

**FOUNDATION INVESTIGATION REPORT
CULVERT REPLACEMENT AT UNKNOWN CREEK
TRIBUTARY OF MONDOR CREEK
SITE NO. 39E-314
HIGHWAY 11
COCHRANE DISTRICT, ONTARIO
G.W.P. No. 5193-13-00**

GEOCRES Number: 42H-56

Report to

URS Canada Inc.

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Foundations\Reports & Memos\Unkown Creek - Mondor
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at the location of a culvert where replacement is proposed along Highway 652 near Cochrane, Ontario.

The foundations terms of reference indicates that there is no record of any previous foundation investigation carried out at or near the subject culvert. A search in the Ministry of Transportation Ontario (MTO) GEOCRES Library did not reveal record of any previous foundation investigation carried out near the subject culverts.

The purpose of this investigation was to obtain subsurface information at the culvert location and, based on the data obtained, to provide a borehole location plan, a stratigraphic profile, cross sections, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber was retained by URS Canada Inc. (URS) to carry out this foundation investigation under the MTO Assignment Number 5012-E-0033.

2 SITE DESCRIPTION

The culvert site is located on Highway 11, 2.9 km south of Highways 11/579 junction in the Township of Calvert, Ontario. This culvert allows a tributary of Mondor Creek to flow under Highway 11.

The existing structure is a 3.9 m span by 2.4 m high by 30 m long steel plate pipe arch (SPPA). It is understood that the structure is in very poor condition.

The grade of the existing Highway 11 in the vicinity of the culvert ranges between approximate Elevations 262.9 and 263.3 m. The embankment fill height at the culvert is approximately 1.5 m.

Naturally low-lying, swampy areas are present near the inlet and outlet of the culvert, with vegetation consisting of tall grass and shrubs with occasional trees. Local topography is of low relief with no visible bedrock outcrops. Areas surrounding the properties are heavily forested. The area in the immediate vicinity of the culvert is undulating and generally sloping from the highway grade to the creek.

Based on published geological information, the general area of the project is covered by glacio-lacustrine sediments of clays and silts laid down by the Glacial Lake Barlow-Ojibway. These deposits are mostly varved clays, but massive clays are also present in some areas. Due to the different rates of seasonal deposition during various periods of glaciation, the lower zones of the deposits display much thicker varves than in the upper zones. Below the varved clays are glacial outwash deposits of silts, sands and gravel underlain by Early Precambrian metasedimentary rocks.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out between October 24 and October 29, 2013. The program consisted of drilling and sampling 6 boreholes (number UC-01 to UC-06) to depths ranging from 6.4 to 18.9 m. Of these boreholes two were located at the culvert inlet and outlet (UC-02 and UC-05), and four were located on the highway (UC-01, UC-03 to UC-04, and UC-06).

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained. The co-ordinates and elevations of the as-drilled boreholes were subsequently provided by Callon Dietz obtained from the DTM, based on borehole location sketches provided by Thurber. The approximate borehole locations are shown on a Borehole Locations and Soil Strata drawing included in Appendix C.

A truck-mounted drill rig was used to drill and sample the boreholes on the highway and the shoulder, and a track-mounted drill rig was used to drill and sample the culvert inlet and outlet boreholes. Hollow stem augers and/or NW casing were used to advance the boreholes. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). Field vane shear testing using an MTO “N” size vane were carried out in soft to firm cohesive soils. A limited number of thin walled Shelby tube (73 mm inside diameter) samples were obtained at selected locations. Below the last sample, dynamic cone penetration tests (DCPT) were conducted until refusal was reached in Boreholes UC-01, UC-03, UC-04 and UC-06. Standpipe piezometers were installed in Boreholes UC-02 and UC-05. Groundwater conditions in the open boreholes were observed throughout the drilling operations. The details of standpipe piezometer installations and borehole completion are summarized in Table 3.1.

Table 3.1
Borehole Completion and Standpipe Piezometer Installation Details

Borehole Number	Standpipe Piezometer Installations				Completion Details
	Tip Location (Depth/Elev.)	Screen Depth (m)	Screen Elevation (m)	Filter Stratum	
UC-01		None Installed			Bentonite holeplug to 0.1 m, Sand and Gravel to Surface
UC-02	6.1 / 255.7	4.6 to 6.4	255.4 – 257.8	Silty Clay	Bentonite holeplug to surface
UC-03		None Installed			Bentonite holeplug to 0.05 m, Sand and Gravel to Surface
UC-04		None Installed			Bentonite holeplug to 0.1 m, Sand and Gravel to Surface
UC-05	6.1 / 256.3	4.2 to 6.7	255.7 – 258.2	Silty Clay	Bentonite holeplug to surface
UC-06		None Installed			Bentonite holeplug to 0.1 m, Sand and Gravel to Surface

Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendix A.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered soil samples in labelled containers, and transported the samples to Thurber's laboratory for further examination and testing.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected soil samples were subjected to grain size distribution analyses (sieve and hydrometer) and plasticity testing (Atterberg Limits). One sample was selected from the Shelby tubes for laboratory consolidation (oedometer) testing. The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix A and on the figures in Appendix B. A sample of creek water was submitted to a qualified analytical laboratory for testing against selected corrosivity parameters.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile and selected cross-sections for this culvert site are presented on the Borehole Locations and Soil Strata Drawings in Appendix C for illustrative purposes. An overall description of the stratigraphy is given in the

following paragraphs; however, the factual data presented in the record of boreholes governs any interpretation of the site conditions.

In general, the subsurface conditions encountered in the boreholes located on the highway shoulder consist of granular fill overlying an extensive deposit of silty clay. The silty clay underlies a thin veneer of topsoil or is exposed at ground surface beyond the highway. Groundwater levels are generally in the order of 0.4 to 3.8 m below original ground surface. More detailed descriptions of the individual stratum are presented below.

5.2 Topsoil

A layer of topsoil 75 mm in thickness was encountered at ground surface in Borehole UC-02 located off the roadway. The topsoil thickness may vary between and beyond the borehole locations, and the limited data is not suitable for estimating topsoil quantities.

5.3 Fill

Embankment fill was encountered at ground surface in Boreholes UC-01, UC-03, UC-04 and UC-06. This fill typically consists of brown sand with some gravel to sand and gravel, organic inclusions and rootlets at shallow depths. A layer of silty clay fill was encountered below the granular fill in Borehole UC-04. Where encountered, the embankment fill was found extending to 1.9 to 2.3 m depths (base Elevations from 261.5 to 260.4 m).

SPT N-values measured in the cohesionless fill ranged from 6 blows per 0.3 m penetration to 42 blows per 0.3 m penetration indicating a loose to dense state. Measured moisture contents of the recovered sand fill samples ranged between 3% and 43%, with the values increasing with higher depth. Grain size analyses conducted on samples of the cohesionless fill are presented on Figure B4 in Appendix B. These results are summarized in the following table.

Soil Particles	%
<u>Gravelly Sand Fill</u>	
Gravel	18 to 22
Sand	72 to 78
Silt and Clay	4 to 6
<u>Sand and Gravel, with Silty Clay Layer</u>	
Gravel	31
Sand	20
Silt	17
Clay	32

5.4 Silty Clay

Underlying the embankment fill and topsoil, silty clay was encountered in all six boreholes drilled at the site. This brown to grey soil typically contained layers of sand and gravel.

Boreholes UC-02 and UC-05 were terminated within the silty clay at depths of 6.4 to 6.7 m (base Elevations 255.4 to 255.7 m). In boreholes UC-01, UC-03, UC-04 and UC-06 Dynamic Cone Penetration Tests (DCPT) were conducted from depths of 15.8 to 18.9 m (base Elevations 247.3 to 244.0 m). DCPT's encountered refusal at depths of 25.7 to 28.5 m (base Elevations 237.6 to 234.6 m).

The weathered crust of the silty clay deposit is approximately 1 to 1.5 m thick. It has a relatively firm consistency and typically brown in colour. Within the crust, the SPT N-values ranged between 4 and 15 blows per 0.3 m of penetration. Measured field vane shear strengths ranging from 25 to 90 kPa, the silty clay crust was found to have a typically stiff to firm consistency.

Below the crust, the silty clay becomes grey with measured N-values of 0 to 29 blows per 0.3 m of penetration, with most values lying at 0 to 7 blows per 0.3 m of penetration. Higher SPT values were associated with sand and gravel layers within the silty clay. Field vane shear strengths ranged from 10 to 20 kPa and was found to have a very soft to soft consistency.

A 1.8 m thick layer of gravel was encountered in borehole UC-01 at a depth of 10.8 m (elevation 252.5 m). A sand layer 0.7 m thick was encountered in borehole UC-05 at a depth of 0.8 m (elevation 261.6 m). A grain size distribution for the sand layer in borehole UC-05 is presented in Figure B5 in Appendix B.

Oedometer test results are not available at the time of preparation of this report.

The measured water contents of samples recovered from these soils typically ranged from 20% to 60%. Grain size analyses conducted on samples of the silty clay are presented on Figures B1 to B2, and Atterberg Limits test results are presented in Figure B7 in Appendix B. Grain size analyses conducted on the silty clay with sand and gravel layer are presented on Figure B3 in Appendix B. The results are summarized in the following table.

Soil Type	Soil Particles	%
Silty Clay	Gravel	0
	Sand	0 to 8
	Silt	33 to 51
	Clay	47 to 67
	Soil Property	%
	Liquid Limit	36 to 58
	Plasticity Index	20 to 32
Silty Clay with Sand and Gravel Layer	Gravel	3 to 21
	Sand	17 to 30
	Silt	14 to 26
	Clay	31 to 56

The results of the Atterberg Limits tests indicate that the silty clay is typically of intermediate plasticity (CI) with occasional high plastic (CH) zones.

5.5 Groundwater Conditions

Free water was observed in most of the boreholes upon completion of drilling. Standpipe piezometers were installed in Boreholes UC-02 and UC-05 to permit groundwater monitoring. Water levels observed in the open boreholes and those measured in the two installed standpipes are presented below.

Borehole	Date of Reading	Water Level Depth (m)	Water Level Elevation (m)
UC-01	Oct. 29, 2013	0.5	262.8
UC-02	Nov. 1, 2013	3.2	258.6
	Nov. 7, 2013	3.1	258.7
UC-03	Oct. 24, 2013	2.4	260.7
UC-04	Oct. 29, 2013	0.6	262.8
UC-05	Nov. 1, 2013	3.8	258.6
	Nov 7, 2013	3.7	258.7
UC-06	Oct. 26, 2013	0.4	262.5

Where surface water is present, the groundwater level should be assumed to coincide with the local surface or creek water level. Based on the observations and measurements above, the groundwater level adjacent to the creek is at approximate Elevation 259.0 m. The groundwater levels are expected to vary seasonally and are subject to severe weather events such as rainstorms.

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Callon Dietz provided the northing and easting coordinates and ground surface elevations using their local DTM based on borehole location sketches provided by Thurber.

Downing Drilling of Hawkesbury, Ontario supplied and operated a truck-mounted drill rig and a track-mounted CME 55 drill rig to carry out the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Ms. Eckie Siu and Mr. Joe Gurzanski of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall project management was provided by Mr. Alastair Gorman, P.Eng. Direction of the field and laboratory program was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Lukasz Gilarski, P.Eng and Dr. Sydney Pang, P.Eng. The report was reviewed by Mr. Alastair Gorman, 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

19-4406-9

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.

EXPLANATION OF ROCK LOGGING TERMS

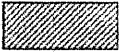




ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
	(MPa)	(psi)	
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

TERMS

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





UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	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			

RECORD OF BOREHOLE No UC-01 Site 39E-314 1 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 734.1 E 302 596.5 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.29 - 2013.10.29 CHECKED BY SKP

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						WATER CONTENT (%)						
								20	40	60	80			100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	GR	SA	SI
263.3	GROUND SURFACE																			
0.0	SAND , some gravel Dense to Compact Brown Moist (FILL)		1	SS	34		263													
			2	SS	26															
	3	SS	10																	
261.3	Silty CLAY , trace organics, trace rootlets Firm to Very Soft Dark Brown							261												
			4	SS	7															
			5	SS	6															
			6	SS	1															
			1	TW																
	Becoming grey		2	TW			257													
			7	SS	1															
					</															

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No UC-01 Site 39E-314 2 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 734.1 E 302 596.5 ORIGINATED BY ES
HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2013.10.29 - 2013.10.29 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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						
								20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
Continued From Previous Page							WATER CONTENT (%) 20 40 60							
							253	+						
252.5														
10.8	GRAVEL, trace sand Compact Brown Wet	◊ ◊<												

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

RECORD OF BOREHOLE No UC-01 Site 39E-314 3 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 734.1 E 302 596.5 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.29 - 2013.10.29 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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							20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L		
								20 40 60 80 100		WATER CONTENT (%)		
237.6							243					
							242					
							241					
							240					
							239					
							238					
25.7	END OF BOREHOLE AND DCPT AT 25.7m. FREE WATER AT 0.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.1m, SAND AND GRAVEL TO SURFACE.											

RECORD OF BOREHOLE No UC-02 Site 39E-314 1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Unknown Culvert N 5 432 730.2 E 302 576.5 ORIGINATED BY JG
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.24 CHECKED BY SKP

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 (%)
261.8	GROUND SURFACE							20	40	60	80	100	20	40	60		
0.0	TOPSOIL: (75mm) Silty CLAY , some organics Firm to Very Soft Brown Moist Becoming grey		1	SS	5									○			
0.1			2	SS	7										○		
			3	SS	8										○		0 0 51 49
				4	SS	1									○		

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No UC-03 Site 39E-314 2 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 739.7 E 302 585.4 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.24 CHECKED BY SKP

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 (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				W P W W L				
								20 40 60 80 100				20 40 60				
	Continued From Previous Page						253	+								
			11	SS	0		252									
							251	+								
			12	SS	20		250									
							249									
	Sand and gravel layer		13	SS	11		248									
							247									
			14	SS	0		246									
247.3							245									
15.8	End of sampling at 15.8m and start DCPT						244									

Continued Next Page

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

RECORD OF BOREHOLE No UC-03 Site 39E-314 3 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 739.7 E 302 585.4 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.24 CHECKED BY SKP





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							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE					
							243							
							242							
							241							
							240							
							239							
							238							
							237							
							236							
							235							
234.6 28.5	END OF BOREHOLE AND DCPT AT 28.5m UPON REFUSAL. WATER LEVEL AT 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.05m, SAND AND GRAVEL TO SURFACE.													

ONTMT4S 4069.GPJ 2012TEMPLATE(MTO).GDT 17/15

RECORD OF BOREHOLE No UC-04 Site 39E-314 1 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 705.2 E 302 595.5 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.28 - 2013.10.29 CHECKED BY SKP

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		GR	SA	SI	CL
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)							
263.4	GROUND SURFACE																			
0.0	SAND, some gravel Dense Brown Frozen to Moist (FILL)		1	SS	42		263													
			2	SS	34															
261.5		3	SS	10																
1.9	Silty CLAY, some sand, trace gravel Stiff Brown																			
			4	SS	3															
260.4																				
3.0	Silty CLAY, trace sand Very Soft Brown to Grey		5	SS	1			260												
			6	SS	0															
			7	SS	0															
			8	SS	0															
							</													

Continued Next Page

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

RECORD OF BOREHOLE No UC-04 Site 39E-314 2 OF 3

METRIC



GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 705.2 E 302 595.5 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.28 - 2013.10.29 CHECKED BY SKP

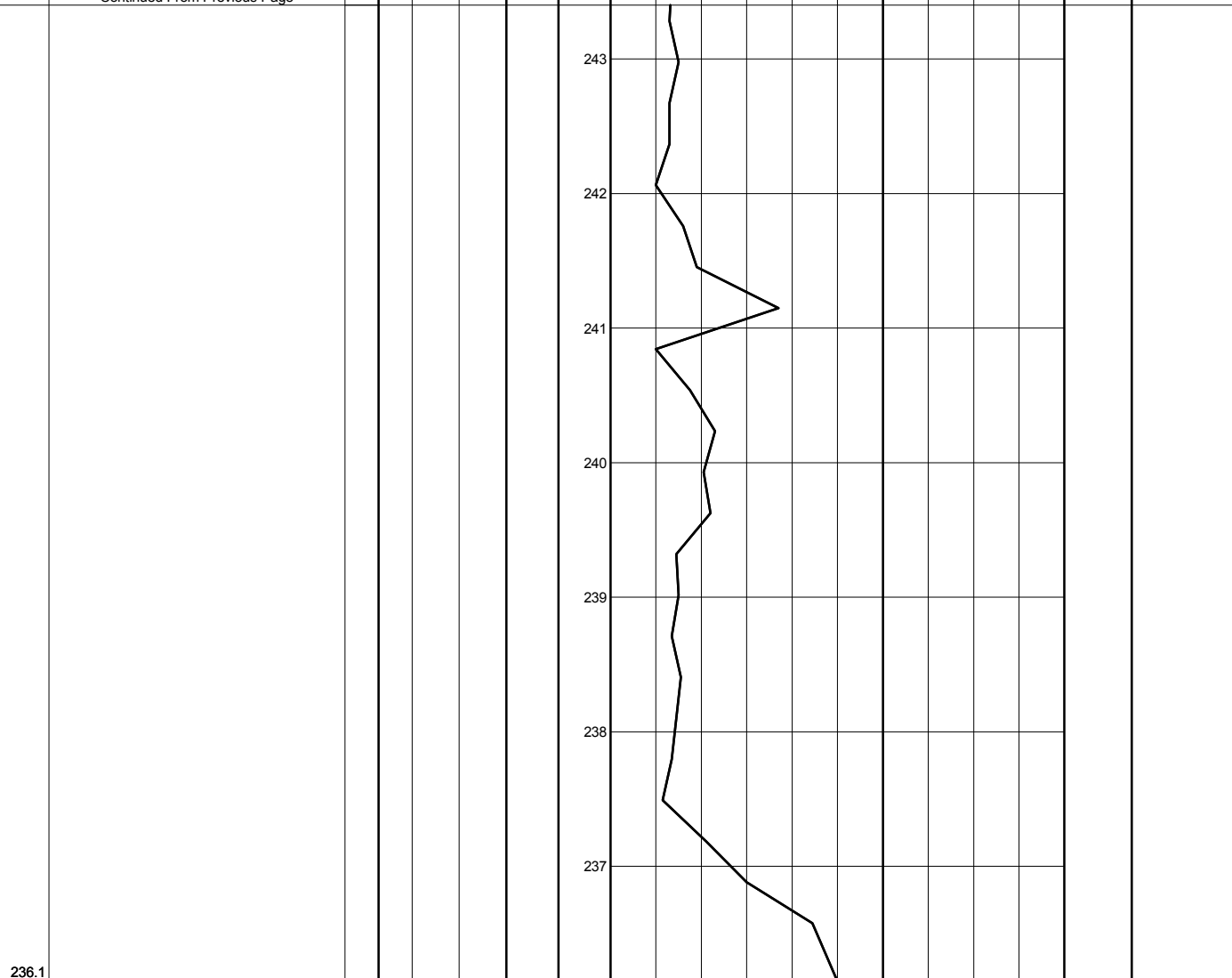
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page													
	Sand and gravel layer		11	SS	0		253	+						
			12	SS	29		252	10.0 +						
			13	SS	7		251							
							250							
			14	SS	5		248							
247.6														
15.8	End of sampling at 15.8m and start DCPT						247							
							246							
							245							
							244							

Continued Next Page

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

METRIC

ELEV. DEPTH	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 (%)
	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			
	Continued From Previous Page										



END OF BOREHOLE AND DCPT AT
27.3m UPON REFUSAL.
FREE WATER AT 0.6m UPON
COMPLETION.
BOREHOLE BACKFILLED WITH
HOLEPLUG TO 0.1m, SAND AND
GRAVEL TO SURFACE.

RECORD OF BOREHOLE No UC-05 Site 39E-314 1 OF 1

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 715.6 E 302 606.0 ORIGINATED BY JG
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.24 CHECKED BY SKP

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			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20	40	60	80	100	W _P	W		
262.4	GROUND SURFACE															
0.0	Silty CLAY , some organics Firm Brown Moist		1	SS	6		262						○			
261.6																
0.8	SAND , trace silt and clay, trace gravel Loose Brown Moist		2	SS	6		261						○		11 85 4 (SI+CL)	
260.9																
1.5	Silty CLAY Firm to Very Soft Brown Moist		3	SS	8		260						○			
			4	SS	3		260						┌───○───┐		0 0 39 61	
							259	2.0 +								
	Becoming grey		5	SS	0		258									
			1	TW			257									
			6	SS	0		256						○			
255.7																
6.7	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov. 1/13 3.8 258.6 Nov. 7/13 3.7 258.7															

ONTMT4S 4069.GPJ 2012TEMPLATE(MTO).GDT 1/7/15

RECORD OF BOREHOLE No UC-06 Site 39E-314 1 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 710.8 E 302 584.4 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.25 CHECKED BY SKP

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									WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
262.9	GROUND SURFACE							20	40	60	80	100		20	40	60	GR	SA	SI	CL
0.0	SAND , some gravel Dense to Compact Brown Moist (FILL)		1	SS	33	▽								○						
			2	SS	17										○					
	Organics, rootlets Loose Dark Brown		3	SS	6										○					
260.6																				
2.3	Silty CLAY , trace sand Firm to Very Soft Brown		4	SS	7										○					
			5	SS	2										○					
	Occasional oxide staining		6	SS	2															
			1	TW																
	Becoming grey		7	SS	0										○					
			8	SS	0											○				
			9	SS	0											○				

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No UC-06 Site 39E-314 3 OF 3

METRIC

GWP# 5193-13-00 LOCATION Unknown Creek N 5 432 710.8 E 302 584.4 ORIGINATED BY ES
 HWY 11 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.10.24 - 2013.10.25 CHECKED BY SKP

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		W P		W		W L			
	Continued From Previous Page							20 40 60 80 100	○ UNCONFINED + FIELD VANE								
								20 40 60 80 100	● QUICK TRIAXIAL × LAB VANE								

Appendix B

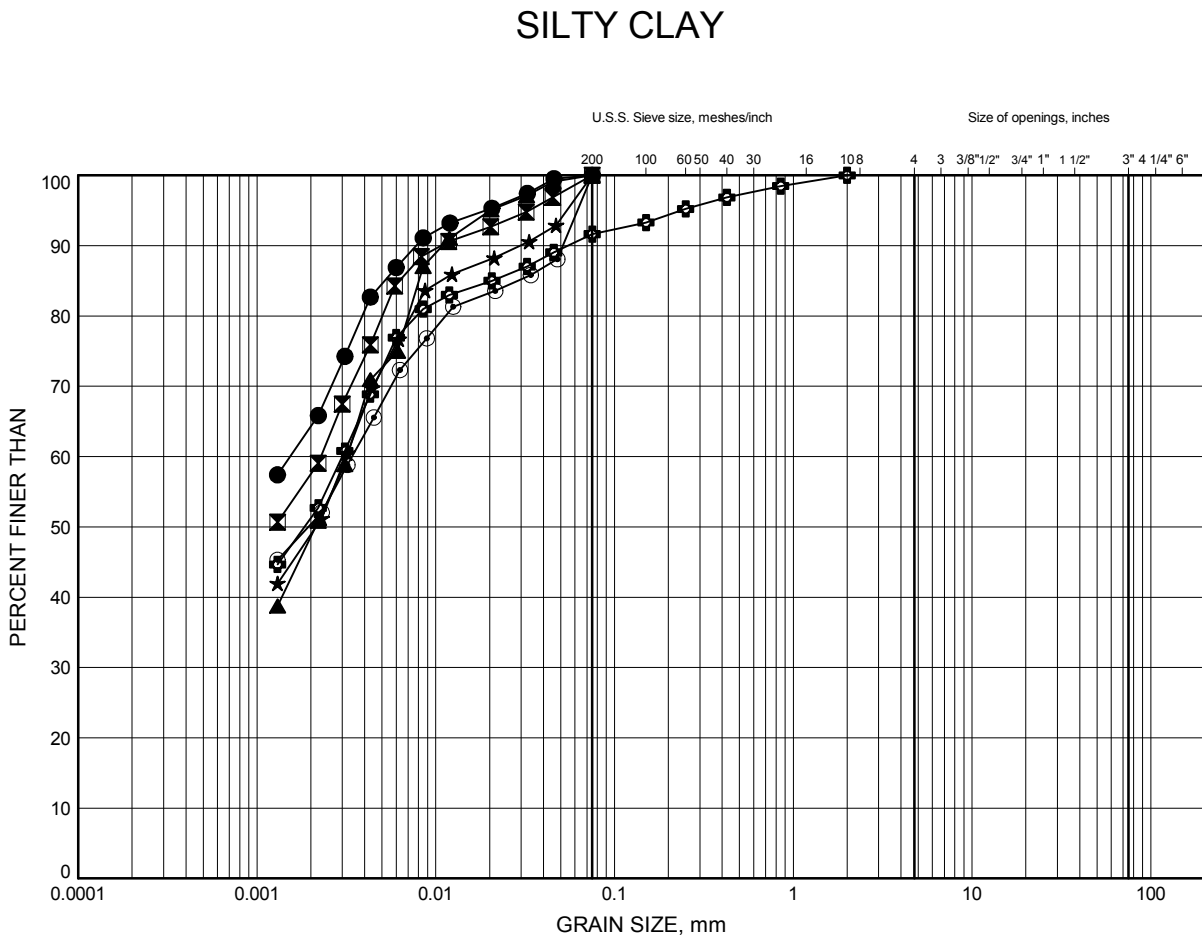
Laboratory Test Results

19-4406-9

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-01 Site 39E-314	4.11	259.19
⊠	UC-01 Site 39E-314	15.54	247.76
▲	UC-02 Site 39E-314	1.83	259.97
★	UC-03 Site 39E-314	4.88	258.22
⊙	UC-04 Site 39E-314	3.35	260.05
⊕	UC-04 Site 39E-314	9.45	253.95

Date December 2013

GWP# 5193-13-00



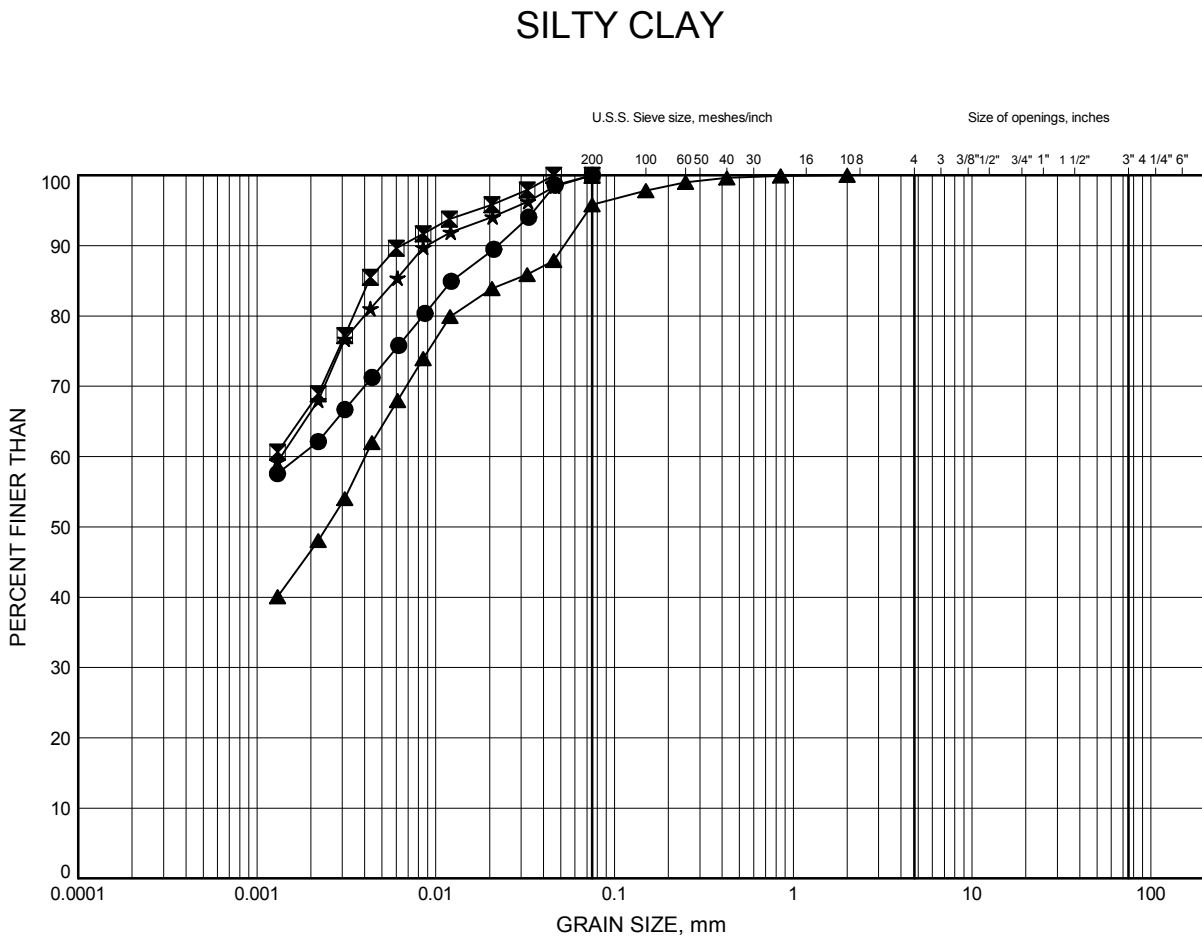
Prep'd AN

Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

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)
●	UC-05 Site 39E-314	2.59	259.81
⊠	UC-06 Site 39E-314	4.11	258.79
▲	UC-06 Site 39E-314	4.88	258.02
★	UC-06 Site 39E-314	18.59	244.31

Date December 2013

GWP# 5193-13-00



Prep'd AN

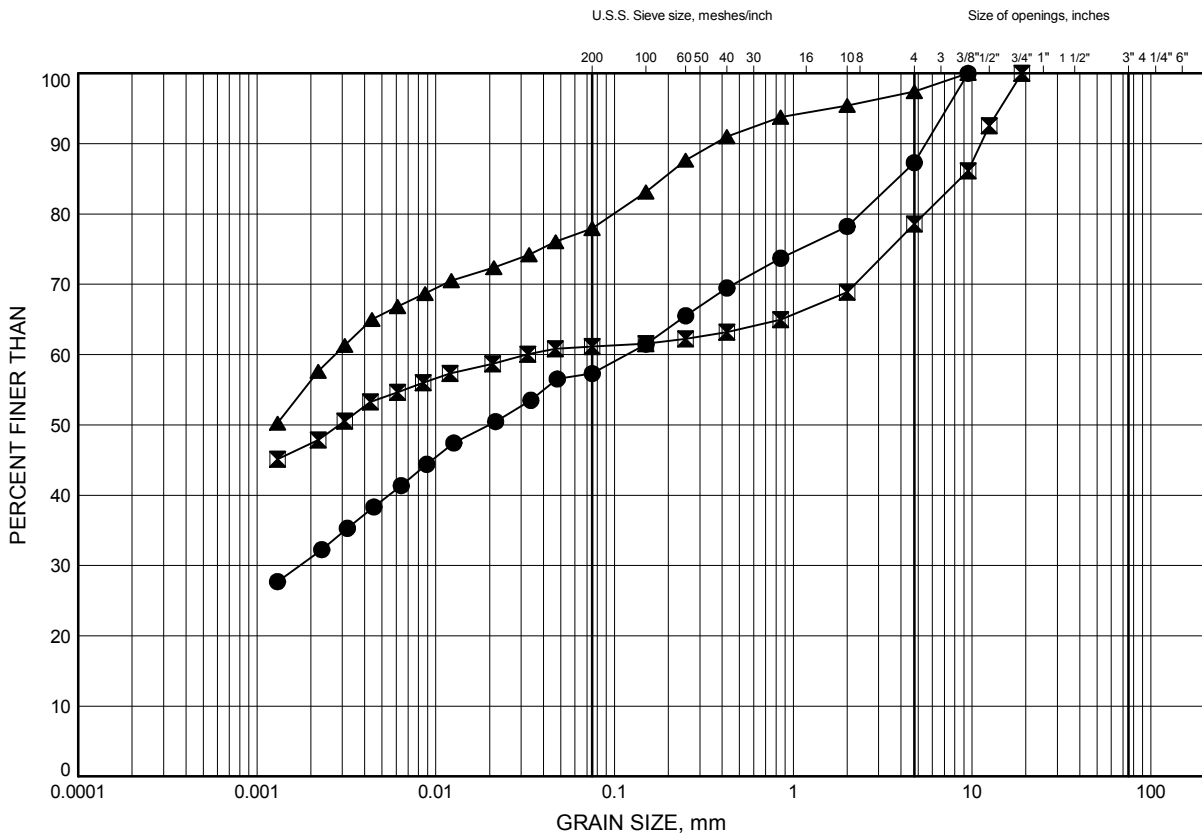
Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY, With Sand & Gravel Layer



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-03 Site 39E-314	14.02	249.08
⊠	UC-04 Site 39E-314	15.54	247.86
▲	UC-06 Site 39E-314	12.50	250.40

Date December 2013

GWP# 5193-13-00



Prep'd AN

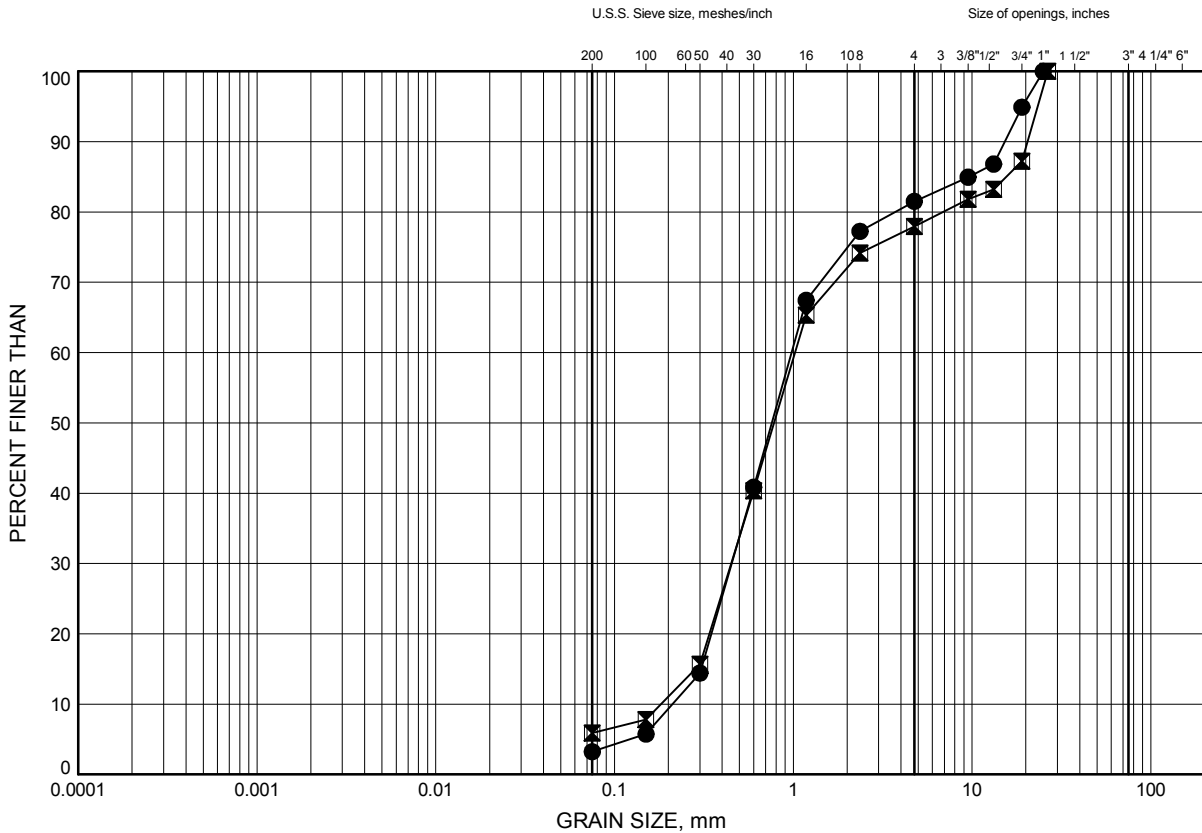
Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND (FILL), Some Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-04 Site 39E-314	1.07	262.33
⊠	UC-06 Site 39E-314	1.07	261.83

Date December 2013

GWP# 5193-13-00



Prep'd AN

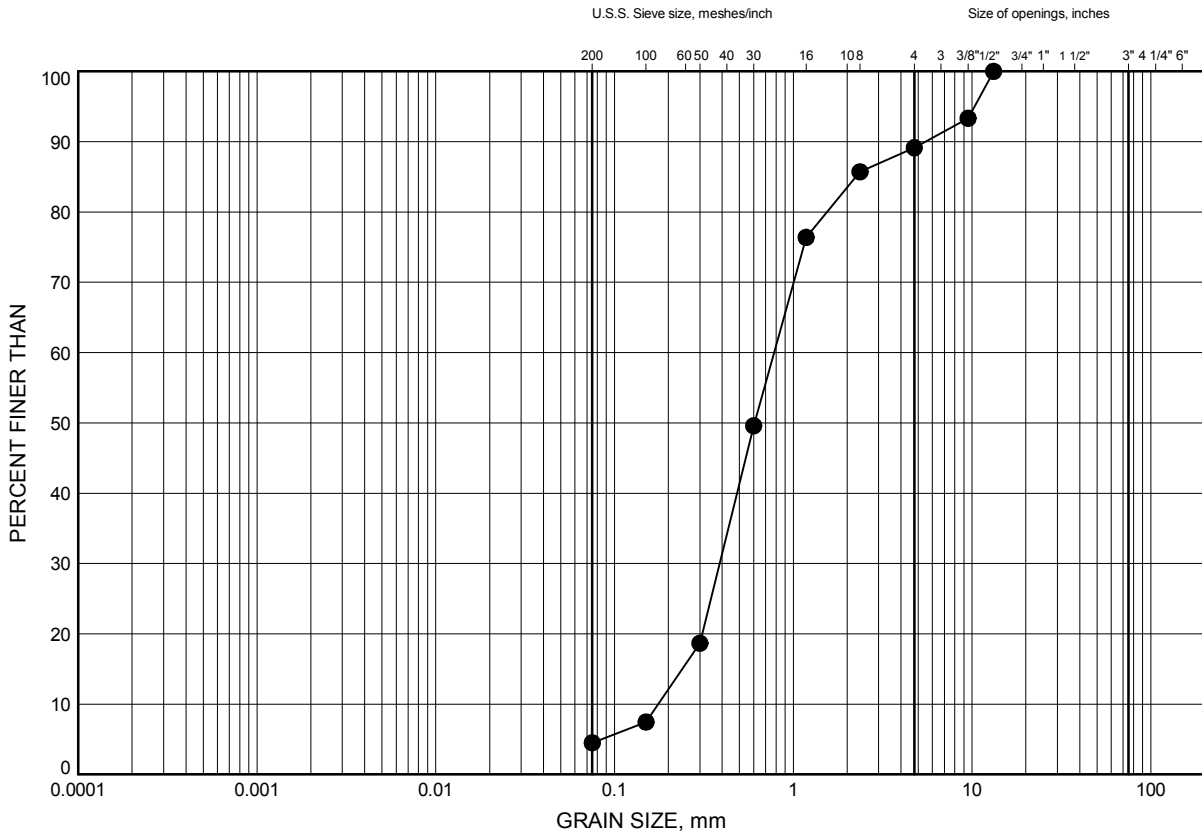
Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND, Some Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-05 Site 39E-314	1.07	261.33

Date December 2013
GWP# 5193-13-00



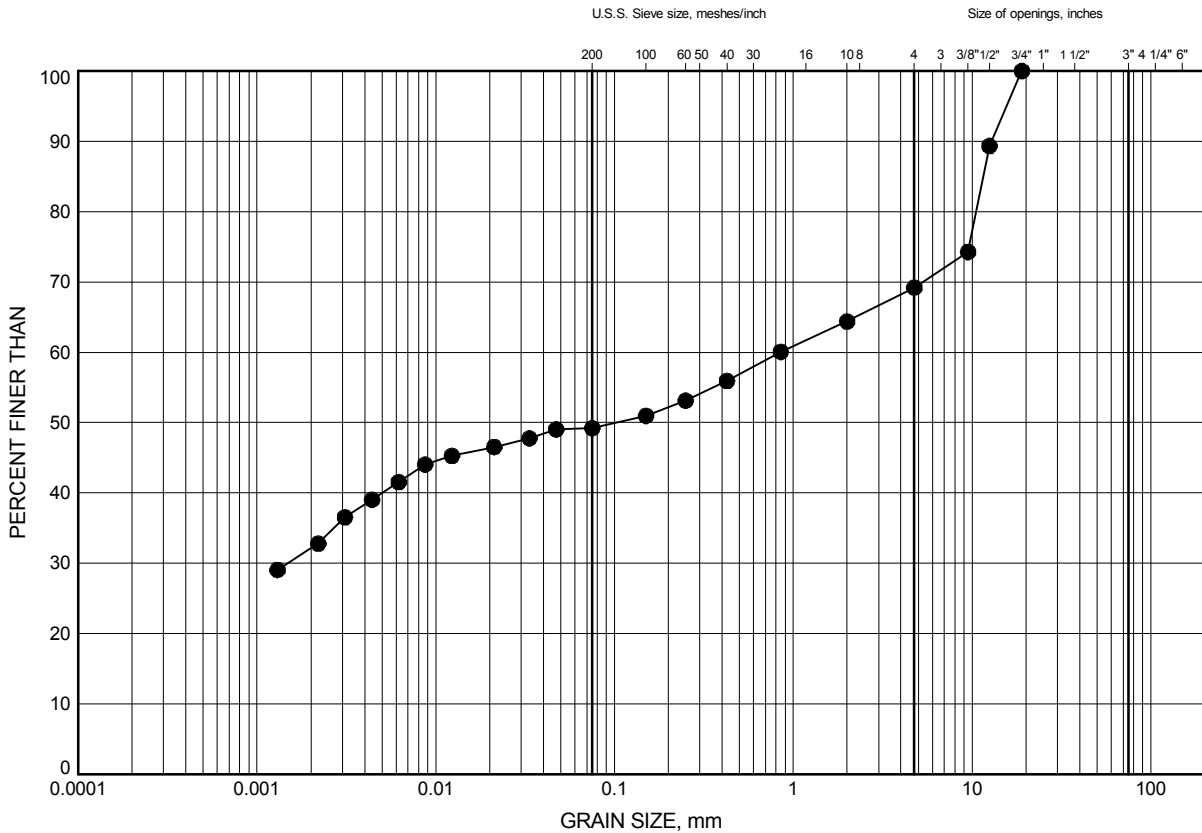
Prep'd AN
Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND & GRAVEL, With Silty Clay Layer (FILL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-03 Site 39E-314	1.07	262.03

Date December 2013

GWP# 5193-13-00



Prep'd AN

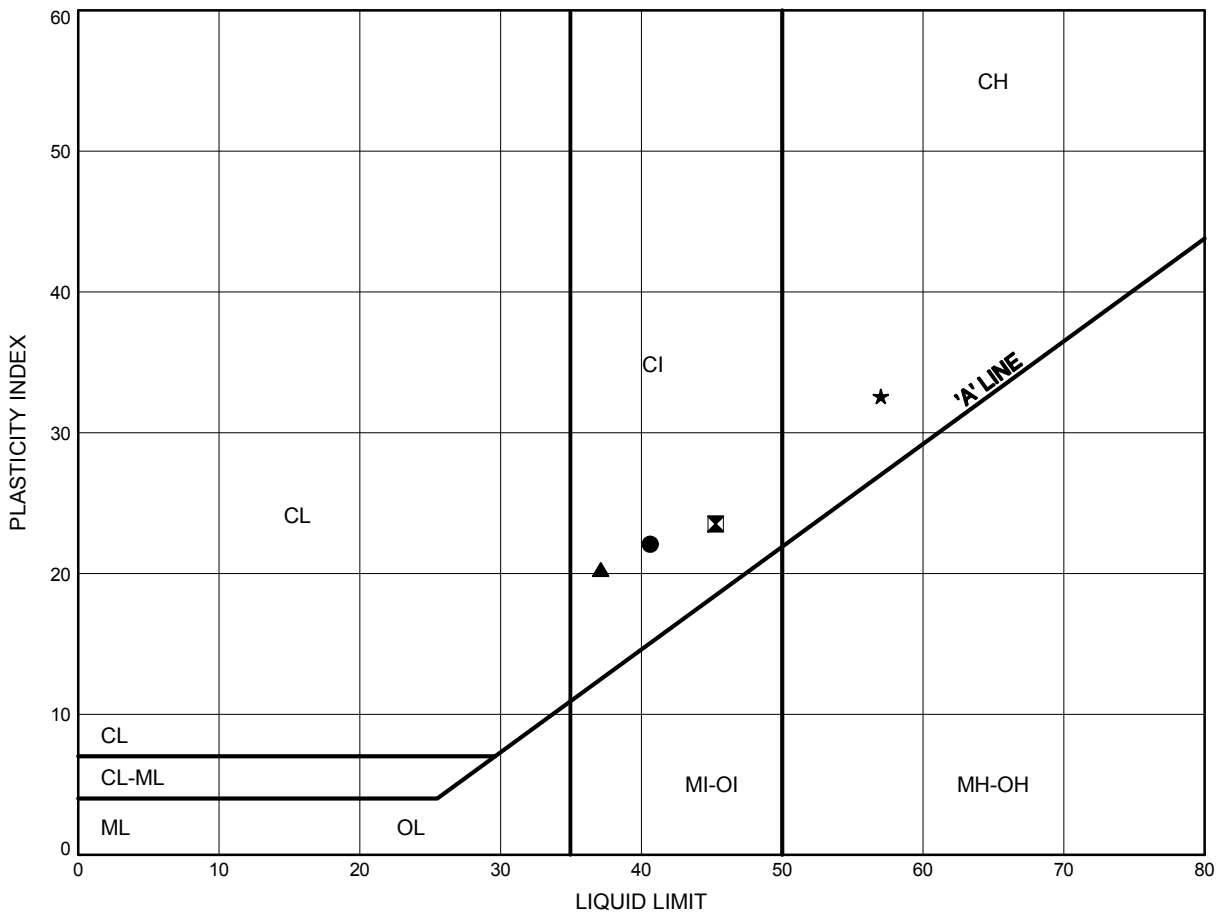
Chkd. LPG

Hwys 11, 583, 652 Culverts - Foundations

ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	UC-01 Site 39E-314	4.11	259.19
⊠	UC-01 Site 39E-314	15.54	247.76
▲	UC-03 Site 39E-314	4.88	258.22
★	UC-05 Site 39E-314	2.59	259.81

Date December 2013

GWP# 5193-13-00



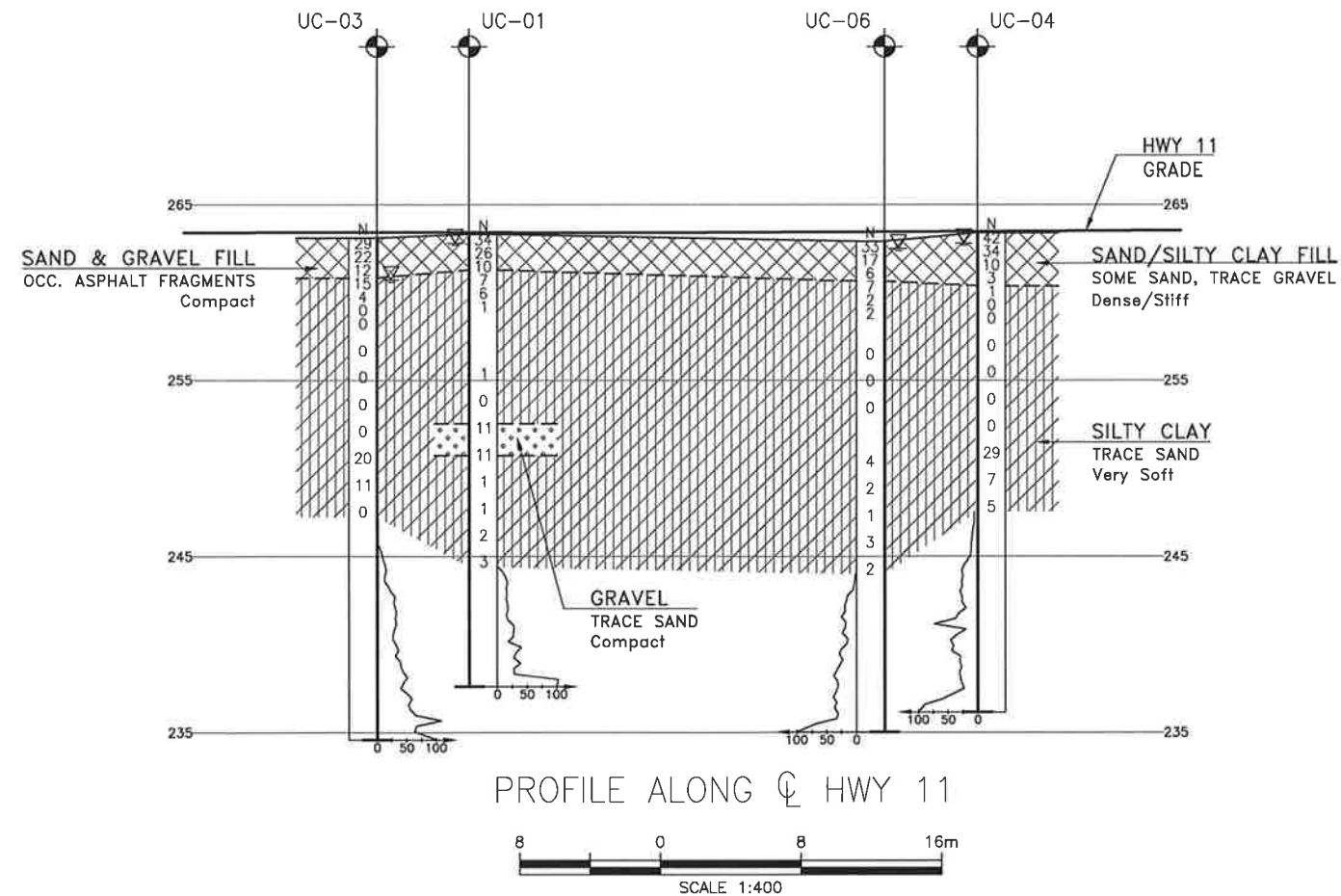
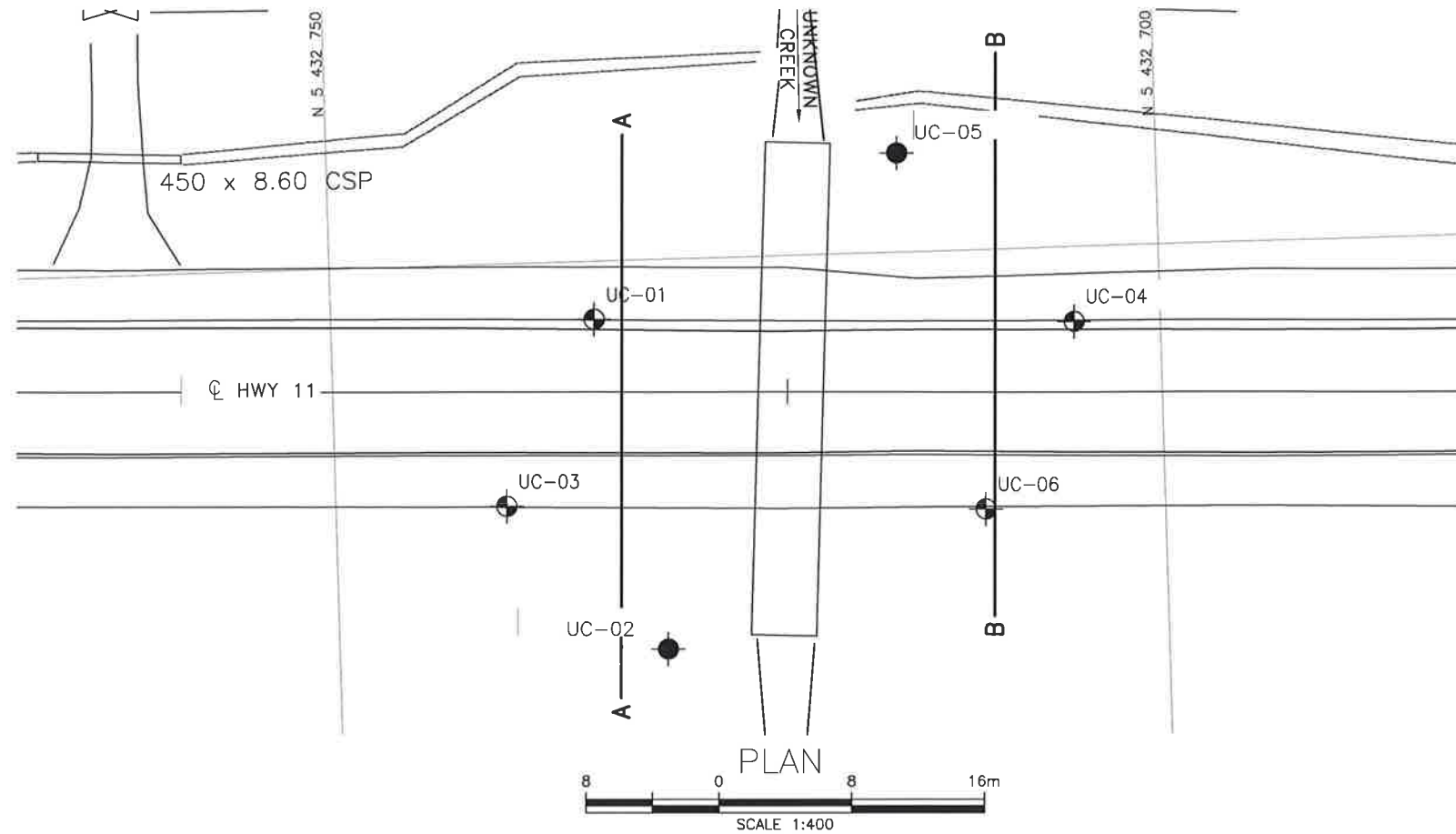
Prep'd AN

Chkd. LPG

Appendix C

Borehole Locations and Soil Strata Drawings

19-4406-9



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



CONT No
GWP No 5193-13-00

HWY 11 UNKNOWN CREEK
(MONDOR CREEK TRIBUTARY)
CULVERT REPLACEMENT I
BOREHOLE LOCATIONS AND SOIL STRATA

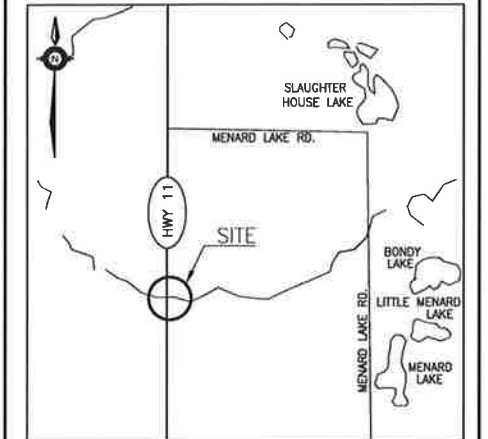


SHEET

URS



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)
WH	Weight Hammer
PH	Pressure, Hydraulic
W	Water Level
W	Head Artesian Water
P	Piezometer
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
UC-01	263.3	5 432 734.1	302 596.5
UC-02	261.8	5 432 730.2	302 576.5
UC-03	263.1	5 432 739.7	302 585.4
UC-04	263.4	5 432 705.2	302 595.5
UC-05	262.4	5 432 715.6	302 606.0
UC-06	262.9	5 432 715.6	302 606.0

-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.






GEOCRE No. 42H-56

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	SKP	CHK	SKP
DRAWN	AN	CHK	AEG
SITE	39E-314C	STRUCT	OWG 2

HWY 11 UNKNOWN CREEK
(MONDOR CREEK TRIBUTARY)
CULVERT REPLACEMENT II
BOREHOLE LOCATIONS AND SOIL STRATA

URS

LEGEND

- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole and Cone |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| WH | Weight Hammer |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| A/R | Auger Refusal |

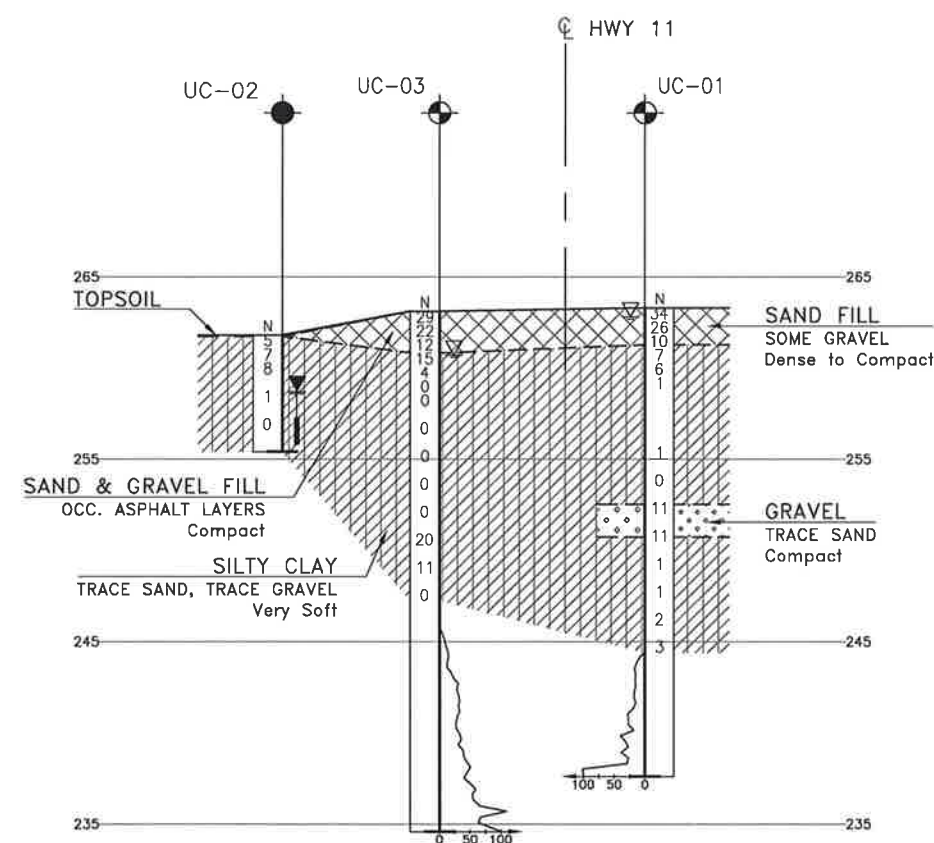
NO	ELEVATION	NORTHING	EASTING
UC-01	263.3	5 432 734.1	302 596.5
UC-02	261.8	5 432 730.2	302 576.5
UC-03	263.1	5 432 739.7	302 585.4
UC-04	263.4	5 432 705.2	302 595.5
UC-05	262.4	5 432 715.6	302 606.0
UC-06	262.9	5 432 715.6	302 606.0

-NOTES-

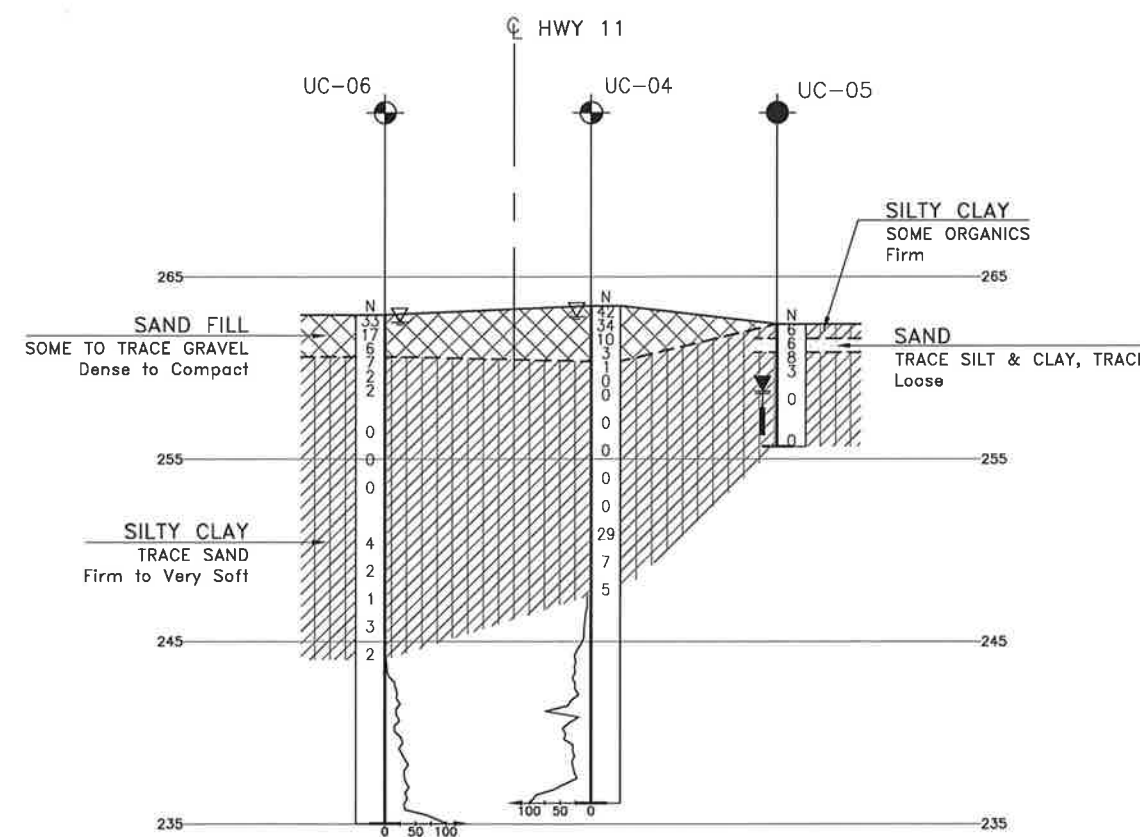
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 42H-56

REVISIONS							
	DATE	BY			DESCRIPTION		
DESIGN	SKP	CHK	SKP	CODE	LOAD	DATE	JAN 2015
DRAWN	AN	CHK	AEG	SITE	39E-314C	STRUCT	DWG 3



SECTION ALONG A-A



SECTION ALONG B-B

