



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 11B
CULVERT REPLACEMENT, 12+880 COLEMAN TWP
NEW LISKEARD AREA
G.W.P. 5421-04-00**

GEOCRES Number: 31M-107

Report to

MMM GROUP LIMITED

5013-E-0031, Assignment 1

Thurber Engineering Ltd.
104, 2460 Lancaster Road
Ottawa, Ontario
K1B 4S5
Phone: (613) 247-2121
Fax: (613) 247-2185

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19-5161-208



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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) for replacement of a culvert under Highway 11B near Cobalt, Ontario in the Township of Coleman.

No previous foundation investigation information for the subject culvert was available.

The purpose of this investigation was to obtain subsurface information at the site and, based on the data obtained, to provide a model of the subsurface conditions including borehole location plans, stratigraphic profiles, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber was retained by MMM Group Limited to carry out this foundation investigation under MTO Agreement Number 5013-E-0031.

2 SITE DESCRIPTION

The culvert site is located on Highway 11B, approximately 2.9 kilometres east of Highway 11 in the Township of Coleman. A 0.8 m diameter by 36 m long corrugated steel pipe (CSP) culvert is present at the site with approximately 5.2 m of cover. The culvert conveys water under Highway 11B from south to north. The invert elevations are 305.5 m at the inlet on the south side and 303.9 m at the outlet on the north side, indicating an average gradient of approximately 4.4%.

The culvert is located within a fill section with the grade of the existing Highway 11B in the vicinity of the culvert at approximately 310.6 m geodetic. The cross-section includes two 3.5 m lanes, 3.0 m wide shoulders and 1.0 m wide rounding. Three cable guide rail is present

on both sides of the highway. The embankment is constructed with side slopes at approximately 2 horizontal to 1 vertical (2H:1V). No evidence of slope instability or erosion were noted during the field investigations.

The site is located in a rural area with lakes, forests, swamps, and creeks. Local topography is generally flat with rolling hills and occasional rock outcrops. Selected photographs of the culvert site are attached in Appendix D. The highway at this site appears to have been re-aligned at some point in the past. Asphalt is present at ground surface at several locations to the north of the existing highway embankment. Bedrock outcrops on the south side of the highway to the east and the west of the site.

The surficial geology of the area is typical of the Wisconsin glaciation. Soil cover consists primarily of organic soils, and thin till cover over bedrock.

3 SITE INVESTIGATION AND FIELD TESTING

This borehole investigation and field testing program was carried out between Sept 30, 2014 and Oct 9, 2014. The program consisted of drilling and sampling six boreholes (numbered 14-7 through 14-12) to depths ranging from 1.0 m to 7.3 m, additionally there was one 0.4 m hand dug hole (14-8A). Of these boreholes, one was located near the culvert outlet (14-7), one located near the culvert inlet (14-10), two (14-11 and 14-12) were located through the embankment (one within each shoulder) on opposite sides of the culvert, and two were located for temporary widening of the highway to the north (14-8 west of the culvert and 14-9 east of the culvert). The location of 14-8A was offset from 14-8 with the intention of investigating the native soil beyond the reach of the old highway fill.

Prior to the start of drilling, the borehole locations were established in the field and utility clearances were obtained. The stationing with offsets and elevations of the as-drilled boreholes were subsequently surveyed by Thurber. The top of the right end of the box culvert at approximate Station 12+805 was used as a benchmark. Contract Drawings for 85-221 indicate the elevation at this location to be 301.80 m Geodetic.

A rubber track-mounted drill rig was used to drill and sample the boreholes on the roadway as well as one temporary widening borehole (14-9) and the culvert outlet borehole (14-7). A portable tripod drill rig was used to drill and sample the culvert inlet borehole (14-10) and one temporary widening borehole (14-8). Hollow stem augers and/or NW casing were used to advance the boreholes until the target depth was reached. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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

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.

The boreholes were backfilled with soil cuttings mixed with bentonite and topped to surface with the existing granular material and, where required, 100 mm of premium cold patch asphalt.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification and to Natural Moisture Content determination. Selected soil samples were subjected to Grain Size Distribution analyses (sieve). The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix B and on the Figures in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. A stratigraphic profile for the existing culvert alignment is presented on the Borehole Locations and Soil Strata Drawing in Appendix A 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 consist of granular embankment fill overlying till deposits and bedrock. More detailed descriptions of the individual strata are presented below.

5.2 Pavement Structure

Three boreholes were advanced through the old highway pavement structure (14-7, 14-8, and 14-9). In each case 100mm of asphalt was found at or near surface. Beneath the old highway asphalt, sand with gravel to silty sand some gravel extended to a depth of 1.0 m to 1.4 m (elevation 302.0 m to 305.9 m). The moisture content of the old highway pavement structure was determined to range from 9% to 28%.

A layer of asphalt 80 mm in thickness was encountered at ground surface in Borehole 14-12 which was drilled through the current roadway shoulder.

Gravelly sand, some silt to a gravel-sand mixture, which was likely placed as part of the pavement structure, extended to a depth of 1.1 m to 1.3 m below ground surface (elevations 309.7 m and 308.9 m) in Boreholes 14-11 and 14-12 respectively.

The moisture content of pavement granular samples ranged from 4% to 6%. The results of grain size analysis conducted on two samples of the granular material are presented on Fig. No 1 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	30 to 48
Sand	46 to 58
Silt and Clay	6 to 12

Also presented on Fig. No 1 in Appendix C are the results of grain size testing of the old pavement granulars acquired in Borehole 14-8. The tested sample included 17% gravel, 55% sand and 28% silt and clay sized particles.

5.3 Embankment Fill

Embankment fill was encountered below the pavement base in Boreholes 14-11 and 14-12. The thickness of the embankment fill was 5.3 m and 4.0 m. The base of the embankment fill was encountered at elevations 304.4 m and 304.9 m. Fill materials, 0.8 m in depth were also encountered at surface at the inlet hole (14-10), extending down to elevation 305.7 m.

The fill within the embankment was observed to be gravelly sand, trace silt while the material found on the side slope near the inlet was a gravel-sand mixture. The fill included cobbles at some intervals.

The SPT N-value for the granular fill ranged from 5 to greater than 100 blows per 0.3 m penetration, typically indicating a loose to dense state. The high blow count are like reprehensive of the presence of cobbles. The water content of the recovered granular fill samples ranged between 4% and 15%. The colour of the granular fill is brown.

The results of grain size analyses conducted on three samples of the fill are presented on Fig. No 2 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	35 to 52
Sand	46 to 60
Silt and Clay	2 to 8

5.4 Amorphous Peat

Amorphous peat with sand was encountered in Boreholes 14-10, 14-11, and 14-12. Peat was also found at surface in the hand dug Borehole 14-8A. In Borehole 14-12 a distinct 0.3 m thick layer of the amorphous peat was found below the embankment fill, extending down to elevation 304.6 m. In Boreholes 14-10 and 14-11 trace amounts of peat were noted at the fill/till interface. The water content of recovered samples of the peat ranged from 61% to 216%, an indication of the high organic content.

5.5 Till

A native soil deposit of gravelly sand with trace to some silt (till) was encountered in five boreholes (14-8A, 14-9, 14-10, 14-11, and 14-12). It is noted that till inherently contains cobbles and boulders. The till was found just below the fill in Boreholes 14-9, 14-10, 14-11 and below the peat layer in 14-8A and 14-12. This layer was observed to range from 0.1 m to 0.9 m in thickness with the elevation of the base of the unit ranging from 300.9 m to 305.3 m. The SPT N-value for this deposit was 77 to greater than 100 blows per 0.3 m penetration, indicating a very dense state. The water content of the recovered samples ranged between 11% and 39%. The colour of this deposit is brown to greyish brown.

Grain size analyses conducted on five samples of the till are presented on Fig. No 3 in Appendix C. These results are summarized in the following table.

Soil Particles	%
Gravel	24 to 44
Sand	47 to 65
Silt and Clay	5 to 24

5.6 Inferred Bedrock or Boulders

The boreholes were not advanced into bedrock using coring techniques. All drilled boreholes were terminated upon refusal on inferred bedrock or boulders. The inferred bedrock surface (or boulders) was encountered at depths ranging from 1.0 m to 7.3 m (elevations from 302.0 m to 305.3 m). The hand dug borehole (14-8A) encountered probable bedrock at a depth of 0.4 m (elevation 300.9 m). Bedrock outcrops on the south side of the highway to the east and west of the site.

5.7 Groundwater Conditions

At the time of drilling, free water was observed in Boreholes 14-11 and 14-12 at depths 6.6 m and 5.8 m respectively, elevation 304.2 m and 304.4 m. Water level in the stream was surveyed to be at elevation 305.5 m near the inlet and 304.1 m near the outlet on September 29, 2014.

Where surface water is present, the groundwater level should be assumed to coincide with the local surface water level. Local high water levels and the effects of heavy rainfall must also be taken into consideration.

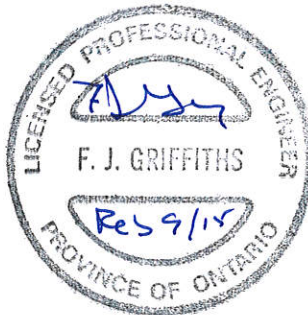
6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. The borehole locations and elevations were surveyed by Thurber.

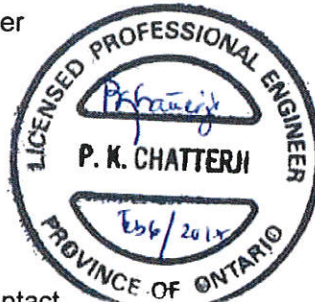
George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated a track-mounted CME 45 drill rig as well as the portable tripod drill rig to carry out the drilling, sampling and in-situ testing operations. The drilling and sampling operations in the field were supervised on a full time basis by Mr. Justin Gray of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall project management and direction of the field program was provided by Dr. Fred Griffiths, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Justin Gray and Dr. Fred Griffiths P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Justin Gray
Geotechnical E.I.T



Fred J. Griffiths, P.Eng.
Associate, Senior Foundations Engineer



P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

Appendix A

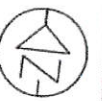
Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

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

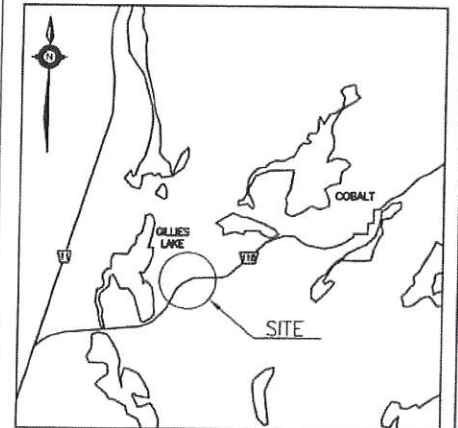
CONT No
WP No

HIGHWAY 11B
CULVERT
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

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
- W Water Level
- W Head Artesian Water
- P Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

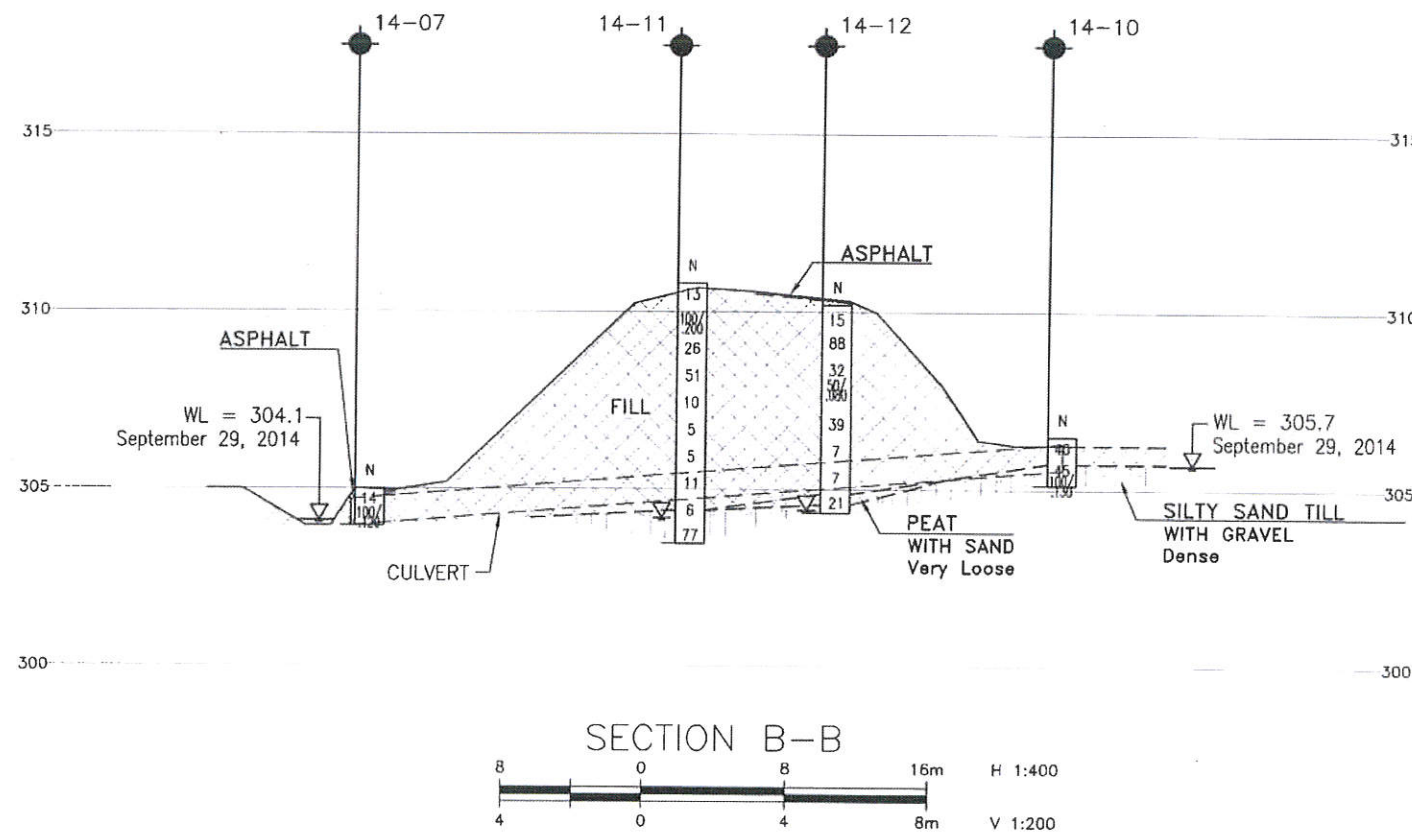
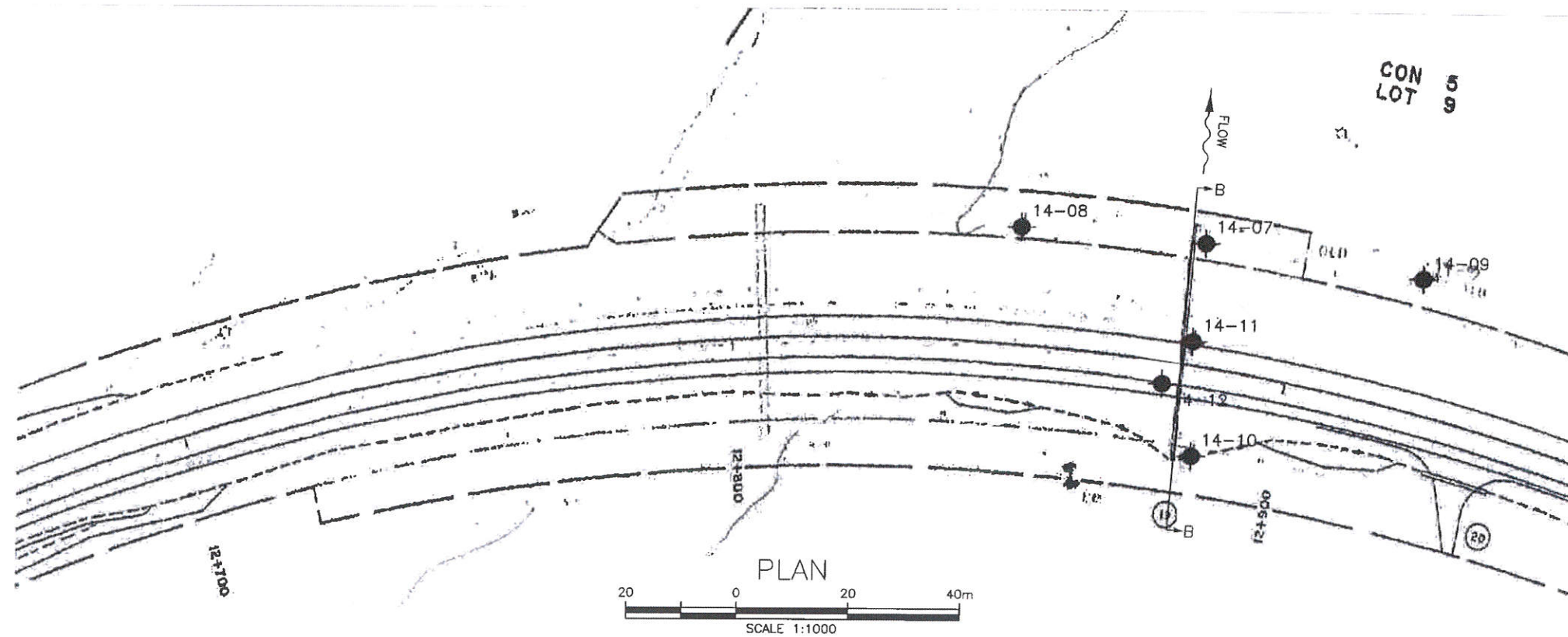
NO	ELEVATION	CHAINAGE	OFFSET
14-07	305.0	12+882	22L
14-08	303.3	12+850	21L
14-09	307.3	12+919	24L
14-10	306.5	12+884	17R
14-11	310.8	12+882	4.3L
14-12	310.2	12+878	4.2R

-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.

GEORES No. 31M-107

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	JG	CHK PC	CODE
DRAWN	MFA	CHK JG	SITE
STRUCT			
DWG	2		
DATE	FEB 2015		



FILENAME: H:\Projects\11B\11B107\200 NER DB Retainer\Design 1 Hwy 11B\CAD\15-02-02\11B107-Plan&Profile.dwg
PLOTDATE: 2/2/2015 1:52 PM

Appendix B

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				
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

<u>TERMS</u>	
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.

RECORD OF BOREHOLE No 14-7

1 OF 1

METRIC

19-5161-208 LOCATION 12+882 22 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.10.02 - 2014.10.02 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
305.0								20	40	60	80	100					
0.0	Gravelly SAND																
0.1	100mm ASPHALT		1	SS	14												
0.2	SAND with Gravel Compact Brown (FILL)																
304.0	cobbles at 0.8m REFUSAL AT 1.04m ON INFERRED BEDROCK OR BOULDERS		2	SS	100/ 120mm		304										
1.0																	

RECORD OF BOREHOLE No 14-8

1 OF 1

METRIC

19-5161-208 LOCATION 12+850 21 LT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Casing COMPILED BY JG
 DATUM geodetic DATE 2014.10.06 - 2014.10.06 CHECKED BY FG

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 (%)
303.3														
0.0	100mm ASPHALT													
303.0	SAND with Gravel Compact Brown (FILL)		1	SS	9		303						17 55 28 (SI+CL)	
0.3	Silty SAND some Gravel Compact Brown (FILL)		2	SS	27									
302.0	REFUSAL AT 1.30m ON INFERRED BEDROCK OR BOULDERS		3	SS	100/									
1.3					80mm									

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

RECORD OF BOREHOLE No 14-8A

1 OF 1

METRIC

19-5161-208

LOCATION

12+850 30 LT CL

ORIGINATED BY JG

HWY 11B

BOREHOLE TYPE Hand Dug

COMPILED BY JG

DATUM geodetic

DATE

2014.10.06 - 2014.10.06

CHECKED BY FG

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 (%)				
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					20 40 60 W P W W L						
301.3																	
0.0	Amorphous Peat		1	GS													
300.0	Loose		2	GS													
0.4	Black																
	Gravelly SAND																
	Compact																
	Brownish grey																
	(TILL)																
	random cobbles throughout																
	TEST HOLE TERMINATED AT 0.36m																
	ON PROBABLE BEDROCK																

ONTMT4S 19-5161-208.GPJ 2012TEMPLATE(MTO).GDT 6/2/15

RECORD OF BOREHOLE No 14-9

1 OF 1

METRIC

19-5161-208 LOCATION 12+919 24 LT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
 DATUM geodetic DATE 2014.10.02 - 2014.10.09 CHECKED BY FG

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										
307.3								20	40	60	80	100						
0.0	100mm ASPHALT																	
0.1	SAND with Gravel Compact Brown (FILL)		1	SS	10		307											
			2	SS	11													
305.9							306											
1.4	Gravelly SAND some Silt Compact Brown (TILL)		3	SS	100/ 130mm													24 65 11 (SI+CL)
305.3																		
2.0	REFUSAL AT 1.96m ON INFERRED BEDROCK OR BOULDERS																	

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

RECORD OF BOREHOLE No 14-10

1 OF 1

METRIC

19-5161-208 LOCATION 12+884 17 RT CL ORIGINATED BY JG
 HWY 11B BOREHOLE TYPE Casing COMPILED BY JG
 DATUM geodetic DATE 2014.10.09 - 2014.10.09 CHECKED BY FG

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									
306.5								20	40	60	80	100					
0.0	GRAVEL - SAND , trace asphalt Dense Brown (FILL) a few random cobbles throughout		1	SS	40		306							○			52 46 2 (SI+CL)
305.7																	
0.8	Gravelly SAND some Silt, trace peat Dense Brown (TILL)		2	SS	45									○			32 51 17 (SI+CL)
305.1	(TILL) random cobbles throughout		3	SS	100/												
1.4	random cobbles throughout REFUSAL AT 1.35m ON INFERRED BEDROCK OR BOULDERS				130mm												

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-11

1 OF 1

METRIC

19-5161-208 LOCATION 12+882 4.3 LT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.09.30 - 2014.09.30 CHECKED BY FG

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			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE
310.8																					
0.0	Gravelly SAND some Silt Dense Brown (FILL)		1	SS	13									○							
309.7							310							○						30 58 12 (SI+CL)	
1.1	Gravelly SAND trace Silt Loose to dense Brown (FILL)		2	SS	100/ 200mm																
			3	SS	26		309							○							
	a few random cobbles 1.0 to 3.0m		4	SS	51		308							○						35 57 8 (SI+CL)	
			5	SS	10									○							
							307														
			6	SS	5									○							
			7	SS	5		306							○							
			8	SS	11		305							○							
304.4			9	SS	6									○							
6.4	Gravelly SAND some Silt, trace peat Compact to very dense Brown (TILL)						304								○						
			10	SS	100/ 180mm									○						29 47 24 (SI+CL)	
303.5																					
7.3	REFUSAL AT 7.34m ON INFERRED BEDROCK OR BOULDERS. UPON COMPLETION WATER LEVEL RECORDED AT 6.6m																				

ONTMT4S 19-5161-208.GPJ 2012TEMPLATE(MTO).GDT 6/2/15

RECORD OF BOREHOLE No 14-12

1 OF 1

METRIC

19-5161-208 LOCATION 12+878 4.2 RT CL ORIGINATED BY JG
HWY 11B BOREHOLE TYPE Hollow Stem Auger COMPILED BY JG
DATUM geodetic DATE 2014.09.30 - 2014.09.30 CHECKED BY FG

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 (%)							
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE	W _P W W _L								
310.2																			
0.0							310												
0.1	80mm ASPHALT SHOULDER																		
	GRAVEL - SAND trace Silt Compact to dense Brown (FILL)		1	SS	15														
			2	SS	88													48 46 6 (SI+CL)	
308.9							309												
1.3	Gravelly SAND trace Silt Loose to dense Brown (FILL)		3	SS	32														
			4	SS	50/ 80mm		308												
	a few random cobbles 1.0 to 3.4m		5	SS	39		307												
			6	SS	7		306												
			7	SS	7													36 60 4 (SI+CL)	
304.9							305												
5.3	Amorphous PEAT with Sand		8	SS	100/ 230mm														
304.6	Very loose																		
5.6	Blackish brown																	42 50 8 (SI+CL)	
304.3																			
5.9	Gravelly SAND trace Silt Dense Greyish brown (TILL) REFUSAL AT 5.87m ON INFERRED BEDROCK OR BOULDERS. UPON COMPLETION WATER LEVEL RECORDED AT 5.79m																		

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

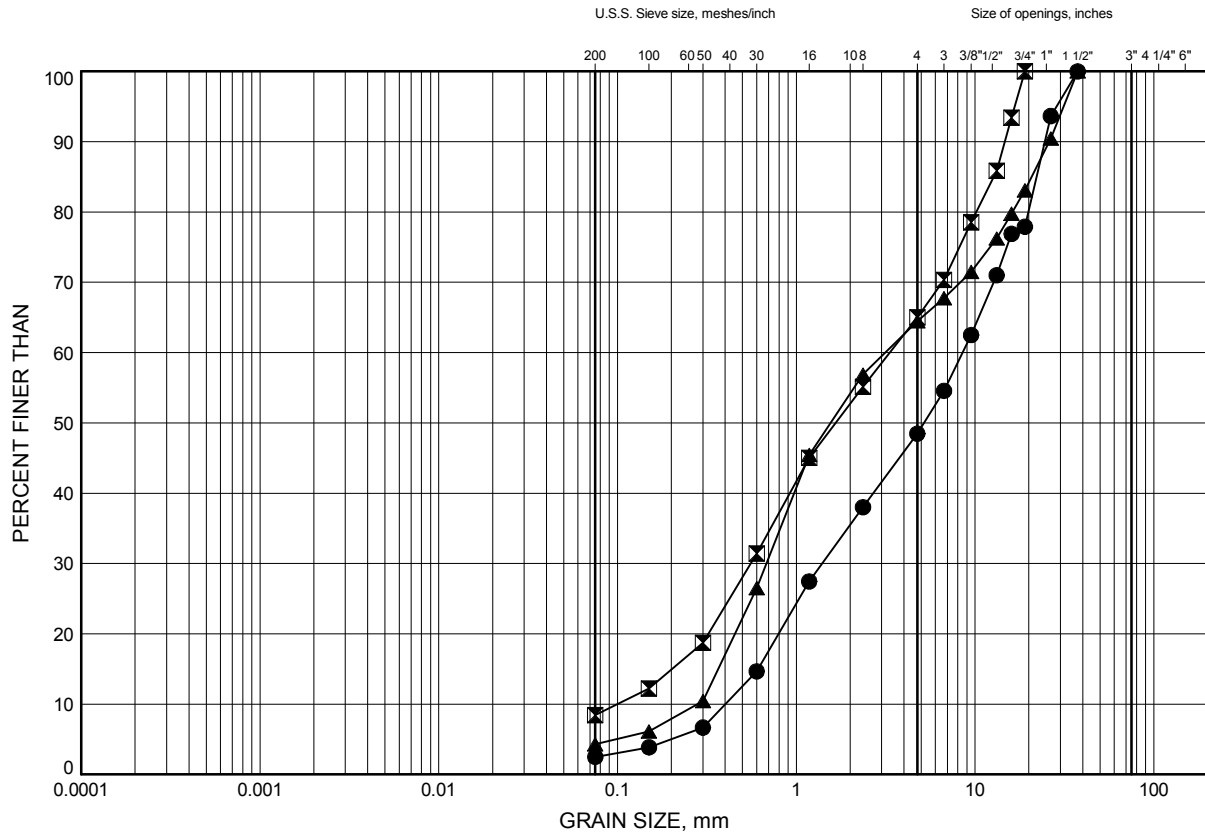
Appendix C

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE 1

FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-10	0.30	306.20
⊠	14-11	2.59	308.21
▲	14-12	4.88	305.32

Date November 2014
19-5161-208

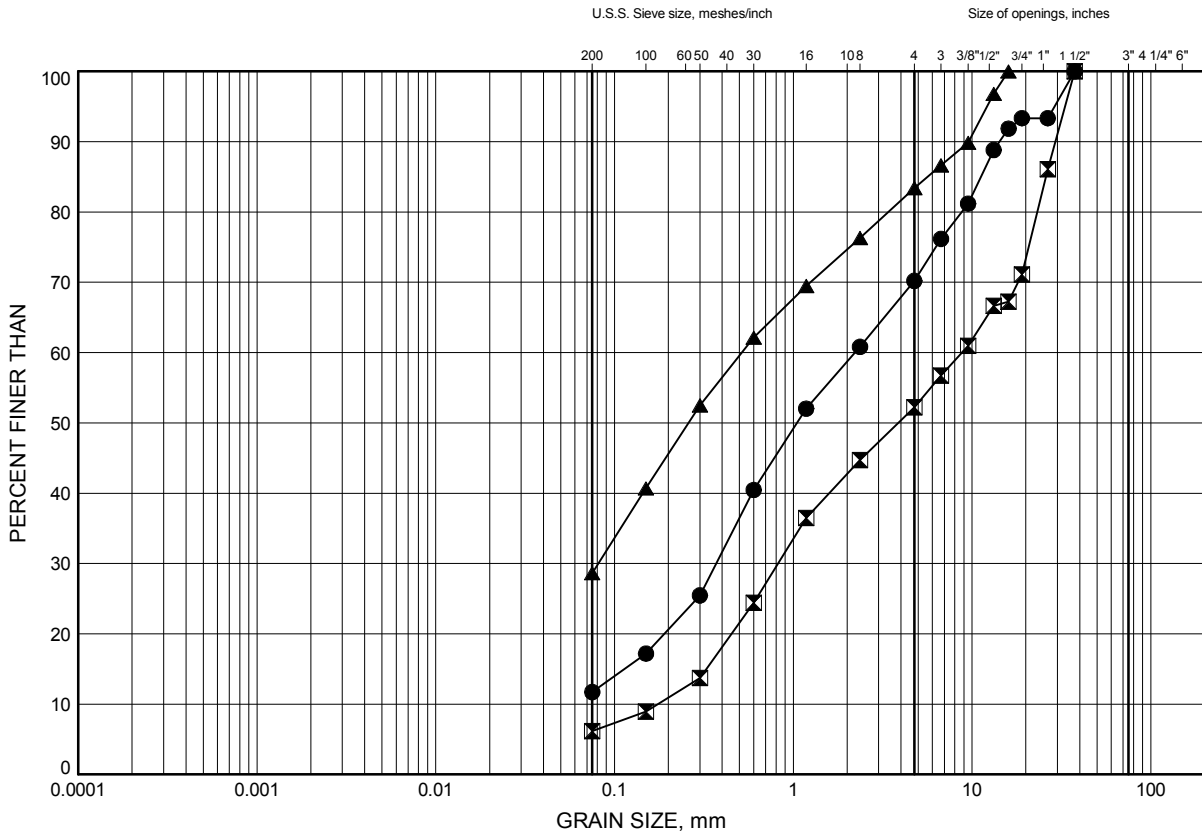


Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 2

PAVEMENT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-11	0.84	309.96
⊠	14-12	1.07	309.13
▲	14-8	0.46	302.84

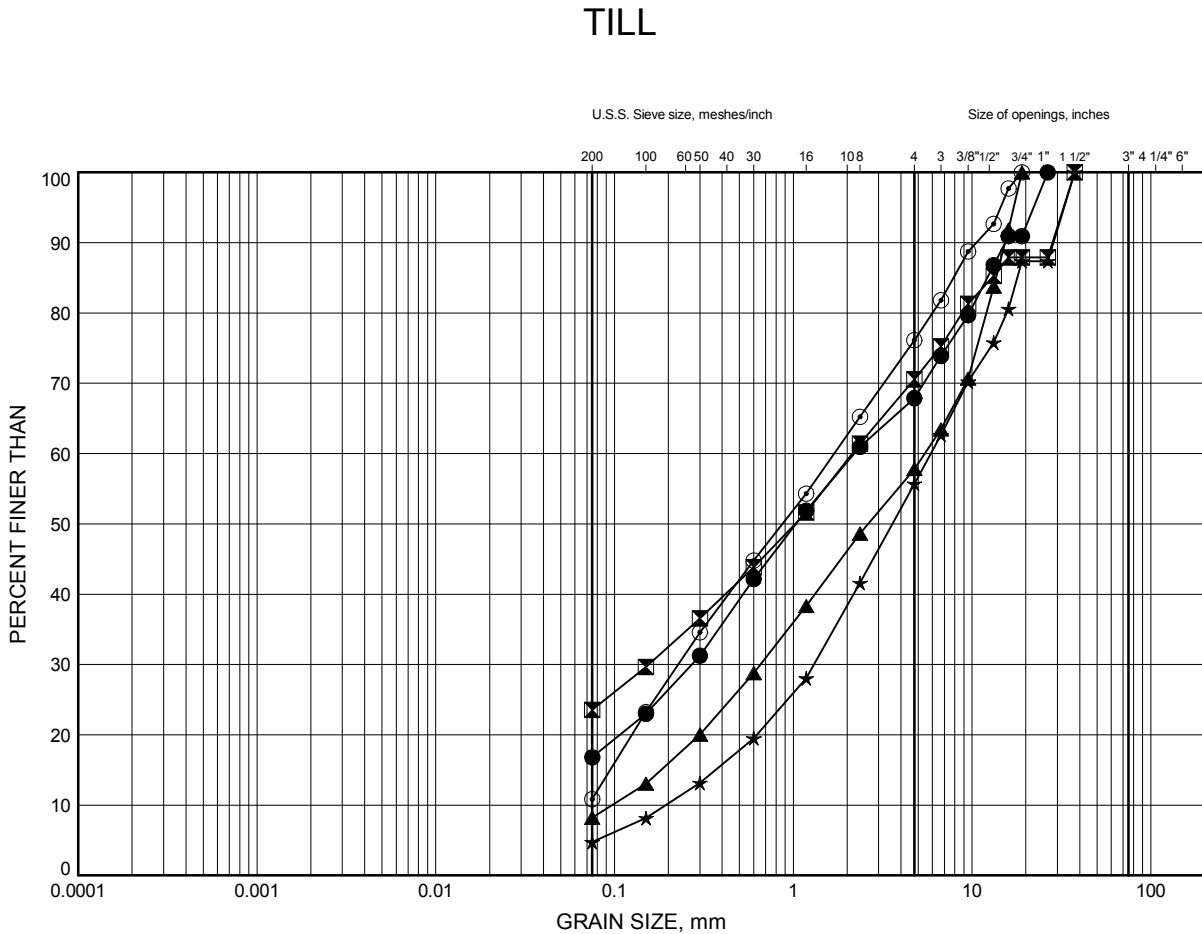
Date November 2014
19-5161-208



Prep'd JG
Chkd. FG

GRAIN SIZE DISTRIBUTION

FIGURE 3



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-10	1.07	305.43
⊠	14-11	7.09	303.71
▲	14-12	5.72	304.48
★	14-8A	0.30	301.02
⊙	14-9	1.75	305.55

Date December 2014
19-5161-208



Prep'd JG
Chkd. FG

Appendix D

Selected Photographs



Photo 1: Looking east along Hwy 11B



Photo 2: Looking west along Hwy 11B



Photo 3: Culvert 2 inlet



Photo 4: Culvert 2 outlet