
	and												
	Clayey Silt		5	SS	1		+ 7.0						
	Traces of Sand												
	Firm to Stiff		6	SS	1		+ 6.0						
	(Varved)												
			7	SS	3		+ 5.3						
			8	SS	3		+ 3.0						0 2 61 37
h.l.													
93.0	End of Borehole												

20
15-5 % STRAIN AT FAILURE
10