

**FOUNDATION INVESTIGATION REPORT  
MUNRO RIVER BRIDGE REPLACEMENT  
HIGHWAY 613  
TOWNSHIP OF DANCE, DISTRICT OF THUNDER BAY, ONTARIO**

**G.W.P. 494-00-00, SITE NO. 45-50**

**Geocres Number: 52C-33**

**Report to**

**Hatch Mott MacDonald**

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**G.W.P. 494-00-00, SITE NO. 45-50**

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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the Munro River Bridge on Highway 613, located approximately 700 m north of Dance Hall Road in the Township of Dance, District of Thunder Bay, Ontario.

The purpose of the investigation was to explore the subsurface conditions at the site, and based on the data obtained, to provide a borehole location plan, record of borehole sheets, a 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 Hatch Mott MacDonald, under the Ministry of Transportation Ontario (MTO) Assignment Number 6010-E-0010.

**2 SITE DESCRIPTION**

The bridge site is located on Highway 613 approximately 700 m north of the Town of Dance, Ontario. The Munro River meanders easterly from Abbott Lake to Rainy Lake. At present, Highway 613 crosses the Munro River on a three span structure with a total length of approximately 18 m.

The area surrounding the site is gently undulating and heavily treed with low-lying swamps in the river flood plain. Photographs of the bridge and surrounding area are presented in Appendix C.

The site lies within the physiographical area of Canadian Shield, which is characterized by Pre-Cambrian igneous and metamorphic bedrock typically occurring as rounded knobs and ridges where exposed. Based on the data from the Ontario Geological Survey, the bedrock at this site generally consists of massive granodiorite to granite. The bedrock is typically overlain by thick glaciolacustrine clay deposit and a discontinuous cover of fine-grained granular till deposit.

### 3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of November 15 to 21, 2013. A total of four boreholes, identified as MRB-01, MRB-02, MRB-05 and MRB-06, were advanced from the existing pavement level to depths ranging from 11.3 m to 43.3 m. Boreholes MRB-03 and MRB-04 were planned as the second borehole at each abutment. However, since Boreholes MRB-02 and MRB-05 were drilled well beyond 30 m depth without encountering refusal, Boreholes MRB-03 and MRB-04 were not drilled. Details of the borehole locations and drilling depths were summarized as follows:

**Table 3.1 – Borehole Summary**

Location	Boreholes	Drilling Depth (m)
South Approach	MRB-01	11.3
South Abutment	MRB-02	40.8
North Abutment	MRB-05	43.3
North Approach	MRB-06	11.3

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix D.

All boreholes were drilled using a CME75 truck-mounted drill rig in combination with hollow stem augers and NW casing methods to advance the boreholes in the native soils. Samples of the fill and native soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Bedrock coring was not carried out as bedrock was not encountered within the depth of drilling.

Groundwater conditions in the open boreholes were observed during the drilling operations. No standpipe piezometer was installed due to the artesian pressure encountered in the silty sand and silt underlying the silty clay deposit. Observations on artesian head were noted in the drill casing.

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. Borehole completion details are summarized in Table 3.2.

**Table 3.2 – Borehole Completion Details**

Borehole	Piezometer Tip		Completion Details
	Depth (m)	Elevation (m)	
MRB-01	None Installed		Borehole backfilled with soil cuttings mixed with bentonite holeplug to 0.1 m, then cold patch asphalt to surface
MRB-02	None Installed		Borehole backfilled with bentonite gel and holeplug to 0.3 m, then filter sand to 0.1 m and cold patch asphalt to surface
MRB-05	None Installed		Borehole backfilled with bentonite holeplug to 29.5 m, then peltonite to 25.9 m, bentonite holeplug and gel to 0.5 m, granular fill to 0.1 m and cold patch asphalt to surface

Borehole	Piezometer Tip		Completion Details
	Depth (m)	Elevation (m)	
MRB-06	None Installed		Borehole backfilled with bentonite holeplug to 1.9 m, then soil cutting to 0.1 m and cold patch asphalt to surface

#### 4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets included in Appendix A. Selected samples were also subjected to gradation analysis. The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and shown on the figures included 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 this appendix and on the “Borehole Locations and Soil Strata” drawing 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.

The subsurface stratigraphy encountered at the site generally consists of embankment fill overlying a layer of fibrous to amorphous peat, which in turn overlies a thick silty clay deposit. Below the silty clay deposit, a layer of silty sand till was encountered at the south abutment before encountering cobbles and boulders, and a silt deposit at the north abutment, respectively. More detailed descriptions of individual strata are presented below.

##### 5.1 Asphalt Pavement

Asphalt pavement was encountered in all boreholes. Thickness of the asphalt ranged from 25 to 50 mm.

##### 5.2 Gravelly Sand Fill

Gravelly sand fill containing occasional cobbles was encountered in all boreholes below the asphalt pavement. Thickness of the brown cohesionless fill ranged from 1.4 to 1.7 m with the base elevations ranging from 359.6 to 360.0 m.

SPT ‘N’ values recorded in the gravelly sand fill ranged from 15 to 58 blows per 0.3 m penetration, indicating a compact to very dense relative density. The measured moisture contents of the cohesionless fill samples ranged from 5 to 9%.

The results of grain size analyses conducted on the gravelly sand fill samples are provided on the Record of Borehole sheets in Appendix A and illustrated on Figure B1a of Appendix B. Grain size distribution analyses carried out on three fill samples indicated that the fill contains 26 to 34% gravel, 55 to 57% sand and 9 to 19% fines.

### **5.3 Silty Clay Fill**

Brown to dark brown silty clay fill containing organics, some sand and trace gravel was encountered below the cohesionless fill in all boreholes except in MRB-02 where peat was encountered directly beneath the cohesionless fill. Thickness of the cohesive fill ranged from 0.6 to 1.5 m with the base elevations from 358.2 to 359.3 m.

SPT 'N' values recorded in the silty clay fill ranged from 4 to 13 blows per 0.3 m penetration, indicating a firm to stiff consistency. The measured moisture contents of the cohesive fill samples ranged from 25 to 65% with the upper bound moisture content likely representing organic content.

One grain size distribution analysis conducted on the silty clay fill sample is provided on the Record of Borehole sheets in Appendix A and illustrated on Figure B1b of Appendix B. The result of grain size distribution analysis indicated that the fill contains 3% gravel, 14% sand, 31% silt and 52% clay.

### **5.4 Peat**

A layer of amorphous to fibrous peat was encountered beneath the fill. The peat contained wood fragments and some clay. Thickness of the peat ranged from 1.5 to 2.0 m with the base of the layer at elevations varying from 356.6 to 357.9 m.

SPT 'N' values recorded in the peat ranged typically from 3 to 9 blows per 0.3 m penetration, indicating a soft to stiff consistency. Two SPT tests recorded 'N' values of 41 and 32 blows per 0.3 m penetration, indicating the presence of wood fragments. The measured moisture contents of the peat samples ranged from 55 to 378%.

### **5.5 Silty Clay**

A layer of silty clay with trace to some sand and some organic matter in the upper 1 to 2 m was encountered below the peat in all boreholes. MRB-01 and MRB-06 were terminated within the silty clay at elevations 350.2 m and 349.8 m, respectively. The silty clay layer was penetrated in MRB-02 and MRB-05. Where penetrated, the thickness of the layer ranged from 33.0 to 37.2 m with the base of the layer at elevations varying from 319.4 to 324.6 m.

SPT 'N' values recorded in the silty clay ranged from 3 to 21 blows per 0.3 m penetration, indicating a soft to very stiff consistency which generally increases with depth. The measured moisture contents of the silty clay samples ranged from 22 to 56% with typical values varying from 35 to 43%.

The results of Atterberg Limits tests conducted on the silty clay samples are provided on the Record of Borehole sheets in Appendix A and illustrated on Figures B6a and B6b of Appendix B. The results indicated that the deposit has plastic limits ranging from 23 to 30% and liquid limits ranging from 58 to 75%, indicating high plasticity (CH).

The results of grain size distribution analyses conducted on the silty clay samples are

provided on the Record of Borehole sheets in Appendix A and illustrated in Figures B2, B3a and B3b of Appendix B. The results are summarized as follows:

Gravel %	0
Sand %	5 to 20
Silt %	21 to 49
Clay %	43 to 71

### **5.6 Silty Sand Till**

A relatively thin layer of grey silty sand till with trace clay and gravel was encountered beneath the silty clay in MRB-02. Thickness of the layer was 2.6 m with the base of the layer at elevation 322.0 m.

One SPT 'N' value recorded in the till was 100 blows for 0.225 m of penetration, indicating a very dense relative density. Measured moisture content was in the order of 17%.

The result of grain size distribution analysis conducted on the till sample is provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B4 of Appendix B. The result indicated that the till contains 3% gravel, 68% sand, 21% silt and 8% clay.

### **5.7 Cobbles and Boulders**

MRB-02 was terminated within a layer of cobbles and boulders encountered below the silty sand till. The cobbles and boulders layer was cored for 1.5 m.

### **5.8 Silt**

A grey silt layer with some clay and trace sand was encountered beneath the silty clay in MRB-05. Soil sampling in MRB-05 was terminated within the silt layer at 43.3 m depth or elevation 317.9 m. Dynamic cone penetration test (DCPT) was carried out from the base of the sampled borehole and encountered refusal at elevation 314.0 m, where 'N' value of 100 blows for 0.225 m of penetration was recorded.

One SPT 'N' value recorded in the silt was 13 blows per 0.3 m of penetration, indicating a compact relative density. Measured moisture content was in the order of 27%.

The result of grain size distribution analysis conducted on the silt sample is provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B5 of Appendix B. The result indicated that the silt contains 0% gravel, 7% sand, 78% silt and 15% clay.

### **5.9 Groundwater Conditions**

Artesian conditions were encountered in the cobbles and boulders/silt layer underlying the silty clay at the base of the boreholes upon completion of drilling in MRB02 and MRB-05. Artesian heads observed in the casings ranged from 2.9 to 3.0 m (elevation 364.2) above the ground surface. Standpipe piezometers were therefore not installed and the boreholes were carefully sealed.

Based on the General Arrangement drawing provided by HMM, the river level was at elevation 359.7 m on October 16, 2013, or about 1.5 m below the existing road grade.

## 6 MISCELLANEOUS

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a truck mounted CME75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations were supervised in the field by Mr. Stephane Loranger of Thurber. Mr. Mark E. Farrant, P.Eng. directed the field operations.

The report was prepared by Mr. Keli Shi, P.Eng. and Mr. Murray Anderson, P.Eng., and reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects.

### THURBER ENGINEERING LTD.

Keli Shi, P.Eng.  
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Review Principal





## **Appendix A**

### **Record of Borehole Sheets**

# RECORD OF BOREHOLE No MRB-01

1 OF 2

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
 HWY 613 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2013.11.21 - 2013.11.21 CHECKED BY MC

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			20    40    60    80    100	W <sub>P</sub> W      W <sub>L</sub>	WATER CONTENT (%)			GR		SA	SI	CL					
								SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE														
361.5																						
0.0	ASPHALT: (50mm)																					
	Gravelly <b>SAND</b> , some silt Brown Moist (FILL)		1	SS	34												26	55	19 (SI+CL)			
360.0																						
1.5	Silty <b>CLAY</b> , with organic matters Stiff Brown Moist (FILL)		2	SS	10																	
359.3																						
2.1	<b>PEAT</b> , fibrous Stiff to Firm Brown to Black Moist		3	SS	9																	
			4	SS	5																	
357.9																						
3.6	Silty <b>CLAY</b> , some sand, with organic matters Stiff Dark Brown Moist		5	SS	11													0	20	35	45	
355.8																						
5.6	Silty <b>CLAY</b> , trace sand Firm Dark grey Moist		6	SS	7														0	8	21	71
			7	SS	7																	
			8	SS	5																	

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-01

2 OF 2

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2013.11.21 - 2013.11.21 CHECKED BY MC

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																
350.2			9	SS	8		351										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND DRY. BOREHOLE BACKFILLED WITH CUTTINGS MIXED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.																

# RECORD OF BOREHOLE No MRB-02

1 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2013.11.19 - 2013.11.20 CHECKED BY MC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  <b>γ</b>  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							
361.3							20	40	60	80	100	PLASTIC LIMIT w <sub>P</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
0.0	ASPHALT: (50mm)						20	40	60	80	100	WATER CONTENT (%)			
	Gravelly SAND, some silt		1	SS	49							○			34 55 11 (SI+CL)
	Dense		2	SS	32							○			
	Brown														
	Moist														
	(FILL)														
359.6															
1.7	PEAT, fibrous		3	SS	8									○	
	Firm														
	Black														
	Moist														
	Wood fragment	4	SS	41									○		
	No recovery, possible timber														
		5	SS	5											
357.6															
3.7	Silty CLAY, some sand, topsoil stained														
	Stiff														
	Dark Brown														
	Moist	6	SS	9									○		0 11 46 43
355.7															
5.6	Silty CLAY, trace sand														
	Firm														
	Dark Grey														
	Moist	7	SS	6									○		
		8	SS	5									○		

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

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES	GROUND WATER CONDITIONS	ELEVATION SCALE
<div>DYNAMIC CONE PENETRATION RESISTANCE PLOT</div> <div>SHEAR STRENGTH kPa</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div> <div>WATER CONTENT (%)</div> <div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>w<sub>p</sub> w w<sub>L</sub></div> <div>UNIT WEIGHT γ</div> <div>REMARKS &amp; GRAIN SIZE DISTRIBUTION (%)</div> <div>GR SA SI C</div>					
	Continued From Previous Page				
	Silty CLAY, trace sand Firm to Stiff Dark Grey Moist		16 SS 5		341
			17 SS 6		338
			18 SS 12		335
			19 SS 9		332

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No MRB-02

4 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
 HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2013.11.19 - 2013.11.20 CHECKED BY MC

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 (%)		
								○ UNCONFINED      + FIELD VANE										
								● QUICK TRIAXIAL    × LAB VANE										
	Continued From Previous Page							20 40 60 80 100										
	Silty <b>CLAY</b> , trace sand Stiff to Hard Dark Grey Moist						331											
							330											
			20	SS	13		329											
							328											
							327											
			21	SS	21		326											
							325											
324.6																		
36.7	Silty <b>SAND</b> , trace clay and gravel Very Dense Grey Moist (TILL)						324											
			22	SS	100/ 0.225		323								3 68 21 8			
322.0	End of sampling and start coring at 39.3m						322											
39.3	<b>BOULDERS</b> and <b>COBBLES</b>														RUN #1 TCR=60% SCR=47% RQD=28%			

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

ONTMT4S 5121.GPJ 2012TEMPLATE(MTO).GDT 7/14/14

RUN #1  
TCR=60%  
SCR=47%  
RQD=28%

# RECORD OF BOREHOLE No MRB-02

5 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
 HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2013.11.19 - 2013.11.20 CHECKED BY MC

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					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page		1	RUN													
320.5																	
40.8	END OF BOREHOLE AT 40.8m. 2.9m OF ARTESIAN PRESSURE OBSERVED IN CASING. BOREHOLE BACKFILLED WITH BENTONITE GEL AND BENTONITE HOLEPLUG TO 0.3m, FILTER SAND TO 0.1m, THEN ASPHALT TO SURFACE.																



# RECORD OF BOREHOLE No MRB-05

1 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
 HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
 DATUM Geodetic DATE 2013.11.15 - 2013.11.17 CHECKED BY MC

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				WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	W <sub>p</sub>	W		W <sub>L</sub>				
361.2																				
0.0	ASPHALT: (25mm)																			
	Gravelly <b>SAND</b> , trace silt Dense to Very Dense Brown Moist (FILL)		1	SS	35							○								
	Occasional cobbles		2	SS	58							○						34 57 9 (SI+CL)		
359.7																				
1.5	Silty <b>CLAY</b> , with organic matters Stiff Dark Brown Moist (FILL)		3	SS	13							○								
			4	SS	11							○								
358.2																				
3.0	<b>PEAT</b> , fibrous, with wood fragments Soft Black Moist		5	SS	3															
356.6																				
4.6	Silty <b>CLAY</b> , trace sand, with organic matters Firm Dark Brown Moist		6	SS	3									○						
355.1																				
6.1	Silty <b>CLAY</b> , trace sand Stiff Grey Moist		7	SS	8								○							
	Trace gravel		8	SS	4									┌─○─┐				0 5 49 46		
			9	SS	8							○								

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-05

2 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.17 CHECKED BY MC

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				WATER CONTENT (%)				
							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page						351									
	Silty <b>CLAY</b> , trace sand Stiff to Firm Grey Moist		10	SS	13		350									
							349									0 7 42 51
			11	SS	6		348									
							347									
			12	SS	7		346									
							345									
			13	SS	6		344									0 7 34 59
							343									
			14	SS	6		342									
			15	SS	5											

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-05

3 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.17 CHECKED BY MC

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> , trace sand Stiff Grey Moist		16	SS	10		341									
							340									
							339									
			17	SS	11		338									
							337									
							336									
			18	SS	9		335									0 9 39 52
							334									
							333									
			19	SS	10		332									

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-05

4 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.17 CHECKED BY MC

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															
	Silty <b>CLAY</b> , trace sand Firm to Very Stiff Grey Moist						331									
							330									
	Sand layers between 28.9m and 32.0m		20	SS	6		329									
							328									
							327									
	Silty sand layer at 35m. Artesian pressure to 20.1m						326									
							325									
			21	SS	11		324									
							323									
							322									
			22	SS	20											

Continued Next Page

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

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-05

5 OF 5

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.17 CHECKED BY MC

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 (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE			w <sub>P</sub> w      w <sub>L</sub>				
								● QUICK TRIAXIAL      × LAB VANE							
	Continued From Previous Page							20   40   60   80   100							
319.4	Silty <b>CLAY</b> , trace sand Very Stiff Grey Moist						321								
41.8	<b>SILT</b> , some clay, trace sand Compact Grey Moist to Wet						320								
317.9			23	SS	13		319								
43.3	End of sampling and start DCPT						318								
							317								
							316								
							315								
314.0															
47.2	END OF BOREHOLE AT 47.2m. PIEZOMETER NOT INSTALL DUE TO ARTESIAN PRESSURE UP TO 3.0m. BOREHOLE CAVED TO 31.4m AFTER REMOVING CASING TO 28.9m BELOW GROUND SURFACE. BOREHOLE BACKFILLED WITH HOLEPLUG BENTONITE FROM 31.3m TO 29.5m, BENTONITE PELLETS HOLEPLUG FROM 29.5m TO 25.9m, BENTONITE HOLEPLUG TO 18.2m, HOLEPLUG GEL TO 0.9m, BENTONITE HOLEPLUG TO 0.5m, GRANULAR FILL TO 0.1m, THEN ASPHALT TO SURFACE														

ONTMT4S 5121.GPJ 2012TEMPLATE(MTO).GDT 7/14/14

# RECORD OF BOREHOLE No MRB-06

1 OF 2

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.15 CHECKED BY MC

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		WATER CONTENT (%)				GR	SA	SI	CL	
								20    40    60    80    100	w <sub>p</sub> w      w <sub>L</sub>									
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE										
361.1							20    40    60    80    100	20    40    60										
0.0	ASPHALT: (25mm)						361											
	Gravelly <b>SAND</b> Compact Brown Moist (FILL)		1	SS	15					○								
			2	SS	18		360			○								
359.6																		
1.4	Silty <b>CLAY</b> , some sand, trace gravel Soft to Firm Dark Brown Moist (FILL)		3	SS	4		359					○		3	14    31    52			
358.9																		
2.1	<b>PEAT</b> , amorphous, mixed with clay Soft Black Moist Wood fragments		4	SS	32		358						207 ○					
			5	SS	3								83 ○					
357.5							357											
3.6	Silty <b>CLAY</b> , with organic matters Firm Dark Brown Moist																	
356.6							356					○		0	7    24    69			
4.4	Silty <b>CLAY</b> , trace sand Stiff Dark Grey Moist		6	SS	8													
			7	SS	9		355					○						
			8	SS	9		354											
												○						
							353											
			9	SS	8		352							0	6    27    67			

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MRB-06

2 OF 2

METRIC

WP# 494-00-00 LOCATION Munro River Bridge ORIGINATED BY SLL  
HWY 613 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2013.11.15 - 2013.11.15 CHECKED BY MC

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						351	20	40	60	80	100					
	Silty <b>CLAY</b> , trace sand Stiff Dark Grey Moist		10	SS	10		350										
349.8																	
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN AND DRY. BOREHOLE BACKFILLED WITH HOLEPLUG BENTONITE TO 1.9m, CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.																

## **Appendix B**

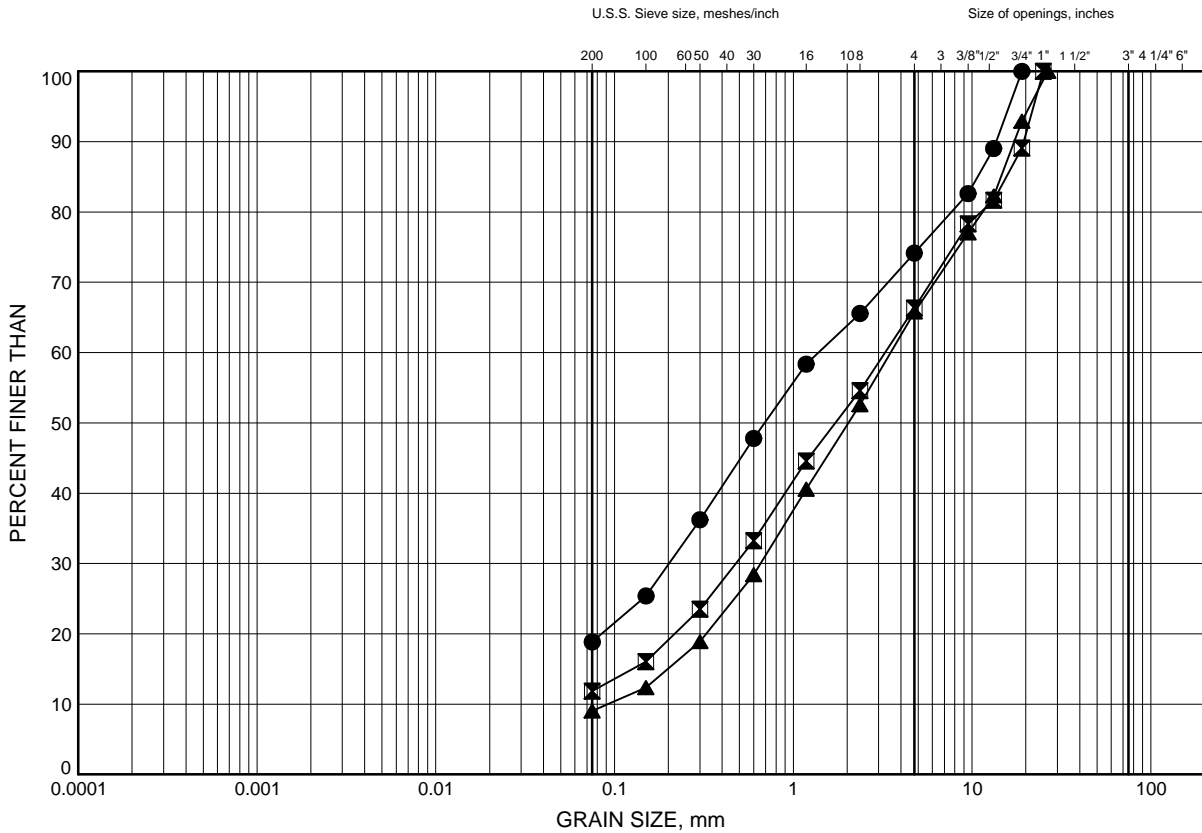
### **Laboratory Test Results**



# Munro River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1a

## GRAVELLY SAND FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-01	1.07	360.41
⊠	MRB-02	0.38	360.92
▲	MRB-05	1.07	360.13

Date July 2014  
WP# 494-00-00

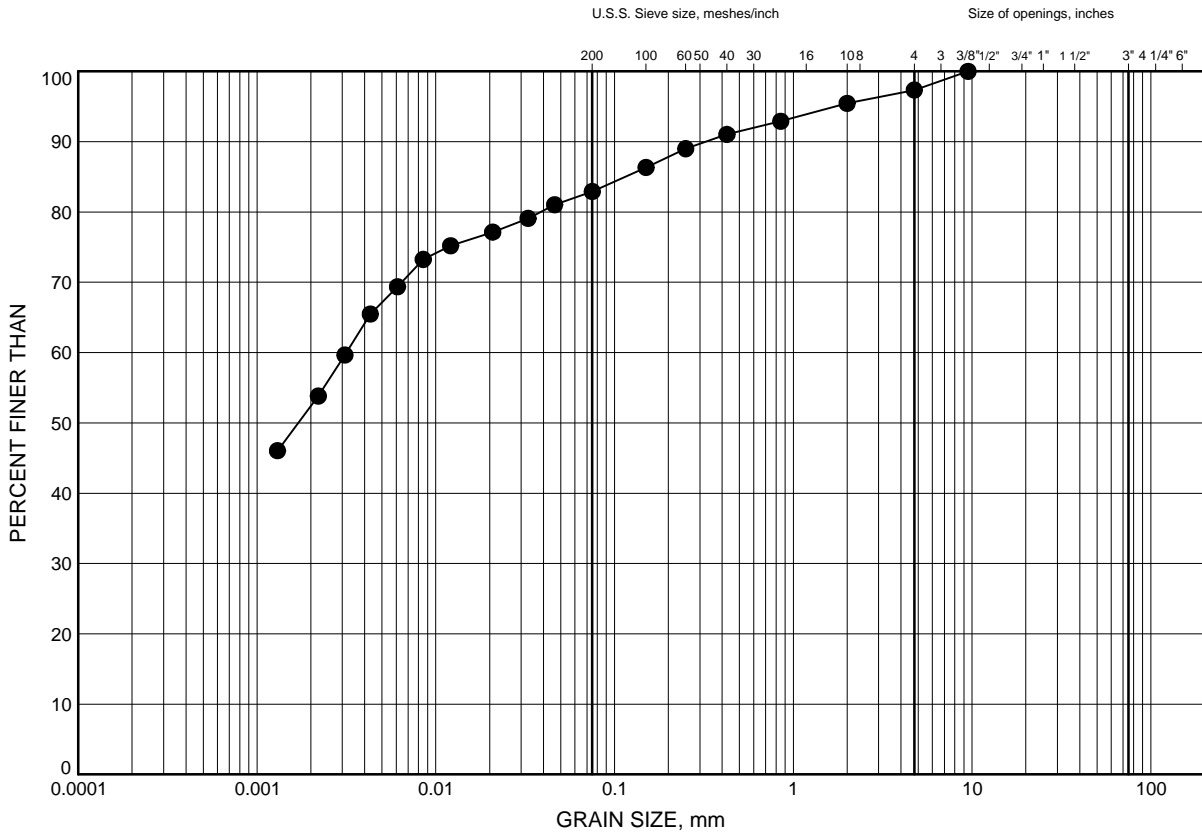


Prep'd AN  
Chkd. KS

# Munro River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B1b

## SILTY CLAY FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-06	1.83	359.22

Date July 2014  
WP# 494-00-00

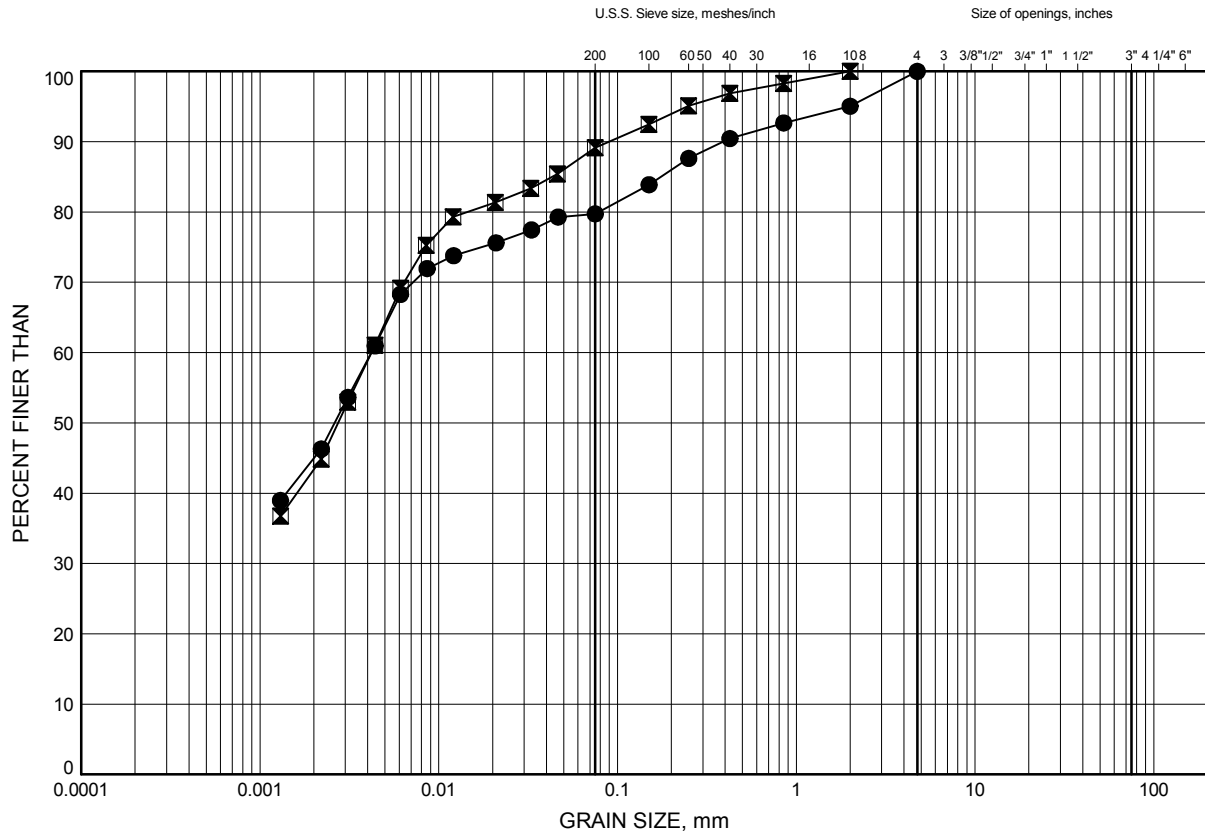


Prep'd AN  
Chkd. KS

# Munro River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B2

## SILTY CLAY, Some Sand



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-01	3.63	357.85
⊠	MRB-02	4.88	356.42

Date July 2014  
WP# 494-00-00



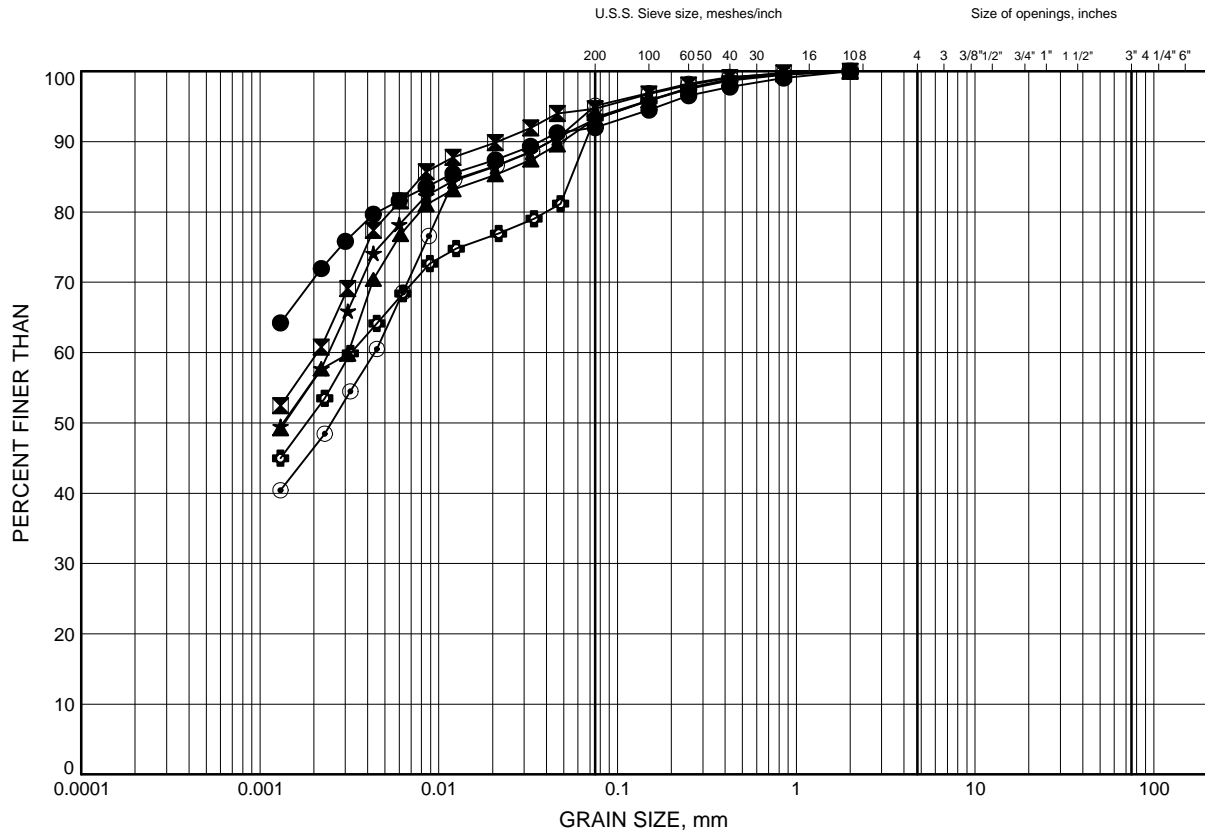
Prep'd AN  
Chkd. KS

# Munro River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE B3a

### SILTY CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-01	6.40	355.08
⊠	MRB-02	9.45	351.85
▲	MRB-02	15.54	345.76
★	MRB-02	26.21	335.09
⊙	MRB-05	7.92	353.28
⊕	MRB-05	12.50	348.70

Date July 2014  
WP# 494-00-00

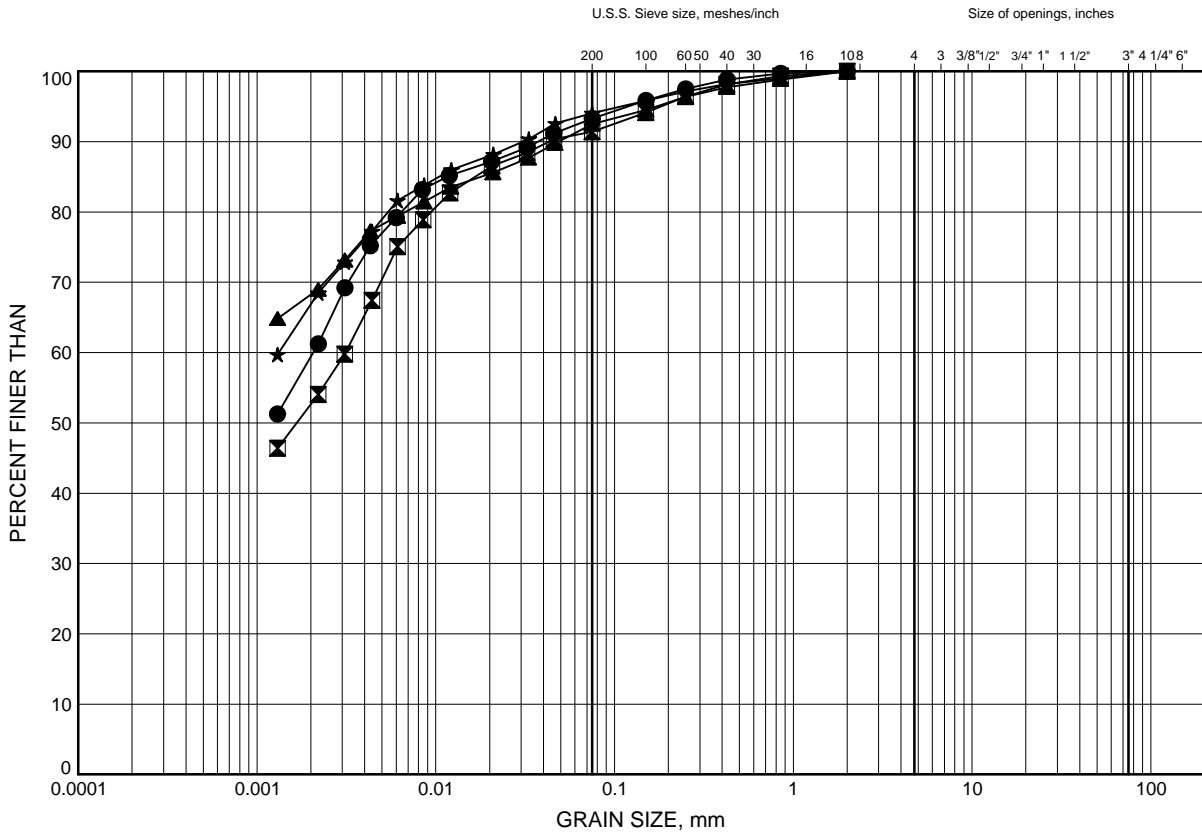


Prep'd AN  
Chkd. KS

# Munro River Bridge GRAIN SIZE DISTRIBUTION

FIGURE B3b

## SILTY CLAY



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-05	17.07	344.13
⊠	MRB-05	26.21	334.99
▲	MRB-06	4.88	356.17
★	MRB-06	9.45	351.60

Date July 2014  
WP# 494-00-00



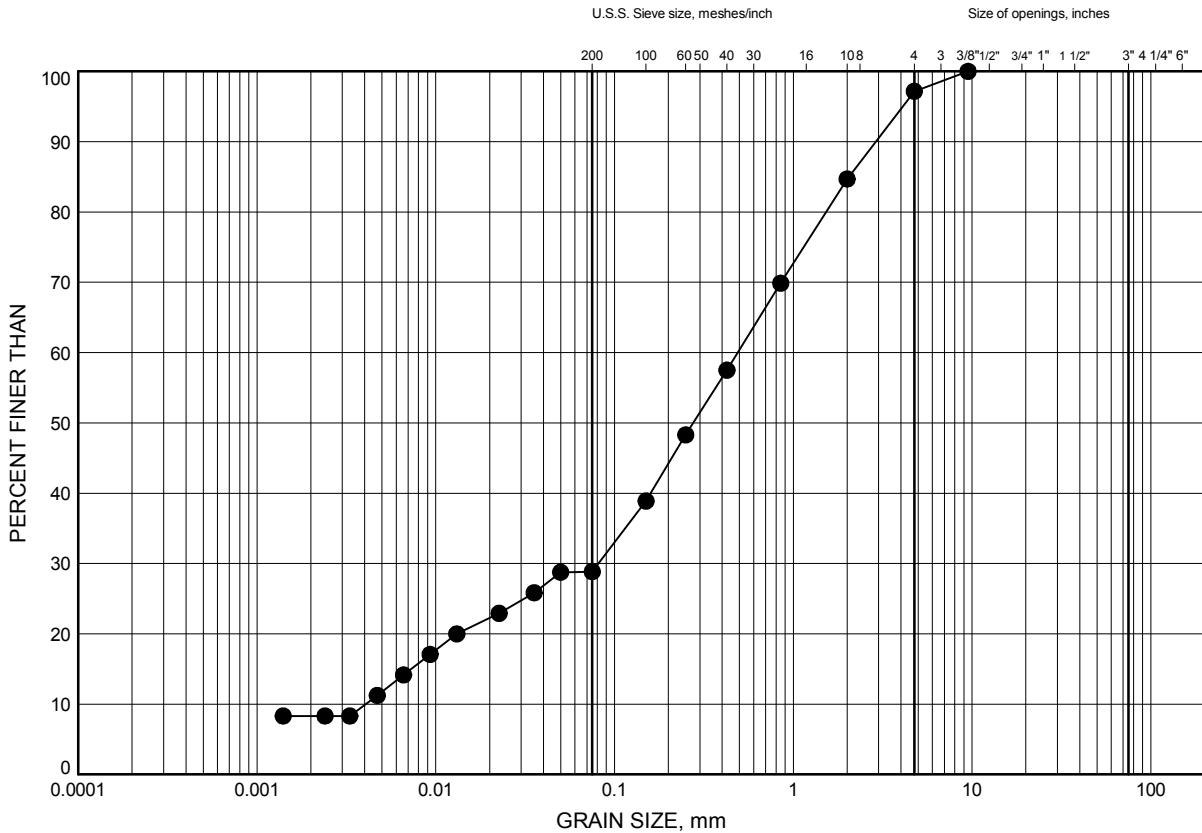
Prep'd AN  
Chkd. KS

# Munro River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE B4

### SILTY SAND TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-02	38.29	323.01

Date July 2014  
 WP# 494-00-00



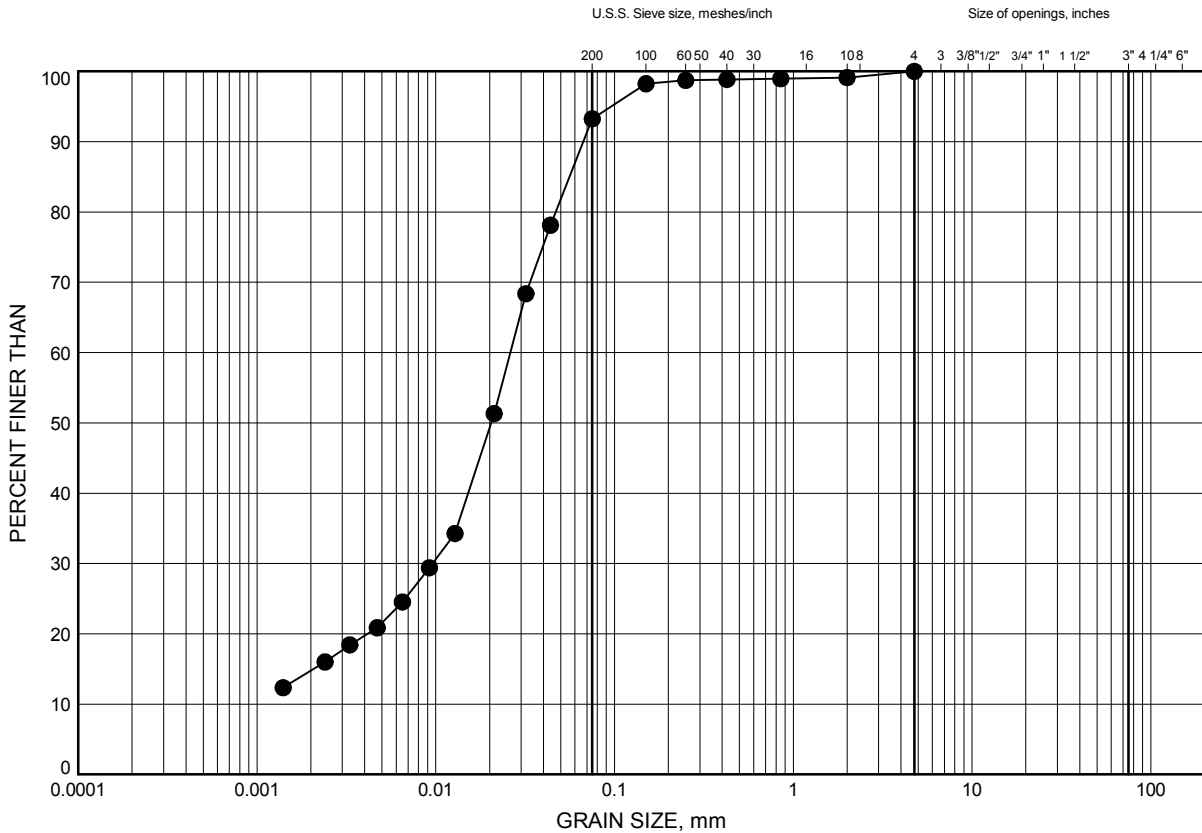
Prep'd AN  
 Chkd. KS

# Munro River Bridge

## GRAIN SIZE DISTRIBUTION

FIGURE B5

SILT, Some Clay



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-05	42.98	318.22

Date July 2014  
 WP# 494-00-00

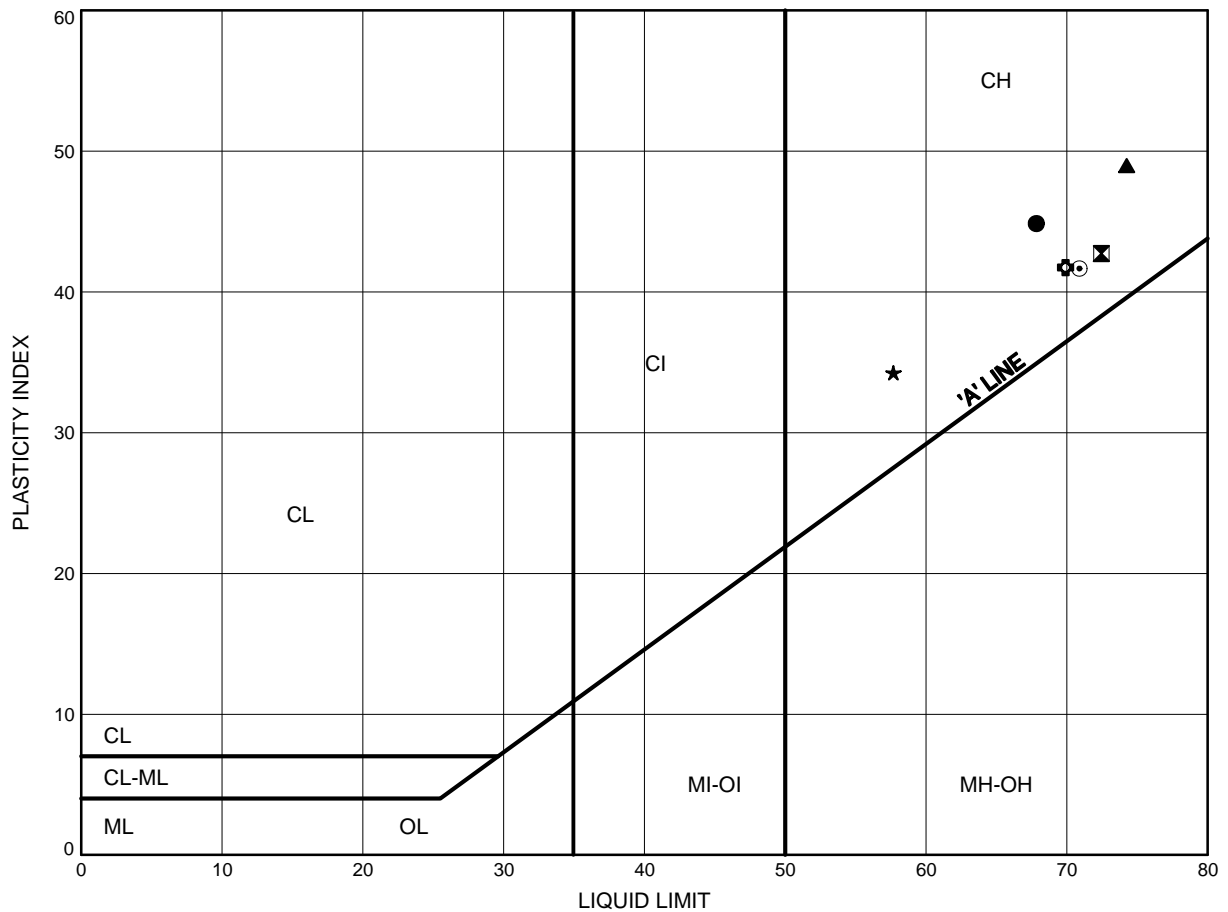


Prep'd AN  
 Chkd. KS

Munro River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6a

**SILTY CLAY**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-01	6.40	355.08
⊠	MRB-02	9.45	351.85
▲	MRB-02	15.54	345.76
★	MRB-05	7.92	353.28
⊙	MRB-05	12.50	348.70
⊕	MRB-05	17.07	344.13

Date July 2014  
 WP# 494-00-00



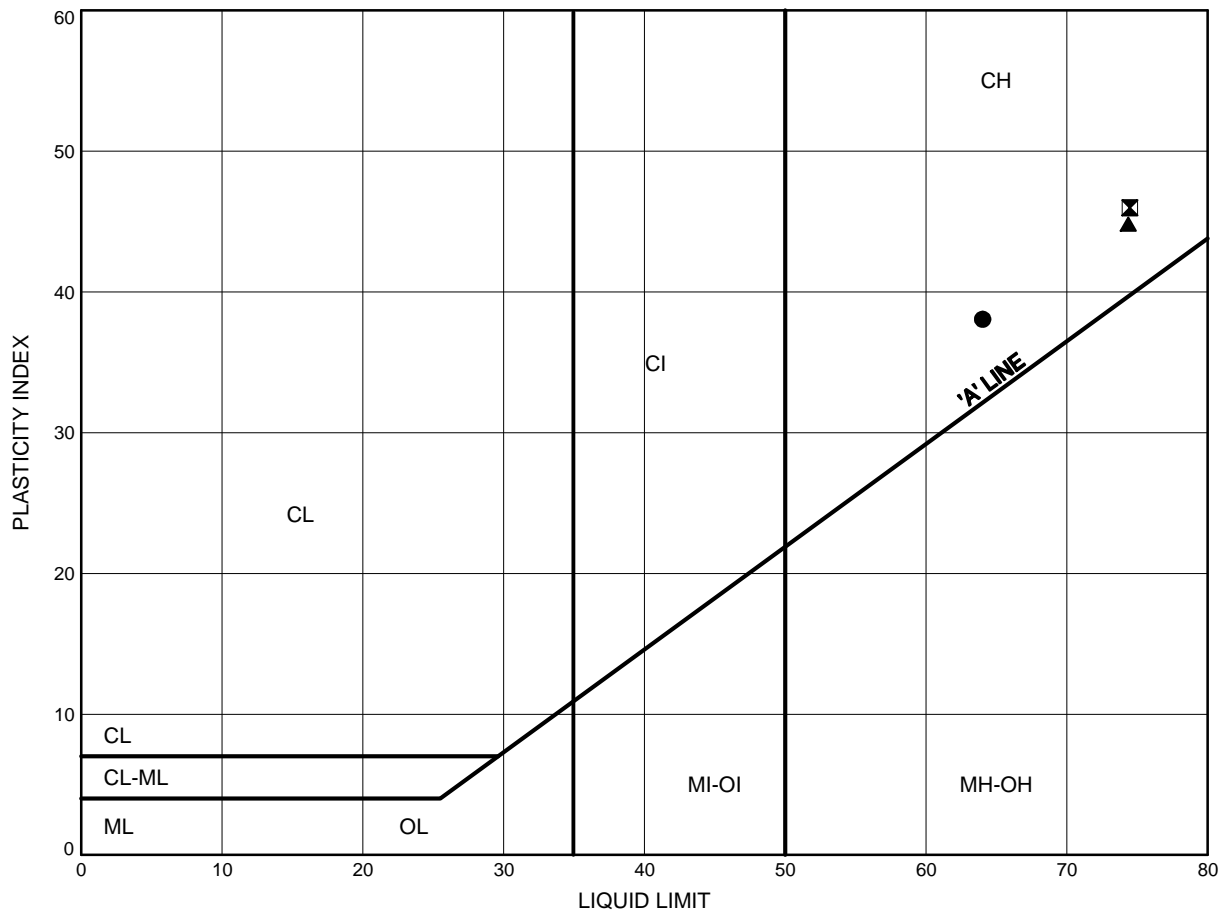
Prep'd AN  
 Chkd. KS



Munro River Bridge  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B6b

**SILTY CLAY**



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	MRB-05	26.21	334.99
⊠	MRB-06	4.88	356.17
▲	MRB-06	9.45	351.60

Date July 2014  
 WP# 494-00-00



Prep'd AN  
 Chkd. KS

## **Appendix C**

### **Site Photographs**



**Looking North from South Abutment**



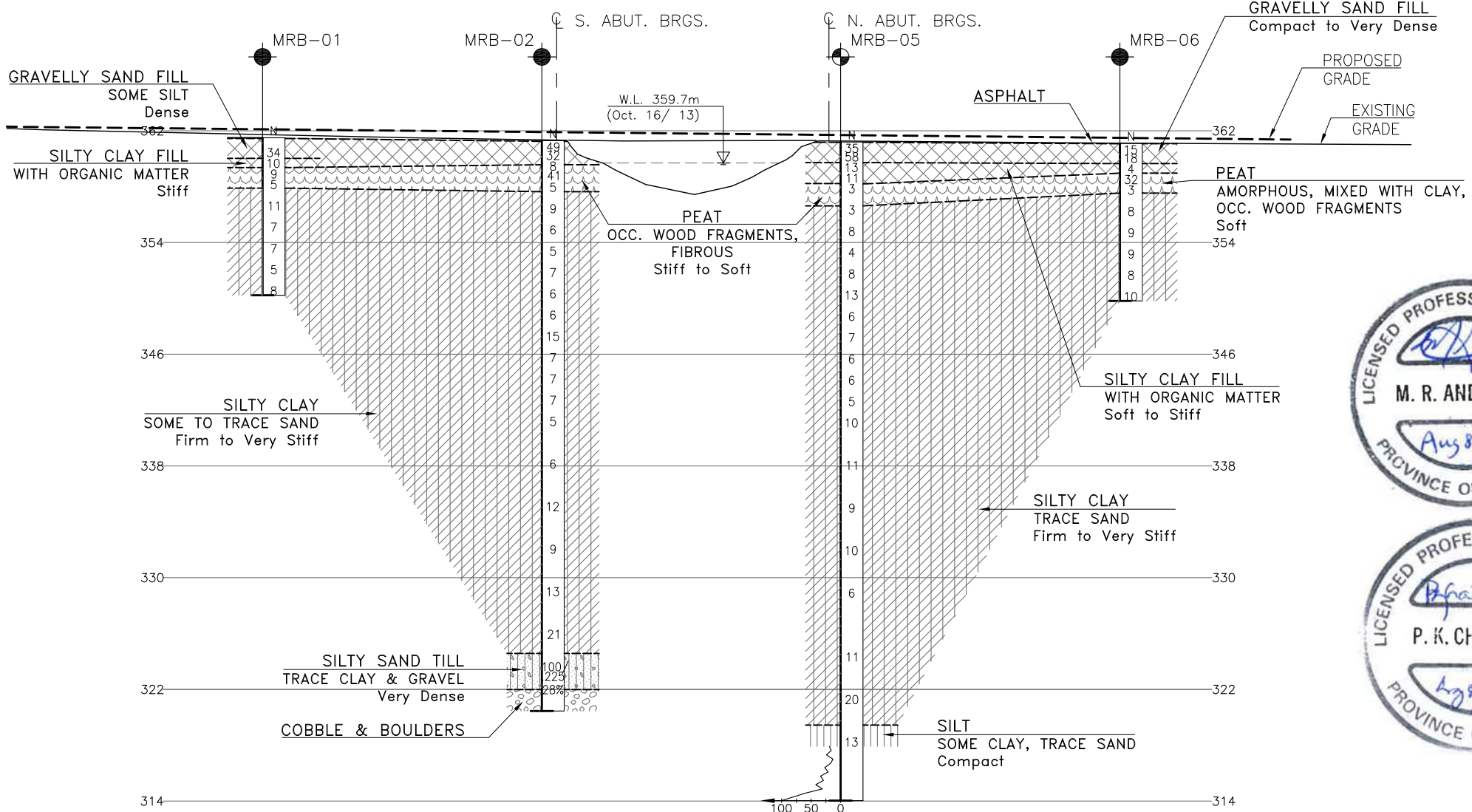
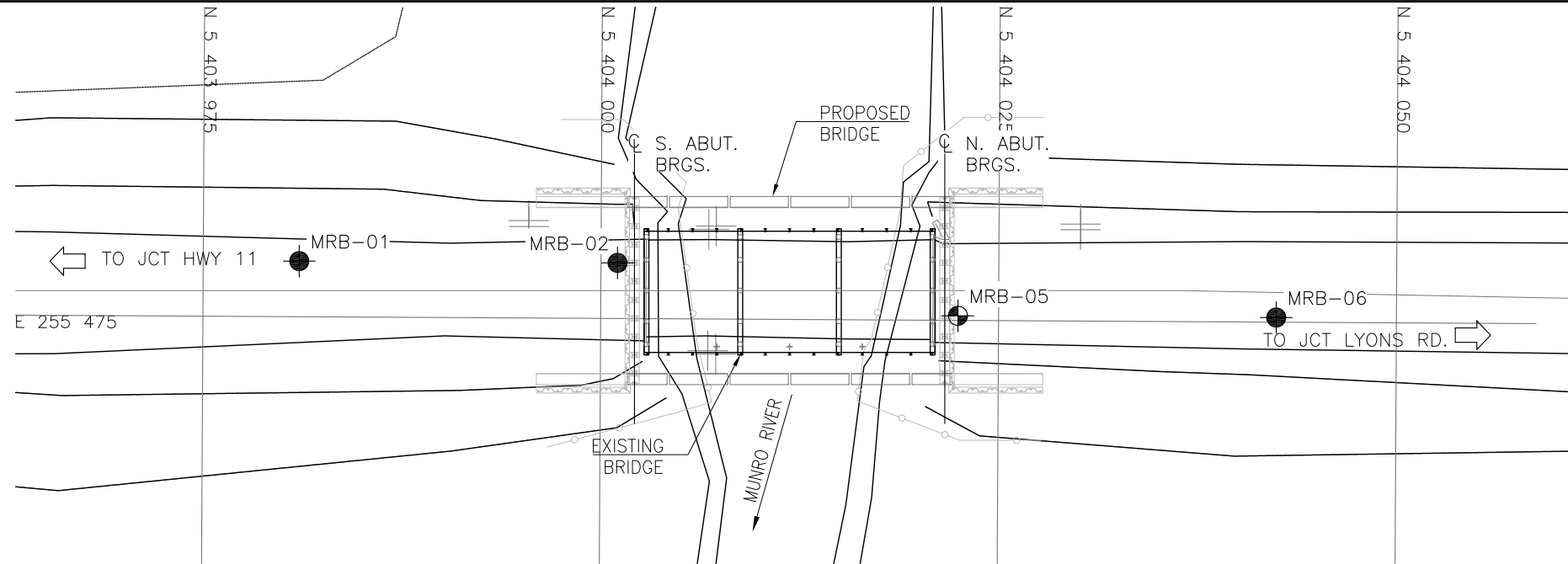
**Looking South from North Approach**



**Looking West (Upstream)**

## **Appendix D**

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



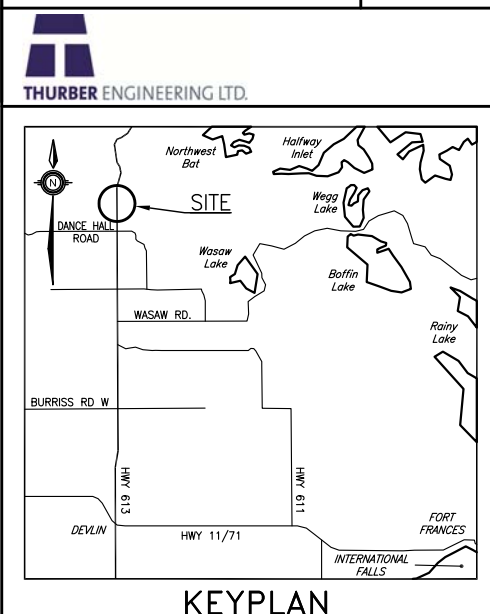
METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

CONT No  
WP No 495-00-01

HIGHWAY 613  
MUNRO RIVER BRIDGE  
STRUCTURAL REPLACEMENT  
BOREHOLE LOCATIONS AND SOIL STRATA

Hatch Mott MacDonald

SHEET  
9

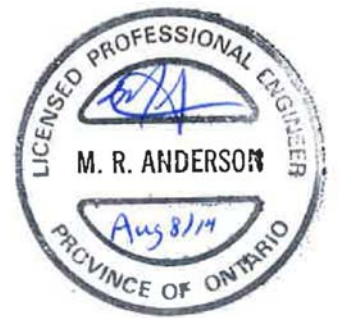


LEGEND			
	Borehole		
	Borehole and Cone		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
	Water Level		
	Head Artesian Water		
	Piezometer		
90%	Rock Quality Designation (RQD)		
A/R	Auger Refusal		

NO	ELEVATION	NORTHING	EASTING
MRB-01	361.5	5 403 981.0	255 471.5
MRB-02	361.3	5 404 001.0	255 471.5
MRB-05	361.2	5 404 022.4	255 474.7
MRB-06	361.1	5 404 042.4	255 474.7

- 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. 52C-33**



REVISIONS		DATE		BY		DESCRIPTION	
DESIGN	KS	CHK	PKC	CODE	CAN/CSA S6-06	LOAD CL-626-ONT	DATE AUG 2014
DRAWN	AN	CHK	KS	SITE	45-50	STRUCT	DWG 2