

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 11
BLACKWATER RIVER BRIDGE REPLACEMENT
GREENSTONE COMMUNITY, DISTRICT OF THUNDER BAY, ONTARIO**

G.W.P. 6066-09-00, Site No. 48C-1

Geocres Number: 42E-14

Report to

McCormick Rankin Corporation

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed replacement of the existing bridge which carries Highway 11 over the Blackwater River. The bridge is located approximately 70 Km north of Nipigon, District of Thunder Bay, 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 McCormick Rankin Corporation (MRC), under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The site is located at the crossing of Highway 11 over the Blackwater River, approximately 400 m north of Garnet Drive in the Greenstone Community, Thunder Bay District, Ontario. At present, the highway crosses the river on a seven-span structure supported on two abutments and six piers. The total length of the bridge is 51.3 m and the width is 11.5 m. The existing north and south embankment heights are approximately 2.0 m to 3.0 m.

At this site, the Blackwater River flows to the west. The river channel is approximately 30 m wide and approximately 3.5 m deep at the bridge. Rock protection is visible above the river level throughout the lower parts of the approach embankments.

The area surrounding the bridge site is generally flat. Crater Lake is approximately 170 m northeast of the bridge. The areas to north of the site are generally heavily treed.

Photographs in Appendix C show the general nature of the site.

The site lies within the physiographic region known as the Wabigoon Subprovince of the Superior Province of the Canadian Shield. The region is characterized by metasedimentary rocks. Locally, at this site, bedrock was not contacted within the depth of exploration. The native soils typically consist of sands and silts.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out on July 18, 25, 27, 28, 29 and 31 and August 9, 11 and 12, 2012 consisted of drilling and sampling six boreholes (numbered BWR-01, BWR-03, BWR-04, BWR-07, BWR-8 and BWR-10) in the area of the proposed south and north approaches, abutments and piers. Boreholes BWR-01 and BWR-10, drilled at the south approach and north approach, respectively, were terminated at 9.8 m depth (elevations 295.7 and 296.1). Boreholes drilled at the south and north abutments and piers were terminated at depths ranging from 31.2 m to 42.8 m (elevations 260.8 to 267.6).

Dynamic Cone Penetration Tests (DCPT), numbered BWR-03D, BWR-07D and BWR-08D, were conducted adjacent to Boreholes BWR-03, BWR-07 and BWR-08 to depths ranging from 14.4 m to 21.0 m (elevations 284.1 to 288.9) and below borehole termination depth in Boreholes BWR-03, BWR-04, BWR-07 and BWR-08, extending to depths ranging from 35.5 m to 42.3 m (elevations 261.3 to 263.3). The DCPTs were conducted to supplement the data/information collected from the boreholes.

Records of boreholes drilled during the investigation are included in Appendix A.

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

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

The drilling was carried out from the highway grade and through the bridge deck using a CME 55 truck-mounted drill rig. Hollow stem augers and NW casing were used to advance the boreholes through the soils. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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.

Two standpipe piezometers consisting of 19 mm PVC pipe with slotted screen and enclosed in filter sand were installed at this site to permit longer term groundwater level monitoring. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. The location and completion details of the piezometer and boreholes are presented in Table 3.1. Piezometers were decommissioned as per O. Reg. 903 on September 26, 2012.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
South approach	BWR-01	None installed	Borehole backfilled with holeplug to 7.9 m, auger cuttings from 7.9 m to 0.15 m, then asphalt to surface.
South abutment	BWR-03	13.0/290.6	Borehole caved-in from 42.8 m to 31.5 m upon completion of drilling. Borehole backfilled with holeplug from 31.5 m to 13.0 m, sand from 13.0 m to 10.5 m, then bentonite holeplug to surface. At bridge deck, borehole backfilled with concrete and asphalt.
South pier	BWR-04	None installed	Borehole caved-in upon completion of drilling.
North pier	BWR-07	None installed	Borehole caved-in upon completion of drilling.
North abutment	BWR-08	12.7/290.8	Borehole backfilled with sand and holeplug from 42.8 m to 12.9 m, sand from 12.9 m to 10.0 m, then bentonite holeplug to ground surface. At bridge deck, borehole backfilled with concrete and asphalt.
North approach	BWR-10	None installed	Borehole backfilled with holeplug and auger cuttings from 9.8 m to 0.15 m, then asphalt to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer). The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and shown on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the stratigraphy encountered at this site consists of pavement structure overlying the embankment granular fill. The granular fill was 2.7 m to 3.0 m thick. Layers of native gravelly sand, sand and silt were encountered below the south and north approaches and at the abutment and pier locations. Layers of gravel and sand and gravel were encountered below the sand and silt layers in boreholes drilled at the south pier and north abutment. The native soils were generally very loose to compact in relative density with zones of dense layers.

More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

Pavement structure was encountered in all the boreholes, which were drilled through the existing Highway 11 roadway or through the bridge deck. The thickness of the asphalt was 100 mm.

A layer of concrete ranging from 200 mm to 225 mm in thickness was encountered below the asphalt in Boreholes BWR-03, BWR-4, BWR-07 and BWR-08, which were drilled through the bridge deck and approach slabs.

5.2 Sand Fill

Fill was encountered below the asphalt pavement in Borehole BWR-01 and BWR-10 drilled at the south and north approaches, respectively.

The fill comprising the existing highway embankment, consisted of the brown sand and silty sand containing trace to some gravel and trace clay. The thickness of the granular fill was 3.0 m and 2.7 m in Boreholes BWR-01 and BWR-10, respectively.

The depth to the base of the fill was 3.1 m and 2.8 m (elevations 302.4 and 303.1) in Boreholes BWR-01 and BWR-10, respectively.

SPT N-values recorded in the fill ranged from 3 to 13 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

Moisture content in the fill layer ranged from 2% to 17%.

Grain size distribution curves for sand fill and silty sand fill samples are presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Sand Fill and Silty Sand Fill Percentage (%)
Gravel	0 to 1
Sand	58 to 79
Silt	18 to 39
Clay	2 to 3

5.3 Gravelly sand

A layer of gravelly sand was contacted in Borehole BWR-10 below the silty sand fill at 2.8 m depth (elevation 303.1). The thickness of the gravelly sand layer was 0.7 m.

The depth to the base of the gravelly sand layer was 3.5 m (elevation 302.4).

An SPT N-value measured in the gravelly sand layer was 15 blows per 0.3 m of penetration, indicating a compact relative density.

The moisture content of the gravelly sand layer was 19% to 21%

5.4 Sand to Sandy Silt

Native brown to grey sand to sandy silt containing trace gravel and trace clay was contacted at various depths and elevations as indicated in Table 5.1.

In Boreholes BWR-07 and BWR-08, wood fragments were noted in the upper 2.0 m of the sand layer. The upper 1.0 m of sand was mixed with clay and organics in Boreholes BWR-01 and BWR-04. At depth, cobbles and boulders were noted in the sand layer.

Table 5.1 – Depths and Elevations of Native Sand to Sandy Silt

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South approach	BWR-01	3.1 to 4.6 7.2 to 9.8 ⁽¹⁾	302.4 to 300.9 298.3 to 295.7	1.5 2.6
South abutment	BWR-03	0.0 to 5.2 6.7 to 7.9	303.6 to 298.4 296.9 to 295.7	5.2 1.2
South pier	BWR-04	0 to 10.7	298.8 to 288.1	10.7
North pier	BWR-07	0 to 1.9 4.9 to 20.6	299.5 to 297.6 294.6 to 278.9	1.9 15.7
North abutment	BWR-08	0 to 19.2	303.5 to 284.3	19.2
North approach	BWR-10	3.5 to 9.8 ⁽¹⁾	302.4 to 296.1	6.3

⁽¹⁾Borehole termination depth

SPT 'N' values recorded in the sand and sandy silt ranged from 0 to 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density. SPT N-values of 56 blows per 0.3 of penetration, indicating a very dense relative density, were recorded in Borehole BWR-08 near elevation 285.9.

The moisture contents of the sand and sandy silt ranged from 8% to 30%. Moisture contents of 45 % and 50% were measured in Borehole BWR-03 near elevation 300.8 and in Borehole BWR-07 just below the river bed, respectively. A moisture content of >80% was measured in the sand with wood fragments just below the river bed in Borehole BWR-04.

Grain size distribution curves for samples of the sand and sandy silt tested are presented on the Record of Borehole sheet and on Figures B2, B3 and B6 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Sandy Silt (%)	Sand (%)
Gravel	0 to 7	0 to 4
Sand	25 to 54	65 to 98
Silt	40 to 73	28
Clay	1 to 5	2
Silt & Clay	-	13 to 33

5.5 Silt

Native brown to grey silt containing trace to some sand and trace clay was contacted at various depths and elevations as indicated in Table 5.2.

Table 5.2 – Depths and Elevations of Native Silt

Foundation Unit	Borehole	Depth below existing ground surface (m)	Elevation (m)	Thickness (m)
South approach	BWR-01	4.6 to 7.2	300.9 to 298.3	2.6
South abutment	BWR-03	5.2 to 6.7	298.4 to 296.9	1.5
		7.9 to 24.2	295.7 to 279.4	16.3
South pier	BWR-04	10.7 to 29.7	288.1 to 269.1	19.0
North pier	BWR-07	20.6 to 35.9 ⁽¹⁾	278.9 to 263.6	15.3
North abutment	BWR-08	19.2 to 35.2	284.3 to 268.3	16.0

⁽¹⁾Borehole termination depth

SPT ‘N’ values recorded in the silt ranged from 2 to 50 blows per 0.3 m of penetration, indicating loose to dense relative density. Generally, the silt layer is in a compact state.

The moisture content of the silt ranged from 18% to 28%.

Grain size distribution curves for samples of the silt tested are presented on the Record of Borehole sheet and on Figures B4 and B5 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Silt (%)
Gravel	0
Sand	0 to 19
Silt	75 to 94
Clay	4 to 8

5.6 Sand

A layer of grey sand containing some silt to silt, trace gravel, trace clay and occasional cobbles and boulders was contacted below the silt at 24.2 m depth (elevation 279.4) in Borehole BWR-03 and at 35.2 m depth (elevation 268.3) in Borehole BWR-08. The thickness of the sand was 3.6 m in Borehole BWR-08.

The depth to the base of the sand in Borehole BWR-08 was 38.8 m (elevation 264.7). Borehole BWR-03 was terminated within the sand at 42.8 m depth (elevation 260.8).

SPT 'N' values recorded in the sand ranged from 24 to 38 blows per 0.3 m of penetration, indicating compact to dense relative density. An SPT-N value of 100 blows with no penetration, indicating a very dense relative density, was recorded in Borehole BWR-08 near elevation 265.3.

The moisture content of the silt ranged from 17% to 22%.

Grain size distribution curves for samples of the sand tested are presented on the Record of Borehole sheet and on Figure B6 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Sand (%)
Gravel	0 to 2
Sand	74 to 98
Silt	22
Clay	2
Silt & Clay	2

5.7 Sand and Gravel

A layer of sand and gravel was contacted below the sand at 1.9 m depth (elevation 297.6) in Borehole BWR-07. The thickness of the sand and gravel layer was 3.0 m. The depth to the base of the sand and gravel layer was 4.9 m (elevation 294.6).

In Borehole BWR-08, a layer of sand and gravel was contacted at 38.8 m depth (elevation 264.7). Borehole BWR-08 was terminated within the sand and gravel layer at 39.5 m depth (elevation 264.0).

In Borehole BWR-07, the SPT N-values measured in the sand and gravel layer were 10 and 0 blows per 0.3 m of penetration, indicating a compact to very loose relative density. An SPT N-value of 45 blows per 0.3 m of penetration was measured in Borehole BWR-08, indicating a dense relative density.

The moisture content of the sand and gravel layer ranged from 8% to 21%.

5.8 Gravel

A layer of gravel was contacted in Borehole BWR-04 below the silt at 29.7 m depth (elevation 269.1)

Borehole BWR-04 was terminated within the gravel layer at 31.2 m depth (elevation 267.6).

The SPT N-value measured in the gravel layer was 20 blows per 0.3 m of penetration, indicating a compact relative density

5.9 Water Levels

Water levels were monitored in the open boreholes during and upon completion of drilling. Two standpipe piezometers were installed in Boreholes BWR-03 and BWR-08 to monitor water levels after completion of drilling. The water levels measured in the piezometer and open boreholes are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Date	Water Level (m)		Comments
		Depth	Elevation	
BWR-01	July 29, 2012	3.8	301.7	Open borehole
BWR-03	September 13, 2012	2.9	302.7	In piezometer
	September 26, 2012	2.6	303.0	
BWR-08	September 13, 2012	2.6	303.2	In piezometer
	September 26, 2012	2.3	303.5	
BWR-10	July 29, 2012	3.4	302.5	Open borehole

Piezometric readings indicate that the water level is near elevations 303.0 and 303.5, at the south and north abutments, respectively.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

GA drawing indicates that the water level in Blackwater River was at Elevation 301.2 in April 2011. Normal high water level is at elevation 302.4, for a two year return period.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. MRC provided plan drawings to obtain the co-ordinates and the ground surface elevations for the boreholes.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied truck mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. George Azzopardi and Ms. Eckie Siu of Thurber Engineering Ltd.

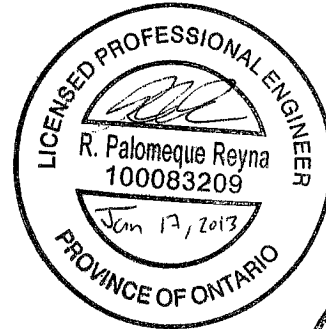
Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P. Eng.

Interpretation of the data and preparation of the report was carried out by Ms. R. Palomeque Reyna, P.Eng. and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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


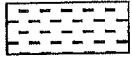



 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

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

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	Field Estimation of Hardness*	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Specimen can only be chipped with a geological hammer	
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	Requires many blows of geological hammer to break	
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	Requires more than one blow of geological hammer to break	
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	Breaks under single blow of geological hammer.	
<u>TERMS</u>					
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No BWR-01

1 OF 2

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 207.0 E 235 637.0 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2012.07.29 - 2012.07.29 CHECKED BY LRB

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			SHEAR STRENGTH kPa					
305.5								20 40 60 80 100					
0.0	ASPHALT: (100mm)												
0.1	SAND, some silt, trace clay Compact to Very Loose Brown Damp (FILL)		1	GS			305						
			1	SS	13								
	Occasional oxide staining		2	SS	4		304						0 79 18 3
			3	SS	3		303						
302.4													
3.1	SAND, trace silt, mixed with organics, occasional rootlets Very Loose Dark Brown Moist		4	SS	2		302						
300.9							301						0 6 89 5
4.6	SILT, trace sand, trace clay Compact Light Brown Wet		5	SS	10		300						
	Loose		6	SS	4		299						
298.3													
7.2	Sandy SILT, some clay Very Loose Brown to Grey Wet		7	SS	1		298						0 47 51 2
							297						
	Loose		8	SS	9		296						
295.7													
9.8	END OF BOREHOLE AT 9.8m.												

Continued Next Page

+³, X³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-01

2 OF 2

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 207.0 E 235 637.0 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.07.29 - 2012.07.29 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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					WATER CONTENT (%)			
							20	40	60	80	100	W _p	W	W _L		
	Continued From Previous Page WATER LEVEL AT 3.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 7.9m, AUGER CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.															

RECORD OF BOREHOLE No BWR-03

1 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 221.0 E 235 636.0 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE Casing/HW/NW COMPILED BY AN
 DATUM Geodetic DATE 2012.07.27 - 2012.07.28 CHECKED BY RPR

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	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
305.6								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
0.0	ASPHALT: (100mm)							20 40 60 80 100				
0.3	CONCRETE: (200mm)											
0.3	Gap between underside of bridge deck and ground surface											
303.6												
2.0	Sandy SILT, trace clay, trace gravel Loose Brown Moist											
	Occasional cobbles		1	SS	4							7 36 54 1
	Occasional wood fragments Dark Brown Wet		2	SS	9							
			3	SS	8							
298.4												
7.2	SILT, some sand, trace clay Very Loose Grey Moist		4	SS	2							0 14 81 5
296.9												
8.7	SAND, trace silt Compact Grey Moist		5	SS	15							
295.7												

Continued Next Page

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

RECORD OF BOREHOLE No BWR-03

2 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 221.0 E 235 636.0 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Casing/HW/NW COMPILED BY AN
DATUM Geodetic DATE 2012.07.27 - 2012.07.28 CHECKED BY RPR

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 (%)					
9.9	Continued From Previous Page SILT, trace sand, trace clay Grey Moist Loose No recovery Occasional cobbles Dense Moist to Wet Compact Wet													
			6	SS	7									
			7	SS	42									
			8	SS	16									0 3 91 6
			9	SS	23									
			10	SS	23									
			11	SS	15									0 7 88 5

Continued Next Page

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

RECORD OF BOREHOLE No BWR-03

3 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 221.0 E 235 636.0 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Casing/HW/NW COMPILED BY AN
DATUM Geodetic DATE 2012.07.27 - 2012.07.28 CHECKED BY RPR

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							WATER CONTENT (%)		
	Continued From Previous Page							20 40 60 80 100									
	SILT, trace to some sand, trace clay Compact Grey Moist		12	SS	22		285										
			13	SS	17		284										
							283										
							282										
	Dense		14	SS	31		281							0 17 76 7			
							280										
279.4																	
26.2	SAND, some silt, trace gravel, trace clay Dense Grey Moist						279										
			15	SS	38		278										
							277										
							276										

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-03

4 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 221.0 E 235 636.0 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Casing/HW/NW COMPILED BY AN
DATUM Geodetic DATE 2012.07.27 - 2012.07.28 CHECKED BY RPR

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100							
	SAND, some silt to silty, trace gravel, trace clay Compact Grey Moist		16	SS	28		275								2 74 22 2
							274								
							273								
	Casing from 30.5m to 33.5m						272								
			17	SS	27		271								
							270								
	Wet Occasional cobbles						269								
			18	SS	24		268								
							267								
							266								
	Occasional boulders														
	Trace silt and clay Dense		19	SS	37										0 98 2

Continued Next Page

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

RECORD OF BOREHOLE No BWR-03

5 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 221.0 E 235 636.0 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Casing/HW/NW COMPILED BY AN
DATUM Geodetic DATE 2012.07.27 - 2012.07.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL (SI+CL)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	20 40 60			
	Continued From Previous Page													
	SAND, trace silt and clay Dense Grey Moist													
	Start DCPT at 43.3m													
260.8			20	SS	37									
265														
264														
263														
262														
261														
44.8	END OF BOREHOLE AT 44.8m. BOREHOLE CAVED IN FROM 33.5m TO 44.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep. 13/12 2.9 302.7 Sep. 26/12 2.6 303.0													

ONTMT4S 1197.GPJ 10/15/12

RECORD OF BOREHOLE No BWR-04

1 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 231.7 E 235 625.1 ORIGINATED BY RK
 HWY 11 BOREHOLE TYPE HW/NW COMPILED BY AN
 DATUM Geodetic DATE 2012.08.11 - 2012.08.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
305.7														
0.0	ASPHALT: (100mm)													
0.1														
305.4	CONCRETE: (225mm)													
0.3	Gap between underside of bridge deck and ground surface													
305														
304														
303														
302														
301														
300														
299														
298.8														
6.9	SAND, mixed with organics, wood fragments Compact Dark Brown Wet		1	SS	11									
298.1														
7.6	Sandy SILT, trace clay, trace gravel Compact Grey Wet		2	SS	14									
297														
296														

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-04

2 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 231.7 E 235 625.1 ORIGINATED BY RK
HWY 11 BOREHOLE TYPE HW/NW COMPILED BY AN
DATUM Geodetic DATE 2012.08.11 - 2012.08.12 CHECKED BY RPR

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			SHEAR STRENGTH kPa					
	Continued From Previous Page							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100					
	Sandy SILT, trace clay Compact Grey Wet		3	SS	12		295						
			4	SS	15		294						0 25 73 2
			5	SS	11		292						
	Loose		6	SS	7		291						
			7	SS	8		289						0 45 53 2
288.1													
17.6	SILT, trace clay, trace sand Compact Grey Wet		8	SS	13		288						
			9	SS	19		286						

Continued Next Page

+³ × 3: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-04

5 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 231.7 E 235 625.1 ORIGINATED BY RK
 HWY 11 BOREHOLE TYPE HW/NW COMPILED BY AN
 DATUM Geodetic DATE 2012.08.11 - 2012.08.12 CHECKED BY RPR

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								
	Continued From Previous Page							20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100					
263.3							265						
42.4	END OF BOREHOLE AT 42.4m. BOREHOLE CAVED IN UPON COMPLETION OF DRILLING.						264						

RECORD OF BOREHOLE No BWR-07

1 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 251.7 E 235 632.2 ORIGINATED BY RK
 HWY 11 BOREHOLE TYPE HW COMPILED BY AN
 DATUM Geodetic DATE 2012.08.09 - 2012.08.11 CHECKED BY RPR

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	WATER CONTENT (%)					
305.7														
0.0	ASPHALT: (100mm)													
0.1														
305.4	CONCRETE: (225mm)													
0.3	Gap between underside of bridge deck and ground surface													
							305							
							304							
							303							
							302							
							301							
301.0							300							
4.7	WATER						299							
							298							
299.5							297							
6.2	SAND, wood fragments Very Loose Grey Wet		1	SS	2		296							
297.6														
8.1	SAND and GRAVEL, some silt Compact Grey Wet		2	SS	10									

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-07

2 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 251.7 E 235 632.2 ORIGINATED BY RK
HWY 11 BOREHOLE TYPE HW COMPILED BY AN
DATUM Geodetic DATE 2012.08.09 - 2012.08.11 CHECKED BY RPR

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	20 40 60 80 100	20 40 60 80 100		
	Continued From Previous Page							SHEAR STRENGTH kPa				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				
								WATER CONTENT (%)				
								20 40 60 80 100				
294.6	SAND and GRAVEL, some silt Very Loose Grey Wet		3	SS	0		295					
11.1	Sandy SILT Loose Grey Wet		4	SS	4		294					
							293					
	Some gravel, trace clay Compact Light Brown Wet		5	SS	16		292					
291.5							291					
14.2	SAND, coarse, trace gravel Loose to Compact Grey Wet		6	SS	5		290					
							289					
	No recovery		7	SS	12		288					
							287					
287.4			8	SS	6		286					
18.3	Sandy SILT, trace clay Loose Grey Wet		9	SS	8							

ONTMT4S 1197.GPJ 10/15/12

Continued Next Page

+³, x³: Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-07

3 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 251.7 E 235 632.2 ORIGINATED BY RK
 HWY 11 BOREHOLE TYPE HW COMPILED BY AN
 DATUM Geodetic DATE 2012.08.09 - 2012.08.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			FLASTIC 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 80 100	20 40 60 80 100	20 40 60					
Continued From Previous Page															
	Sandy SILT, trace clay Compact Grey Wet														
			10	SS	15		285								
							284								
							283								
							282								
							281								
			11	SS	29		280								
							279								
278.9							278								
26.8	SILT, trace clay, trace sand Compact Grey Moist						277								
			12	SS	29		276								

Continued Next Page

+³ ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-07

4 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 251.7 E 235 632.2 ORIGINATED BY RK
HWY 11 BOREHOLE TYPE HW COMPILED BY AN
DATUM Geodetic DATE 2012.08.09 - 2012.08.11 CHECKED BY RPR

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	WATER CONTENT (%)					
	Continued From Previous Page													
	SILT, trace sand, trace clay Compact Grey Wet		13	SS	26		275							
							274							
							273							
							272							
			14	SS	19		271							
							270							
							269							
	Some sand Dense		15	SS	38		268							0 19 75 6
							267							
							266							

Continued Next Page

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

RECORD OF BOREHOLE No BWR-07

5 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 251.7 E 235 632.2 ORIGINATED BY RK
HWY 11 BOREHOLE TYPE HW COMPILED BY AN
DATUM Geodetic DATE 2012.08.09 - 2012.08.11 CHECKED BY RPR

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	WATER CONTENT (%)					
	Continued From Previous Page													
263.6	SILT, trace sand, trace clay Compact Grey Wet		16	SS	23									
42.1	Boulders													
262.7	Start DCPT from 42.1m													
43.0	END OF BOREHOLE AT 43.0m. BOREHOLE CAVED IN UPON COMPLETION OF DRILLING.													

RECORD OF BOREHOLE No BWR-08

2 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 262.5 E 235 621.2 ORIGINATED BY ES/SLL
HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2012.07.18 - 2012.07.25 CHECKED BY LRB

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 80 100	20 40 60 80 100					
	Continued From Previous Page													
	SAND, some silt, trace gravel, trace clay Compact Grey Wet		5	SS	18		295							
			6	SS	23		294							
			7	SS	18		293							
			8	SS	26		292							
			9	SS	29		291							
			10	SS	20		290							
							289							
							288							
							287							
							286							

Continued Next Page

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

RECORD OF BOREHOLE No BWR-08

4 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 262.5 E 235 621.2 ORIGINATED BY ES/SLL
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2012.07.18 - 2012.07.25 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W P W W L	WATER CONTENT (%) 20 40 60		GR SA SI CL
	SILT, trace clay Compact Grey Wet											
			15	SS	13		275					
							274					
							273					
							272					
			16	SS	19		271					
							270					
							269					
268.3							268					
37.5	SAND, some silt Dense Grey Moist		17	SS	34		267					
							266					

Continued Next Page

+³ x³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-08

5 OF 5

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 262.5 E 235 621.2 ORIGINATED BY ES/SLL
HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2012.07.18 - 2012.07.25 CHECKED BY LRB

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	WATER CONTENT (%)					
	Continued From Previous Page													
264.7	SAND, some silt Grey Moist Coring through cobbles and boulders from 40.5m to 41.8m		18	SS	100/ 0.0		265							
264.0	SAND and GRAVEL Dense Brown Moist		19	SS	45		264							
261.0	End of sampling and start DCPT						263							
44.8	END OF BOREHOLE AT 44.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Sep. 13/12 2.6 303.2 Sep. 26/12 2.3 303.5						262							

RECORD OF BOREHOLE No BWR-10

1 OF 2

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 275.0 E 235 620.5 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.07.29 - 2012.07.29 CHECKED BY LRB

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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
305.9 0.0 0.1	ASPHALT: (100mm) Silty SAND, trace to some gravel, trace clay, occasional oxide staining Compact to Very Loose Brown Damp (FILL)		1	GS										
			1	SS	12		305							
			2	SS	3		304							1 58 39 2
	Occasional asphalt fragments		3	SS	10									
303.1														
2.8	Gravelly SAND Compact Brown Damp		4	SS	15		303							
302.4														
3.5	Sandy SILT, trace clay Compact Light Brown Wet						302							
			5	SS	12		301							0 31 56 3
	Compact		6	SS	10		300							
							299							
	Loose Grey		7	SS	5		298							0 27 58 5
							297							
			8	SS	9									
296.1														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+³, x³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BWR-10

2 OF 2

METRIC

W.P. 6066-09-00 LOCATION Blackwater River Bridge N 5 497 275.0 E 235 620.5 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2012.07.29 - 2012.07.29 CHECKED BY LRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100					
	Continued From Previous Page												
	WATER LEVEL AT 3.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.15m, THEN ASPHALT TO SURFACE.												

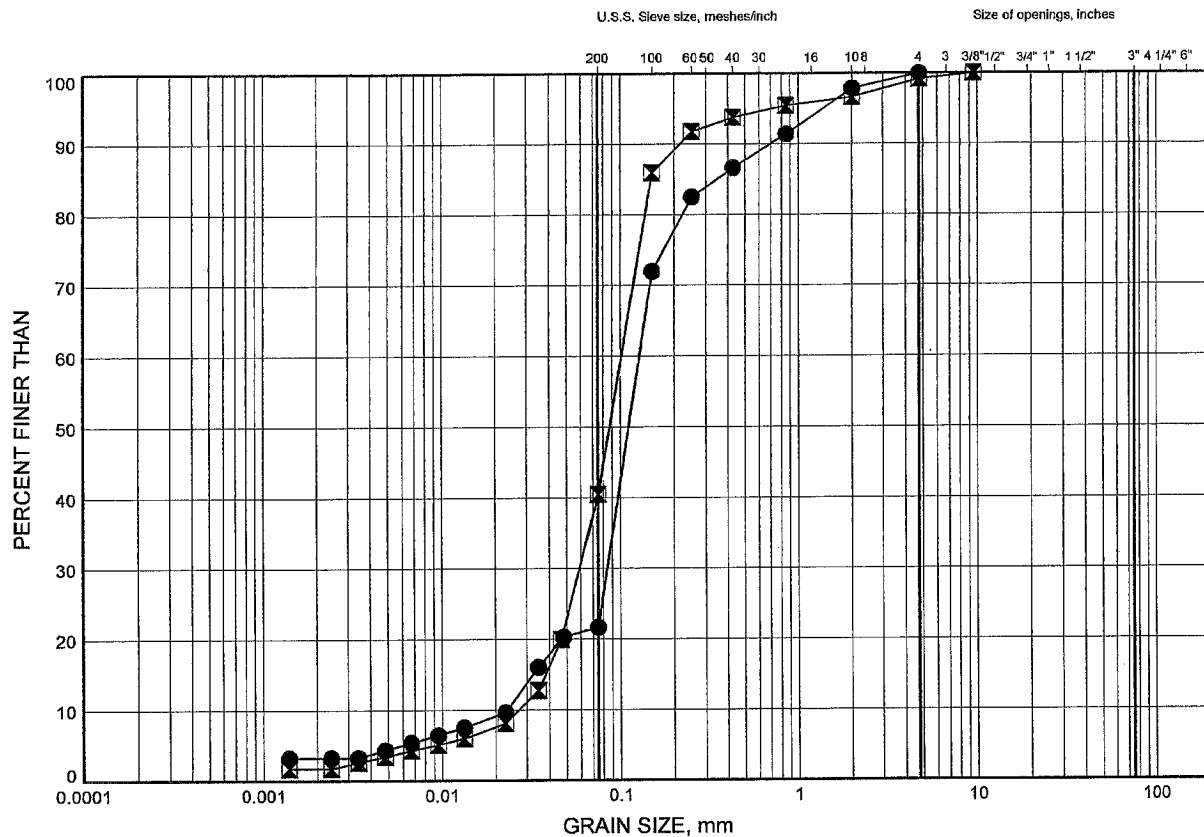
Appendix B

Laboratory Test Results

BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND & SILTY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-01	1.83	303.67
⊠	BWR-10	1.83	304.07

GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 10/15/12

Date October 2012
W.P.# 6066-09-00

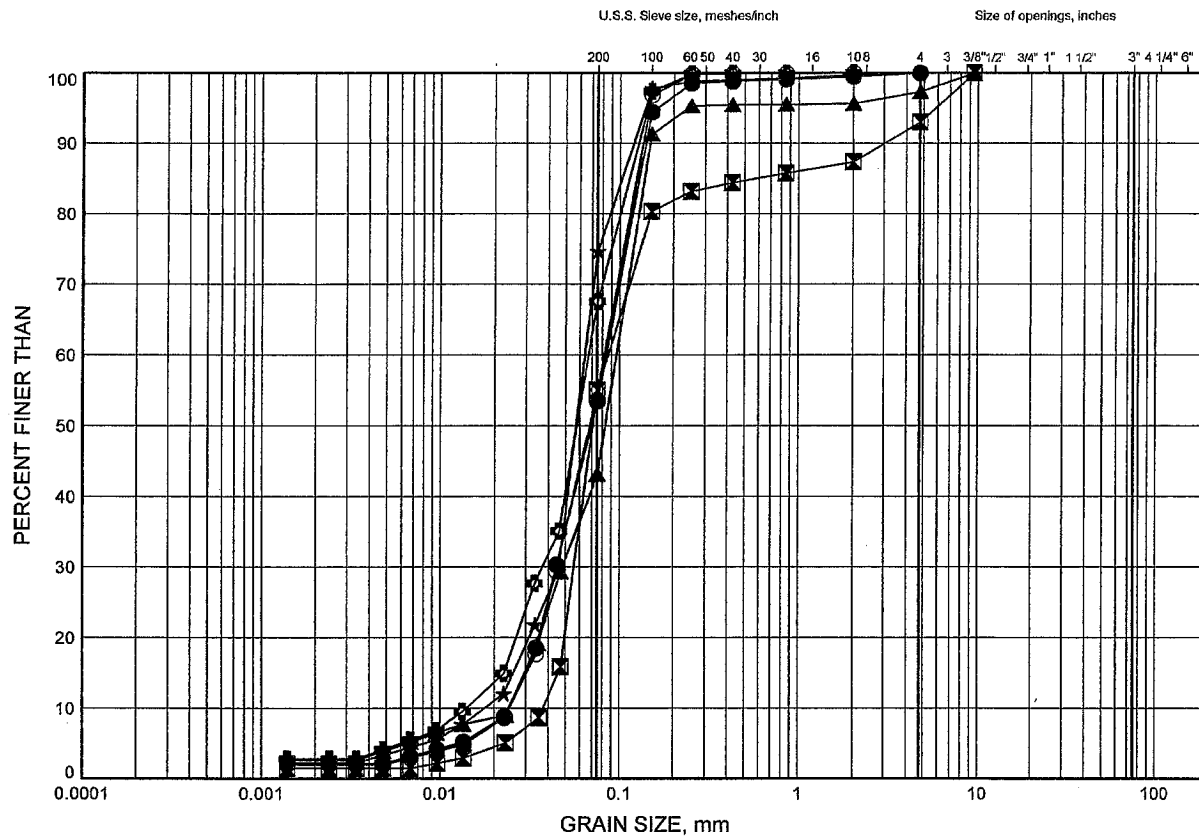


Prep'd AN
Chkd. RPR

BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B2

SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-01	7.92	297.58
⊠	BWR-03	3.35	302.25
▲	BWR-04	8.84	296.86
★	BWR-04	11.89	293.81
⊙	BWR-04	16.46	289.24
⊗	BWR-07	19.51	286.19

Date September 2012

W.P.# 6066-09-00



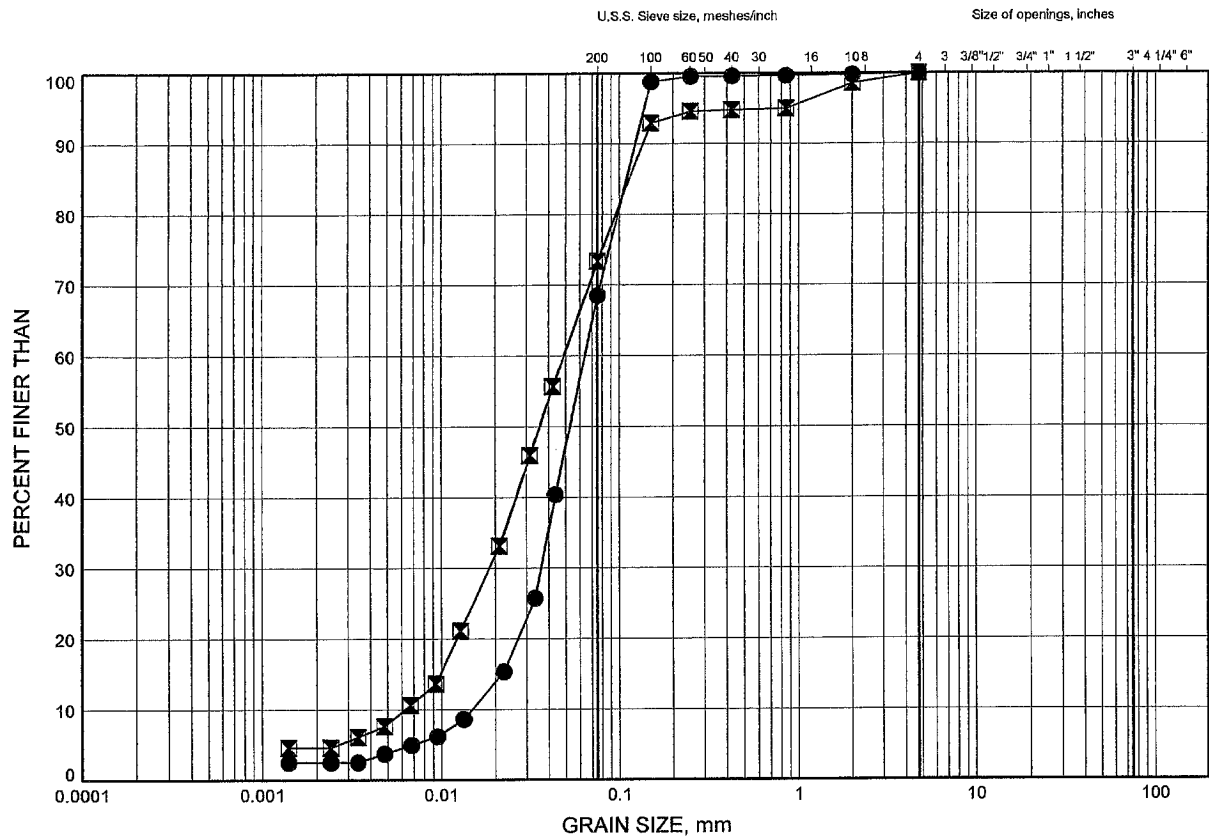
Prep'd AN

Chkd. RPR

BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B3

SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-10	4.88	301.02
×	BWR-10	7.92	297.98

Date October 2012
W.P.# 6066-09-00

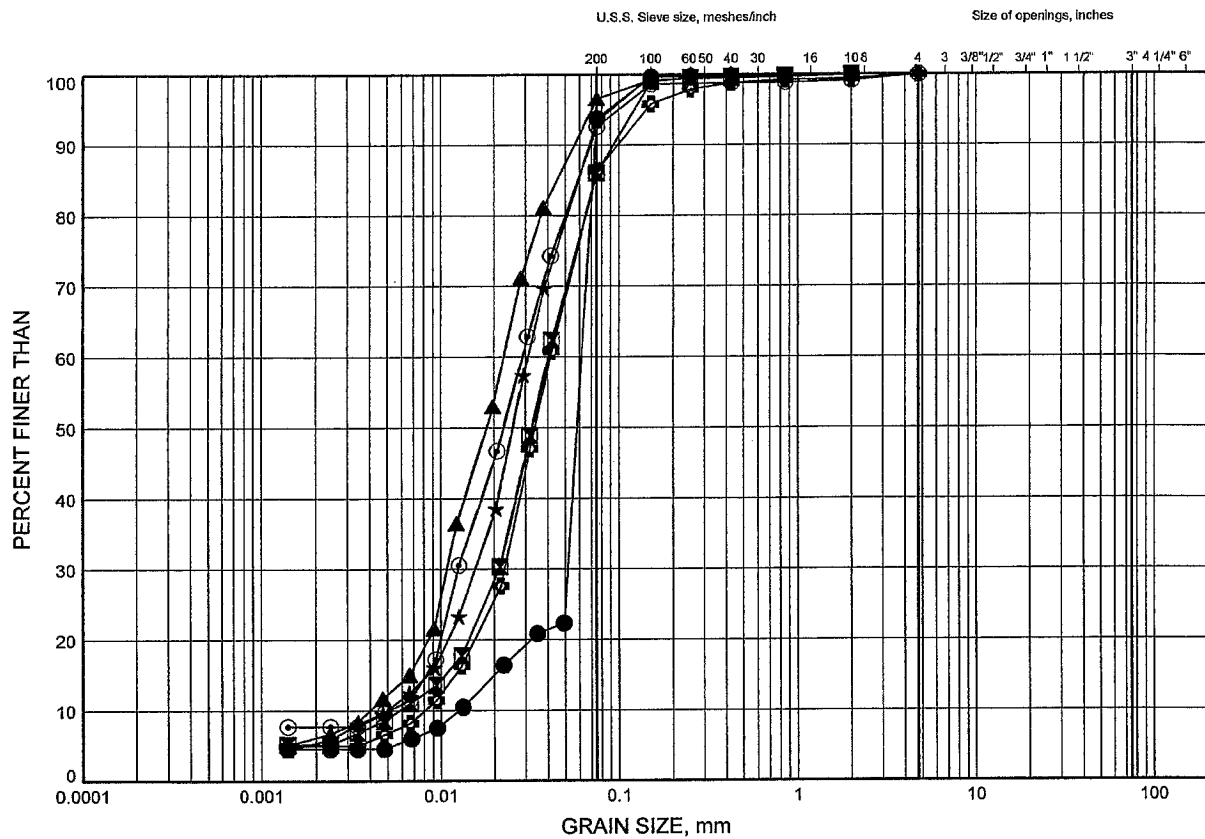


Prep'd AN
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BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B4

SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-01	4.88	300.62
⊠	BWR-03	7.92	297.68
▲	BWR-03	14.02	291.58
★	BWR-03	18.59	287.01
⊙	BWR-04	22.56	283.14
⊕	BWR-04	34.75	270.95

Date September 2012

W.P.# 6066-09-00

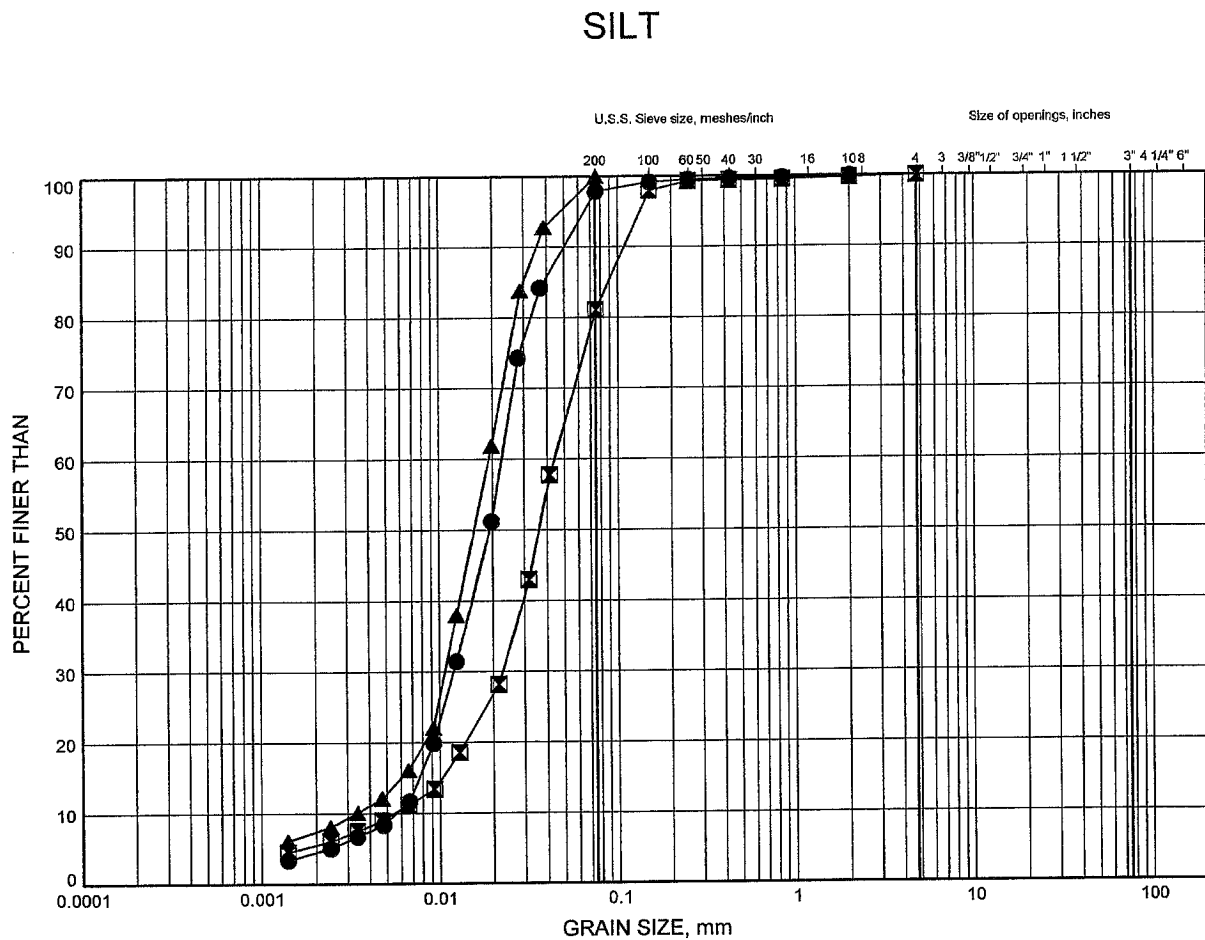


Prep'd AN

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BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-07	28.65	277.05
⊠	BWR-07	37.80	267.90
▲	BWR-08	29.26	276.54

Date ..September 2012.....
W.P.# ..6066-09-00.....

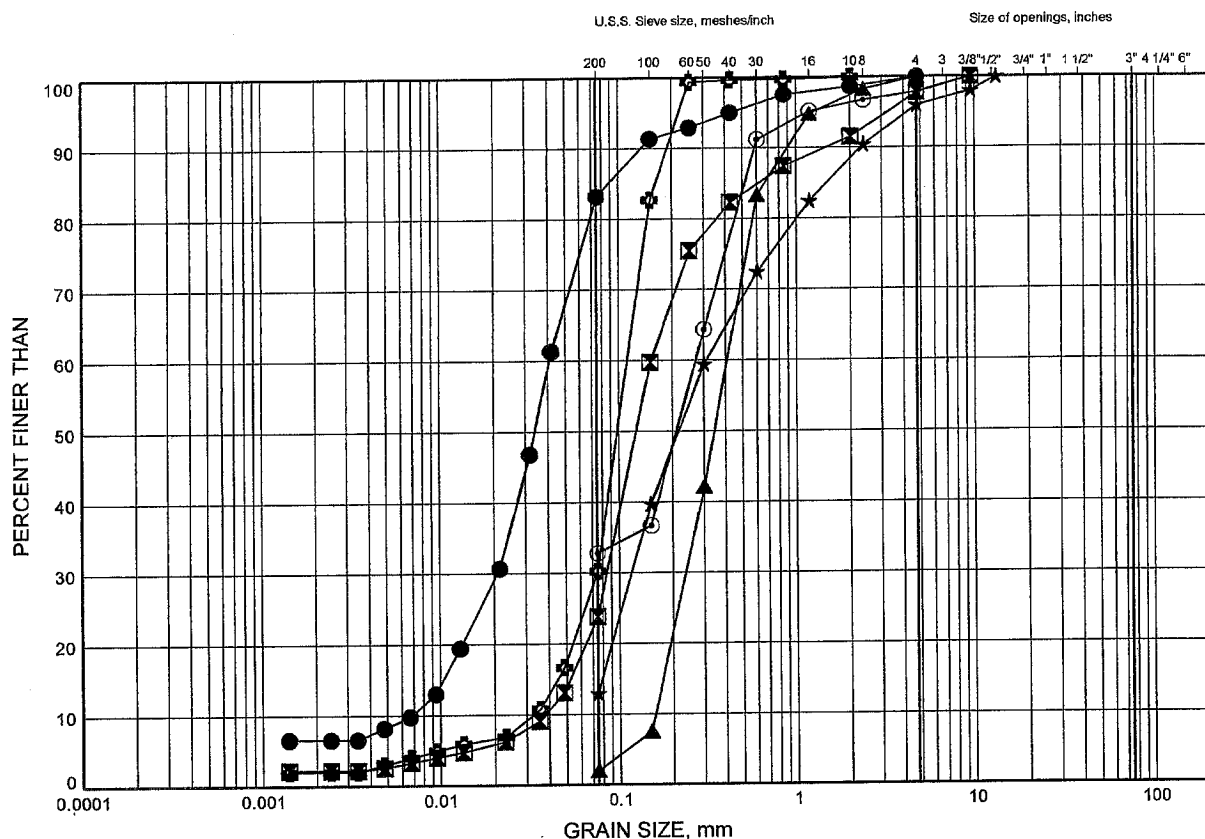


Prep'dAN.....
Chkd.RPR.....

BLACKWATER RIVER BRIDGE GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BWR-03	24.69	280.91
⊠	BWR-03	30.78	274.82
▲	BWR-03	39.93	265.67
★	BWR-08	9.45	296.35
⊙	BWR-08	12.50	293.30
⊞	BWR-08	20.12	285.68

Date September 2012
W.P.# 6066-09-00



Prep'd AN
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Appendix C

Site Photographs



Photograph 1– Blackwater River bridge



Photographs 2– Blackwater River bridge

Blackwater River Bridge Replacement
Highway 11, Site 48C-1



Photographs 3 and 4— Blackwater River bridge embankment



Photographs 5 and 6– Blackwater River bridge, existing piers

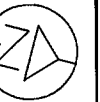
Appendix D

Drawing titled “Borehole Locations and Soil Strata”

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

CONT. No.
WP No. 6066-09-00

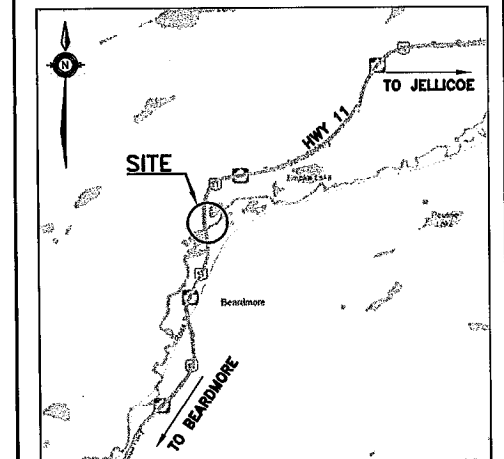
BLACKWATER CREEK BRIDGE
REHABILITATION HWY 11
BOREHOLE LOCATIONS AND SOIL STARTS



SHEET
11



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
BWR-01	305.5	5 497 207.0	235 637.0
BWR-03	305.6	5 497 221.0	235 636.0
BWR-04	305.7	5 497 231.7	235 625.1
BWR-07	305.7	5 497 251.7	235 632.2
BWR-08	305.8	5 497 262.5	235 621.2
BWR-10	305.9	5 497 275.0	235 620.5

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. 42E-14

DATE	BY	DESCRIPTION
DESIGN	RPR	CHK RPR
DRAWN	AN	CHK
SITE	48C-1	STRUCT
DATE	JAN 2013	DWG 1

