

**FOUNDATION INVESTIGATION REPORT
LITTLE GRASSY RIVER CULVERT REPLACEMENT
HIGHWAY 600
DISTRICT OF RAINY RIVER, ONTARIO**

G.W.P. 6937-11-00, SITE NO: 45-156/C

Geocres Number: 52D-16

Report to:

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February 13, 2014
File: 19-1605-121

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the Little Grassy River Culvert on Highway 600 west of Highway 621 in the District of Rainy River, 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, a stratigraphic profile, laboratory test results and written descriptions 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) Agreement Number 6010-E-0010.

2 SITE DESCRIPTION

The Little Grassy River Culvert is located on Highway 600 approximately 5 km west of Highway 621, approximately 2.5 km south of Lake of the Woods and 25 km north of Highway 11. The existing water crossing comprises three 1.8 m diameter corrugated steel pipes (CSP), approximately 21 m long with a fill cover of approximately 1.5 m. The approach embankments are approximately 2.0 m high and rock fill is visible on the side slopes.

The section of the Little Grassy River at the culvert site comprises the west branch of the river, and flows northerly towards Lake of the Woods. The surrounding lands are relatively flat and comprise a mix of farmland and brush covered, poorly drained lands.

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

The site lies within the physiographic region known as the Wabigoon Subprovince of the Superior Province of the Canadian Shield. The site is underlain by intermediate to felsic intrusive rocks overlain by glaciolacustrine fine-grained deposits of silt and clay with minor sand. Modern alluvial deposits consisting of fine sand, silt and clay with detrital organic remains underlie the river channels.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between October 26 and November 14, 2013, and comprised drilling and sampling three boreholes, identified as Boreholes LGC-1 to LGC-3.

Borehole LGC-1 was drilled on the Highway 600 pavement and terminated upon auger refusal at 13.2 m depth. Boreholes LGC-2 and LGC-3 were drilled off of the roadway using portable equipment, and sampling was terminated in these boreholes at depths of 5.8 and 5.9 m upon reaching the practical limit of the portable equipment. The approximate borehole locations 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 coordinates and ground surface elevations for the boreholes were estimated from topographic plans provided by HMM.

A truck-mounted CME75 drill rig was used to advance Borehole LGC-1 using NW casing and wash-boring techniques. Boreholes LGC-2 and LGC-3 were advanced using portable tripod equipment with BW and BX casing. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Dynamic Cone Penetration Tests were carried out below the bottom of Boreholes LGC-2 and LGC-3, to total depths of 7.9 m.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling were not representative of site conditions as water was introduced into the boreholes during coring and wash boring operations. A standpipe piezometer was installed in one borehole to monitor the groundwater level after drilling. The piezometer was decommissioned and the boreholes without piezometers were backfilled in general accordance with MOE Regulation 903. Completion details of the piezometer and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
LGC-1	13.2/ 312.3	Borehole backfilled with sand to 11.3 m, bentonite holeplug from 11.3 m to 0.3 m, sand from 0.3 m to 0.15 m, then asphalt cold patch with flush mount cover to surface.
LGC-2	None installed	Borehole backfilled with bentonite holeplug to 0.1 m, then rock fill to surface.
LGC-3	None installed	Borehole backfilled with bentonite holeplug to surface.

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 testing. The results of this testing 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.

The site stratigraphy typically comprises sand fill and/or peat overlying native silty clay. Clayey silt overlying probable bedrock was encountered at depth in one borehole. More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

Asphalt was encountered in Borehole LGC-1 which was drilled from the highway surface. The asphalt was 25mm thick.

5.2 Fill

Fill comprising brown sand with trace to some gravel, trace silt and occasional cobbles was encountered beneath the asphalt in Borehole LGC-1 and below a 50 mm thick veneer of organics in Borehole LGC-3. The fill was 4.1 m thick in Borehole LGC-1, with a lower

boundary at Elev. 321.4. In Borehole LGC-3, the fill was 0.7 m thick with a lower boundary at Elev. 323.3.

SPT N-values recorded in the embankment fill typically ranged from 15 to 27 blows for 0.3 m of penetration, indicating a compact relative density. An SPT-N value of 50 blows for no penetration was recorded in Borehole LGC-1 due to probable cobbles. An N-value of 7 blows for 0.3 m (loose) was recorded in the fill in Borehole LGC-3 drilled off of the embankment. Moisture contents ranged from 9% to 20%.

A sample of the fill underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curve for this sample is shown on Figures B1 of Appendix B.

Soil Particles	Sand Fill (%)
Gravel	14
Sand	82
Silt & Clay	4

5.3 Peat

Dark brown fibrous peat with rootlets and wood fragments was encountered surficially in Borehole LGC-2 and beneath the fill in Borehole LGC-3. The peat layer was 0.8 and 0.4 m thick in these boreholes, with the lower boundary at depths of 0.8 and 1.1 m (Elev. 322.9).

An SPT N-value of 2 blows per 0.3 m penetration was recorded, indicating a soft consistency. A moisture content of 49% was measured in the peat.

5.4 Silty Clay

Native silty clay was encountered beneath the fill and peat in all boreholes. In general, the silty clay was grey and contained some sand (to sandy). The upper 2.0 m in Borehole LGC-1 was brown. In Boreholes LGC-2 and LGC-3, the top 1.1 m to 1.4 m of the silty clay was described as dark brown to dark grey and contained sand seams and trace gravel.

In Borehole LGC-1, the silty clay layer was 7.5 m thick with a lower boundary at 11.6 m depth (Elev. 313.9). Sampling was terminated in the clay at 5.8 m and 5.9 m depth (Elev. 317.9 and 318.1) in Boreholes LGC-2 and LGC-3, and a dynamic cone penetration test was extended below this level to a total depth of 7.9 m (Elev. 315.8 and 316.1).

SPT N-values recorded in the upper 1.4 to 2.9 m of the silty clay ranged from 3 to 8 blows per 0.3 m penetration, indicating a soft to firm consistency. Below this level, the N-values varied from 8 to 39 blows per 0.3 m penetration, indicating a stiff to hard consistency, typically stiff. Moisture contents ranged from 21% to 39%.

Selected samples of the silty clay underwent laboratory grain size analysis testing and Atterberg Limits tests. The grain size distribution curves for tested samples are shown on Figure B2 of Appendix B. The results of the Atterberg Limits tests are presented in Figure B4, Appendix B. The results are summarized on the Record of Borehole sheets included in Appendix A, and in the following tables:

Soil Particles	Silty Clay (%)
Gravel	0
Sand	18 to 49
Silt	30 to 42
Clay	19 to 52

Liquid Limit	40 to 52
Plastic Limit	17 to 19

The above results indicate that the silty clay has intermediate to high plasticity with group symbols of CI to CH.

5.5 Clayey Silt

Grey clayey silt with trace sand and occasional clay seams was encountered beneath the silty clay in Borehole LGC-1. The borehole was terminated upon refusal on probable bedrock at the base of this deposit at a depth of 13.2 m (Elev. 312.3), indicating a layer thickness of 1.6 m.

An SPT N-value of 14 blows per 0.3 m penetration was obtained in the deposit, indicating a stiff consistency. A moisture content of 43% was measured.

The results of a grain size distribution analysis are shown on the Record Borehole sheets in Appendix A and in Figure B3 of Appendix B. The results are as summarized below.

Soil Particles	Clayey Silt (%)
Gravel	0
Sand	4
Silt	77
Clay	19

5.6 Water Levels

Wash boring methods were used to advance the boreholes and therefore water levels were not measured in the open boreholes during and upon completion of drilling operations. A standpipe piezometer was installed in Borehole LGC-1 to monitor the groundwater level after completion. The water levels measured in the piezometer are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
LGC-1	October 28, 2013	0.3	325.2	Piezometer
	November 12, 2013	0.3	325.2	

The preliminary GA drawing provided by HMM indicates a water level at Elevation 323.3 in the Little Grassy River on September 5, 2013. In general, the groundwater level is expected to be at or slightly above the water level in the river. The higher water level measured in the piezometer is believed to indicate an artesian condition in the clayey silt underlying the clay deposit.

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.

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 HMM.

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

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a truck mounted CME75 drill rig and tripod, and conducted the drilling, sampling and in-situ testing operations. The drilling operations were supervised by Mr. George Azzopardi and Mr. Stephane Loranger.

Overall supervision of the field program was conducted by Mr. Mark Farrant, P.Eng. Interpretation of the data and preparation of the report were carried out by Ms. Mei Cheong, P.Eng.

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

Thurber Engineering Ltd



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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


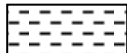



C_{pen} Shear Strength Determination by Pocket Penetrometer

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

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		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	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	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Very thinly bedded	20 to 60mm				
Laminated	6 to 20mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Thinly Laminated	Less than 6mm				

<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 LGC-1

1 OF 2

METRIC

WP# 6937-11-01 LOCATION Little Grassy River Culvert N 5 423 757.3 E 198 073.3 ORIGINATED BY GA
 HWY 600 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.26 - 2013.10.26 CHECKED BY WM

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	GR
325.5																		
0.0	ASPHALT: (25mm)																	
	SAND, trace to some gravel, trace silt Compact Brown Wet (FILL)		1	SS	19							○						
			2	SS	16							○						
			3	SS	27							○					14	82
	Occasional cobbles		4	SS	50/ 0.0												4	(SI+CL)
			5	SS	15							○						
321.4																		
4.1	Silty CLAY, some sand to sandy Firm to Stiff Brown Wet		6	SS	7								○					
	Grey		7	SS	13												0	21
																	31	48
			8	SS	15							○						
			9	SS	13							○						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No LGC-1

2 OF 2

METRIC

WP# 6937-11-01 LOCATION Little Grassy River Culvert N 5 423 757.3 E 198 073.3 ORIGINATED BY GA
 HWY 600 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.26 - 2013.10.26 CHECKED BY WM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page													
313.9	Silty CLAY , some sand Stiff Grey Wet		10	SS	8									
11.6	Clayey SILT , trace sand, occasional clay seams Stiff Grey Wet		11	SS	14									0 4 77 19
312.3	END OF BOREHOLE AT 22.4m ON REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Oct. 28/13 0.3 325.2 Nov. 12/13 0.3 325.2													

RECORD OF BOREHOLE No LGC-2

1 OF 1

METRIC

WP# 6937-11-01 LOCATION Little Grassy River Culvert N 5 423 744.2 E 198 071.8 ORIGINATED BY SLL
 HWY 600 BOREHOLE TYPE Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.11.14 - 2013.11.14 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 ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W P W W L	WATER CONTENT (%)			
323.7													
0.0	PEAT, fibrous, with wood fragments Soft Moist		1	SS	2								
322.9							323						
0.8	Silty CLAY, with sand seams, trace gravel Firm Dark Brown Moist		2	SS	8								0 35 34 31
			3	SS	6		322						
321.5													
2.2	Silty CLAY, some sand to sandy Stiff to Hard Grey Moist		4	SS	12		321						0 24 42 34
			5	SS	12								
							320						
			6	SS	13		319						
			7	SS	39								0 18 30 52
317.9							318						
5.8	End of sampling and start DCPT												
							317						
315.8							316						
7.9	END OF BOREHOLE AND DCPT AT 7.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN ROCKFILL TO SURFACE.												






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

RECORD OF BOREHOLE No LGC-3

1 OF 1

METRIC

WP# 6937-11-01 LOCATION Little Grassy River Culvert N 5 423 771.3 E 198 086.1 ORIGINATED BY SLL
 HWY 600 BOREHOLE TYPE Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.11.13 - 2013.11.14 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		<div><div>PLASTIC LIMIT</div><div>NATURAL MOISTURE CONTENT</div><div>LIQUID LIMIT</div></div> <div><div>W_P</div><div>W</div><div>W_L</div></div> <div>WATER CONTENT (%)</div>	UNIT WEIGHT <div>γ</div> kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								<div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>					
324.0								<div>20 40 60 80 100</div>	<div>20 40 60</div>				
0.0	ORGANICS: (50mm)		1	SS	7		324			<div>○</div>		0 49 32 19	
323.3	SAND, some gravel Loose Brown Moist (FILL)												
0.7													
322.9	PEAT, with rootlets, mixed with clay Firm Dark Brown Moist		2	SS	5		323			<div>○</div>			
1.1													
	Silty CLAY, with thin wet sand seams Soft Dark Grey Moist to Wet		3	SS	3		322			<div>○</div>			
321.8													
	Silty CLAY, some sand to sandy Firm to Very Stiff Grey Moist		4	SS	5		321			<div>○</div>			
2.2			5	SS	7		320						
			6	SS	23		319			<div><div></div><div></div><div></div></div>		0 25 32 43	
			7	SS	28		318			<div>○</div>			
318.1													
5.9	End of sampling and start DCPT						317						
316.1	END OF BOREHOLE AT 7.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.												
7.9													

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

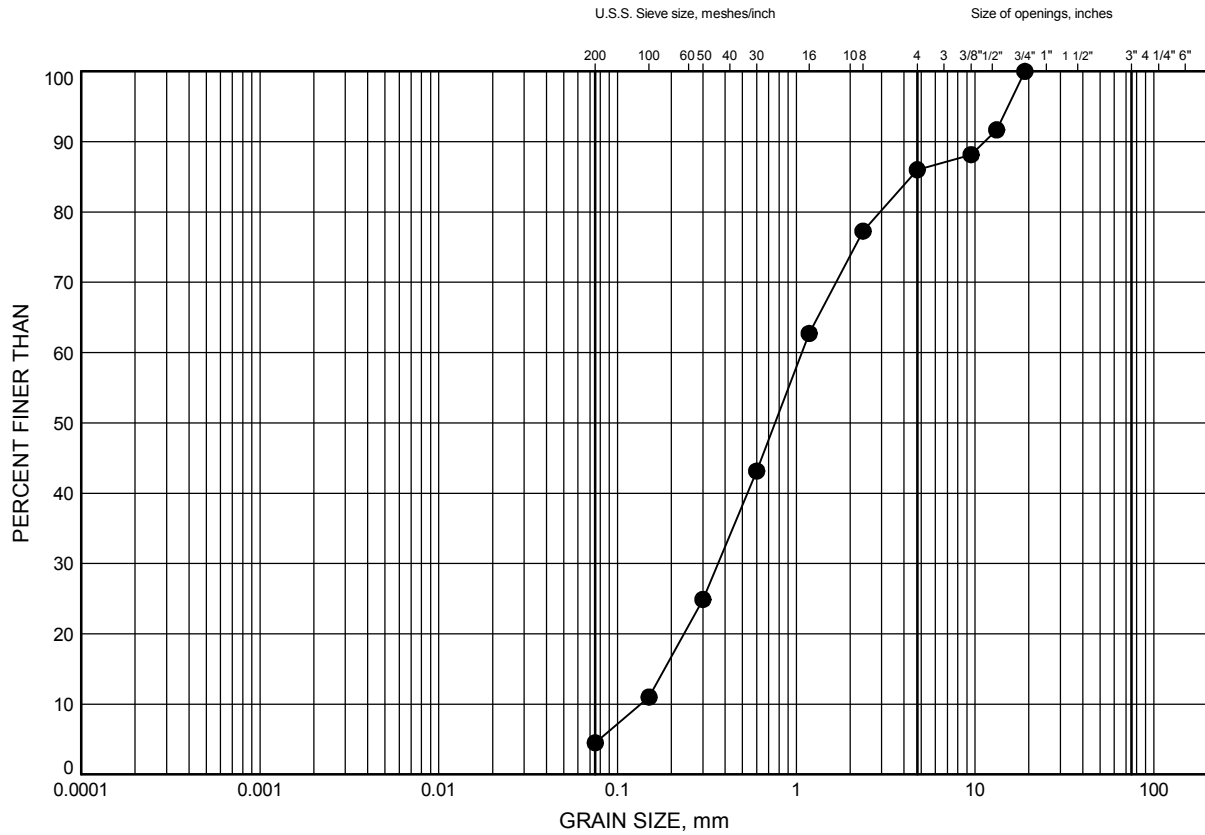
Appendix B

Laboratory Test Results

Little Grassy Culvert
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGC-1	1.83	323.67

Date January 2014
WP# 6937-11-01

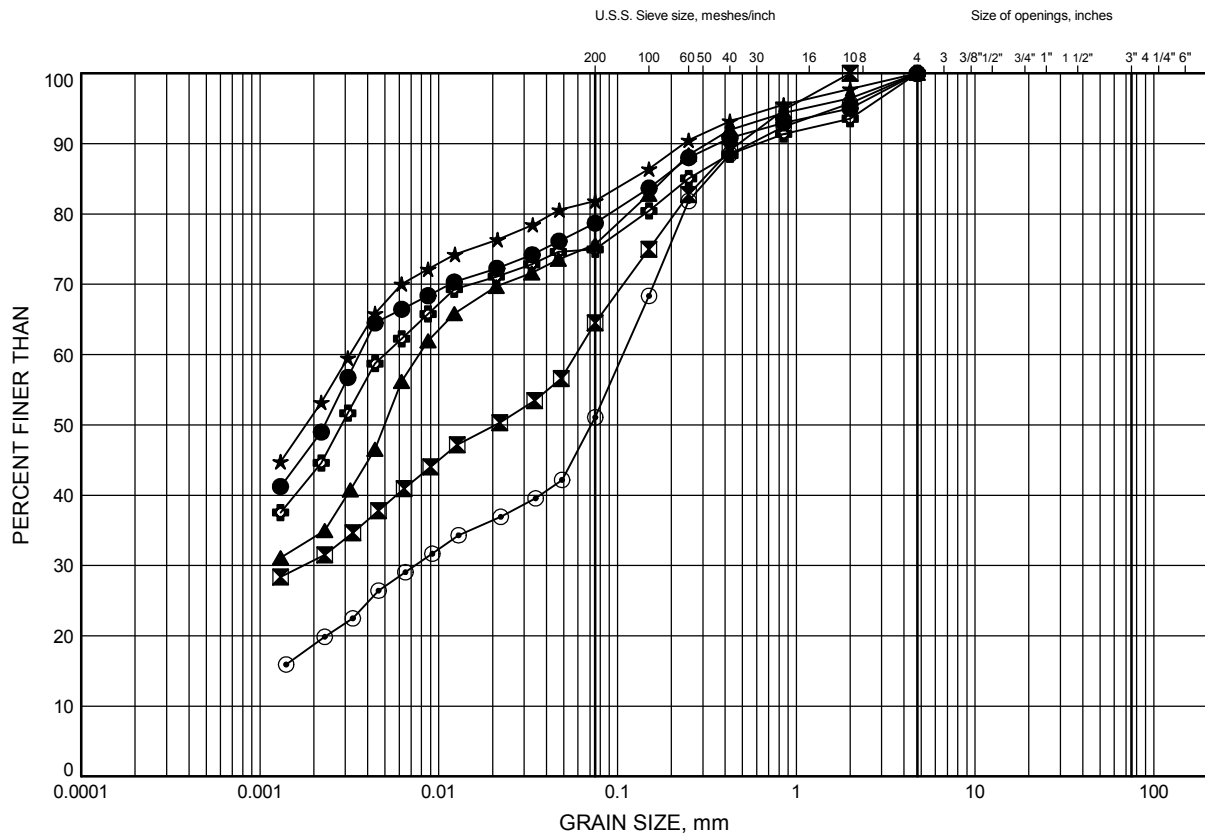


Prep'd AN
Chkd. MC

Little Grassy Culvert 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)
●	LGC-1	6.40	319.10
⊠	LGC-2	1.07	322.63
▲	LGC-2	2.59	321.11
★	LGC-2	5.49	318.21
⊙	LGC-3	1.83	322.17
⊕	LGC-3	4.88	319.12

Date January 2014
WP# 6937-11-01

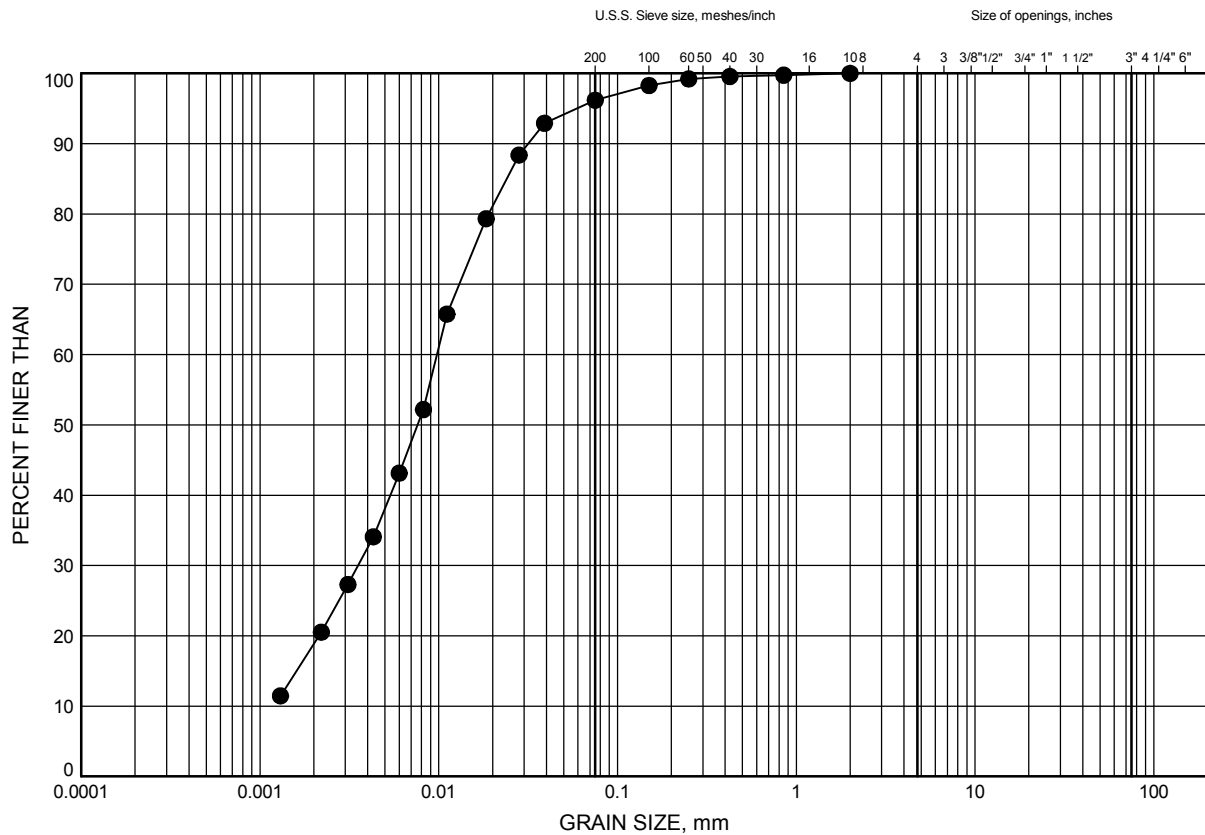


Prep'd AN
Chkd. MC

Little Grassy Culvert GRAIN SIZE DISTRIBUTION

FIGURE B3

CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGC-1	12.50	313.00

Date January 2014
WP# 6937-11-01

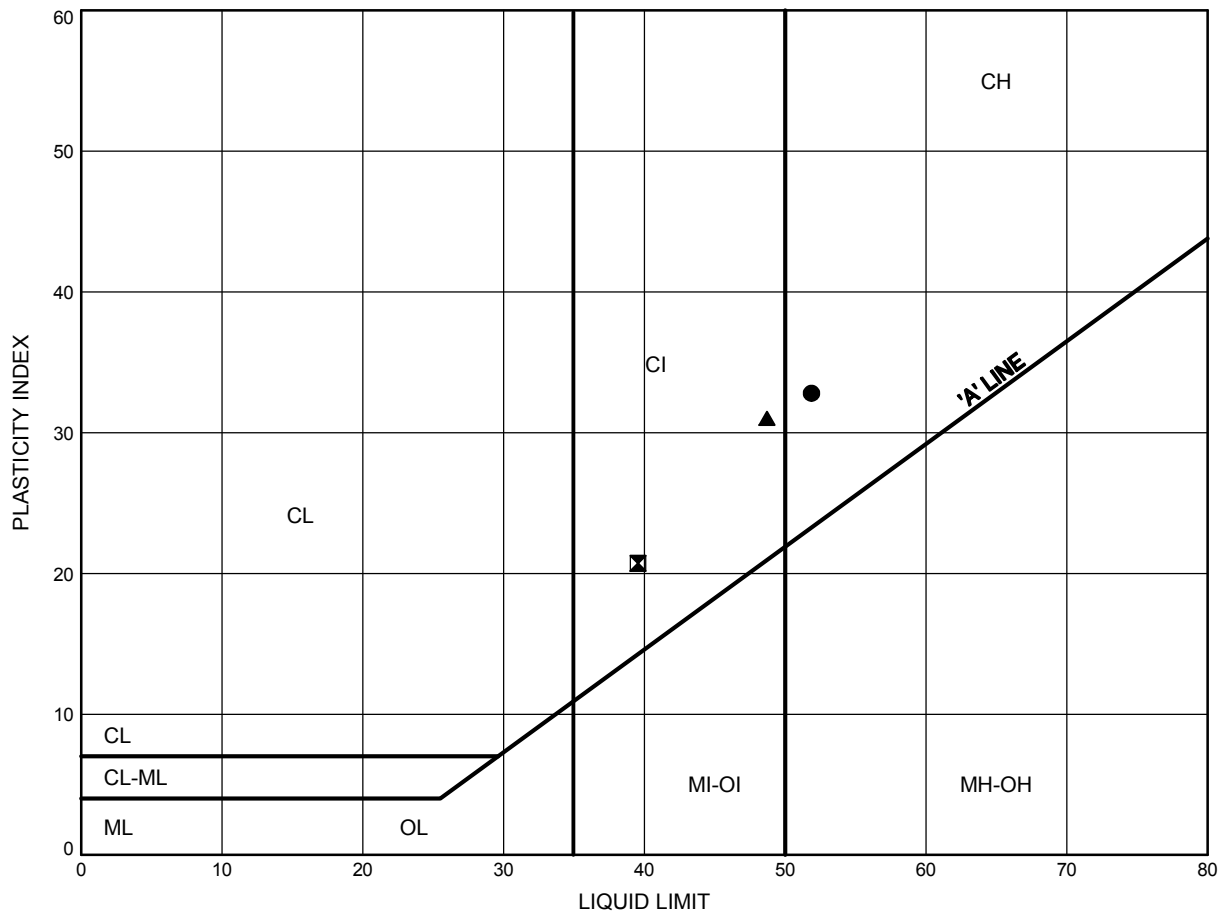


Prep'd AN
Chkd. MC

Little Grassy Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE B4

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	LGC-1	6.40	319.10
⊠	LGC-2	2.59	321.11
▲	LGC-3	4.88	319.12

Date January 2014
 WP# 6937-11-01



Prep'd AN
 Chkd. MC

Appendix C

Site Photographs



Photograph 1 – North end of culvert



Photograph 2 – South end of culvert



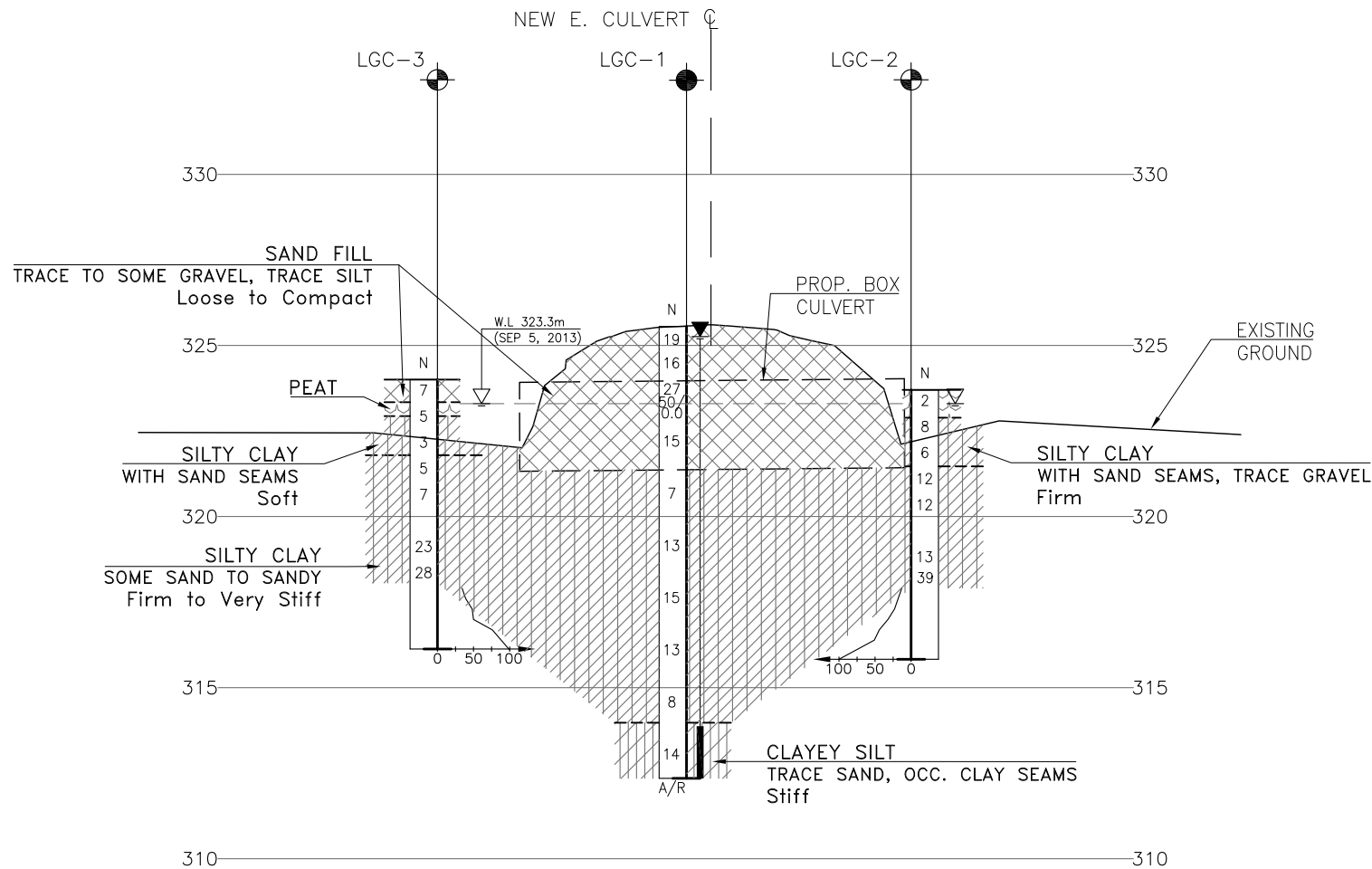
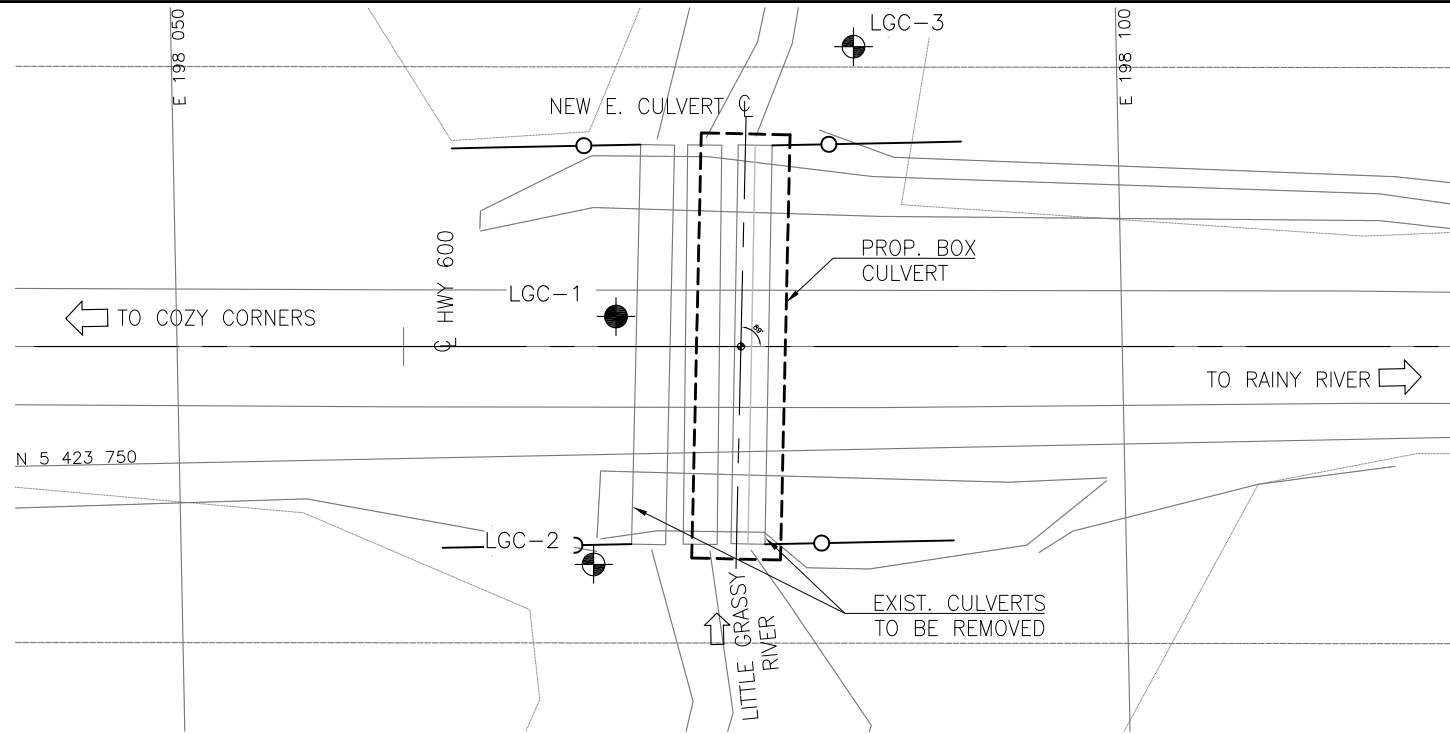
Photograph 3 – South end of culvert, looking southwest



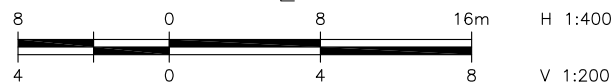
Photograph 4 – North end of culvert, looking northwest

Appendix D

Borehole Locations and Soil Strata Drawing



SECTION ALONG CL EAST CULVERT



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

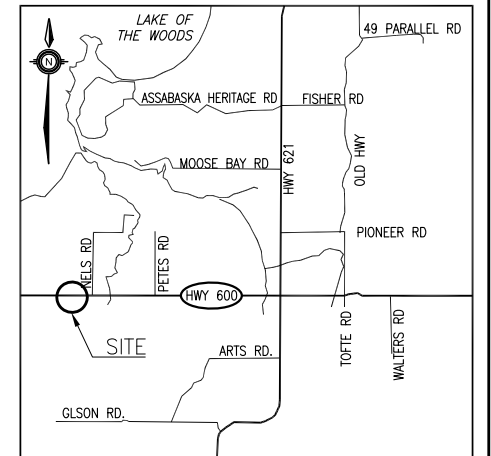


CONT No 2013-6025
WP No 6937-11-01

LITTLE GRASSY RIVER CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET
33



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 During Drilling
	Water Level In Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
LGC-1	325.5	5 423 757.3	198 073.3
LGC-2	323.7	5 423 744.2	198 071.8
LGC-3	324.0	5 423 771.3	198 086.1

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRIS No. 52D-16

REVISIONS		DATE		BY		DESCRIPTION	
DESIGN	MC	CHK	MC	CODE	CAN/CSA S6-06/LOAD CL-625-01	DATE	FEB 2014
DRAWN	AN	CHK		SITE	45-156/C/STRUCT	DWG	2