

**FOUNDATION INVESTIGATION AND DESIGN REPORT  
WOLF CREEK CULVERT REPLACEMENT  
HIGHWAY 602  
EMO TOWNSHIP  
DISTRICT OF RAINY RIVER, ONTARIO**

**G.W.P. 6938-10-00, SITE No. 45-263/C**

**Geocres Number: 52C-26**

**Report to**

**Hatch Mott MacDonald**

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

December 9, 2011  
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 location of a culvert at the Highway 602 crossing of the Wolf Creek 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 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) Agreement Number 6010-E-0010.

**2 SITE DESCRIPTION**

The Wolf Creek culvert is located on Highway 602, approximately 3.5 km south of the intersection of Highway 602 and Highway 11. This site is located in Emo Township in the Rainy River District of Ontario.

The existing Wolf Creek culvert is a concrete open frame culvert supported on footings. The culvert is 4.3 m wide and 27.2 m long. The existing Highway 602 grade was near elevation 344.0 and the original ground surface was at about elevation 337.0, resulting in a maximum embankment height of 7.0 m. The water flows through the culvert from east to west.

The road embankment is approximately 6.6 m high above Wolf Creek. The surrounding lands are undeveloped and heavily treed.

Around mid-July, 2011, the existing culvert collapsed and actions to construct a replacement crossing involving a modular bridge were taken immediately.

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

This region is characterized by Precambrian meta-volcanic and meta-sedimentary rocks intruded by later stage diabase dykes. The bedrock is mantled by glaciolacustrine clays and sand and gravel deposits.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project were carried out on July 15, 17 and 18, 2011 and consisted of drilling and sampling three boreholes (identified as WCC-01 to WCC-03) near the existing culvert. Borehole WCC-02 was drilled on the highway shoulder, through the existing highway embankment. Boreholes WCC-01 and WCC-03 were drilled at the toe of the highway embankment, near each end of the existing culvert.

Boreholes WCC-01 and WCC-02 were advanced to 15.2 m and 18.9 m depth, respectively.

Prior to completion of the field investigation, the existing culvert failed. During drilling of Borehole WCC-03, Thurber's field inspector was instructed by MTO staff to conclude the field investigation as construction of the new culvert was planned to start immediately. Borehole WCC-03 was terminated at 5.5 m depth.

A Dynamic Cone Penetration Test (DCPT) was conducted from the base of Borehole WCC-01 to 20.1 m depth.

The approximate borehole and DCPT 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.

Drilling on the highway shoulders was carried out using a truck-mounted CME 75 drill rig and the boreholes were advanced with hollow-stem auger techniques. The drilling at the toe of the embankment was carried out using wash-boring methods with casing and tripod. Portable split spoon sampling equipment driven with a Standard SPT hammer was used for penetration testing. In general, samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations. A standpipe piezometer consisting of 19 mm PVC pipe with slotted screen was installed in Borehole WCC-01 and enclosed in filter sand to permit longer term groundwater level monitoring. The location and completion details of the piezometer and boreholes are shown in Table 3.1.

**Table 3.1 – Borehole Completion Details**

<b>Foundation Unit</b>	<b>Borehole</b>	<b>Piezometer Tip Depth/ Elevation (m)</b>	<b>Completion Details</b>
East end of the culvert	WCC-01	10.7/328.0	Sand from 10.7 m to 8.5 m, holeplug from 8.5 m to surface.
Middle of the culvert	WCC-02	None installed	Borehole backfilled with holeplug to 15.8 m, auger cuttings to 3.0 m, holeplug from 0.3 m to 0.15 m, then sand and gravel to surface.
West end of the culvert	WCC-03	None installed	Borehole backfilled with holeplug to surface.

#### **4 LABORATORY TESTING**

All recovered soil samples were subjected to Visual Identification (VI) and moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. 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.

In general terms, the overburden encountered at this site consists of topsoil, silty clay fill and gravelly sand fill overlying native silty clay.

##### **5.1 Topsoil**

A thin layer of topsoil was encountered surficially in Borehole WCC-03. The thickness of the topsoil was 25 mm.

## 5.2 Silty Clay Fill

Dark brown to grey silty clay fill containing trace to some sand, trace gravel and occasional wood fibres was encountered surficially in Borehole WCC-01 and at 1.2 m depth in Borehole WCC-02. The thickness of the silty clay fill was 1.3 m and 3.6 m in Boreholes WCC-01 and WCC-02, respectively.

The depth to the base of the silty clay fill was 1.3 m and 4.8 m (elevations 337.5 and 338.2) in Boreholes WCC-01 and WCC-02, respectively.

SPT N-values recorded in the silty clay fill ranged from 4 to 5 blows per 0.3 m of penetration, indicating a soft to firm consistency.

The moisture content of the fill samples ranged from 21% to 35%.

Grain size distribution curve for a silty clay sample is presented in Appendix B, Figure B1. The results are also summarized on the Record of Borehole sheets included in Appendix A. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	14
Silt	38
Clay	48

## 5.3 Gravelly Sand Fill

Brown gravelly sand fill was contacted surficially in Borehole WCC-02 drilled through the highway embankment. The thickness of the gravelly sand fill was 1.2 m.

An SPT N-value recorded in the gravelly sand fill was 4 blows per 0.3 m of penetration, indicating a loose relative density.

The moisture content of the gravelly sand fill was 2% to 21%.

## 5.4 Silty Clay

Native brown to grey silty clay containing trace to some sand, trace gravel and occasional organics and wood fibres was encountered below the silty clay fill at 1.3 m and 4.8 m depth (elevations 337.5 and 338.2) in Boreholes WCC-01 and WCC-2, respectively. In Borehole WCC-03, the native silty clay was contacted below the topsoil.

Boreholes WCC-01, WCC-02 and WCC-03 were terminated within the silty clay layer at 15.2 m, 18.9 m and 5.5 m depth (elevations 323.5, 324.1 and 332.5), respectively.

SPT 'N' values recorded in the silty clay ranged from 6 to 33 blows for 0.3 m of penetration, indicating a firm to hard consistency.

The moisture content of samples collected from the silty clay varies between 20% and 58%.

Grain size distribution curves for selected silty clay samples are presented in Appendix B, Figures B2 and B3. The results are also summarized on the Record of Borehole sheets included in Appendix A. Atterberg Limits test results are presented in Figures B4 and B5 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 2
Sand	11 to 30
Silt	34 to 59
Clay	27 to 51

Index Property	
Liquid Limit	48 to 65
Plastic Limit	17 to 21

The above results show that the silty clay is of medium to high plasticity with group symbols of CI and CH.

## 5.5 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling.

In Borehole WCC-02, water level was measured at 17.3 m (elevation 325.7) upon completion of borehole.

Water level inside the existing culvert was at elevation 336.7 on June 18, 2008 as indicated in GA drawing.

A piezometer was installed in Borehole WCC-01. However, no water level readings were taken as it had to be decommissioned when construction of the replacement structure started.

The above value is short-term reading 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. Upon completion of drilling, the borehole elevations were established from a contour plan provided by Hatch Mott MacDonald.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario supplied a truck mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

OGS Drilling Inc. of Almonte, Ontario supplied the portable drilling/coring equipment to drill and core the boreholes that were not accessible using a truck mounted rig.

The field program was supervised by Ms. Eckie Siu of Thurber.

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. R. Palomeque Reyna, P.Eng.

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

Thurber Engineering Ltd

Rocio Palomeque Reyna, P.Eng.  
Geotechnical Engineer



P. K. Chatterji, P.Eng.  
Review Principal





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**PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS**

**7 GENERAL**

As indicated in Part 1, the existing culvert located at the crossing of Highway 602 and Wolf Creek in the District of Rainy River, Ontario collapsed around mid-July 2011, before the field investigation was fully completed.

Thurber was requested by Hatch Mott MacDonald to provide immediate foundation recommendations for the design of a replacement structure involving a modular bridge.

Preliminary geotechnical recommendations were presented based on available data from Boreholes WCC-02 and WCC-01 and a GA drawing.

The new structure was constructed as a two-lane modular bridge supported on H-piles. The new structure is approximately 42.6 m long and 8.2 m wide.

Recommendations were provided for driven steel pile foundations.

**8 STRUCTURE FOUNDATIONS**

**8.1 Driven Steel H-Piles**

Driven steel H-piles will develop resistance to vertical loads primarily through frictional resistance along the shafts of the piles within the native firm to stiff silty clay.

The preliminary factored Geotechnical Resistances at ULS (per pile) and Geotechnical Resistance at SLS (25 mm settlement) recommended for an HP 310x110 H-pile section driven to various depths into the native clay are as follows:

Embedment Length in Native Silt (m)	Factored ULS Resistance per pile (kN)	SLS Resistance (kN)
10	110	80
15	220	150
20	360	250
25	540	390

The SLS values are based on a vertical pile settlement of 25 mm at the base of the embankment fill.

Since the modular bridge was constructed using the above foundation recommendations, no further geotechnical recommendations for the bridge were requested/developed.

## 9 CLOSURE

Engineering analysis and preparation of the report were carried out by Ms. R. Palomeque Reyna, P.Eng.

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

Thurber Engineering Ltd.

Rocío Palomeque Reyna, P.Eng., M.Eng.  
Geotechnical Engineer

Report reviewed by:  
P.K. Chatterji, P.Eng., Ph.D.  
Review Principal



## **Appendix A**

### **Record of Borehole Sheets**

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

### 1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

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

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

NOTE: Hierarchy of Soil Strength Prediction

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

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

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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



Water Level

C<sub>pen</sub>

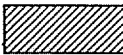




Shear Strength Determination by Pocket Penetrometer

- (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

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
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)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength (MPa) (psi)	Field Estimation of Hardness*	
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				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	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	3,500 to 7,500	Breaks under single blow of geological hammer.
		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
		Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
		Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS	
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

## METRIC

[illegible]

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

## METRIC

[illegible]

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



RECORD OF BOREHOLE No WCC-01

3 OF 3

METRIC

W.P. 6938-10-00 LOCATION N 5 386 111.0 E 245 348.3 Wolf Creek Culvert ORIGINATED BY ES  
HWY 602 BOREHOLE TYPE Mud Rotary and Tripod COMPILED BY AN  
DATUM Geodetic DATE 2011.07.15 - 2011.07.17 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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
318.6	Continued From Previous Page																
20.1	END OF BOREHOLE AT 20.1m UPON DCPT REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m)						318										

ONTMT4S 5121.GPJ 9/19/11

RECORD OF BOREHOLE No WCC-02

1 OF 2

METRIC

W.P. 6938-10-00 LOCATION N 5 386 118.1 E 245 331.5 Wolf Creek Culvert ORIGINATED BY ES  
HWY 602 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.07.17 - 2011.07.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  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 (%)		
343.0							20 40 60 80 100									
0.0	Gravelly <b>SAND</b> Loose Brown Damp (FILL)		1	GS												
341.8			1	SS	4											
1.2	Silty <b>CLAY</b> , some sand, trace gravel Soft to Firm Grey (FILL)		2	SS	5									0 14 38 48		
			3	SS	4											
	Occasional wood fibres		4	SS	5											
338.2			5	SS	8											
4.8	Silty <b>CLAY</b> , some sand to sandy, trace gravel, occasional rootlets Firm to Stiff Dark Grey to Black		6	SS	9									0 30 35 35		
	Grey		7	SS	7											
			8	SS	7											

Continued Next Page

+<sup>3</sup> X<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No WCC-02

2 OF 2

METRIC

W.P. 6938-10-00 LOCATION N 5 386 118.1 E 245 331.5 Wolf Creek Culvert ORIGINATED BY ES  
HWY 602 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2011.07.17 - 2011.07.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y 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 (%)	W <sub>p</sub>	W	W <sub>L</sub>		
	Continued From Previous Page													
	Silty CLAY, some sand, trace gravel Stiff Grey		9	SS	8									2 13 34 51
			10	SS	9									
			11	SS	10									
			12	SS	6									0 11 38 51
	Firm													
			13	SS	9									
			14	SS	11									
324.1 18.9	END OF BOREHOLE AT 18.9m. WATER LEVEL AT 17.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 15.8m, CUTTINGS TO 3.0m, HOLEPLUG TO 0.15m, THEN SAND AND GRAVEL TO SURFACE.													

ONTMT4S 5121.GPJ 9/19/11

RECORD OF BOREHOLE No WCC-03

1 OF 1

METRIC

W.P. 6938-10-00 LOCATION N 5 386 109.2 E 245 319.4 Wolf Creek Culvert ORIGINATED BY ES  
HWY 602 BOREHOLE TYPE Mud Rotary and Tripod COMPILED BY AN  
DATUM Geodetic DATE 2011.07.18 - 2011.07.18 CHECKED BY RPR

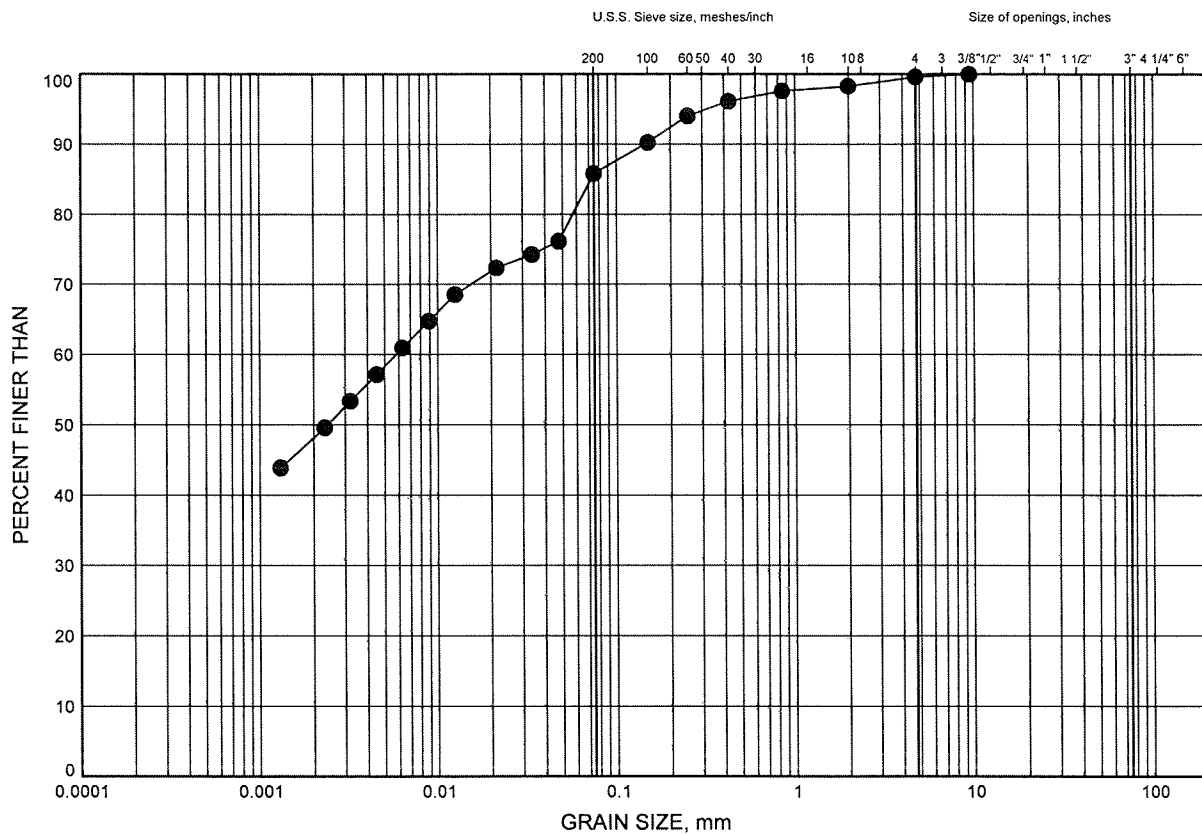
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE							
338.0																		
0.0	TOPSOIL: (25mm)		1	SS	9													
	Silty CLAY, some sand to sandy Stiff Brown		2	SS	12											0 26 43 31		
	Occasional organics and wood fibres		3	SS	15													
			4	SS	9													
	Grey		5	SS	9											1 15 43 41		
			6	SS	10													
	Firm		7	SS	6													
			8	SS	10											0 12 38 50		
			9	SS	11													
332.5																		
5.5	END OF BOREHOLE AT 5.5m. BOREHOLE BACKFILLED WITH HOLEPLUG TO SURFACE.																	

**Appendix B**  
**Laboratory Test Results**

6010-E-0010 Bridge and Culvert Rehabs NWR  
GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WCC-02	1.83	341.17

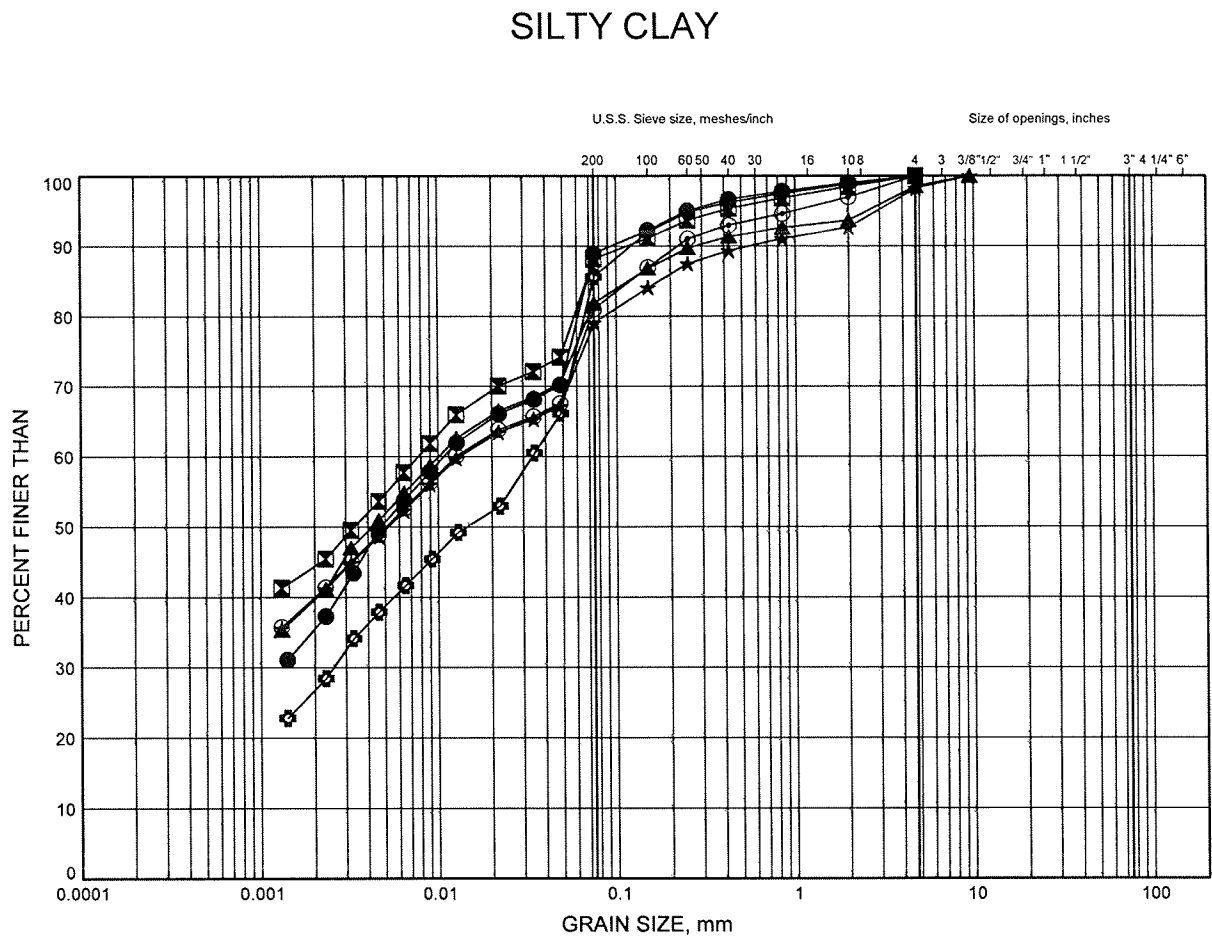


W.P.# .6938-10-00.....  
Prepared By .AN.....  
Checked By .RPR.....

6010-E-0010 Bridge and Culvert Rehabs NWR

# GRAIN SIZE DISTRIBUTION

FIGURE B2



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WCC-01	1.52	337.22
⊠	WCC-01	2.74	336.00
▲	WCC-01	5.18	333.56
★	WCC-01	10.06	328.69
⊙	WCC-01	12.50	326.25
⊛	WCC-01	14.33	324.42

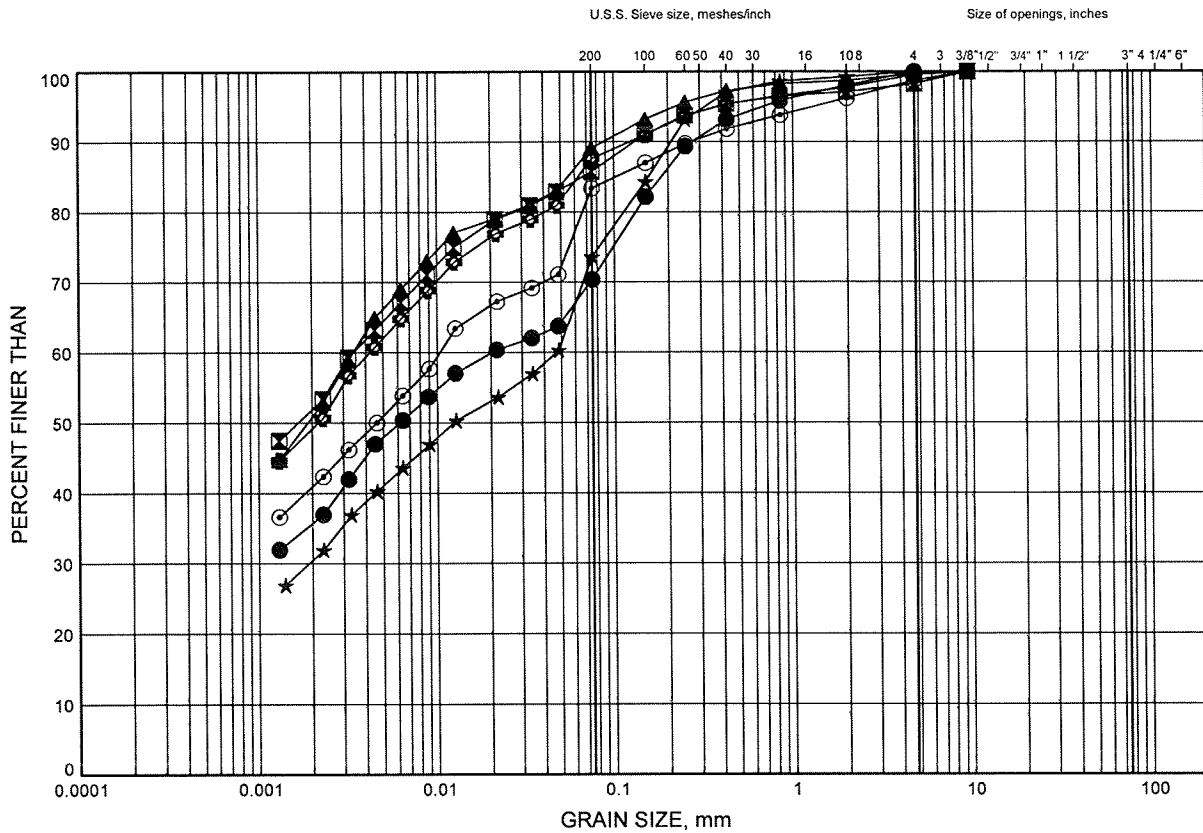


W.P.# 6938-10-00.....  
 Prepared By AN.....  
 Checked By RPR.....

6010-E-0010 Bridge and Culvert Rehabs NWR  
GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	WCC-02	6.40	336.60
⊠	WCC-02	10.97	332.02
▲	WCC-02	15.54	327.45
★	WCC-03	0.91	337.08
⊙	WCC-03	2.74	335.25
⊕	WCC-03	4.57	333.42



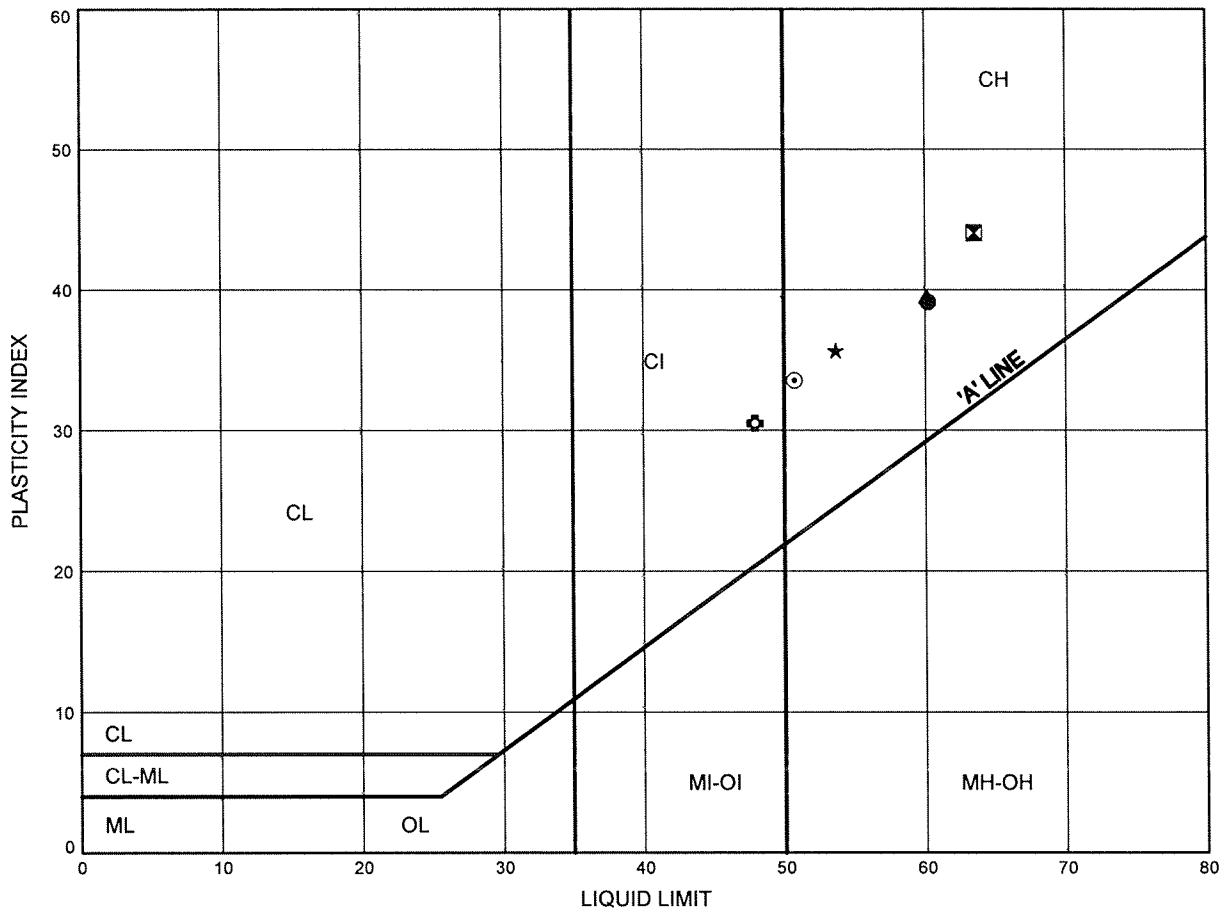
W.P.# 6938-10-00.....  
Prepared By AN.....  
Checked By RPR.....



6010-E-0010 Bridge and Culvert Rehabs NWR  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B4

**SILTY CLAY**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WCC-01	1.52	337.22
⊠	WCC-01	2.74	336.00
▲	WCC-01	5.18	333.56
★	WCC-01	12.50	326.25
⊙	WCC-01	14.33	324.42
⊛	WCC-02	6.40	336.60

Date September 2011  
 Project 6938-10-00

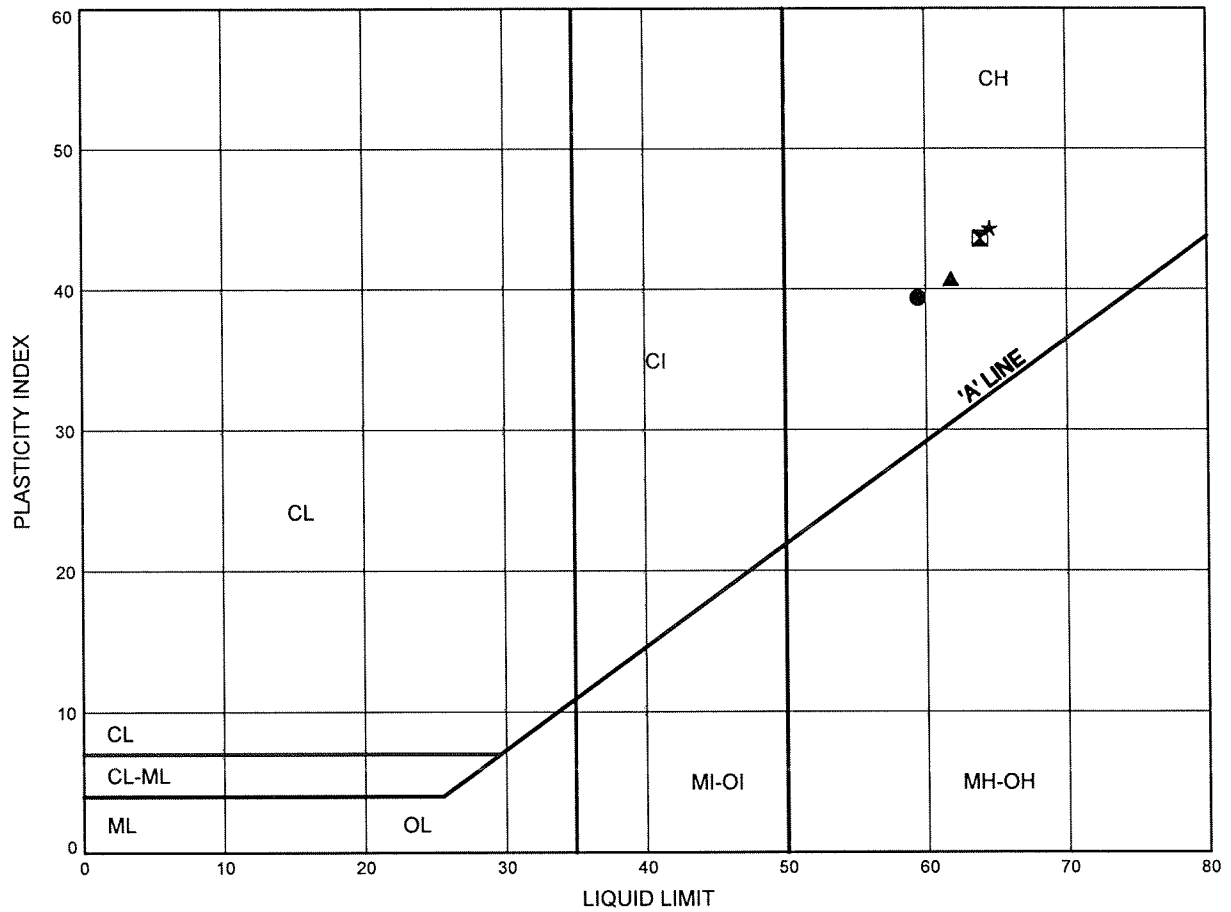


Prep'd AN  
 Chkd. RPR

6010-E-0010 Bridge and Culvert Rehabs NWR  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE B5

**SILTY CLAY**



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WCC-02	10.97	332.02
⊠	WCC-02	15.54	327.45
▲	WCC-03	2.74	335.25
★	WCC-03	4.57	333.42

Date September 2011  
 Project 6938-10-00



Prep'd AN  
 Chkd. RPR

**Appendix C**  
**Site Photographs**



**Photograph 1** – Highway 11 and Wolf Creek Culvert crossing



**Photograph 2 –** Highway 11 and Wolf Creek Culvert crossing





**Photograph 3 –** Existing conditions of Wolf Creek Culvert before field investigation started





**Photograph 4** – New modular bridge at the crossing of Highway 602 and Wolf Creek, built in July 2011

**Appendix D**  
**Borehole Locations and Soil Strata Drawings**



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

GWP 6938-10-00  
CONT No  
WP No

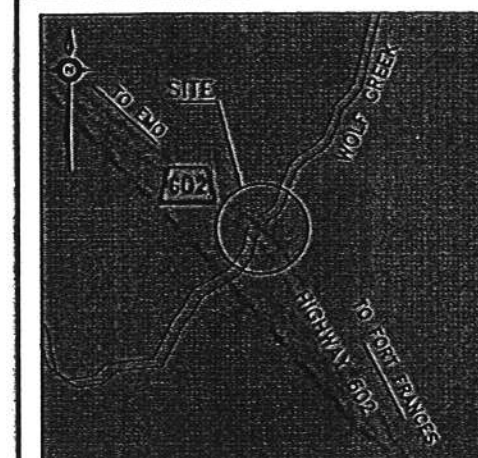


SHEET

**HIGHWAY 602  
BRIDGE & CULVERT REHABS  
WOLF CREEK  
BOREHOLE LOCATIONS AND SOIL STRATA**







**Hatch Mott  
MacDonald**

**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
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auqer Refusal

NO	ELEVATION	NORTHING	EASTING
WCC-01	338.7	5 386 111.0	245 348.3
WCC-02	343.0	5 386 118.1	245 331.5
WCC-03	338.0	5 386 109.2	245 319.4

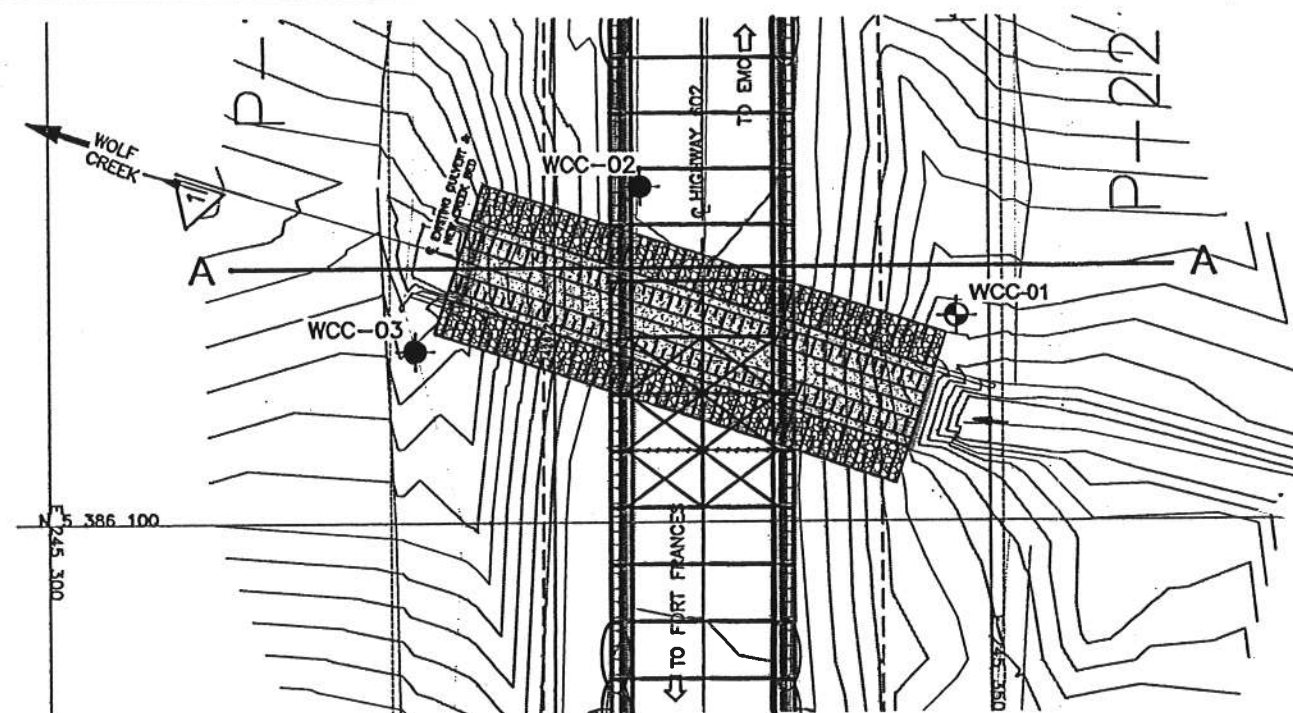
**-NOTES-**

- 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.

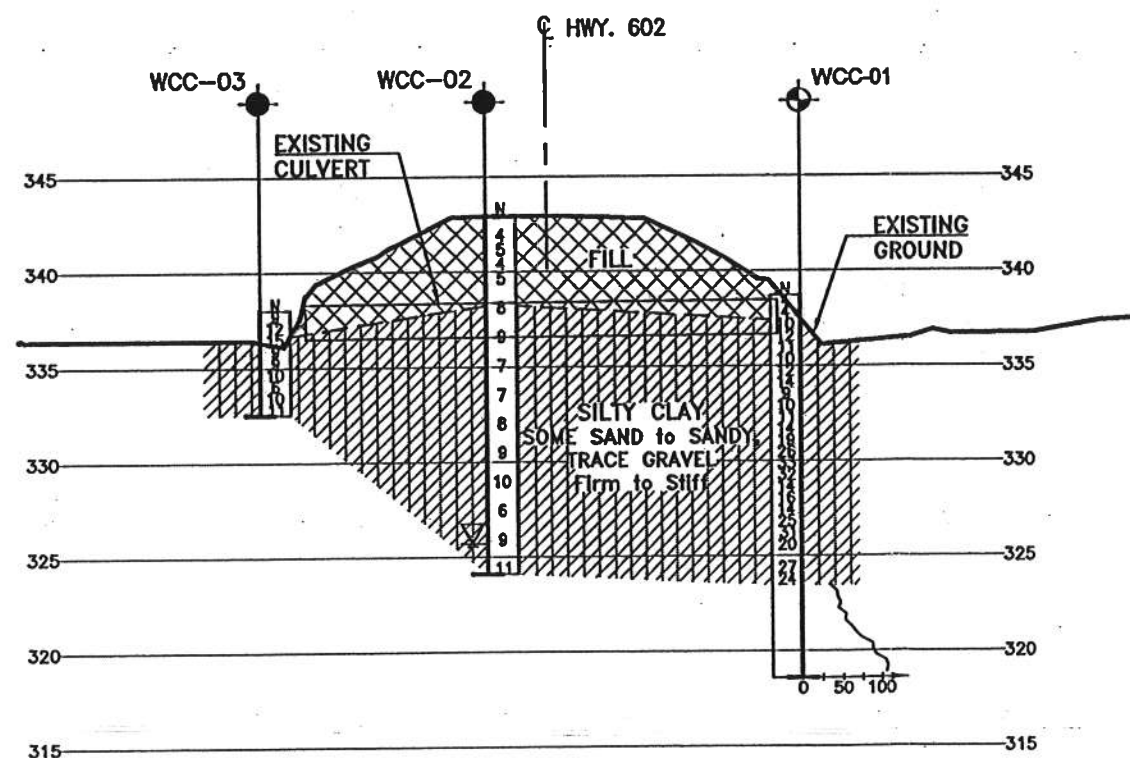
**GEOCRES No. 52C-26**

REVISIONS									
	DATE	BY				DESCRIPTION			
DESIGN	RPR	CHK	RPR	CODE		LOAD		DATE	DEC. 201
DRAWN	AN	CHK		SITE		STRUCT		DWG	1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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## PLAN



SECTION ALONG A-A