

**FOUNDATION INVESTIGATION REPORT
ITZCAULDE CREEK CULVERT
HIGHWAY 11/17 RED ROCK TO NIPIGON
FROM 4.8 KM WEST OF HWY 628 TO 1.5 KM WEST OF HWY 585
TOWNSHIP OF RED ROCK**

G.W.P. 647-89-00, SITE No. 48C-352

Geocres Number: 52A-179

Report to

Hatch Mott MacDonald

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TABLE OF CONTENTS

PART 1 FACTUAL INFORMATION

1 INTRODUCTION..... 1

2 SITE DESCRIPTION..... 1

3 SITE INVESTIGATION AND FIELD TESTING 2

4 LABORATORY TESTING 4

5 DESCRIPTION OF SUBSURFACE CONDITIONS 4

 5.1 Sand Fill..... 5

 5.2 Silty Clay (Fill and Possible Fill) 5

 5.3 Organics and Organic Clay with Peat..... 6

 5.4 Silty Clay 7

 5.5 Sand and Silt to Gravelly Sand..... 8

 5.6 Bedrock and Probable Bedrock 8

 5.7 Water Levels..... 9

6 MISCELLANEOUS..... 10

Appendices

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Site Photographs
Appendix D	Borehole Locations and Soil Strata Drawings

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the proposed location of the Itzcaulde Creek culvert to be installed under the eastbound and westbound lanes of Highway 11/17 in the Township of Red Rock, Ontario. The new culvert is planned as part of the Highway 11/17 four-laning project, involving construction of a divided highway from 4.8 km west of Highway 628 to 1.5 km west of Highway 585 in the District of Thunder Bay.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to Hatch Mott MacDonald (HMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0006.

2 SITE DESCRIPTION

The site is located approximately 13 km (by highway) southwest of Nipigon, Ontario and about 1.5 km southwest of the intersection of Highway 11/17 and Highway 628. At the culvert site, the new eastbound lanes of Highway 11/17 will be located approximately 10 m east of the existing highway alignment and the new westbound lanes will be approximately 20 m to the west.

At the existing Highway 11/17 crossing, Itzcaulde Creek flows in a northwest to southeast direction within an approximate 45 m wide, low-lying wet area. The culvert under the existing highway embankment consists of an 1800 mm diameter CSP and the highway embankment is approximately

6 m high. An approximate 2.5 m high embankment from a former highway alignment runs adjacent to the northwest side of the existing highway, and the creek is carried under this embankment in a 900 mm diameter CSP. An open timber box forms the connection between the two different size culverts.

Preliminary drawings provided by HMM indicate creek water levels of Elev. 212.7 at the inlet and Elev. 212.0 at the outlet in November 2010.

The surrounding lands are typically treed with occasional areas of grass and shrubs. Occasional residential dwellings, businesses and sideroads are present along the highway corridor.

Photographs in Appendix C show the existing Itzcaulde Creek culvert and the general nature of the site.

The site lies within the physiographic region known as the Quetico Subprovince of the Superior Province of the Canadian Shield. The region is characterized by early Precambrian felsic igneous (granite) and metamorphic (granitic gneiss) bedrock. The bedrock is mantled by a thin discontinuous layer of drift or deeper deposits of glaciolacustrine clay.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing in the vicinity of this structure was carried out in several stages as the design evolved and the culvert alignment was revised:

- Initially during the period February 6 to 23, 2013, investigation was completed through this area for assessment of proposed high fill embankments. The investigation included advancing ten boreholes and nine dynamic cone penetration tests (DCPT) along the proposed eastbound and westbound lanes. Four of the boreholes and one DCPT were located within 20 m of the currently proposed culvert alignment, and this information has been incorporated into this report. The boreholes and DCPT are identified by Station and Offset as follows: 13+321 17.4L, 13+324 27L (DCPT), 13+340 19R, 13+350 19L, and 13+375 30R.
- Subsequently during May 4 to 9, 2013, three boreholes designated SB-01 to SB-03 were drilled along the culvert alignment proposed at that time. The culvert alignment was subsequently revised such that only Boreholes SB-01 and SB-03 are located within 20 m of the currently proposed alignment, and these two boreholes are included in this report.
- On March 25, 2014, three additional boreholes were drilled along the existing highway embankment to determine the composition of the embankment fill. These boreholes are identified by Station and Offset as follows: 13+318 01L, 13+342 07R, and 13+380 07R. The boreholes at Stations 13+318 and 13+342 are located within 20 m of the currently proposed culvert alignment and are included in this report.

- On May 5, 2014, an additional borehole designated SB-04 was drilled near the west end of the culvert alignment to prove bedrock.

All borehole logs from the high fill section, including those not incorporated in this report, are presented in the Foundation Investigation Report for the high fill embankments, along with stratigraphic profiles along the eastbound and westbound lanes.

The approximate borehole locations near the culvert are shown on the attached Borehole Locations and Soil Strata drawing included in Appendix D.

The boreholes were advanced to depths of 13.3 to 18.4 m (Elev. 205.8 to 194.4 m), including recovery of 3.0 to 3.2 m of bedrock core from Boreholes SB-03 and SB-04 using NQ coring techniques. Two of the boreholes (SB-01 and 13+321 17.4L) and the DCPT (13+324 27L) were terminated upon refusal on probable bedrock or boulders.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. The boreholes were relocated as necessary subject to access constraints, steep slopes and overhead utilities.

Drilling was carried out using track and truck mounted drill rigs and the boreholes were advanced with hollow-stem augers and NQ coring techniques. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was conducted to further assess the undrained shear strength of the cohesive deposits. All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

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 and rock cores for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions were observed in the open boreholes upon completion of the drilling operations, except where bedrock coring was performed, since water is added to the borehole during coring operations. A standpipe piezometer was installed in one borehole to measure groundwater levels. The piezometer was subsequently decommissioned in general accordance with MOE Regulation 903. The piezometer installation and borehole completion details are summarized in Table 3.1.

Table 3.1 – Borehole Completion and Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elev. (m)	Completion and Installation Details
SB-01	None installed	Backfilled with bentonite holeplug to 2.4 m, then cuttings to surface.
SB-03	None installed	Backfilled with bentonite holeplug to surface.
SB-04	None installed	Backfilled with bentonite holeplug to surface.
13+318 01L	None installed	Backfilled with bentonite holeplug to 1.5 m, then cuttings to surface.
13+321 17.4L	None installed	Backfilled with bentonite holeplug to 1.5 m, then cuttings to surface.
13+324 27L	None installed	(DCPT)
13+340 19R	13.1 / 201.1	19 mm diameter piezometer installed with filter sand from 13.1 m to 11.3 m, clay cuttings from 11.3 m to 1.2 m, then bentonite holeplug to surface.
13+342 07R	None installed	Backfilled with bentonite holeplug to 1.4 m, then cuttings to surface.
13+350 19L	None installed	Backfilled with bentonite holeplug to 2.3 m, then cuttings to surface.
13+375 30R	None installed	Backfilled with bentonite holeplug to surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and sieve) and Atterberg Limits testing, where appropriate. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

Point load tests were carried out on selected samples of intact bedrock to evaluate the unconfined compressive strength (UCS) of the bedrock. The UCS values of the rock assessed from the point load data are reported on the borehole logs (as average per run).

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, the subsurface stratigraphy encountered at the culvert site consisted of existing embankment fill, peat and organics, overlying a thick deposit of silty clay, underlain by a layer of gravelly sand to sand and silt, overlying bedrock and probable bedrock. More detailed descriptions of the individual strata are presented below.

A description of the subsurface conditions within the overall embankment area is presented under separate cover in the Foundation Investigation Report prepared for the high fill embankments.

5.1 Sand Fill

Sand fill was encountered in the boreholes drilled on both the former and the existing Highway 11/17 embankments.

In Boreholes 13+318 01L and 13+342 07R drilled on the shoulder of the existing highway, the fill consisted of a 0.4 to 0.7 m thick layer of granular material underlain by silty sand to sand with some silt and trace of gravel. The sand fill in these boreholes extended to depths of 5.1 and 7.1 m (Elev. 214.0 and 211.6), and was interrupted in Borehole 13+342 07R by a 0.6 m thick layer of clay fill at 5.7 m depth.

In boreholes drilled through the former highway embankment, sand fill was encountered below a surficial organic layer (Borehole SB-01), below silty clay fill at 1.8 m depth (Borehole 13+321 17.4L), and at the ground surface (Boreholes SB-04 and 13+350 19L). The sand fill varied from gravelly to silty. The thickness of the sand fill ranged from 1.2 to 1.9 m, with a lower boundary at depths of 1.2 to 3.6 m (Elev. 213.9 to 211.9).

In general, SPT N-values recorded in the sand fill varied widely from 0 to 30 blows for 0.3 m penetration, indicating a very loose to compact relative density. Higher N-values of 89 blows for 0.3 m to 50 blows for 0.05 m of penetration were obtained in the upper frozen material. Moisture contents of 4% to 30% were measured, reflecting the presence of silty/clayey zones or organic inclusions in samples of the sand fill.

Three samples of the sand fill were selected for laboratory grain size analysis testing. The results of the tests are summarized below and are presented on the corresponding Record of Borehole sheets included in Appendix A. The grain size distribution curves for the samples are plotted on Figure B1, Appendix B.

Gravel %	0 to 29
Sand %	50 to 74
Silt and Clay %	21 to 28

5.2 Silty Clay (Fill and Possible Fill)

Silty clay identified as fill or possible fill was encountered below the sand fill at depths of 1.2 to 1.8 m (Elev. 213.6 to 213.9) in Boreholes SB-01, SB-04 and 13+350 19L drilled

from the former embankment level, and at depths of 5.1 and 5.7 m (Elev. 214.0 and 213.0) in Boreholes 13+318 01L and 13+342 07R drilled on the existing highway embankment. The clay (fill) contained organic seams, wood fibres/fragments, roots/rootlets and peat layers. Of note are a 0.7 m thick layer of silty sand with peat encountered in Borehole 13+350 19L and a 0.8 m thick sand layer in Borehole 13+342 07R. The colour of the silty clay (fill) was generally brown to dark brown.

The thickness of the silty clay (fill) including the intermixed peat and sand layers ranged from 2.4 to 4.6 m, with a lower boundary at depths of 4.6 to 9.8 m (Elev. 211.6 to 208.9).

Silty clay fill was also encountered below a thin organic layer and above the sand fill in Borehole 13+321 17.4L drilled on the former highway alignment. The clay fill was 1.5 m thick with a lower boundary at 1.7 m depth (Elev. 213.8) in this borehole.

SPT N-values recorded in the silty clay (fill) ranged from 0 to 12 blows for 0.3 m penetration, indicating a very soft to stiff consistency. An N-value of 21 blows for 0.3 m was recorded in frozen material in Borehole 13+321 17.4L. An undrained shear strength of 52 kPa was measured by in situ vane testing in Borehole SB-01. Moisture contents ranged from about 23% to 53% in the silty clay fill.

The results of grain size distribution analyses conducted on three samples of the silty clay fill are presented on the Record of Borehole sheets in Appendix A and on the grain size distribution curves plotted on Figure B2, Appendix B. The results of Atterberg Limits testing conducted on the samples are presented on the Record of Borehole sheets and plotted on Figure B7 of Appendix B. The results are summarized below.

Gravel%	0 to 9
Sand%	11 to 19
Silt%	43 to 61
Clay%	28 to 38
Liquid Limit	34 to 36
Plastic Limit	17 to 20

5.3 Organics and Organic Clay with Peat

A thin layer of organic material was encountered at the ground surface in Boreholes SB-01, 13+321 17.4L and 13+340 19R. The organic layer was 50 to 175 mm thick at these locations. The thickness of the organic layer may vary between and beyond the borehole locations.

A layer of organic clay with peat was encountered at the ground surface in Boreholes SB-03 and 13+375 30R drilled to the east of the existing highway embankment, and below

the embankment fill in Boreholes SB-04 and 13+318 01L. The organic layer was 3.0 m thick in Borehole 13+375 30R and 0.8 to 1.5 m thick in the remaining boreholes. The lower boundary was at Elev. 212.0 to 208.7.

SPT N-values recorded in the organic clay ranged from 0 to 4 blows for 0.3 m penetration, locally 16 blows in Borehole 13+318 01L. Moisture contents ranged from 47 to 74%.

A further 0.9 m of sandy clayey silt with organics was encountered below the organic clay in Borehole SB-04. An N-value of 4 blows for 0.3 m and a moisture content of 53% were obtained in this layer. The lower boundary was at 7.0 m depth (Elev. 207.8). The results of a grain size distribution analysis conducted on this layer are presented on Figure B3 of Appendix B, and are summarized below.

Gravel%	0
Sand%	34
Silt%	43
Clay%	23

5.4 Silty Clay

Native silty clay was encountered below the organic layer, organic clay deposits and fill in all boreholes. The silty clay was typically grey and occasionally brown in the upper 2 to 3 m.

Where fully penetrated, the silty clay layer was 5.7 to 12.3 m thick, with a lower boundary encountered at depths of 12.5 to 14.2 m (Elev. 203.0 to 200.2 m). Boreholes 13+318 01L, 13+375 30R, and 13+342 07R were terminated within the silty clay layer at depths of 13.3 to 13.7 m (Elev. 205.8 to 198.4 m), indicating a thickness of at least 3.5 to 10.7 m.

SPT N-values recorded in the silty clay ranged from 0 to 6 blows for 0.3 m penetration, typically less than 3. In situ shear vane testing indicated undrained shear strengths in the order of 22 to 84 kPa, typically 22 to 44 kPa. Based on this data, the consistency of the silty clay is generally soft to firm with stiff zones.

The moisture content of the silty clay typically ranged from 29% to 60%. A value of 91% was measured in one sample from about 1.0 m depth in Borehole 13+340 19R.

The results of grain size distribution analyses conducted on samples of the silty clay are presented on the Record of Borehole sheets in Appendix A and on Figures B4 and B5 in Appendix B. The results of Atterberg Limits testing conducted on the samples are presented on the Record of Borehole sheets and plotted on Figures B8 and B9 of Appendix B. The results are summarized below.

Gravel%	0
Sand%	0 to 1
Silt%	25 to 67
Clay%	32 to 75
Liquid Limit	28 to 57
Plastic Limit	16 to 25

The results of the Atterberg Limits tests indicate that the silty clay is typically of intermediate plasticity (CI), varying from low to high plastic (CL to CH).

5.5 Sand and Silt to Gravelly Sand

A cohesionless deposit varying in gradation from sand and silt to gravelly sand was encountered below the silty clay layer in Boreholes SB-01, SB-03, SB-04, 13+321 17.4L, 13+340 19R, and 13+350 19L. Boreholes SB-01, SB-03, SB-04 and 13+321 17.4L were terminated upon encountering bedrock or refusal below the cohesionless material at depths of 14.0 to 17.4 m (Elev. 197.4 to 201.4), indicating a thickness of 1.3 to 3.2 m. Boreholes 13+340 19R and 13+350 19L were terminated in the buried cohesionless layer at 13.7 and 14.3 m depth (Elev. 200.5 and 200.8).

SPT N-values recorded within the cohesionless deposit ranged from 1 blow for 0.3 m penetration to 100 blows for 0.075 m penetration, indicating a widely variable relative density of very loose to very dense. An SPT N-value of 100 blows with no penetration was recorded on a probable cobble above the bedrock in Borehole SB-03. Moisture contents ranged from 5% to 23%.

Two samples of the silty sand were selected for laboratory grain size analysis testing, the results of which are summarized below. The results are also presented on the Record of Borehole sheets included in Appendix A and grain size distribution curves on Figure B6, Appendix B.

Gravel%	10 to 11
Sand%	53 to 54
Silt%	32 to 33
Clay%	3 to 4

5.6 Bedrock and Probable Bedrock

Bedrock or refusal on probable bedrock was encountered below the cohesionless sand layer in Boreholes SB-01, SB-03, SB-04 and 13+321 17.4L, as well as in DCPT 13+324 27L. The depths and elevations of bedrock and probable bedrock are summarized in Table 5.1

Table 5.1 – Depth to Bedrock and Refusal on Probable Bedrock

Borehole / DCPT	Bedrock or Probable Bedrock	
	Depth (m)	Elevation
SB-01	17.4	198.3
SB-03	15.4*	197.4
SB-04	14.0*	200.8
13+321 17.4L	14.1	201.4
13+324 27L	15.2	200.2

* Proven by coring

A 3.0 to 3.2 m length of rock core was recovered from Boreholes SB-03 and SB-04. The bedrock recovered in the core samples was described as grey gneiss. Total core recovery was 100% in both all runs. RQD values of 95 to 100% were recorded, indicating excellent rock quality. The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 5.

Average unconfined compressive strengths (UCS) of 219 and 356 MPa were assessed from the results of point load tests conducted on the rock core samples, indicating a very strong to extremely strong intact rock strength. The UCS results are included on the borehole logs in Appendix A (as average per run).

5.7 Water Levels

Groundwater levels in the boreholes were observed during drilling and a standpipe piezometer was installed in one borehole to monitor groundwater levels after completion of drilling. A summary of the recorded groundwater levels is provided below.

Table 5.2 - Groundwater Level Measurements

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation	
SB-01	May 7, 2013	4.8	210.9	In open borehole
13+318 01L	Mar. 25, 2014	7.7	211.4	In open borehole
13+340 19R	May 22, 2013	1.3	212.9	In piezometer
13+342 07R	Mar. 25, 2014	7.7	211.0	In open borehole
13+350 19L	Feb. 9, 2013	5.2	209.9	In open borehole
13+375 30R	Feb. 23, 2013	3.9	208.2	In open borehole

The recorded groundwater levels are considered short-term readings and seasonal fluctuations of the groundwater level are to be expected, particularly after spring snowmelt as well as periods of prolonged and/or significant precipitation.

The groundwater level is also expected to be influenced by the water level in Itzcaulde Creek, which is shown on the preliminary drawings provided by HMM to be at Elev. 212.7 at the inlet and Elev. 212.0 at the outlet in November 2010.

6 MISCELLANEOUS

In general, the borehole locations were positioned in the field by TBT Engineering Limited surveyors who also provided co-ordinates and ground surface elevations at the boreholes. Where boreholes required relocation from the staked location, field measurements were recorded and the surveyed coordinates and elevations were adjusted accordingly.

TBT Engineering Limited from Thunder Bay, Ontario supplied a track mounted CME 55 drill rig and conducted the drilling, sampling and in-situ testing operations.

Full time supervision of the field activities was carried out by Ms. Eckie Siu, Mr. Stephane Loranger, and Mr. George Azzopardi of Thurber. Overall supervision of the field program was conducted by Mr. Mark Farrant, P. Eng.

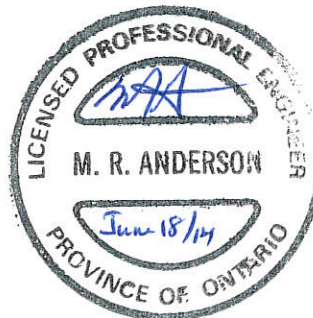
Interpretation of the data and preparation of this report were carried out by Mr. Mark Farrant, P.Eng. and Mr. Murray R. Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS


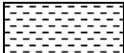



ROCK WEATHERING CLASSIFICATION

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 (MPa)	Approximate Uniaxial Compressive Strength (psi)	Field Estimation of Hardness*
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.

RECORD OF BOREHOLE No SB-01

1 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 383.5 E 205 713.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.07 - 2013.05.07 CHECKED BY MEF

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	W _P	W		W _L				
215.7																				
0.0	ORGANICS: (50mm) SAND , some gravel, occasional cobble Loose Brown Moist (FILL) Sandy silt layer (410mm) at 0.9m																			
			1	SS	6							○								
												○								
213.9			2	SS	6							○								
1.8	Silty CLAY , some sand to sandy, occasional organic seams (25mm to 75mm) Firm to Very Soft Brown (Possible FILL)																			
			3	SS	3							├─┤					0	19	43	38
												○								
			4	SS	0															
	Organics seam (200mm thick) at 4.5m		5	SS	2									○						
	Wood fibres, trace roots and trace rootlets		6	SS	1								○							
209.3																				
6.4	Silty CLAY , trace sand Very Soft Grey																			
			7	SS	0							├─┤	○				0	0	46	54
			8	SS	1								○							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SB-01

2 OF 2

METRIC

WP# 607189-0037 LOCATION N 5 424 383.5 E 205 713.3 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.05.07 - 2013.05.07 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			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	
								○ UNCONFINED + FIELD VANE													
								● QUICK TRIAXIAL × LAB VANE													
	Continued From Previous Page						20	40	60	80	100	W _p	W	W _L							
201.5	Silty CLAY , trace sand Very Soft Grey		9	SS	0																
			10	SS	0																
			11	SS	0																
14.2	Silty SAND , trace gravel Very Loose Grey Wet																				
			12	SS	2																
199.5	Auger grinding																				
16.2	Gravelly SAND Very Dense Grey Wet		13	SS	100/ 0.150																
198.3																					
17.4	END OF BOREHOLE AT 17.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 4.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.4m, THEN CUTTINGS TO SURFACE.																				

ONTMT4S 1237.GPJ 2012TEMPLATE(MTO).GDT 5/23/14

RECORD OF BOREHOLE No SB-03

1 OF 2

METRIC

WP# 60718910237 LOCATION N 5 424 344.9 E 205 733.6 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2013.05.09 - 2013.05.09 CHECKED BY MEF

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 (%)					
212.8														
0.0	Organic CLAY , with peat, some sand, trace rootlets Dark Brown Wet													
212.0														
0.8	Silty CLAY , trace sand, trace roots and rootlets Very Soft to Soft Brown		1	SS	1									
			2	SS	2									0 0 36 64
			3	SS	1									
	Grey		4	SS	0									
			5	SS	0									
			6	SS	0									
	Occasional sand seams		7	SS	0									
			8	SS	0									0 0 25 75

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 SB-04

1 OF 2

METRIC

WP# 6071891037 LOCATION N 5 424 381.6 E 205 694.8 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2014.05.07 - 2014.05.07 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		<div>PLASTIC LIMIT w_p</div> <div>NATURAL MOISTURE CONTENT w</div> <div>LIQUID LIMIT w_L</div>	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
214.8								20 40 60 80 100				
0.0	SAND , some gravel Loose to Compact Reddish Brown Moist (FILL)		1	SS	9		214					
213.6			2	SS	15							0 11 61 28
1.2	Silty CLAY , some sand, occasional cobbles Stiff Brown to Grey (FILL)		3	SS	12		213					
			4	SS	10		212					
	Occasional wood fibres		5	SS	8		211					
210.2			6	SS	4		210					
4.6	ORGANIC CLAY , some sand, with roots, rootlets and wood fibres Firm Dark Brown						209					
208.7			7	SS	4		208					0 34 43 23
6.1	Sandy Clayey SILT , with wood fibres Soft to Firm Dark Grey Wet						207					
207.8			8	SS	0		206					
7.0	Silty CLAY , occasional silt seams Very Soft Grey		9	SS	0		205					0 0 34 66

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SB-04

2 OF 2

METRIC

WP# 607189-10237 LOCATION N 5 424 381.6 E 205 694.8 ORIGINATED BY ES
 HWY 11/17 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2014.05.07 - 2014.05.07 CHECKED BY MEF

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 x LAB VANE								
Continued From Previous Page																
			10	SS	0		204									
							203									
202.1			11	SS	1											
12.7	SAND and SILT , trace gravel Compact Grey Moist						202									
200.8	cobbles						201									
14.0	BEDROCK , gneiss, grey, with quartz veins Sub-horizontal fracture at 14.5m Sub-vertical fractures at 14.8m, 15.1m and 15.6m		1	RUN			200									
			2	RUN			199									
			3	RUN			198									
197.6																
17.2	END OF BOREHOLE AT 17.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

ONTMT4S 1237.GPJ 2012TEMPLATE(MTO).GDT 5/23/14

RECORD OF BOREHOLE No 13+318 01L

1 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 359.6 E 205 690.8 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2014.03.25 - 2014.03.25 CHECKED BY MEF

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					W P W W L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
219.1																		
0.0	SAND , some gravel Brown to Reddish Brown Frozen (FILL)		1	GS			219							○			0 72 26 2	
																○		
218.4		2	GS															
0.7	Silty SAND , trace gravel, trace clay Very Dense Brown Frozen to 2.0m (FILL) Dense Moist Becoming Loose to Very Loose		1	SS	89		218								○			
				2	SS		30									○		
				3	SS		5	217										○
		4	SS	1	216													
	Becoming Compact Grey Wet		5	SS	11	215									○			
214.0																		
5.1	Silty CLAY Firm to Stiff Dark Brown (FILL) Trace wood fragments Brown						214								○			
				6	SS	11	213									○		
211.6																		
7.5	ORGANIC CLAY , with fibrous peat Very Stiff Dark Brown Wet		7	SS	16		212									○		
210.8																		
8.3	Silty CLAY , with wood fragments Stiff Grey						211											
				8	SS	6	210									○		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13+318 01L

2 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 359.6 E 205 690.8 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2014.03.25 - 2014.03.25 CHECKED BY MEF

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						209	1.5						
			9	SS	2		208							
	With thin silty sand seams						207							
			10	SS	3		206	1.6						
205.8 13.3	END OF BOREHOLE AT 13.3m. BOREHOLE OPEN TO 11.4m AND WATER LEVEL AT 7.7m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

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15
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5
0
5
10
15
20
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13+321 17.4L

1 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 375.5 E 205 685.5 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SBP
 DATUM Geodetic DATE 2013.02.11 - 2013.02.11 CHECKED BY MEF

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					
215.5								20 40 60 80 100					
0.0	ORGANICS: (175mm)												
0.2	Silty CLAY , trace organics Brown Frozen (FILL)		1	SS	21		215						
213.8							214						
1.7	SAND , some silt to silty, trace clay Loose to Compact Brown Moist (FILL)		2	SS	5		213						
			3	SS	2								
			4	SS	26		212						
211.9													
211.8	ORGANICS						211						
3.7	Silty CLAY , trace roots, trace rootlets Firm to Soft Brown to Grey		5	SS	3		210						
	Grey		6	SS	0		209						
	Soft						208						
			7	SS	1		207						
			8	SS	2		206						

Continued Next Page



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

RECORD OF BOREHOLE No 13+321 17.4L

2 OF 2

METRIC

WP# 60718910237 LOCATION N 5 424 375.5 E 205 685.5 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SBP
 DATUM Geodetic DATE 2013.02.11 - 2013.02.11 CHECKED BY MEF

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						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
Continued From Previous Page							20 40 60 80 100				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L WATER CONTENT (%)			
203.0	Silty CLAY Firm Grey						205	3.1 +						
			9	SS	2									
								204						
								2.8 +						
12.5	SAND , some silt to silty, trace clay Loose Grey Wet		10	SS	6		203							
								202						
201.4			11	SS	100/ .075									
14.1	END OF BOREHOLE AT 14.1m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, THEN CUTTINGS TO SURFACE.													

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

METRIC[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 13+324 27L

2 OF 2

METRIC

WP# 607189-10237 LOCATION N 5 424 385.3 E 205 683.4 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.02.09 - 2013.02.09 CHECKED BY MEF

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	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W			LIQUID LIMIT W _L
	Continued From Previous Page							20 40 60 80 100	WATER CONTENT (%)				
				</									

RECORD OF BOREHOLE No 13+340 19R

1 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 353.2 E 205 720.2 ORIGINATED BY GA
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.02.20 - 2013.02.20 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W P W W L				WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
214.2								20 40 60 80 100						
0.0	ORGANICS: (150mm)													
0.2	Silty CLAY, trace rootlets, trace organics						214							
	Firm Brown													
	occasional rootlets		1	SS	4		213					91		
			2	SS	3								0 1 31 68	
							212							
	trace sand seams		3	SS	0									
							211							
	Grey		4	SS	0									
							210							
			5	SS	0									
							209							
							208							
			6	SS	1									
							207							
			7	SS	2								0 1 50 49	
							206							
							205							
	trace gravel		8	SS	2									

Continued Next Page

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

RECORD OF BOREHOLE No 13+340 19R

2 OF 2

METRIC

WP# 6071891037 LOCATION N 5 424 353.2 E 205 720.2 ORIGINATED BY GA
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.02.20 - 2013.02.20 CHECKED BY MEF

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 (%)		
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page							20 40 60 80 100										
201.7	Silty CLAY , trace gravel Firm Grey						204	2.8 +										
			9	SS	4													
12.5	Gravelly SAND , trace silt Very Loose to Loose Grey Moist to Wet						203											
200.5	Unable to take SPT sample at 13.7m (auger filled with gravelly sand)		10	SS	2		202	4.2 +										
13.7	END OF BOREHOLE AT 13.7m. BOREHOLE OPEN TO 13.1m AND WATER LEVEL AT 11.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2013.05.22 1.3 212.9						201											

RECORD OF BOREHOLE No 13+342 07R

1 OF 2

METRIC

WP# 60718910237 LOCATION N 5 424 364.6 E 205 716.1 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA
 DATUM Geodetic DATE 2014.03.25 - 2014.03.25 CHECKED BY MEF

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				w P w w L							
								● QUICK TRIAXIAL × LAB VANE											
218.7							20	40	60	80	100								
0.0	SAND , some gravel Brown Frozen (FILL) SAND , trace gravel Very Dense Brown Frozen to 2.0m (FILL) Some silt With clayey silt pockets Becoming Loose to Very Loose Moist Becoming Very Dense		1	GS										○					
218.3															○				
0.4																			
					1	SS	50/ .050									○			
					2	SS	100/ 275									○			
					3	SS	6										○		
					4	SS	0												
					5	SS	52									○			
213.0																			
5.7	Silty CLAY Firm Mottled Brown/Grey (FILL)																		
212.4																			
6.3	SAND , some silt Compact Grey Wet (FILL)		6	SS	10										○				
211.6																			
7.1	Silty CLAY , trace roots and rootlets Firm Brown (Possible FILL) With organics, trace wood fragments Dark Brown																		
					7	SS	8										○		
					8	SS	4											○	
208.9																			
9.8	Silty CLAY																		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	SHEAR STRENGTH kPa	PLASTIC LIMIT			W P	W L
									○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
215.1 0.0	Gravelly SAND, trace to some silt, trace clay, trace cobbles Brown Moist (FILL)		1	GS		▽	215						29 50 21 (SI+CL)	
			1	SS	23		214							
213.6 1.5	Silty CLAY, some sand Firm Brown (FILL)		2	SS	6		213							
212.9 2.2	Silty SAND, mixed with amorphous peat, trace clay Loose Grey Moist (FILL)		3	SS	4		212							
212.2 2.9	Silty CLAY, some sand, trace gravel, trace roots, trace rootlets Soft to Stiff Dark Brown (Possible FILL) Wood fragments		4	SS	11		211							
			5	SS	2		210							
209.5 5.6	Silty CLAY Firm Brown		6	SS	1		209							
	Grey	7	SS	2	208									
	Soft	8	SS	2	207									
					206									

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 13+350 19L

2 OF 2

METRIC

WP# 607189-0237 LOCATION N 5 424 391.1 E 205 710.3 ORIGINATED BY SLL
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SBP
 DATUM Geodetic DATE 2013.02.09 - 2013.02.09 CHECKED BY MEF

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 (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
								20	40	60	80						100	20	40	60
	Continued From Previous Page						205	2.7 +												
			9	SS	1		204							○						
								2.9 +												
			10	SS	0		203							○						
							202	2.5 +												
201.5	Silty CLAY Soft Grey																			
13.6	SAND and SILT , trace gravel Very Loose Grey Wet		11	SS	1		201						○							
200.8																				
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 12.6m AND WATER LEVEL AT 5.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.3m, THEN CUTTINGS TO SURFACE.																			

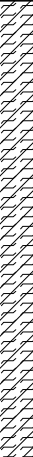
+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13+375 30R

1 OF 2

METRIC

WP# 60718910237 LOCATION N 5 424 361.2 E 205 756.5 ORIGINATED BY GA
 HWY 11/17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2013.02.23 - 2013.02.23 CHECKED BY MEF

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							
								○ UNCONFINED + FIELD VANE											
								● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)							
						20	40	60	80	100	20	40	60						
212.1	0.0	ORGANIC CLAY , with peat, trace sand, trace rootlets Dark Brown Soft Moist																	
				1	SS	2													
				2	SS	2													
		trace grey sand seams																	
		3	SS	0															
209.1	3.0	Silty CLAY , trace organics Soft to Firm Grey 																	

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

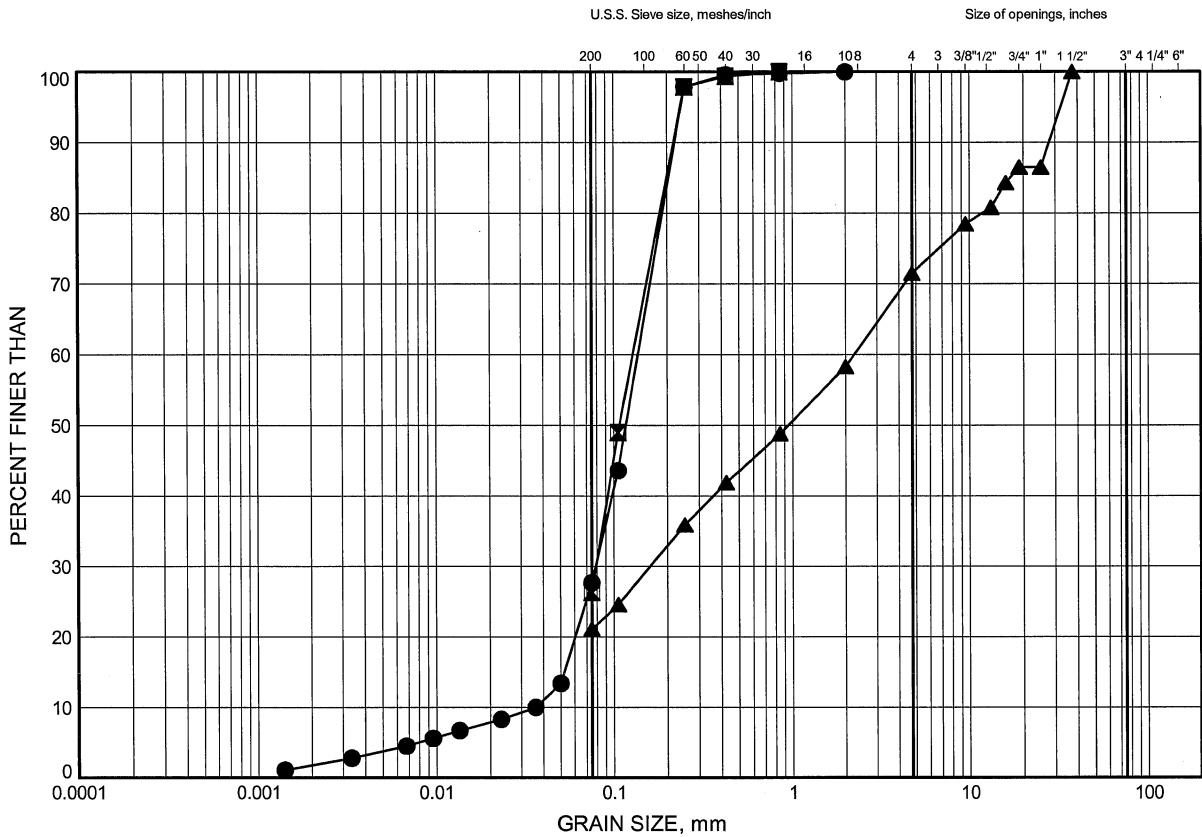
Appendix B

Laboratory Test Results

Itzcaulde Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY SAND to GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13+318 01L	1.07	218.03
⊠	13+321 17.4L	2.59	212.87
▲	13+350 19L	0.46	214.67

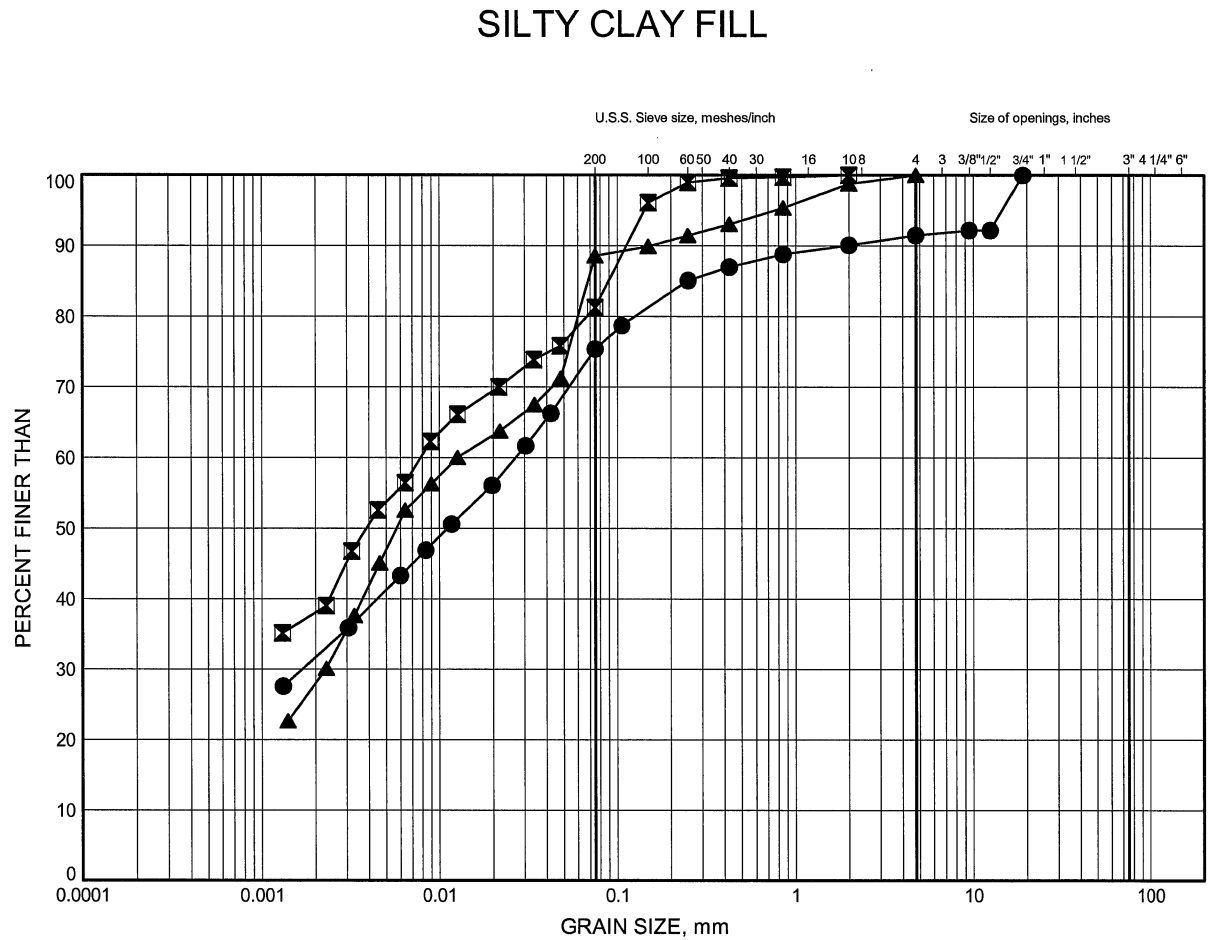
Date April 2014
WP# 647-89-00



Prep'd AN
Chkd. MRA

Itzcaulde Creek Culvert 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)
●	13+350 19L	3.35	211.78
⊠	SB-01	2.59	213.11
▲	SB-04	1.07	213.73

Date May 2014
WP# 647-89-00

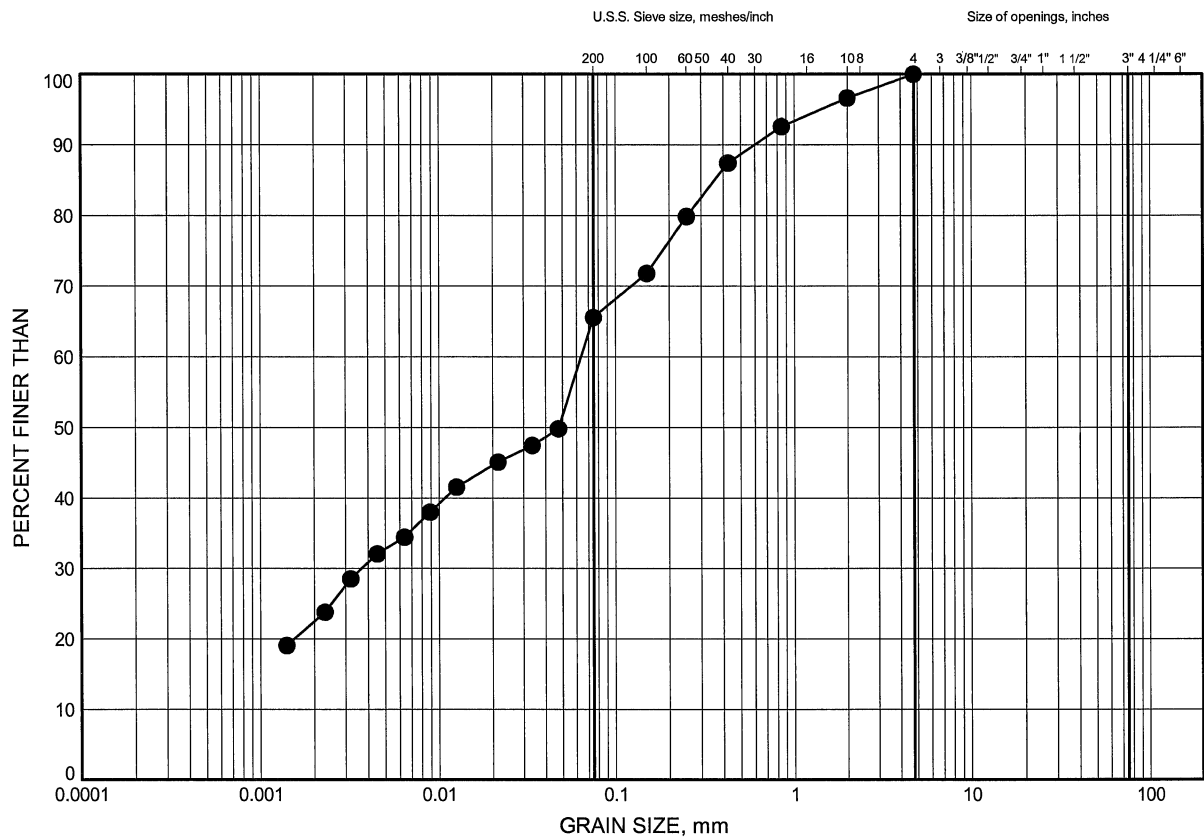


Prep'd AN
Chkd. MRA

Itzcaulde Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B3

SANDY CLAYEY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SB-04	6.40	208.40

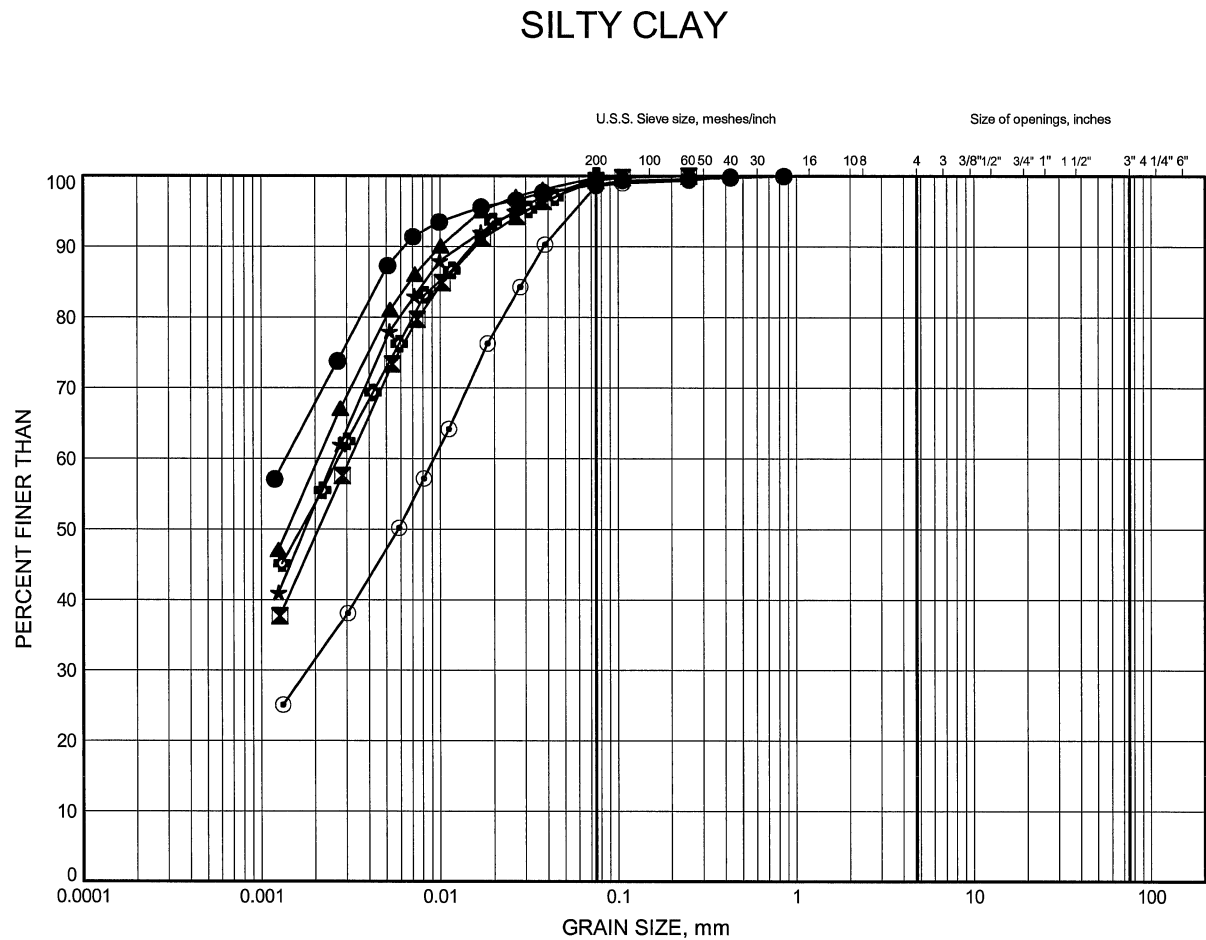
Date May 2014
WP# 647-89-00



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Chkd. MRA

Itzcaulde Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13+340 19R	1.83	212.38
⊠	13+340 19R	7.92	206.29
▲	13+350 19L	9.45	205.68
★	13+375 30R	6.40	205.74
⊙	13+375 30R	12.50	199.64
⊕	SB-01	7.92	207.78

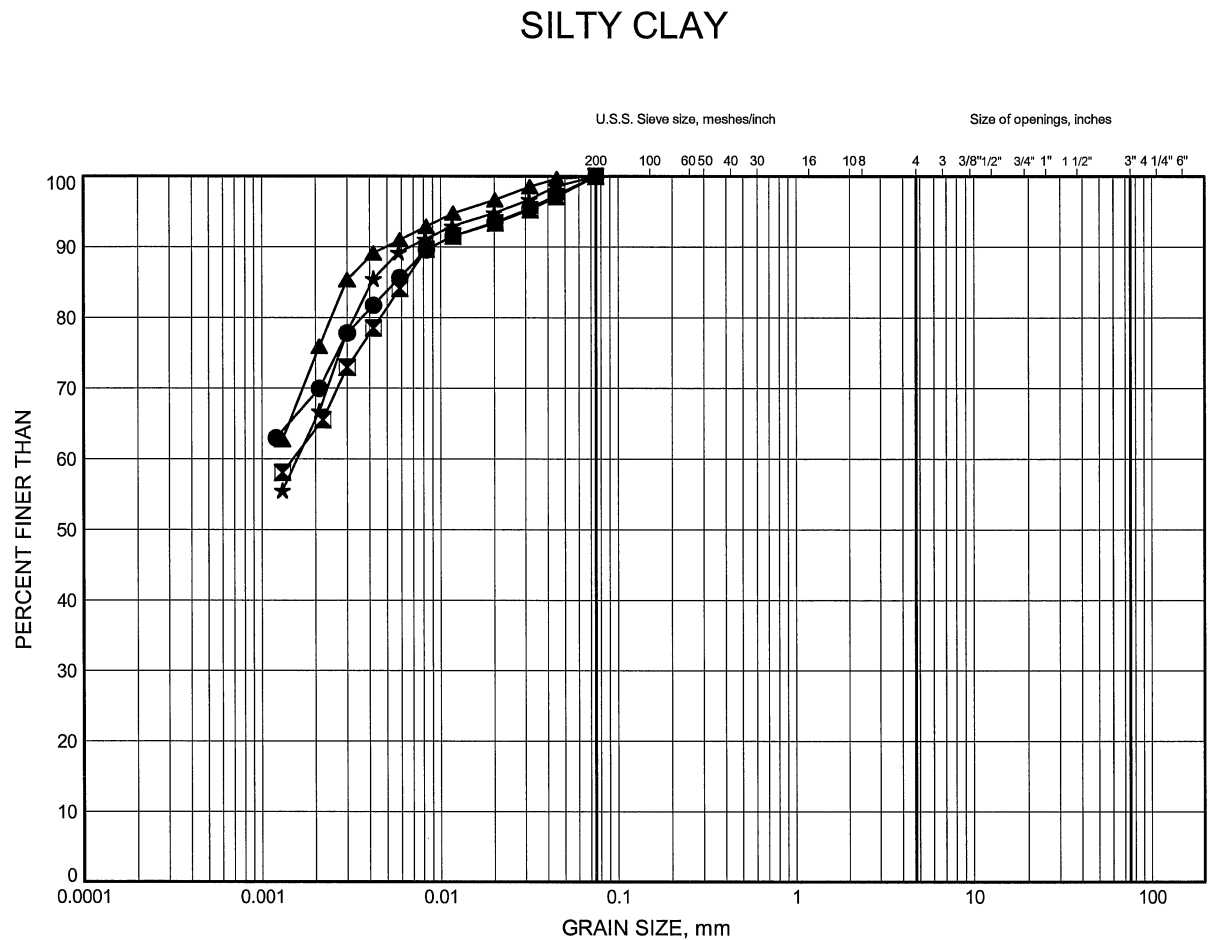
Date May 2014
WP# 647-89-00



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Chkd. MRA

Itzcaulde Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SB-01	12.50	203.20
■	SB-03	1.83	210.97
▲	SB-03	9.45	203.35
★	SB-04	9.45	205.35

Date May 2014
WP# 647-89-00

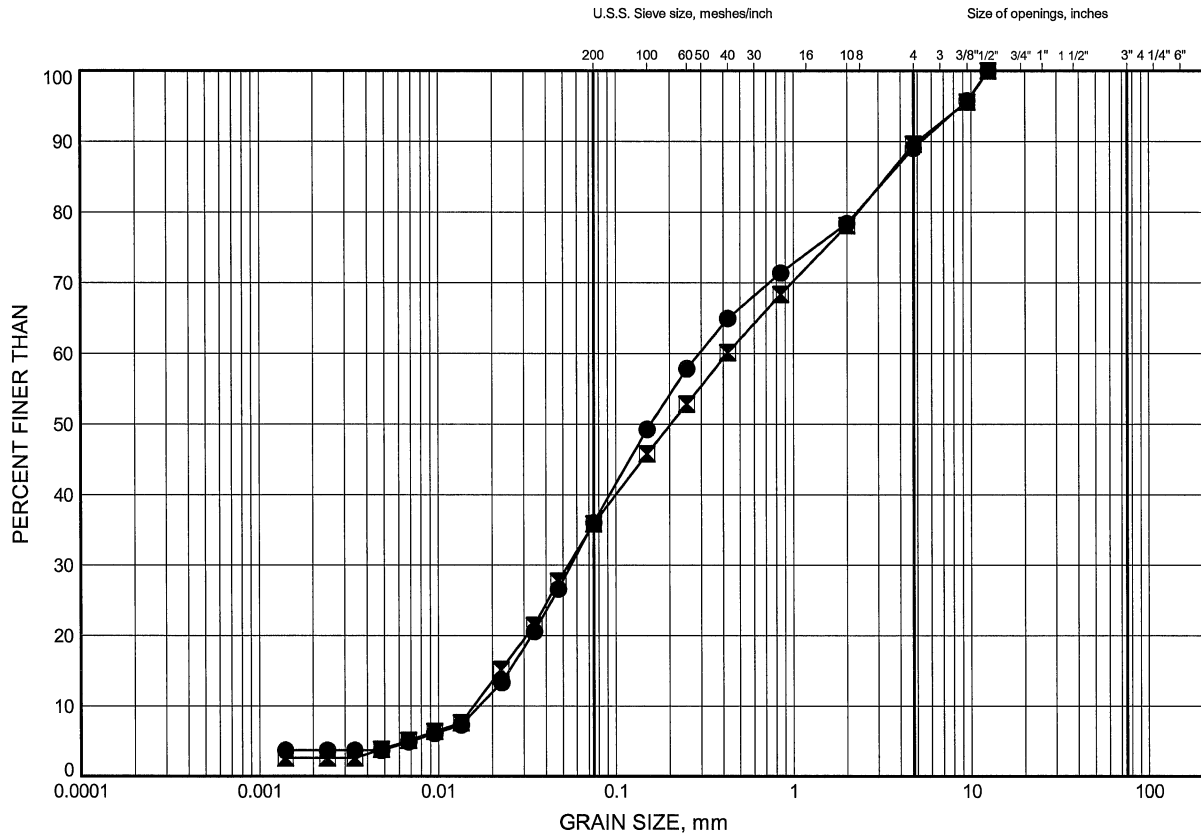


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Chkd. MRA

Itzcaulde Creek Culvert GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SB-01	15.54	200.16
■	SB-03	14.02	198.78

Date May 2014
WP# 647-89-00

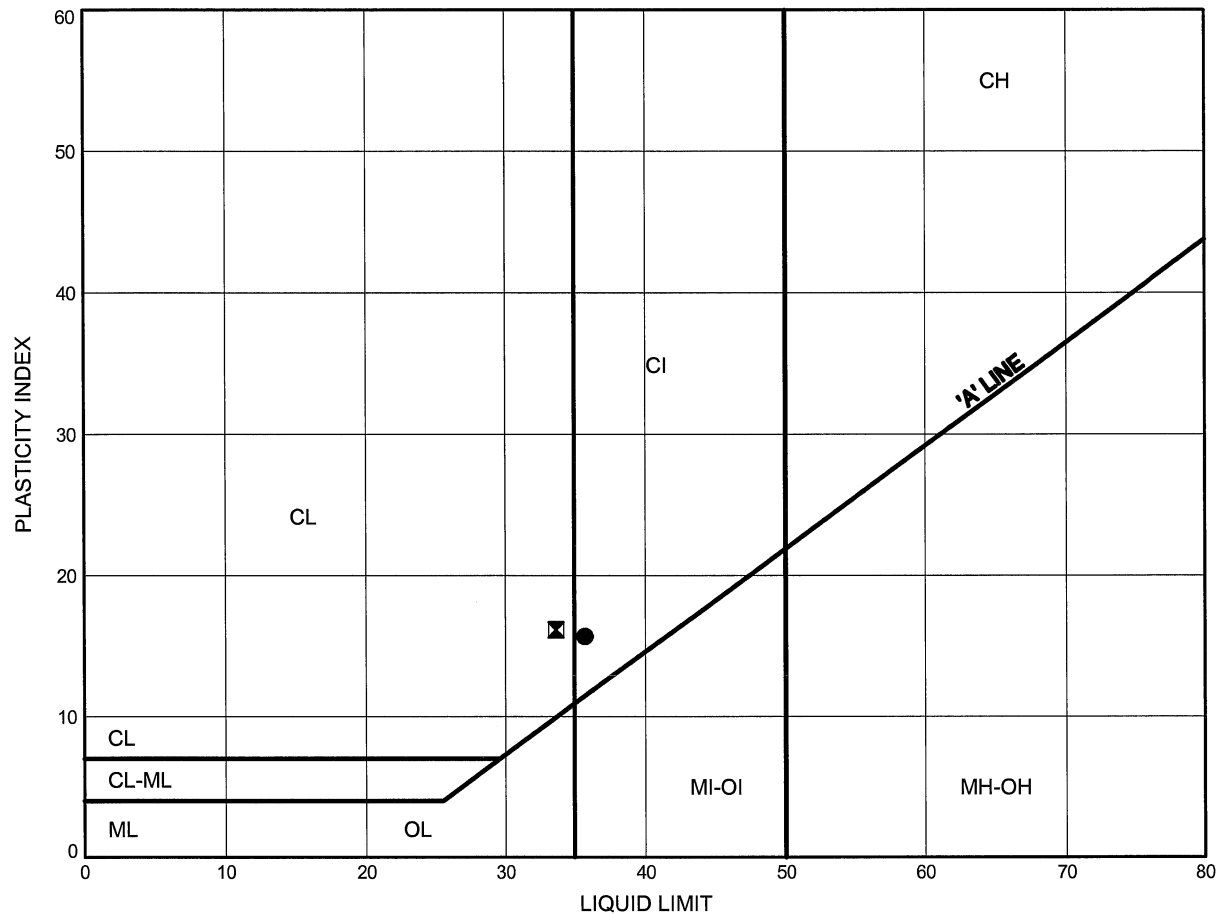


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Chkd. MRA

Itzcaulde Creek Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE B7

SILTY CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13+350 19L	3.35	211.78
⊠	SB-01	2.59	213.11

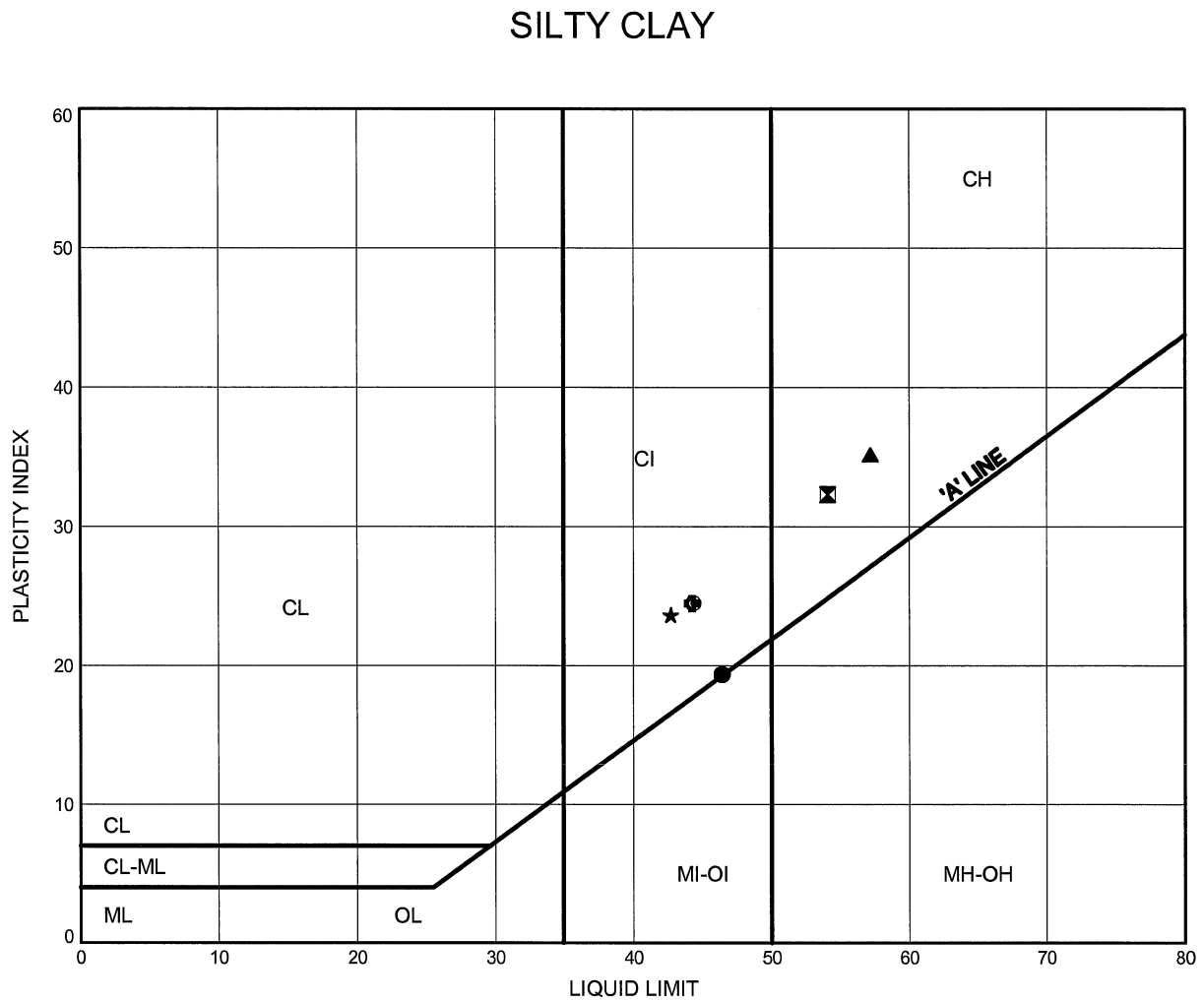
Date May 2014
 WP# 647-89-00



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Itzcaulde Creek Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE B8



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13+321 17.4L	4.88	210.59
⊠	13+321 17.4L	10.97	204.49
▲	13+340 19R	1.83	212.38
★	13+340 19R	7.92	206.29
⊙	13+350 19L	9.45	205.68
⊕	13+375 30R	6.40	205.74

Date May 2014
 WP# 647-89-00

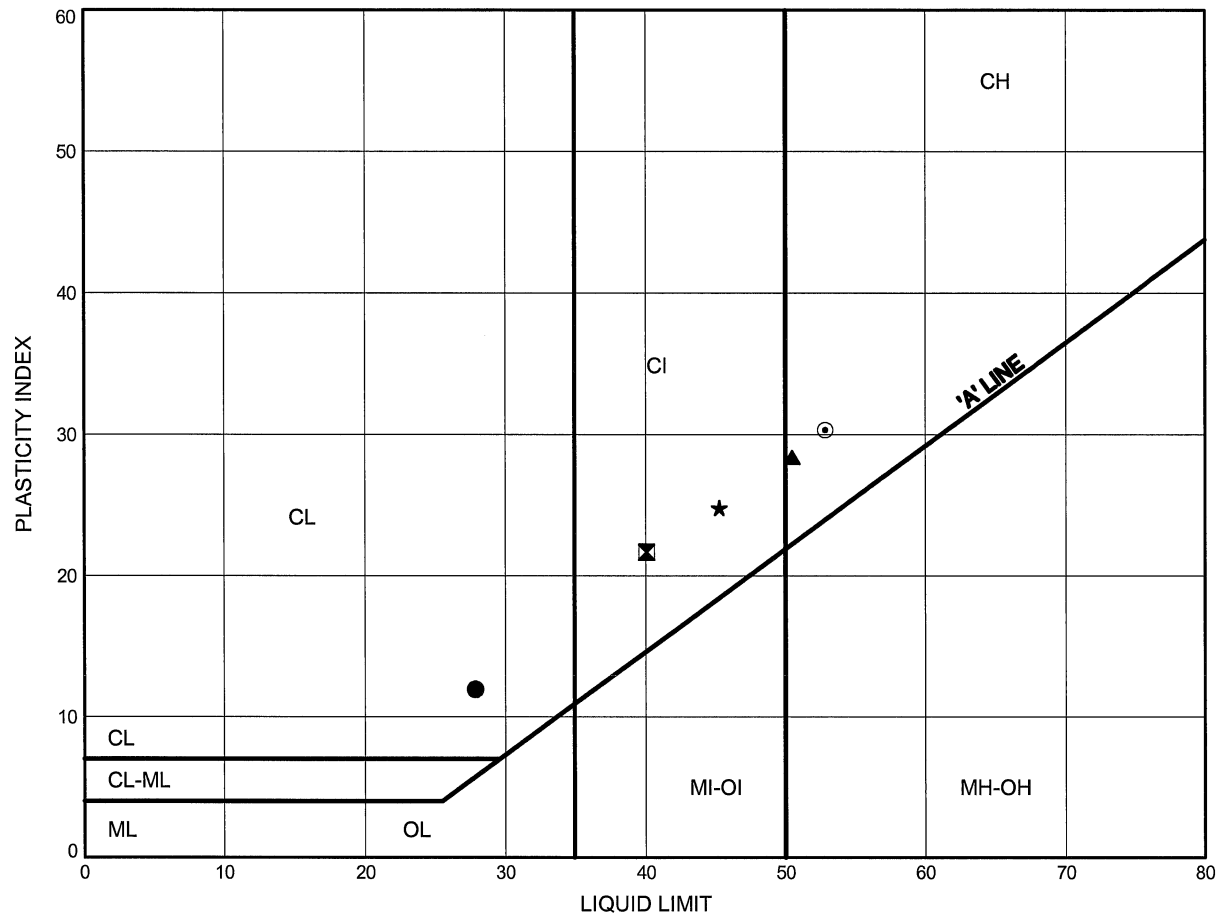


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 Chkd. MRA

Itzcaulde Creek Culvert
ATTERBERG LIMITS TEST RESULTS

FIGURE B9

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13+375 30R	12.50	199.64
⊠	SB-01	7.92	207.78
▲	SB-01	12.50	203.20
★	SB-03	1.83	210.97
⊙	SB-03	9.45	203.35

Date May 2014
 WP# 647-89-00



Prep'd AN
 Chkd. MRA

Appendix C

Site Photographs



Photograph 1: North side of existing embankment looking west.



Photograph 2: Former highway alignment looking east.



Photograph 3: South side of existing embankment looking east.



Photograph 4: South side of existing embankment looking west.



Photograph 5: Existing Itzcaulde Creek culvert outlet.



Photograph 6: Embankment above existing Itzcaulde Creek culvert outlet.



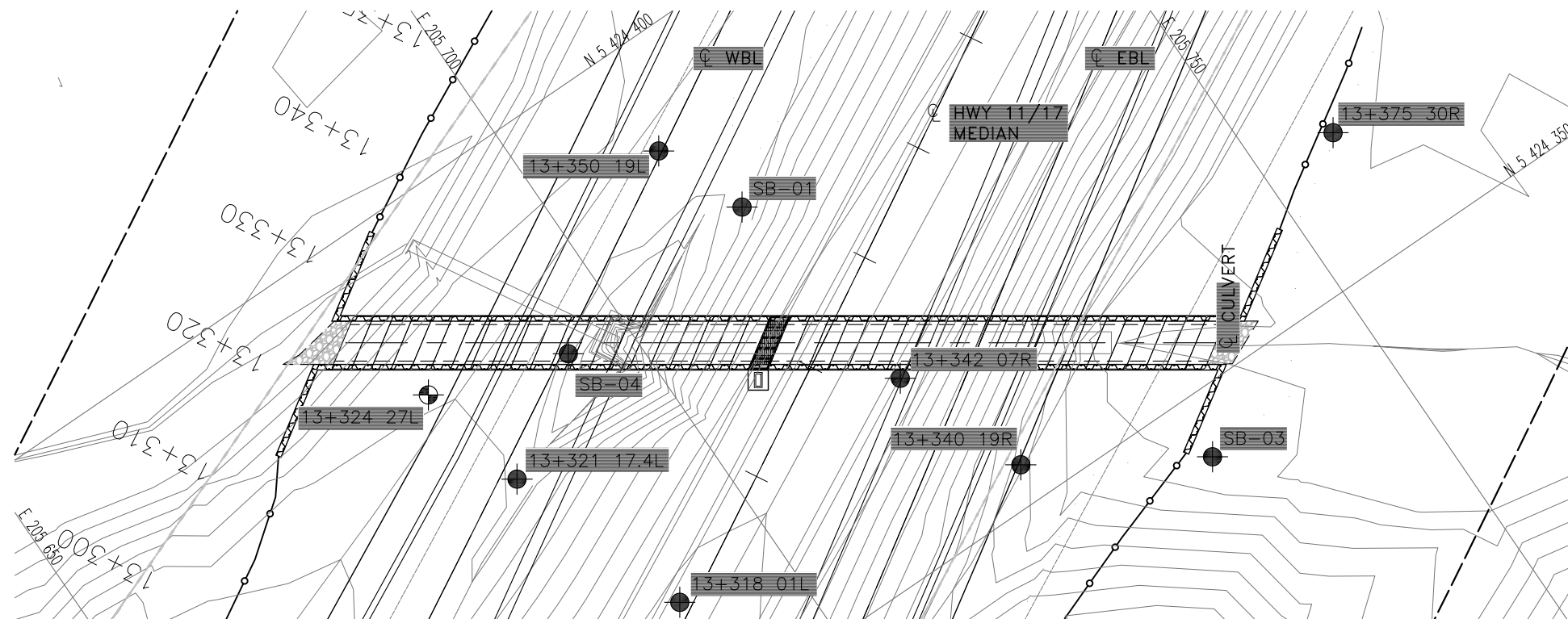
Photograph 7: Existing Itzcaulde Creek culvert outlet.



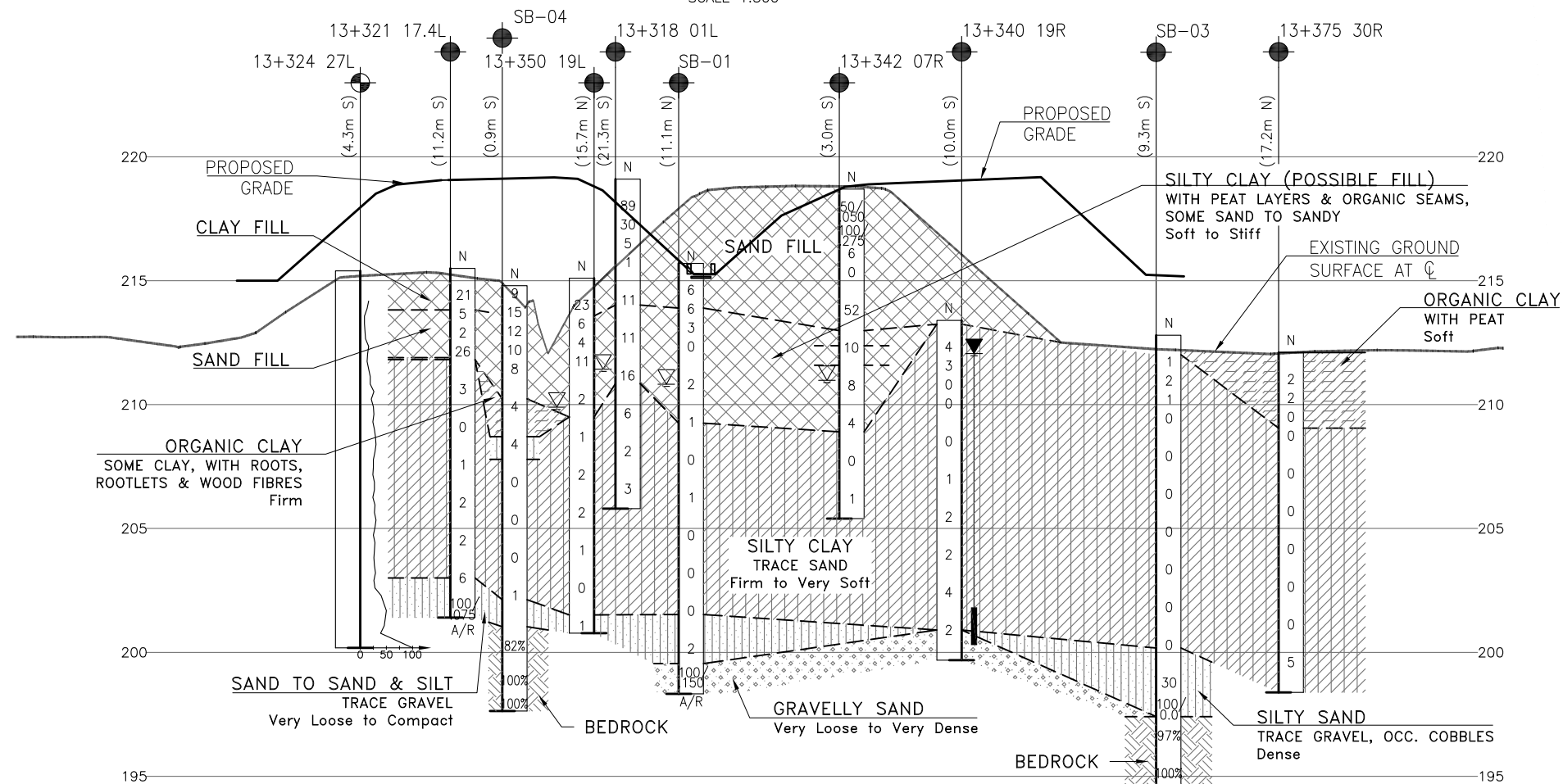
Photograph 8: Existing Itzcaulde Creek culvert Inlet.

Appendix D

Borehole Locations and Soil Strata Drawing



PLAN
SCALE 1:500



PROFILE ALONG ϕ CULVERT

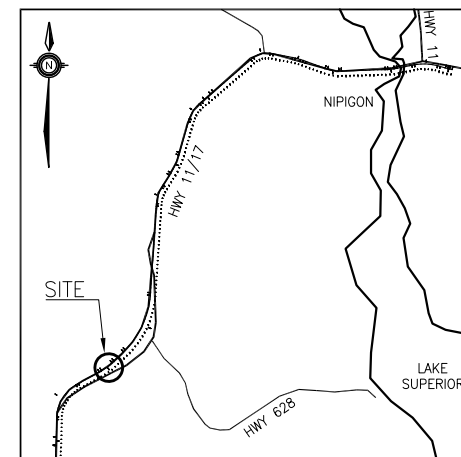
SCALE 1:250
H 1:500
V 1:250

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



CONT No
WP No 6647-13-01

HIGHWAY 11/17 FOUR LANING
ITZCAULDE CREEK CULVERT
EBL & WBL
BOREHOLE LOCATIONS AND SOIL STRATA



KEYPLAN

LEGEND

- Borehole (Current Investigation)
- DCPT (Dynamic Cone Penetration Test)
- Blows /0.3m (Std Pen Test, 475J/blow)
- Blows /0.3m (60' Cone, 475J/blow)
- Pressure, Hydraulic
- Water Level During Drilling
- Water Level In Piezometer
- Rock Quality Designation (RQD)
- Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SB-01	215.7	5 424 383.5	205 713.3
SB-03	212.8	5 424 344.9	205 733.6
SB-04	214.8	5 424 381.6	205 694.8
13+318 01L	219.1	5 424 359.6	205 690.8
13+321 17.4L	215.5	5 424 375.5	205 685.5
13+324 27L	215.5	5 424 385.3	205 683.4
13+340 19R	214.2	5 424 353.2	205 720.2
13+342 07R	218.7	5 424 364.6	205 716.1
13+350 19L	215.1	5 424 391.1	205 710.3
13+375 30R	212.1	5 424 361.2	205 756.5

-NOTES-

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

GEOCREs No. 52A-179

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	MEF	CHK MEF	CODE
DRAWN	AN	CHK MRA	SITE 48C-352 STRUCT
DATE	JUN 2014	DATE	JUN 2014
DWG	1	DWG	1