



**THURBER** ENGINEERING LTD.



**FOUNDATION INVESTIGATION REPORT  
BLANCHE RIVER BRIDGE REPLACEMENT  
HIGHWAY 569  
NEW LISKEARD DISTRICT, ONTARIO  
G.W.P. 5163-13-00, SITE NO. 47-038**

**GEOCRES No. 31M-120**

**Report**

to

**WSP**

Date: June 9, 2017  
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**FOUNDATION INVESTIGATION REPORT  
BLANCHE RIVER BRIDGE REPLACEMENT  
HIGHWAY 569  
NEW LISKEARD DISTRICT, ONTARIO  
G.W.P 5163-13-00, SITE NO. 47-038**

**GEOGRES No. 31M-120**

**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 Highway 569, in the District of New Liskeard, 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-0019.

**2. SITE DESCRIPTION**

The Blanche River Bridge is located on Highway 569, approximately 10.9 km east of Highway 11. Originally built in 1923 and rehabilitated in 1992, the existing bridge is a three-span structure with a total length of approximately 92.5 m and a deck width of 5.4 m. The middle span is supported on a 64 m long arched steel truss.

Blanche River flows easterly to southeasterly at the bridge site. The land surrounding the site has a generally flat to gently undulating terrain and is typically used for agricultural purposes. Residential houses exist sporadically to the north and south of the site.

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

The site lies within the physiographical area of Cobalt Embayment. Surficial geology at the site is featured by glacio-lacustrine silts and clays and swamp deposits consisting of peat, muck and marl. The bedrock consists typically of Ordovician sedimentary rocks of Liskeard Group.

### 3. INVESTIGATION PROCEDURES

The field investigation and testing was carried out between November 18 and 27, 2015. A total of four boreholes, identified as BR-01 to BR-04, were drilled in conjunction with Standard Penetration Testing (SPT) to depths of 34.1 to 52.4 m (Elev. 147.0 to 127.2) from the ground surface or river bed. A Dynamic Cone Penetration Test (DCPT) was carried out below the drilled portion of BR-02 to a depth of 45.4 m below the water surface (Elev. 133.3). BR-01 and BR-04 were drilled on the land near the proposed south and north abutments, respectively. BR-02 and BR-03 were drilled from a barge in the river near the proposed south and north piers, respectively.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing included in Appendix D. Completion details of the piezometer and boreholes are summarized in Table 3.1.

**Table 3.1 – Borehole Completion Details**

Foundation Element	Borehole	Piezometer Installation		Completion Details
		Screen Depth / Elevation	Stratum	
South Abutment	BR-01	10.7 – 12.2 / 175.1 – 173.6	Silty Clay	Grout from 52.4 m to 15.2 m, bentonite holeplug to 12.2 m, sand to 10.4 m, and bentonite holeplug to surface.
South Pier	BR-02	None Installed		Grout from 37.5 m to riverbed.
North Pier	BR-03	None Installed		Grout from 51.8 m to riverbed.
North Abutment	BR-04	None Installed		Grout from 38.7 m to 2.1 m and bentonite holeplug to surface.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling operations. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by MMM Group Limited.

A track-mounted D-25 drill rig was used to advance all four boreholes in the overburden using NW casing/wash boring techniques. Boreholes BR-02 and BR-03 were advanced from the river water surface on a barge. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Field vane shear testing (VST)

was carried out at selected depths to measure the undrained shear strength of the silty clay. A total of six (6) undisturbed silty clay samples were collected using Shelby Tube samplers.

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 Boreholes BR-01 and BR-04 were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling were not representative of site conditions as water was used to assist drilling during wash-boring operations. A standpipe piezometer was installed in Borehole BR-01 to monitor the groundwater level after drilling. All boreholes were backfilled in general accordance with MOE Regulation 903.

#### **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 Atterberg Limits tests. One undisturbed Shelby Tube sample was subjected to standard 24-hour incremental loading (IL) consolidation test as per ASTM D2435-04 Test Method A. 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.

#### **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 must be recognized that soil conditions may vary between and beyond the borehole locations.

The soil stratigraphy encountered below the existing embankment fill generally comprises a thick deposit of grey varved silty clay underlain by clayey silt to silt. More detailed descriptions of the individual strata are presented below.

##### **5.1 Topsoil**

Topsoil was encountered in Boreholes BR-01 and BR-04 drilled near the existing abutments. The topsoil thickness was approximately 50 mm in both boreholes. Topsoil thickness may vary beyond

borehole locations and in other areas of the site. This limited data should not be used for estimating topsoil quantity.

## 5.2 Embankment Fill

Sand to gravelly sand fill was encountered below the topsoil in Boreholes BR-01 and BR-04. Silty clay fill was encountered below the gravelly sand fill in BR-04. The fill thickness ranged between 1.4 and 2.4 m with the lower boundaries at Elev. 184.4 and 183.3, respectively.

SPT-N values recorded in the cohesionless fill ranged from 4 to 10 blows per 0.3 m of penetration, indicating a loose relative density. One SPT-N value obtained in the silty clay fill was 4 blows per 0.3 m of penetration indicating a firm consistency. Moisture contents ranged from 6 to 15%.

The results of two gradation analyses performed on the sand to gravelly sand fill samples are provided on the Record of Borehole sheets in Appendix A and plotted in Figure B1 of Appendix B. The results are summarized below.

Particle Size	Percentage (%)
Gravel	1 to 33
Sand	59 to 95
Silt & Clay	4 to 8

## 5.3 Silty Clay

A thick deposit of grey varved silty clay was encountered below the fill in Boreholes BR-01 and BR-04 and from the riverbed in Boreholes BR-02 and BR-03. The water depth during drilling was about 3.1 m and 4.6 m at BR-02 and BR-03, respectively. BR-02 (drilled portion) and BR-04 were terminated within the silty clay layer at a depth of 34.1 m below the riverbed and 38.7 m below the ground surface or Elev. 141.5 and 147.0, respectively. A Dynamic Cone Penetration Test (DCPT) was carried out in BR-02 and terminated at a depth of 8.2 m below the base of the drilled portion or Elev. 133.3. The thickness of the silty clay layer fully penetrated in BR-01 and BR-03 ranged between 47.1 and 40.8 m with the lower boundary at Elev. 137.3 and 133.3, respectively.

SPT-N values recorded in the silty clay ranged from 0 to 7 blows per 0.3 m of penetration. Field vane shear tests measured undrained shear strengths ranging typically from 35 to 60 kPa. The field test data indicates that the silty clay has a very soft to stiff consistency.

The results of the Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figures B7 to B10 of Appendix B. The results of the Atterberg Limits testing indicated that the silty clay has plastic limits ranging

from 17 to 26% and liquid limits ranging from 26 to 59%, yielding plasticity indices ranging from 9 to 37%. Moisture contents of the silty clay ranged from 24 to 62%.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figures B2 to B5 of Appendix B. The results for the typical deposit and one sample immediately beneath the embankment fill are summarized below.

Particle Size	Percentage (%)	
	Typical	Immediately Below Fill
Gravel	0	0
Sand	0	25
Silt	20 to 64	50
Clay	36 to 80	25

One incremental loading (IL) consolidation test was carried out on an undisturbed silty clay sample collected using thin-wall Shelby Tube sampler. The test results are included in the Appendix B and summarized below.

BH No.	Sample Depth (m)	Moisture Content $w_n$ (%)	Initial Void Ratio $e_o$	In-situ Vertical Stress $\sigma_{vo}'$ (kPa)	Pre-consolidation Pressure $P'_c$ (kPa)	Compression Index $C_c$	Recompression Index $C_r$
BR-1	4.6 – 5.2	52.4	1.391	50	135	0.57	0.039

#### 5.4 Clayey Silt to Silt

A layer of grey clayey silt to silt was encountered below the silty clay in BR-01 and BR-03. The boreholes were terminated within the clayey silt to silt layer at a depth of 52.4 m below the ground surface or Elev. 133.4 and 46.9 m below the riverbed or Elev. 127.2, respectively.

SPT-N values recorded in the layer ranged from 4 to 8 blows per 0.3 m of penetration, indicating a firm to stiff consistency or loose relative density. Natural moisture contents of the deposit ranged from 25% to 33%.

The results of two gradation analyses performed on the clayey silt to silt samples are provided on the Record of Borehole sheets in Appendix A and plotted in Figure B6 of Appendix B. The results are summarized below.

Particle Size	Percentage (%)
Gravel	0
Sand	0
Silt	63 to 82
Clay	18 to 37

The results of one Atterberg Limits test conducted on a clayey silt sample is provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B11 of Appendix B. The test results indicated that the soil has a plastic limit of 18% and a liquid limit of 26%, yielding a plasticity index of 8%.

## 5.5 Groundwater Conditions

Where possible, water levels were monitored in the open boreholes during drilling operations. Wash boring was used to advance all boreholes and therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater conditions. A standpipe piezometer was installed in Borehole BR-01 after completion of drilling. The water level measured in the piezometer and in open boreholes are presented in Table 5.1.

**Table 5.1 – Water Level Measurements**

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
BR-01	Nov. 26, 2015	2.0	183.8	In piezometer
	Nov. 27, 2015	1.4	184.4	
	Nov. 28, 2015	1.4	184.4	
BR-02	Nov. 18, 2015	-	178.7	Observed River Level
BR-03	Nov. 20, 2015	-	178.7	Observed River Level
BR-04	Nov. 27, 2015	2.1	183.6	In Open Borehole

The river level in the GA drawing was reported at Elev. 179.43 on May 22, 2015. The water levels recorded in the boreholes are short-term readings and seasonal fluctuations of the groundwater and river level are to be expected. The GA drawing indicates a 100-year flood level at Elev. 183.3.

## 6. MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by MMM Group Limited.

Thurber obtained utility clearances for the borehole locations prior to drilling.



Walker Drilling Limited of Utopia, Ontario supplied a track-mounted D-25 drill rig and a barge, and conducted the drilling, sampling and in-situ testing operations for the boreholes. The drilling operations were supervised by Mr. George Azzopardi of Thurber.

Overall supervision of the field program, interpretation of the data, and preparation of the report were carried out by Ms. Deanna Pizycki, E.I.T., and Mr. Keli Shi, P. Eng.

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

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## **Appendix A**

### **Record of Borehole Sheets**

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

### 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

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

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

NOTE: Hierarchy of Soil Strength Prediction

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



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

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT      Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

## EXPLANATION OF ROCK LOGGING TERMS


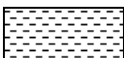



### ROCK WEATHERING CLASSIFICATION

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

### DISCONTINUITY SPACING

<b>Bedding</b>	<b>Bedding Plane Spacing</b>
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

<b>Rock Strength</b>	<b>Approximate Uniaxial Compressive Strength</b>		<b>Field Estimation of Hardness*</b>
	<b>(MPa)</b>	<b>(psi)</b>	
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





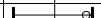

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

# RECORD OF BOREHOLE No BR-01

1 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 448.0 E 402 608.3 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.24 - 2015.11.26 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE				WATER CONTENT (%) w <sub>p</sub> w      w <sub>L</sub>				GR	SA	SI	CL
185.8	GROUND SURFACE							20	40	60	80	100							
0.0	<b>TOPSOIL:</b> (50mm)  <b>SAND</b> , trace silt, trace gravel Loose Brown Moist (FILL)		1	SS	7									○					1    95    4 (SI+CL)
			2	SS	4									○					
184.4																			
1.4	Silty <b>CLAY</b> , occasional sand seams, varved Firm to Stiff Grey Wet		3	SS	7									○					
			4	SS	4														0    0    44    56
			5	SS	2										○				
			1	TW											○				0    0    28    72
			6	SS	2										○				
			7	SS	1											○			
			8	SS	1										○				0    0    20    80
											</								

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No BR-01

2 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 448.0 E 402 608.3 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.24 - 2015.11.26 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	Silty <b>CLAY</b> , occasional sand seams, varved Firm to Stiff Grey Wet		2	TW			175	4.0						
							174							
			9	SS	1		173							
							172	5.0						
			10	SS	2		171							
							170							
			11	SS	2		169	5.0						
							168							
			12	SS	2		167							
							166	4.0						

Continued Next Page

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

## METRIC

[illegible]

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



## METRIC

[illegible]

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

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 5/11/16

# RECORD OF BOREHOLE No BR-01

5 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 448.0 E 402 608.3 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.24 - 2015.11.26 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	Silty <b>CLAY</b> , varved Firm to Stiff Grey Wet		21	SS	4		145							0 0 32 68
							144	3.0						
							143							
							142							
			22	SS	4		141							
							140							
							139							
			23	SS	3		138							
							137							
137.3 48.5	<b>SILT</b> , some clay to clayey silt, occasional clay seams Loose Grey Wet						136							

Continued Next Page

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

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 5/11/16

# RECORD OF BOREHOLE No BR-01

6 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 448.0 E 402 608.3 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.24 - 2015.11.26 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	SILT, trace to some clay Loose Grey Wet		24	SS	6		135										
	Silty clay seam at 51.8m depth						134										
133.4			25	SS	8											0 0 63 37	
52.4	END OF BOREHOLE AT 52.4m. BOREHOLE OPEN TO 52.4m AND WATER LEVEL AT 0.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov26/2015 2.0 183.8 Nov27/2015 1.4 184.4 Nov28/2015 1.4 184.4																

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 3/22/17

## METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	<p>PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT</p> <p>w<sub>P</sub>                  w                  w<sub>L</sub></p>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
179.0	TOP OF BARGE						<p>20 40 60 80 100</p>	<p>20 40 60</p>				

[illegible]

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

# RECORD OF BOREHOLE No BR-02

2 OF 5

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 475.4 E 402 612.8 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.18 - 2015.11.19 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)				
	Continued From Previous Page													
	Silty <b>CLAY</b> , varved Very Soft to Stiff Grey Wet		7	SS	2		168							
			8	SS	1		167							
			9	SS	1		166	6.0						
			10	SS	2		164							
			11	SS	1		163	6.0						
			12	SS	1		161							
			13	SS	6		160	5.0						

Continued Next Page

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

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 5/11/16

# RECORD OF BOREHOLE No BR-02

3 OF 5

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 475.4 E 402 612.8 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.18 - 2015.11.19 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
Continued From Previous Page																	
	Silty <b>CLAY</b> , varved Very Soft Grey Wet																
			14	SS	3		158										
							157										
							156										
							155										
							154										
			15	SS	2		153										
							152										
							151										
			16	SS	4		150										

Continued Next Page

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

## METRIC

[illegible]

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

RECORD OF BOREHOLE No BR-02

5 OF 5

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 475.4 E 402 612.8 ORIGINATED BY GA  
HWY 569 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN  
DATUM Geodetic DATE 2015.11.18 - 2015.11.19 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
133.3	Continued From Previous Page																
45.7	END OF BOREHOLE AT 45.7m. BOREHOLE OPEN TO 45.7m AND WATER LEVEL IN CASING AT 0.3m. BOREHOLE BACKFILLED WITH GROUT TO SURFACE.																

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 5/11/16



# RECORD OF BOREHOLE No BR-03

1 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 520.3 E 402 610.0 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.20 - 2015.11.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
179.0	TOP OF BARGE													
0.0	DECK													
178.7														
0.3	WATER													
174.1	Bottom of river													
4.9	Silty CLAY, varved Very Soft to Stiff Grey Wet		1	SS	2									0 0 32 68
			2	SS	2									
			3	SS	2									
			1	TW										
			4	SS	2									
			5	SS	2									

Continued Next Page

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

# RECORD OF BOREHOLE No BR-03

2 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 520.3 E 402 610.0 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.20 - 2015.11.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT      NATURAL LIMIT      MOISTURE      CONTENT LIMIT      LIQUID      LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				GR	SA	SI	CL		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE												
	Continued From Previous Page																			
	Silty <b>CLAY</b> , varved Very Soft to Stiff Grey Wet		6	SS	2															
							168	3.0												
			7	SS	1		167													
							166													
			8	SS	1		165	5.0												
							164													
			9	SS	2											0	0	41	59	
							163													
			10	SS	1		162	4.0												
							161													
			11	SS	2		160													
			12	SS	2												0	0	33	67

Continued Next Page

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

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RECORD OF BOREHOLE No BR-03

3 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 520.3 E 402 610.0 ORIGINATED BY GA  
HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2015.11.20 - 2015.11.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page													
	Silty <b>CLAY</b> , varved Very Soft Grey Wet													
			13	SS	2									
			14	SS	2									
			15	SS	4									

Continued Next Page

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

## METRIC

[illegible]

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

ONTMT4S 19-5161-265B.GPJ 2015TEMPLATE(MTO).GDT 5/11/16

RECORD OF BOREHOLE No BR-03

5 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 520.3 E 402 610.0 ORIGINATED BY GA  
HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2015.11.20 - 2015.11.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
	Silty <b>CLAY</b> , varved Very Soft Grey Wet		19	SS	4		138							
							137	4.0 +						
							136							
			20	SS	4		135							
							134							
133.3							133							
45.7	<b>SILT</b> , some clay to clayey silt, occasional silty clay seams Loose Grey Wet		21	SS	4		132							
							131							
							130							

Continued Next Page

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

# RECORD OF BOREHOLE No BR-03

6 OF 6

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 520.3 E 402 610.0 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.20 - 2015.11.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
	Continued From Previous Page		22	SS	6												
	SILT, some clay, occasional silty clay seams Loose Grey Wet																
127.2			23	SS	8												
51.8	END OF BOREHOLE AT 51.8m. BOREHOLE OPEN TO 51.8m AND WATER LEVEL IN CASING AT 0.3m. BOREHOLE BACKFILLED WITH GROUT TO SURFACE.																

# RECORD OF BOREHOLE No BR-04

1 OF 4

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 551.0 E 402 605.2 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.26 - 2015.11.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							PLASTIC LIMIT    NATURAL MOISTURE CONTENT    LIQUID LIMIT w <sub>p</sub> w    w <sub>L</sub> WATER CONTENT (%)				
20	40	60	80	100	20			40	60	80	100	20	40		60	GR	SA	SI	CL
185.7	GROUND SURFACE					▽													
0.0	TOPSOIL: (50mm)																		
	Gravelly <b>SAND</b> , trace silt, occasional rootlets Compact to Loose Grey Moist (FILL)		1	SS	10														33   59   8 (SI+CL)
			2	SS	9														
184.2																			
1.5	Silty <b>CLAY</b> , sandy, trace gravel Firm Brown Wet (FILL)		3	SS	4														
183.3																			
2.4	Silty <b>CLAY</b> , occasional sand seams, varved Very Soft to Stiff Grey Wet		4	SS	4														
			5	SS	2														0   25   50   25
			6	SS	2														
			7	SS	6														
			1	TW															

Continued Next Page

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

# RECORD OF BOREHOLE No BR-04

2 OF 4

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 551.0 E 402 605.2 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.26 - 2015.11.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	20 40 60			
	Continued From Previous Page													
	Silty <b>CLAY</b> , occasional sand seams, varved Very Soft to Stiff Grey Wet		9	SS	2		175							
							174	5.0						
			10	SS	1		173							0 0 36 64
							172							
			2	TW			171	5.0						
							170							
			11	SS	1		169							
							168	5.0						
							167							
			12	SS	0		166							
			13	SS	1									

Continued Next Page

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



# RECORD OF BOREHOLE No BR-04

3 OF 4

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 551.0 E 402 605.2 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.26 - 2015.11.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page		14	SS	1									
	Silty <b>CLAY</b> , occasional sand seams, varved Very Soft to Stiff Grey Wet						165	5.0						
							164							
			15	SS	0		163							
							162	5.0						
							161							
							160							
			16	SS	0		159							
							158	4.0						
							157							
			17	SS	1		156							

Continued Next Page

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

# RECORD OF BOREHOLE No BR-04

4 OF 4

METRIC

W.P. 5163-13-00 LOCATION Blanche River Bridge N 5 288 551.0 E 402 605.2 ORIGINATED BY GA  
 HWY 569 BOREHOLE TYPE NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2015.11.26 - 2015.11.27 CHECKED BY AMP

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W <sub>P</sub>	W	W <sub>L</sub>			WATER CONTENT (%)	
	Continued From Previous Page							20	40	60	80	100						
	Silty <b>CLAY</b> , occasional sand seams, varved Very Soft to Stiff Grey Wet																	
					18	SS	2											

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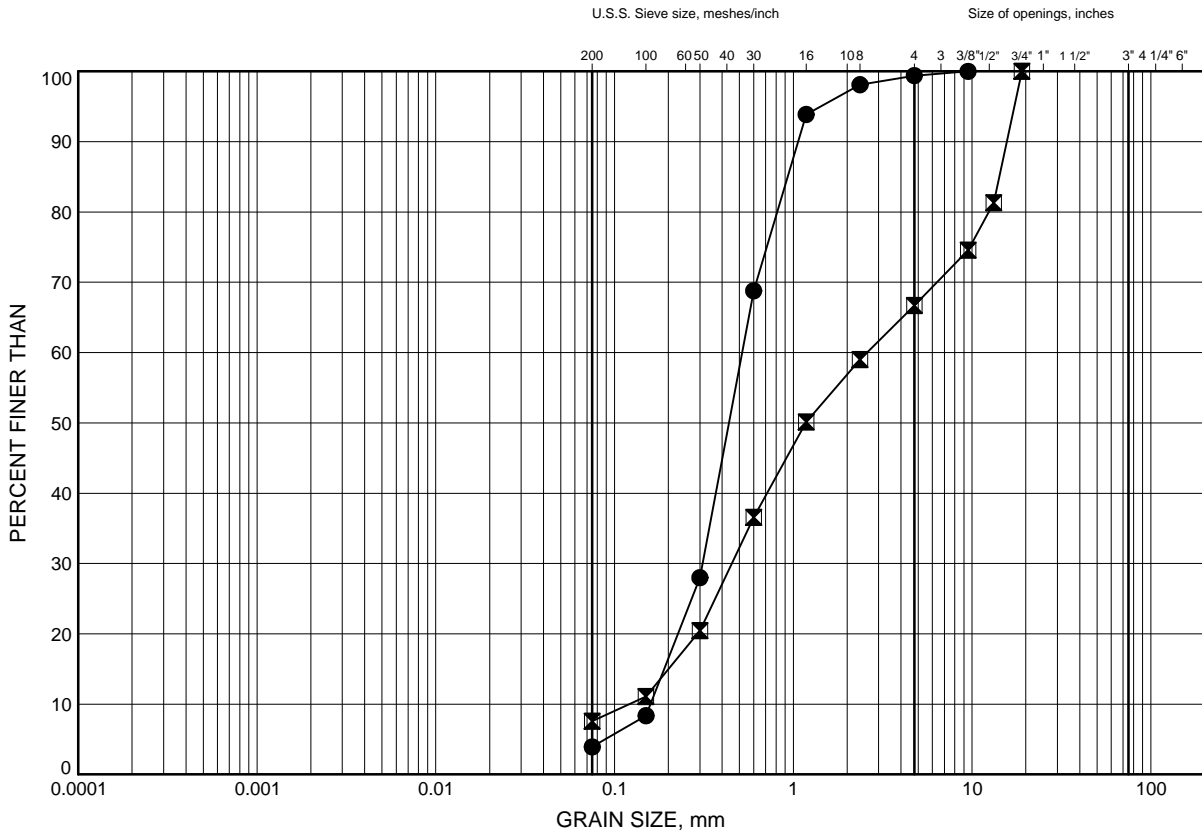
## **Appendix B**

### **Laboratory Test Results**

# Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND to Gravelly SAND FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	1.07	184.73
⊠	BR-04	0.30	185.40

Date December 2015  
W.P. 5163-13-00

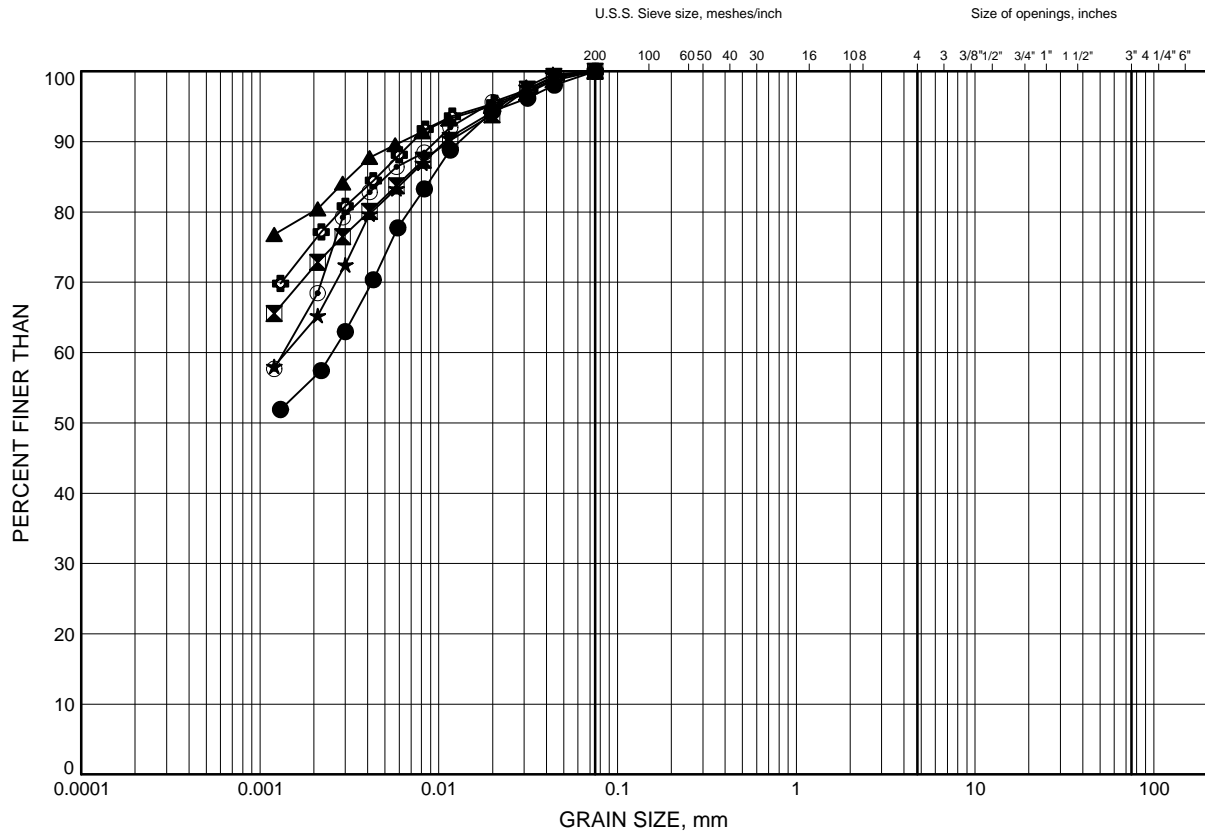


Prep'd AN  
Chkd. AMP

# Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B2

## 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	2.59	183.21
⊠	BR-01	4.88	180.92
▲	BR-01	9.45	176.35
★	BR-01	23.16	162.64
⊙	BR-01	41.45	144.35
⊕	BR-02	5.18	173.82

Date December 2015  
W.P. 5163-13-00

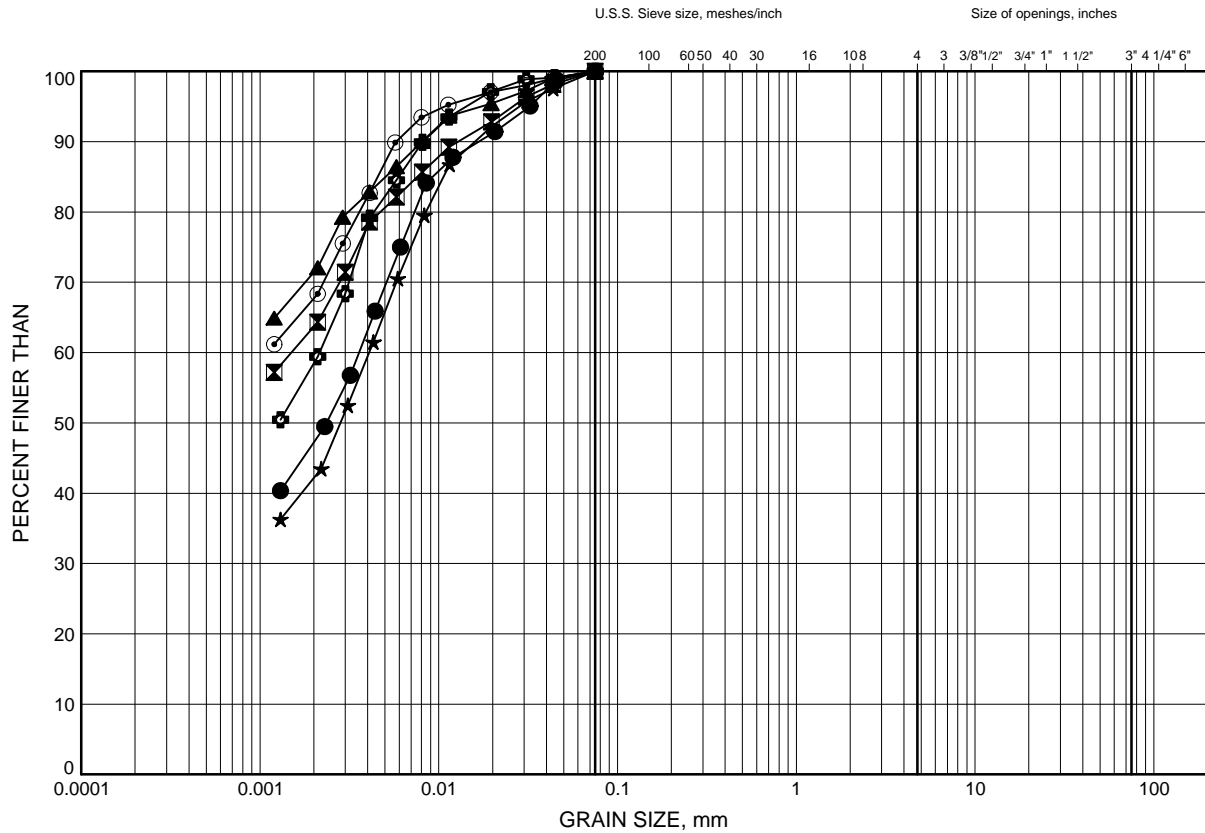


Prep'd AN  
Chkd. AMP

# Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3

## 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	8.84	170.16
⊠	BR-02	13.41	165.59
▲	BR-02	19.51	159.49
★	BR-02	36.27	142.73
⊙	BR-03	5.18	173.82
⊕	BR-03	14.33	164.67

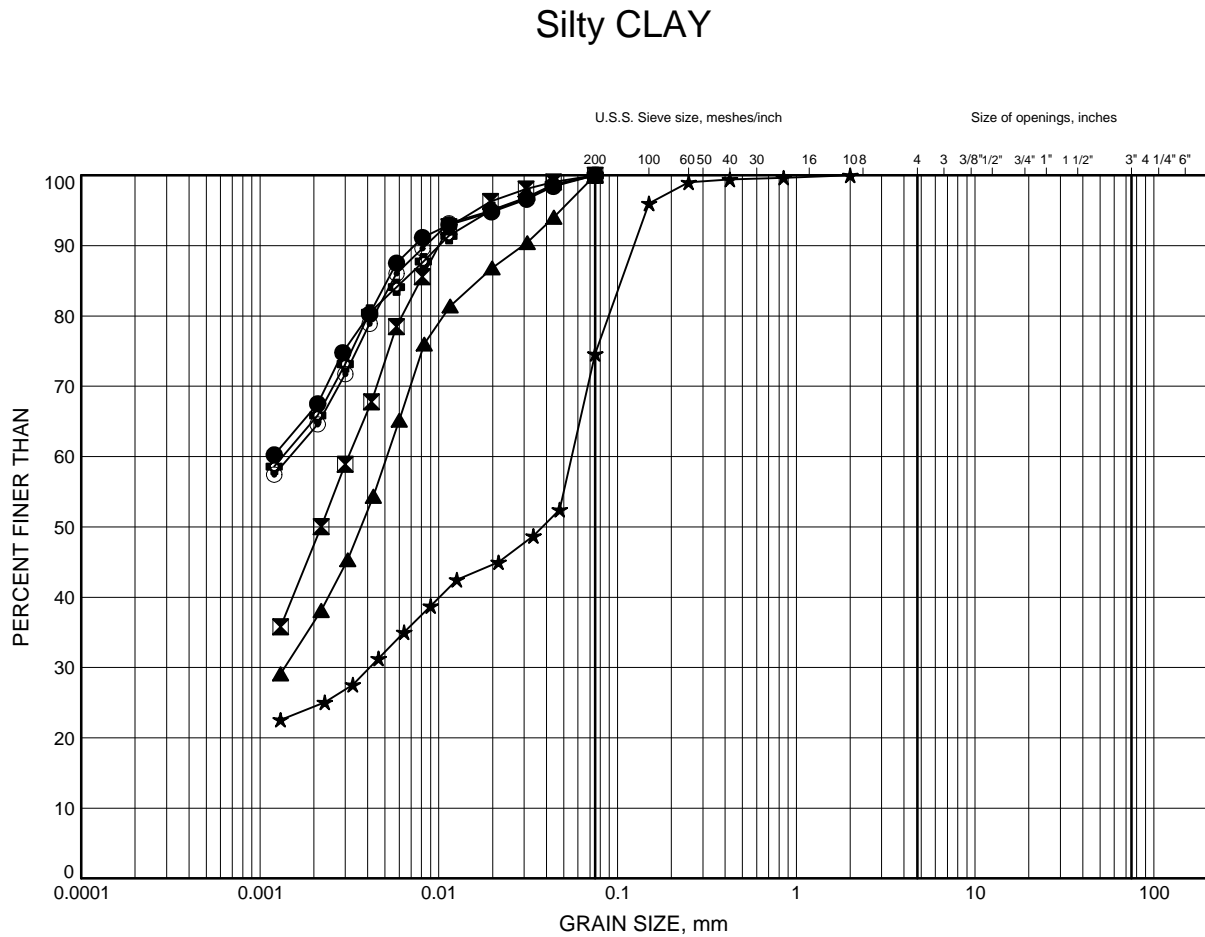
Date December 2015  
W.P. 5163-13-00



Prep'd AN  
Chkd. AMP

# Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B4



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-03	19.51	159.49
⊠	BR-03	37.80	141.20
▲	BR-03	43.89	135.11
★	BR-04	3.35	182.35
⊙	BR-04	12.50	173.20
⊕	BR-04	20.12	165.58

Date December 2015  
W.P. 5163-13-00

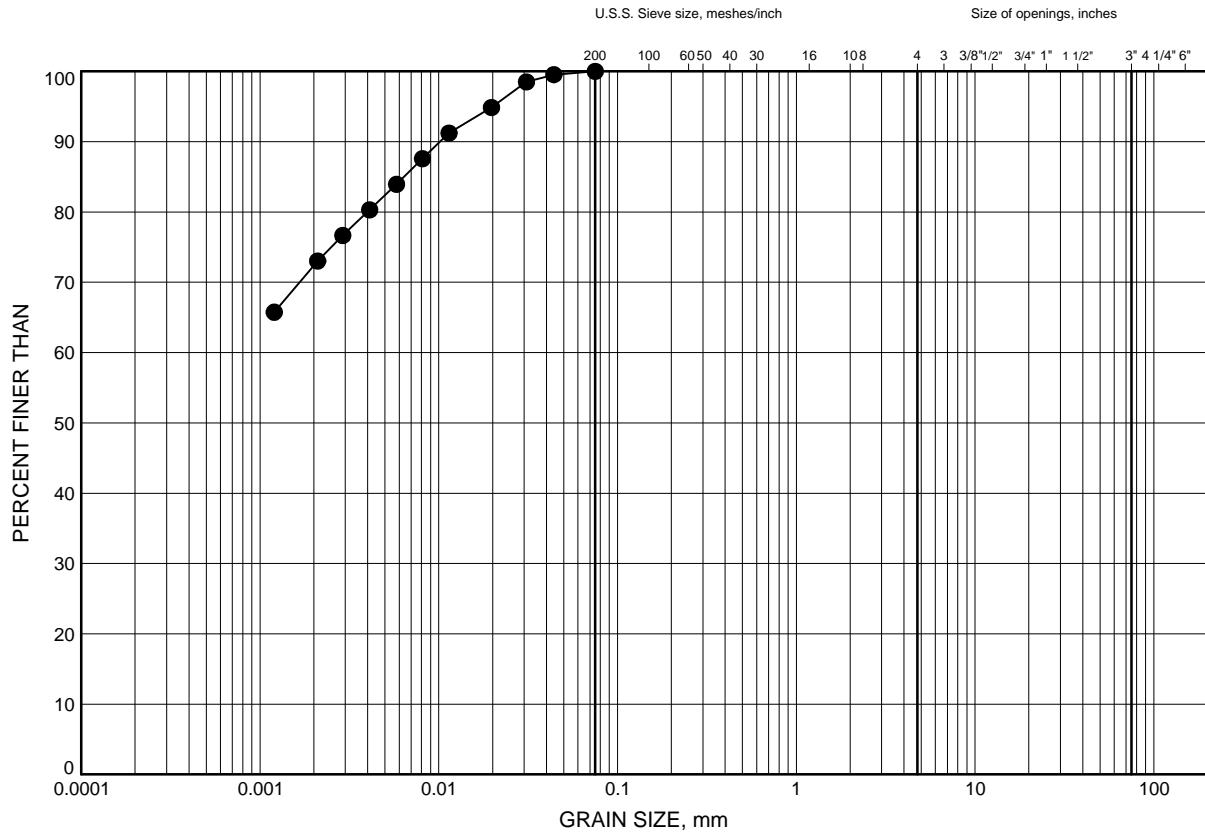


Prep'd AN  
Chkd. AMP

# Blanche River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B5

## 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	35.36	150.34

Date December 2015  
W.P. 5163-13-00



Prep'd AN  
Chkd. AMP

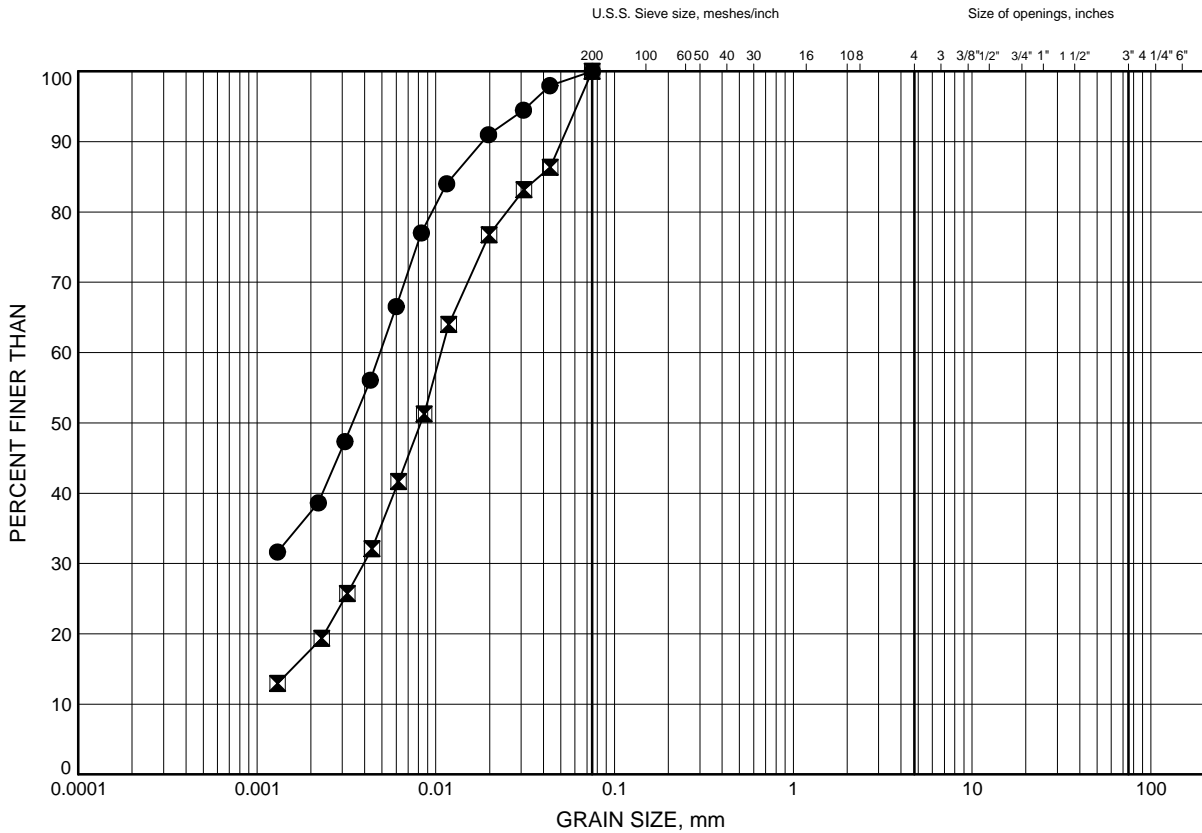


# Blanche River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE B6

### SILT to Clayey SILT



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	52.12	133.68
⊠	BR-03	49.99	129.01

Date December 2015  
W.P. 5163-13-00

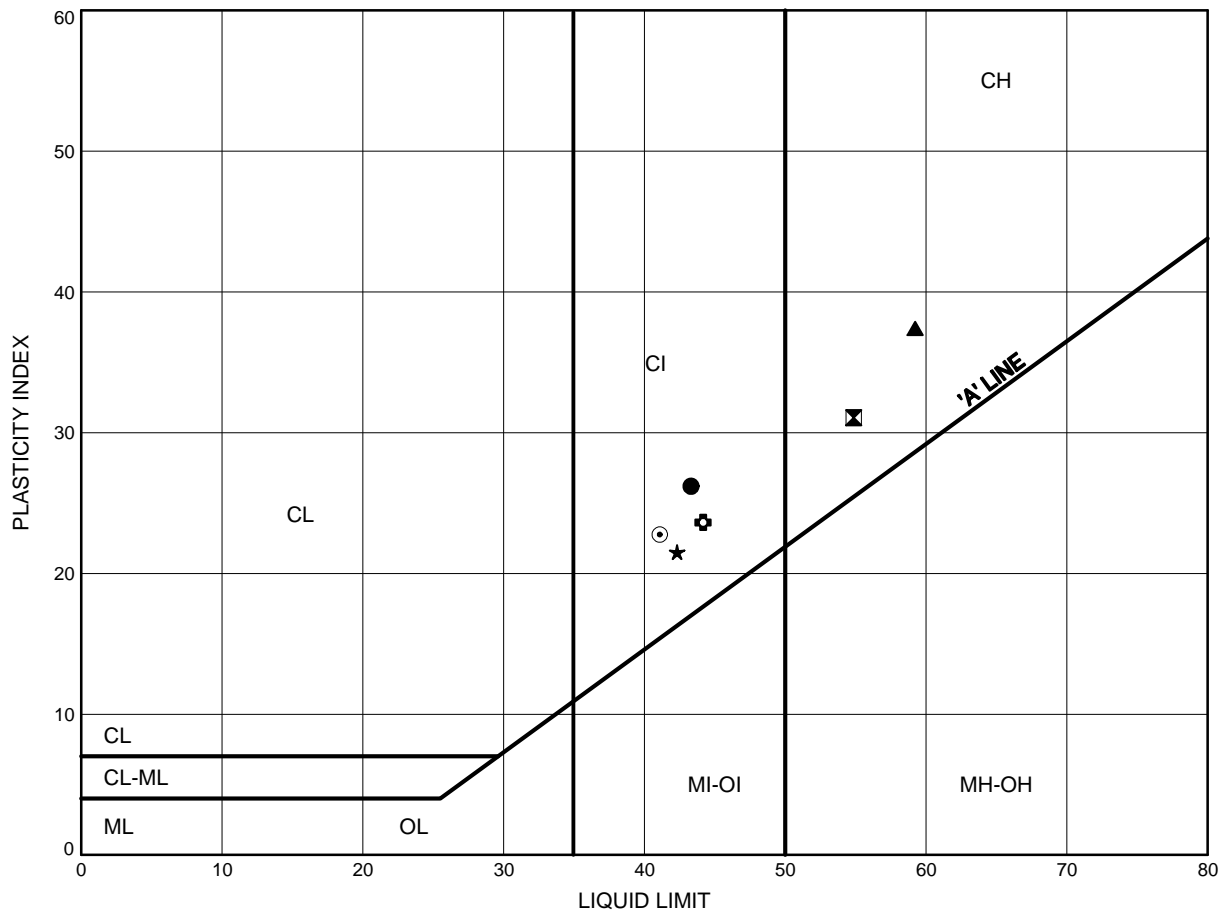


Prep'd AN  
Chkd. AMP

# Blanche River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE B7

Silty CLAY



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	2.59	183.21
⊠	BR-01	4.88	180.92
▲	BR-01	9.45	176.35
★	BR-01	23.16	162.64
⊙	BR-01	41.45	144.35
⊕	BR-02	5.18	173.82

Date December 2015  
W.P. 5163-13-00

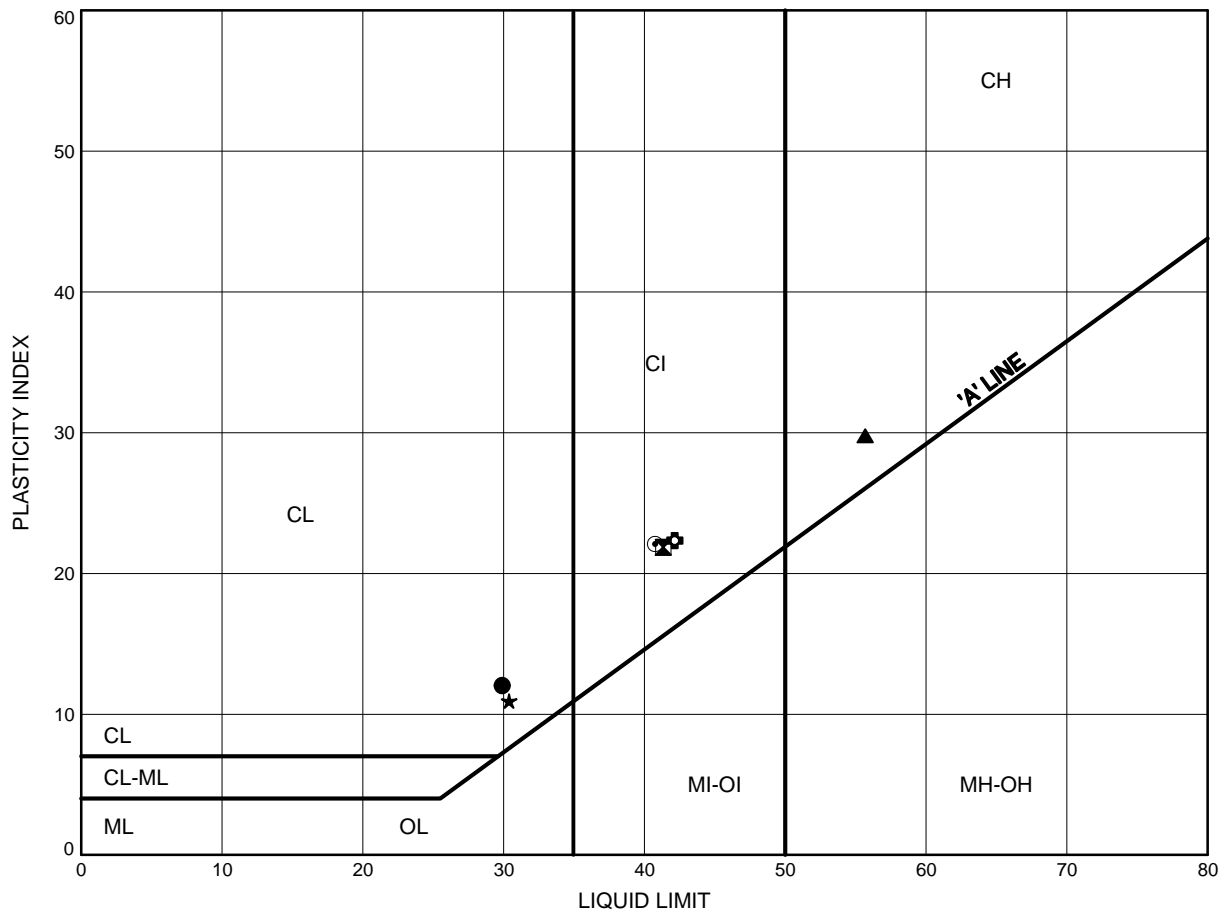


Prep'd AN  
Chkd. AMP

# Blanche River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE B8

Silty CLAY



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-02	8.84	170.16
⊠	BR-02	13.41	165.59
▲	BR-02	19.51	159.49
★	BR-02	36.27	142.73
⊙	BR-03	5.18	173.82
⊕	BR-03	14.33	164.67

Date December 2015  
W.P. 5163-13-00

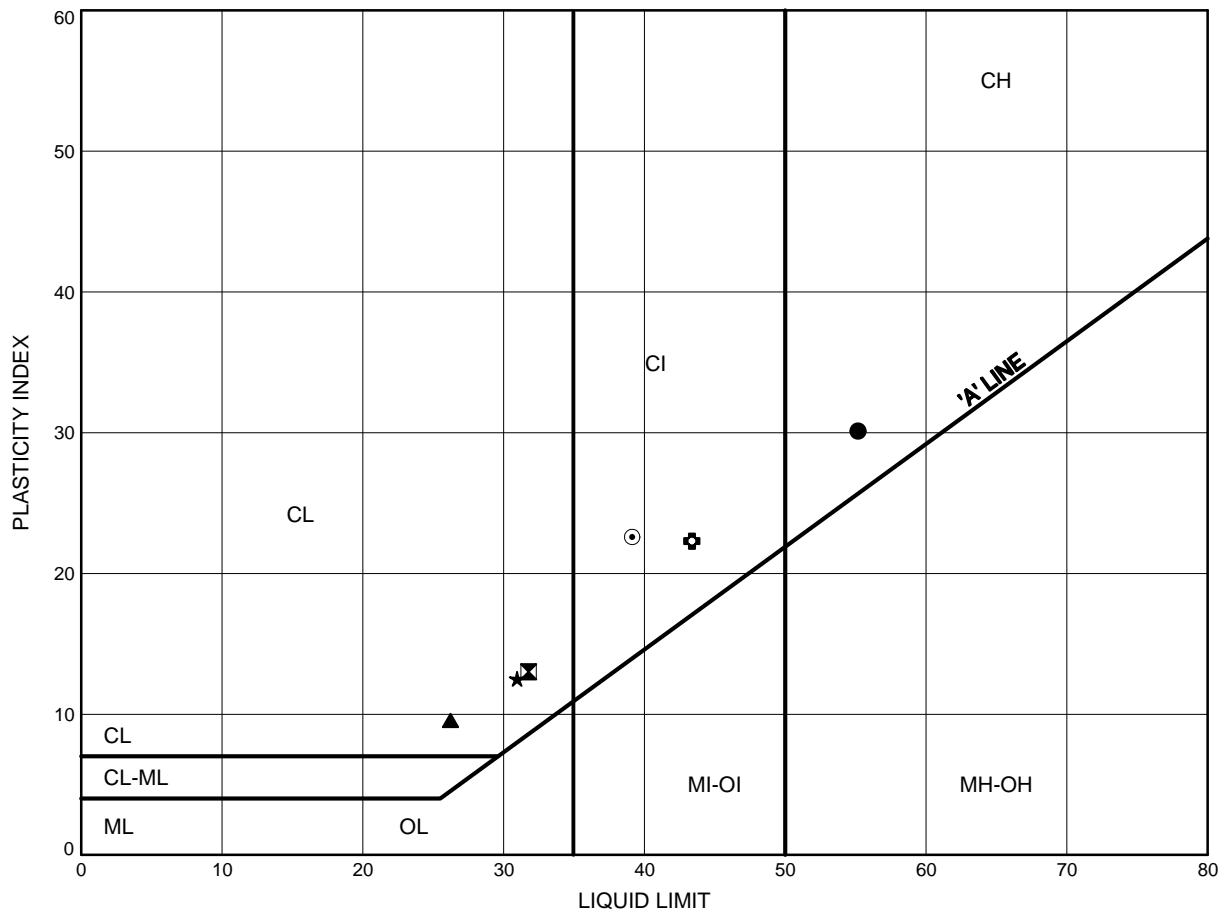


Prep'd AN  
Chkd. AMP

# Blanche River Bridge ATTERBERG LIMITS TEST RESULTS

FIGURE B9

Silty CLAY



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-03	19.51	159.49
⊠	BR-03	37.80	141.20
▲	BR-03	43.89	135.11
★	BR-04	3.35	182.35
⊙	BR-04	12.50	173.20
⊕	BR-04	20.12	165.58

Date December 2015  
W.P. 5163-13-00

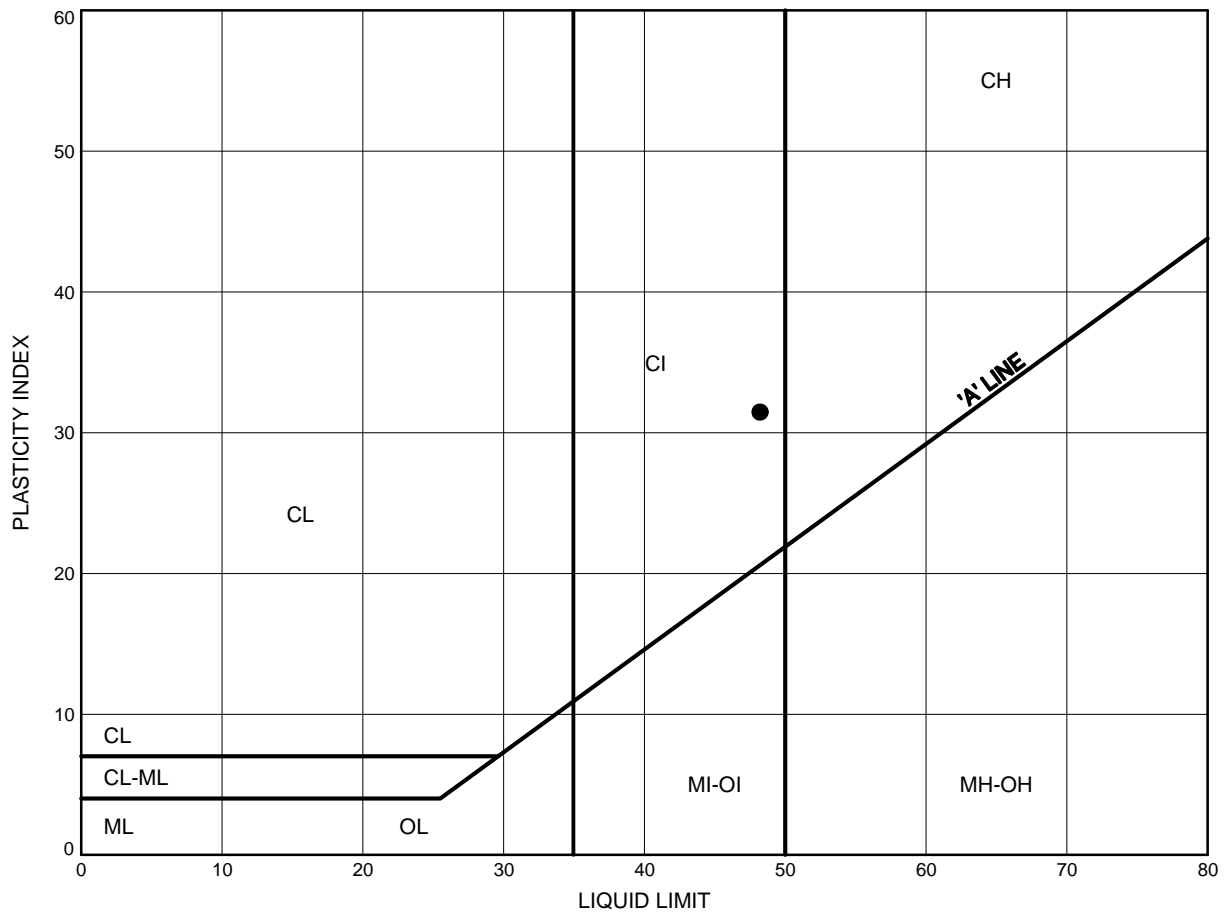


Prep'd AN  
Chkd. AMP

Blanche River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B10

Silty CLAY



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-04	35.36	150.34

Date December 2015  
 W.P. 5163-13-00

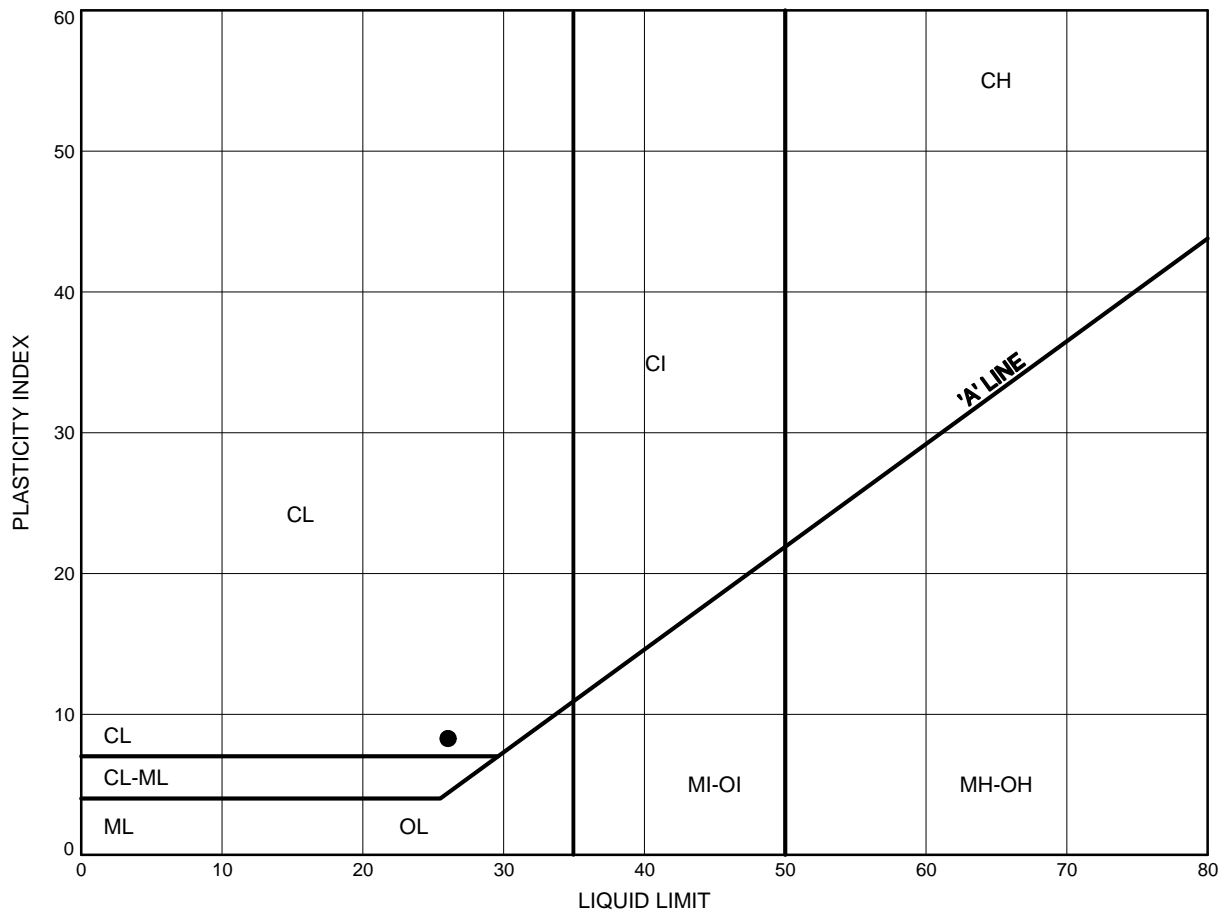


Prep'd AN  
 Chkd. AMP

Blanche River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B11

Clayey SILT



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BR-01	52.12	133.68

Date December 2015  
 W.P. 5163-13-00



Prep'd AN  
 Chkd. AMP

## Consolidation Test Report

CLIENT: **MMM Group Limited**

FILE NUMBER: **19-5161-251**

PROJECT: **Highway 569 Blanche River Bridge**

REPORT DATE: **4-Jan-2016**

TEST DATES: **December 09, 2015 - December 18, 2015**

SAMPLE: **BR-1-TW1 (15'-17')**  
**Silty Clay, varved, grey, 27% Silt and 73% Clay, LL=54.9%, PL=23.8%.**

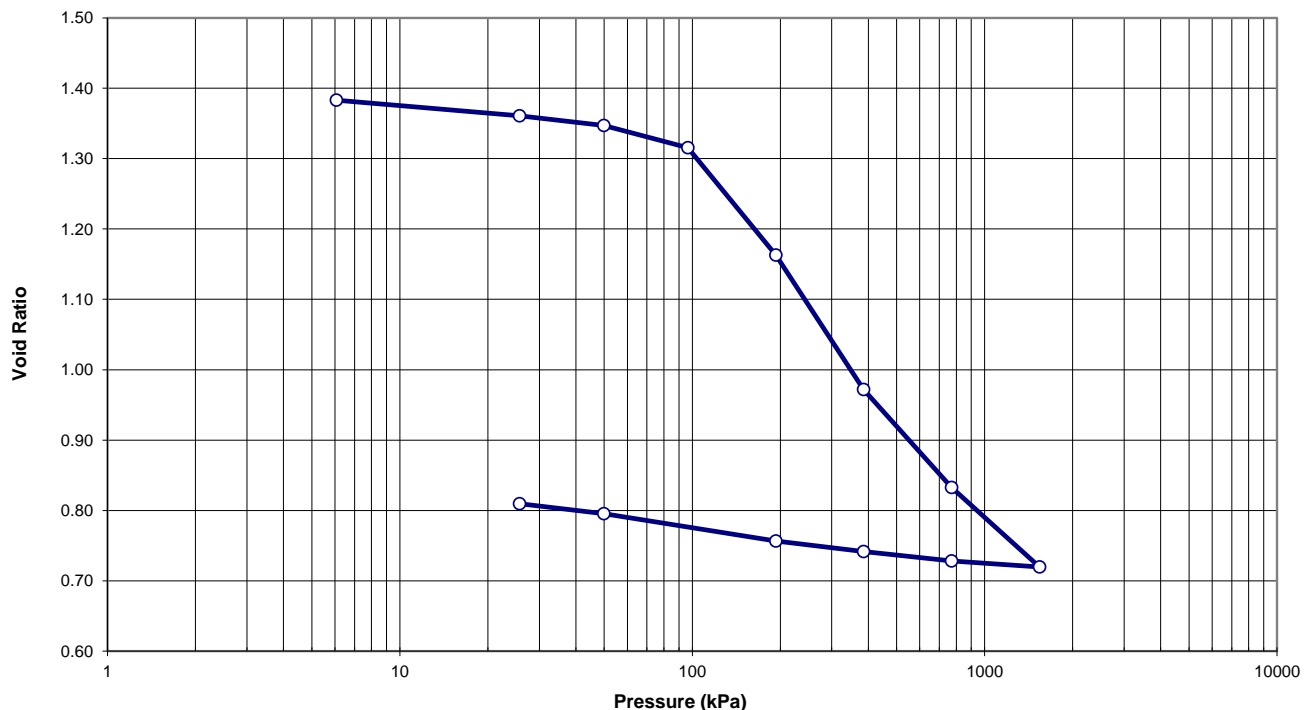
PROCEDURE: Test carried out in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method A

	<u>Start of Test</u>	<u>End of Test</u>
Wet Dens. (kg/m <sup>3</sup> )	1775.6	2028.1
Dry Dens. (kg/m <sup>3</sup> )	1164.7	1539.1
Moisture Cont. (%)	52.4	31.8
Void Ratio	1.391	0.809

Note: A Specific Gravity (Gs) of 2.79 was measured for the void ratio and saturation calculations.

Project #: 19-5161-251  
 Client: MMM Group Limited  
 Project Name: Highway 569 Blanche River Bridge  
 Sample: BR-1-TW1 (15'-17')

**Void Ratio vs. Pressure**



## Consolidation Test Report

Highway 569 Blanche River Bridge

19-5161-251

BR-1-TW1 (15'-17')

**TRIMMING:** The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer.

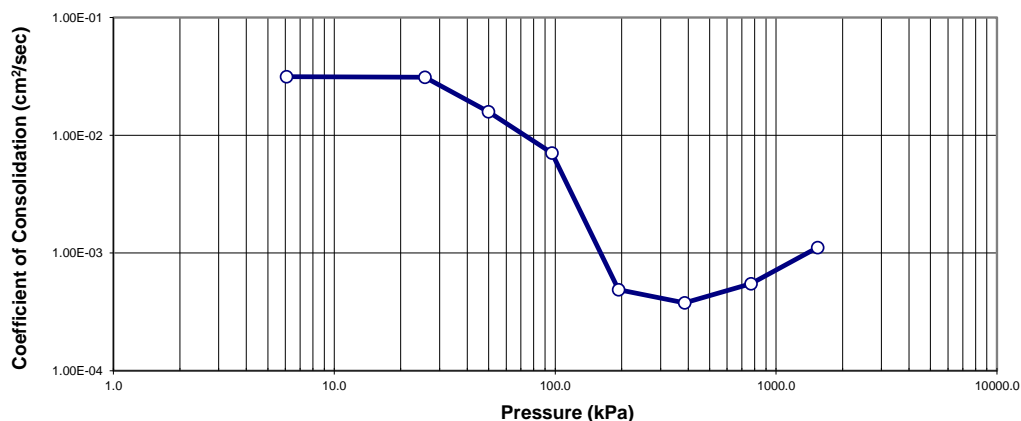
**LOADING:** A seating load of 6.1 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied after a constant load increment duration of 24 hours.

**CALCULATIONS:** Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. H. (mm)	Avg. H. (mm)	$D_{90}$ (mm)	$t_{90}$ (min)	$c_v$ (cm <sup>2</sup> /s)	Void Ratio	$m_v$ (m <sup>2</sup> /kN)	k (cm/s)
0.0	25.400					1.391		
6.1	25.316	25.358	-0.055	0.72	3.14E-02	1.383	5.45E-04	1.68E-06
25.7	25.082	25.199	-0.199	0.72	3.11E-02	1.361	4.72E-04	1.44E-06
49.9	24.935	25.009	-0.080	1.39	1.59E-02	1.347	2.42E-04	3.77E-07
96.6	24.599	24.767	-0.147	3.06	7.08E-03	1.316	2.88E-04	2.00E-07
193.2	22.978	23.789	-0.930	40.96	4.88E-04	1.163	6.82E-04	3.27E-08
385.7	20.947	21.963	-1.535	45.16	3.77E-04	0.972	4.59E-04	1.70E-08
770.7	19.470	20.209	-1.075	26.32	5.48E-04	0.833	1.83E-04	9.85E-09
1540.7	18.268	18.869	-0.764	11.29	1.11E-03	0.720	8.02E-05	8.76E-09
770.7	18.357	18.313				0.728		
385.7	18.499	18.428				0.741		
193.2	18.658	18.579				0.756		
49.9	19.074	18.866				0.795		
25.7	19.222	19.148				0.809		

Project #: 19-5161-251  
Client: MMM Group Limited  
Project Name: Highway 569 Blanche River Bridge  
Sample: BR-1-TW1 (15'-17')

**Coefficient of Consolidation vs. Pressure**



Notes:  $C_v$  and k calculated using  $t_{90}$  values

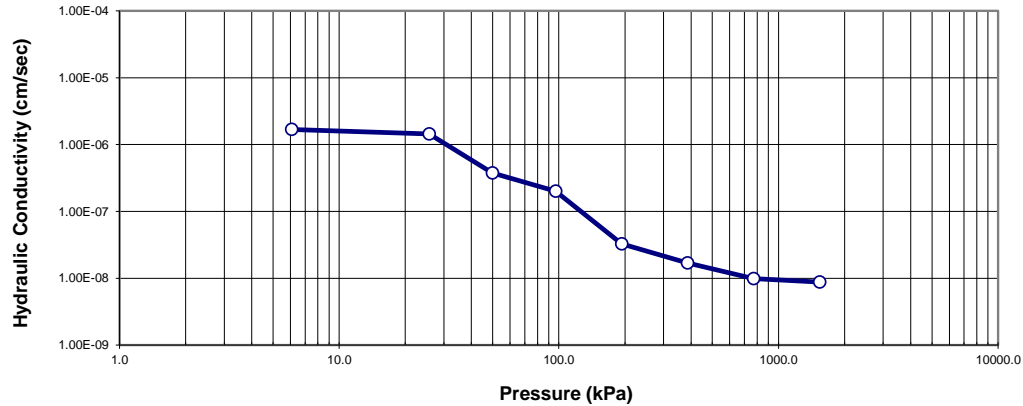


## Consolidation Test Report

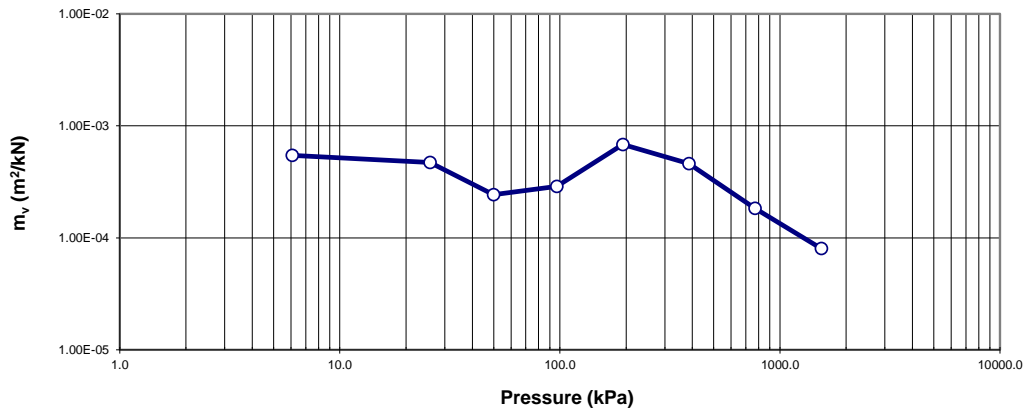
Highway 569 Blanche River Bridge  
19-5161-251

BR-1-TW1 (15'-17')

**Hydraulic Conductivity vs. Pressure**



**$m_v$  vs. Pressure**





## **Appendix C**

### **Site Photographs**



Photograph 1 – East Elevation Looking North



Photograph 2 – South Approach Looking North



**Photograph 3 – North Abutment**



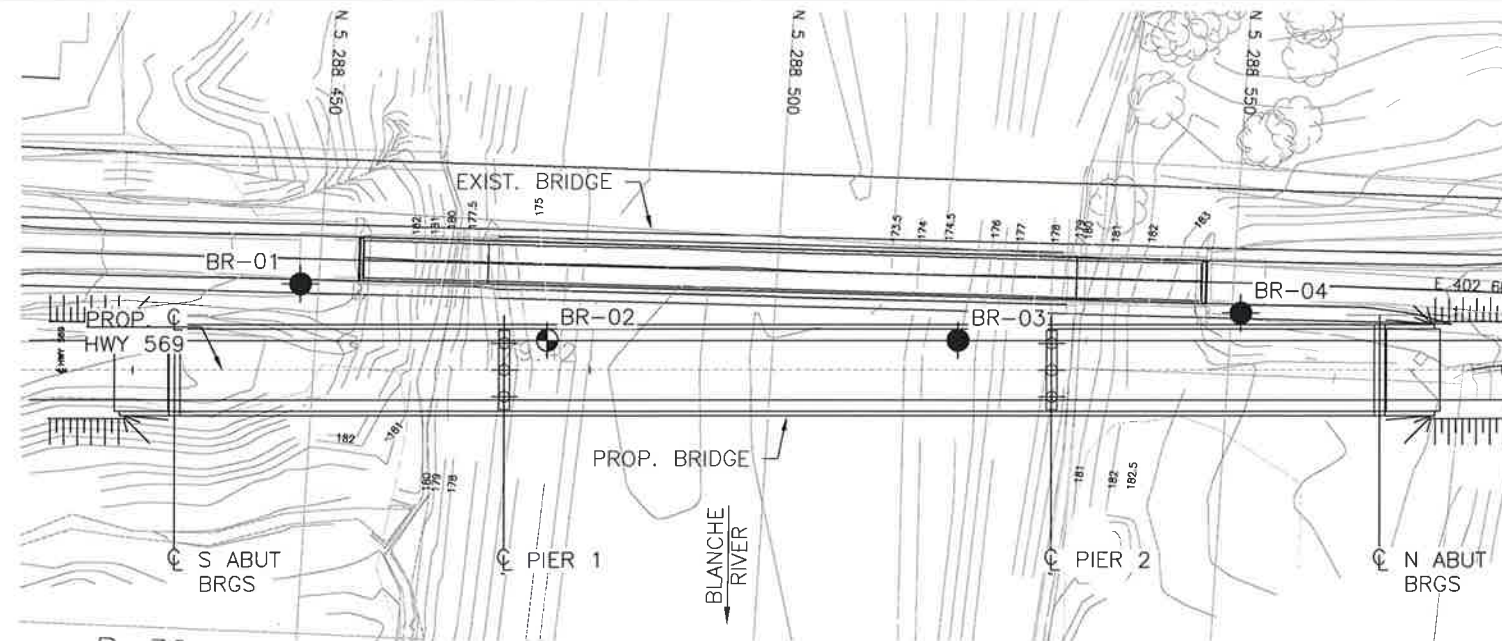
**Photograph 4 – Typical Pier**



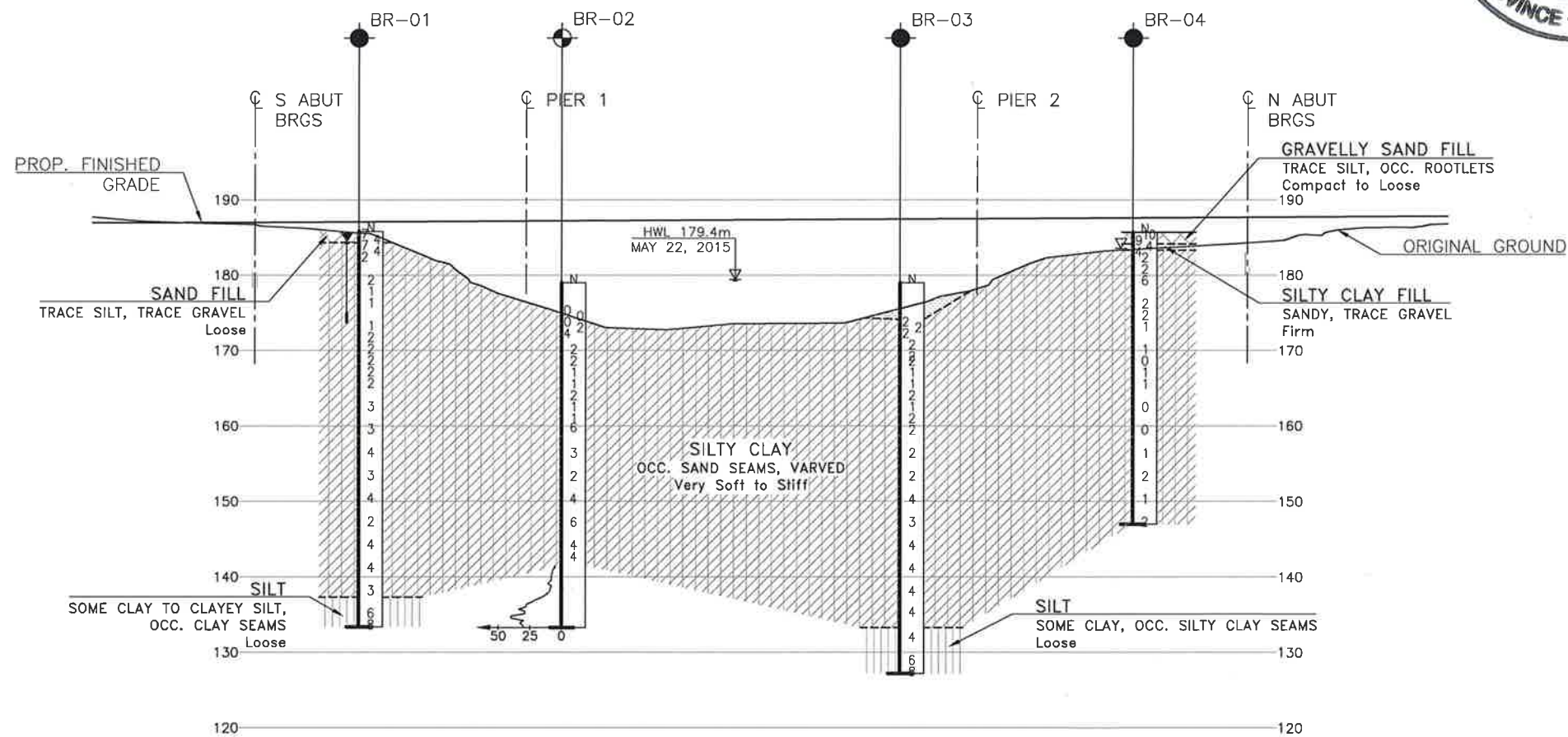
## **Appendix D**

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





PLAN  
SCALE 1:800



PROFILE ALONG C HWY 569

SCALE 1:800  
SCALE 1:200

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

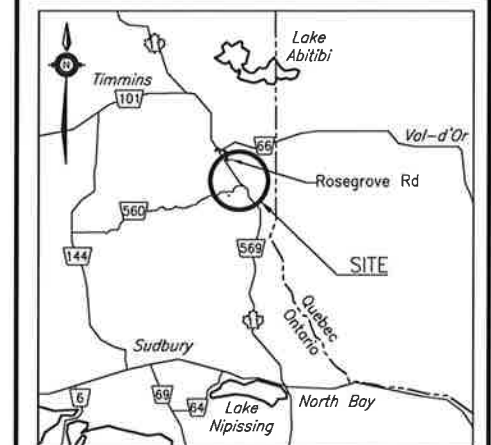


CONT No  
WP No 5163-13-00

HIGHWAY 569  
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 (MTM)	EASTING (MTM)
BR-01	185.8	5 288 448.0	402 608.3
BR-02	179.0	5 288 475.4	402 612.8
BR-03	179.0	5 288 520.3	402 610.0
BR-04	185.7	5 288 551.0	402 605.2

-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. 31M-120

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AMP	CHK	KS
DRAWN	AN	CHK	SITE
LOAD	DATE	JUN 2017	
STRUCT	DWG	1	