



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT
REMEDIATION OF SOUTH EMBANKMENT AT CNR OVERPASS
HIGHWAY 140
PORT COLBORNE, ONTARIO
G.W.P. 2284-13-00; SITE NO. 34-234

GEOCRES No. 30L14-61**

Report

to

MMM Group Limited

Date: December 7, 2016
File: 11336



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the south embankment of the CNR Overpass on Highway 140 in Port Colborne, Ontario.

The terms of reference for the scope of work are outlined in Thurber's original proposal 115-3126 and a subsequent proposal letter dated March 15, 2016. Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 2014-E-0030.

Geotechnical investigations were conducted along the south embankment by the MTO in the 1960's and 1970's prior to and following the construction of the existing overpass and the Highway 140 embankments. Compilation of the historic subsurface information, interpretation of the data and discussion on the remedial measures for the south embankment distress were provided in the report titled "Foundation Investigation and Design Report, Remedial Measures for South Embankment Slope Instabilities, Highway 140/CNR Overpass, Agreement No. 2013-E-0051, GWP 2044-13-00, Geocres No. 30L14-58", prepared by Terraprobe Inc., dated January 09, 2015. The noted report was prepared based on the historical subsurface information, with no information on the existing south embankment fill materials, and under the assumptions that the fill materials at the south embankment is similar to the fill materials at the north embankment. Selected information presented in the above report was reviewed and incorporated in the current report, as appropriate.

The purpose of this investigation was to supplement the information on subsurface conditions, and in particular on the south embankment fill. Based on the data obtained during the course of this investigation, a borehole location plan, record of borehole sheets, stratigraphic cross sections, laboratory test results and a written description of the subsurface conditions are provided in the

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report. A model of the subsurface conditions was developed from the information collected during the investigation.

2. SITE DESCRIPTION

The Highway 140 Overpass at CNR is located approximately 550 m north of the intersection of Highway 140 and Forkes Road East in St. Catharines, Ontario.

Highway 140 crosses over the CNR on a three-span concrete structure of approximately 40 m in length. The approach fill adjacent to the south abutment of the overpass is approximately 9.5 m in height and slopes downwards towards the south. A concrete box culvert 3.6 m x 2.4 m in size crosses under the south forward slope in an east-west direction. Highway 140 is a two-lane road with a posted speed of 80 km/hr in the vicinity of the site.

Based on a review of the available Geocres information, the existing Highway 140 embankments were constructed in 1971 out of locally available material excavated from borrow pits located on the east side of the highway. Presently, two storm water ponds can be observed on the east side of the highway at the locations of the borrow pits.

The terrain adjacent to the embankment is generally flat with poor surficial drainage. The vegetation consists of tall grass, weeds, shrubs and occasional trees. The land to the north of the site is used for agricultural purposes.

Selected photographs of the south embankment and its immediate surroundings are presented in Appendix C.

The site is situated within the physiographic region known as the Haldimand Clay Plain, which is characterized by glacio-lacustrine deposits laid down in glacial Lake Warren during the Wisconsinian Age. These deposits consist of silts and clays and are generally underlain by a glacial till, which in turn overlies dolomitic limestone bedrock.

3. INVESTIGATION PROCEDURES

The current investigation for the remediation of the south embankment included the following components:

- Review of available background information from the MTO Geocres Library;
- Site visit for visual inspection of the existing Highway 140 south embankment conditions;
- Field investigation including drilling and sampling eighteen (18) boreholes specifically for



- this site; making reference of several boreholes advanced for other aspects of this project.

The following reports from the Geocres library have been reviewed:

- Foundation investigation and Design Report, Remedial Measures for South Embankment Slope Instabilities, Highway 140/CNR Overpass, Agreement No. 2013-E-0051, GWP 2044-13-00, Terraprobe Inc., dated January 9, 2015, Geocres No. 30L14-58 (Reference 1);
- Foundation Investigation Report for Failure of Approach Embankments, Overhead Structure at the Crossing of Hwy 140 and CNR, WO 70-11025, WP 60-68-02, Contract 70-212, MTO Foundation Office, July 17, 1972, Geocres No. 30L-45 (Reference 2);
- Foundation Investigation and Design Report, Rehabilitation of North Embankment and Approach, Highway 140/CNR Overpass, Port Colborne, Ontario, Report No. 08-1111-0031, Golder Associates Ltd., dated August 2009, Geocres No. 30L14-50 (Reference 3).

A visual inspection of the south embankment was carried out by a Senior Geotechnical Engineer from Thurber on June 9, 2016. The purpose of this inspection was assess the embankment stability conditions, and to observe and confirm the nature and severity of the distress features noted in Reference 1. Particular attention was paid to surficial instabilities of the side slopes, presence of tension cracks, evidence of settlements, deformation of the guide rails, vegetation on the slopes and repair works. Results of this inspection are discussed in the following Section 9.

The current site investigation and field testing for this project were conducted between May 24 and June 1, 2016. A total of eighteen (18) boreholes, denoted as 16-01 to 16-18, were advanced specifically for this slope assessment project to depths ranging from 3.7 m to 14.3 m below the existing grade. Boreholes 16-01A, 16-01CN and 16-02CN, ranging from 2.1 m to 11.3 m depths, were advanced for pavement and foundation assessment associated with the CNR overhead rehabilitation works. The slope assessment boreholes were positioned to provide subsurface information at selected cross sections of the south embankment (see drawings in Appendix D), namely:



Station (approx.)	Borehole Number
15+325, east side	16-13, 16-14
15+375, west side (Section A-A)	16-10 to 16-12 and 16-16
15+400, east side (Section B-B)	16-07 to 16-9 and 16-17
15+475, west side (Section C-C)	16-01, 16-02, 16-03 and 16-15
15+475, east side (Section C-C)	16-04 to 16-06, and 16-18
15+550	16-01A
Station 15+590; near the south abutment of the CNR Structure	16-01CN, 16-02CN

Typically for one slope section, one borehole was drilled at the top of the embankment, one borehole half way up the upper slope above the stabilizing berm and one borehole from top of berm. Selected boreholes were also located at the toe of the embankment. Boreholes 16-01CN and 16-02CN were located near the south abutment, and Borehole 16-01A was advanced through the pavement structure approximately 50 m south of the abutment. The locations of the boreholes are presented on the Borehole Locations and Soil Strata drawing in Appendix D.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. Drilling was carried out using a track mounted D-50 drill rig with solid stem augers. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures as per ASTM D-1586-99.

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

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Standpipe piezometers were installed in selected boreholes. Each piezometers consisted of 19 mm Schedule 40 PVC pipe with a 1.5 m long slotted screen enclosed in filter sand to permit groundwater level monitoring. Piezometer installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. Upon completion of the drilling operations, the boreholes without piezometers were abandoned in general accordance with Ontario Regulation 903 amended by Ontario Reg. 372. Following the final set of water level readings, the piezometer installations will be decommissioned accordingly.

Details of the borehole depths and completion are summarized in Table 3.1 below.



Table 3.1 – Borehole Completion Details

Borehole No.	Borehole Depth / Base Elevation (m)	Piezometer Tip Elevation (m)	Completion Details
16-01A	2.1 / 184.4	None installed	Borehole backfilled with bentonite holeplug and cuttings to 0.2 m then asphalt cold patch to surface.
16-01	14.3 / 170.9	None installed	Borehole backfilled with bentonite holeplug and cuttings to 0.5 m, concrete to 0.2 m then asphalt patch to surface.
16-02	8.2 / 175.0	177.0	Borehole backfilled with cuttings to 6.1 m, sand to 4.3 m, bentonite holeplug to 3.3 m, bentonite holeplug and cuttings to surface.
16-03	5.2 / 175.6	175.6	Borehole backfilled with sand to 3.3 m, bentonite holeplug to 2.7 m, bentonite holeplug and cuttings to surface.
16-04	14.3 / 170.9	None installed	Borehole backfilled with bentonite holeplug and cuttings to 0.5 m, concrete to 0.2 m then asphalt patch to surface.
16-05	8.2 / 175.2	175.8	Borehole backfilled with sand to 6.4 m, bentonite holeplug to 5.8 m and bentonite holeplug and cuttings to surface.
16-06	5.2 / 175.5	176.1	Borehole backfilled with sand to 2.7 m, bentonite holeplug to 2.1 m, and holeplug and cuttings to surface.
16-07	11.3 / 171.7	None installed	Borehole backfilled with bentonite holeplug and cuttings to surface.
16-08	6.7 / 174.5	176.7	Borehole backfilled with cuttings to 4.6 m, sand to 2.7 m, bentonite holeplug to 2.1 m, and bentonite holeplug and cuttings to surface.
16-09	4.4 / 175.9	176.0	Borehole backfilled with sand to 1.8 m, bentonite holeplug to 1.2 m, bentonite holeplug and cuttings to surface.
16-10	9.8 / 172.2	None installed	Borehole backfilled with bentonite holeplug and cuttings to surface.
16-11	5.2 / 175.1	175.1	Borehole backfilled with sand to 3.4 m, bentonite holeplug to 2.7 m, bentonite holeplug and cuttings to surface.
16-12	4.4 / 175.1	176.5	Borehole backfilled with cuttings to 3.0 m, sand to 1.2 m, bentonite holeplug to 0.6 m, bentonite holeplug and cuttings to surface.



Borehole No.	Borehole Depth / Base Elevation (m)	Piezometer Tip Elevation (m)	Completion Details
16-13	6.7 / 173.7	None installed	Borehole backfilled with bentonite holeplug and cuttings to surface.
16-14	3.7 / 174.6	174.6	Borehole backfilled with sand to 1.8 m, bentonite holeplug to 1.2 m, and cuttings to surface.
16-15	3.7 / 173.3	None installed	Borehole backfilled with bentonite holeplug and cuttings to surface.
16-16	3.7 / 173.5	173.5	Borehole backfilled with sand to 1.8 m, bentonite holeplug to 1.2 m, and cuttings to surface.
16-17	3.7 / 174.3	174.3	Borehole backfilled with sand to 1.8 m, bentonite holeplug to 1.2 m, and cuttings to surface.
16-18	3.7/ 173.8	173.1	Borehole backfilled with sand to 1.8 m, bentonite holeplug to 1.2 m, and cuttings to surface.
16-01CN	11.3 / 175.7	None installed	Borehole backfilled with bentonite holeplug and cuttings to 0.5 m, concrete to 0.2 m, then asphalt patch to surface.
16-02CN	11.3 / 175.7	None installed	Borehole backfilled with bentonite holeplug and cuttings to 0.5 m, concrete to 0.2 m, then asphalt patch to surface.

The borehole locations were established in the field by Thurber and the completed borehole locations will be surveyed by the MMM surveyors. Once the as-drilled borehole survey results are available from MMM, the drawings and record of borehole sheets will be updated for incorporation into the final report.

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 grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A and are presented on the figures included in Appendix B.



5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A for details of the encountered soil stratigraphy. Selected cross-sections are presented on the “Borehole Locations and Soil Strata” drawing 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

It is noted that the subsurface conditions presented in the previous boreholes from References 2 and 3 are generally consistent with the results of the current investigation.

The new boreholes advanced from the top of the embankment encountered a pavement structure of asphalt overlying a sand and gravel fill. Underlying the pavement structure was a stiff to very stiff silty clay embankment fill. A deposit of native silty clay underlies the fill and extends to below the base of boreholes.

More detailed descriptions of the individual strata are presented below.

5.1 Asphalt

Boreholes 16-01A, 16-01 and 16-04 advanced from the top of the road embankment encountered between 50 mm and 88 mm of asphalt. In Boreholes 16-01CN and 16-02CN located in the vicinity of the south abutment of the Overpass Structure, the thickness of asphalt was 115 mm. The thickness of asphalt may vary at other pavement structure locations.

5.2 Topsoil

A surficial layer of topsoil ranging in thickness from 65 mm to 125 mm was encountered in the boreholes advanced beyond the roadway and at the toe of the embankment.

The thickness of the asphalt may vary in other areas of the site.

5.3 Sand and Gravel to Gravelly Sand Fill

Granular fill was encountered below the asphalt in Boreholes 16-01A, 16-01, 16-04, 16-01CN and 16-02CN drilled through the pavement structure. The thickness of fill was 0.5 m in Boreholes 16-01A, 16-01B and 16-04 with the base ranging from Elev. 185.9 to Elev. 184.6. In Boreholes 16-01CN and 16-02CN, the fill was 1.3 m to 2.0 m thick and extended to 2.1 m and 1.4 m depth with



the base at Elev. 184.9 and Elev. 185.6, respectively. In Boreholes 16-07, 16-10 and 16-13 drilled through the unpaved shoulder of the roadway, a 0.6 m layer of granular fill was found extending from the ground surface with the base between Elev. 182.4 and 179.8. In Boreholes 16-15 and 16-18 drilled at the embankment toe, approximately 0.7 m and 0.3 m of granular fill was encountered below the cohesive fill at 0.5 m and 0.6 m depths, respectively. The base of this fill was at Elev. 175.8 in Borehole 16-15 and Elev. 176.6 in Borehole 16-18.

The granular fill was classified mainly as sand and gravel with some silt. In Boreholes 16-13 and 16-01CN, the sand content was somewhat greater and the material was classified as gravelly sand.

SPT 'N' values recorded in the granular fill ranged from 14 to 51 blows for 0.3 m penetration, indicating compact to dense conditions. Moisture contents of the granular fill ranged from 2% to 6%.

The results of a grain size analyses conducted on fill samples are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B1 and B2 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	31 to 51
Sand	35 to 52
Silt & Clay	11 to 18

5.4 Silty Clay Fill

Underlying the granular fill or topsoil in the majority of the boreholes, except of Boreholes 16-14, 16-16 and 16-17, a cohesive fill material classified as silty clay with trace sand and trace gravel was encountered. The fill was generally brown in colour with occasional rootlets and wood fragments and/or silt lenses present at some locations in the upper zone or at the base of the fill.

The thickness of the silty clay fill varied from 0.4 m to 9.3 m. The base of the fill was encountered at depths ranging from 0.5 m to 10.7 m or from Elev. 175.9 to Elev. 177.4. The shallow Borehole 16-01A was terminated in the silty clay fill at 2.1 m depth (Elev. 184.4). In Boreholes 16-15 and 16-18 drilled at the toe of the berm, the silty clay fill was encountered below the topsoil and overlying the granular fill. The thickness of the cohesive fill in those boreholes was 0.4 m and 0.5 m with the base at 0.5 and 0.6 m depth or Elev. 176.5 and Elev. 176.9, respectively.



SPT 'N' values obtained in the silty clay fill ranged from 9 to 28 blows for 0.3 m penetration, indicating a stiff to very stiff consistency. Typically, lower N values were recorded in the upper zone of the fill immediately underlying the granular fill, or near the base of fill, immediately above the native ground.

Moisture contents of the silty clay fill ranged from 10% to 43%; however typical moisture values ranged from 20% to 26%.

The results of a grain size analyses conducted on silty clay fill samples are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B3 to B6 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 14
Silt	24 to 48
Clay	52 to 76
Silt and Clay	100

The results of Atterberg Limits tests conducted on samples of the silty clay fill are provided on the Record of Borehole sheets in Appendix A and are illustrated in Figures B9 to B13 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Plastic Limit	21 to 29
Liquid Limit	49 to 59
Plasticity Index	24 to 34

The results of the Atterberg Limits testing indicate the fill to be mainly of high plasticity with occasional layers of intermediate plasticity.

5.5 Native Silty Clay

A deposit of brown silty clay with trace sand was encountered below the silty clay fill in all boreholes except for shallow Borehole 16-01A. Occasional seams of silty clay with some sand were encountered in the upper zone of the deposit. The boreholes were terminated in the silty clay at depths ranging from 3.7 m to 14.3 m below the existing ground surface. (Elev. 170.9 to Elev. 175.9).



SPT 'N' values recorded in the silty clay varied between 9 and 30 blows for 0.3 m of penetration indicating stiff to very stiff consistency. The higher 'N' values of 20 to 28 blows measured within the upper zone of the deposit in Boreholes 16-01A, 16-07, 16-10 and 16-01CN may be an indication of the presence of a discontinuous very stiff crust. Natural moisture contents of the silty clay ranged from 10% to 37%, with typical values between 24% and 28%.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figures B7 and B8 of Appendix B. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 11
Silt	24 to 41
Clay	59 to 76

The results of Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figures B14 to B17 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Plastic Limit	23 to 28
Liquid Limit	48 to 58
Plasticity Index	23 to 34

The results of the Atterberg Limits testing indicate the deposit to be of high plasticity with group symbol CH with occasional intermediate plasticity layers.

5.6 Groundwater Conditions

The water levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. All boreholes were open to the depths investigated and dry upon completion of drilling, except for Boreholes 16-18 and 16-02CN.

In Borehole 16-18, seepage of water was noted from the interface of granular fill and native clay and the water level upon completion of drilling was measured at 1.5 m depth. The water level in Borehole 16-02CN was at 11.0 m upon completion of drilling. The water levels measured in the



open boreholes upon completion of drilling and measured in the piezometers are summarized in Table 5.1.

Table 5-1. Measured Groundwater Levels

Borehole Number	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
16-01A	May 30, 2016	Dry	-	Open Borehole
16-01	May 27, 2016	Dry	-	Open Borehole
16-02	May 31, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-03	May 25, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-04	May 24, 2016	Dry	-	Open Borehole
16-05	May 26, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-06	May 26, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-07	May 25, 2016	Dry	-	Open Borehole
16-08	May 26, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-09	May 25, 2016	Dry	-	Piezometer
	June 1, 2016			



Borehole Number	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
	July 4, 2016			
16-10	May 26, 2016	Dry	-	Open Borehole
16-11	May 27, 2016	Dry	-	Piezometer
	June 1, 2016	Dry		
	July 4, 2016	4.6	175.7	
16-12	May 25, 2016	Dry	-	Piezometer
	June 1, 2016	Dry	-	
	July 4, 2016	1.5	178.0	
16-13	May 26, 2016	Dry	-	Open Borehole
16-14	May 24, 2016	Dry	-	Piezometer
	June 1, 2016			
	July 4, 2016			
16-15	May 30, 2016	Dry	-	Open Borehole
16-16	May 30, 2016	Dry	-	Piezometer
	June 1, 2016	Dry	-	
	July 4, 2016	0.7	176.5	
16-17	June 1, 2016	Dry	-	Piezometer
	July 4, 2016			
16-18	May 31, 2016	1.5	176.0	Piezometer
	June 1, 2016	1.5	176.0	
	July 4, 2016	1.1	176.4	
16-01CN	June 30, 2016	Dry	-	Open Borehole
16-02CN	June 31, 2016	11.0	176.0	Open Borehole



The values shown in Table 5-1 are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant or prolonged precipitation events.

6. MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. The completed borehole locations and ground surface elevations were obtained from the cross sections provided by MMM for the purpose of preparing this draft report.

Walker Drilling Ltd. of Utopia, Ontario, supplied and operated a track-mounted D-50 drill rig to carry out the drilling, sampling and in-situ testing operations for the boreholes at this site.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. G. Azzopardi of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET.

Ms. Anna Piascik, P.Eng. interpreted the data and prepared the report. The report was reviewed by Dr. Sydney Pang, P.Eng., and 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		SYMBOLS			
Fresh (FR)	No visible signs of weathering.				
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE		
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE		
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE		
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL		
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)		
DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		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.
TERMS		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
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 16-01

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 320.7 E 328 339.4 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.27 - 2016.05.27 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										
185.2	GROUND SURFACE							20	40	60	80	100						
0.0	ASPHALT: (75mm)							20	40	60	80	100						
0.1	SAND and GRAVEL , some silt Dense Brown/Grey		1	SS	34													41 41 18 (SI+CL)
184.6	Moist (FILL)		2	SS	12													
0.6	Silty CLAY , trace sand, trace gravel, occasional grey silt inclusions, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		3	SS	15													0 0 28 72
			4	SS	14													
			5	SS	15													
			6	SS	18													
			7	SS	20													
			8	SS	24													0 0 30 70
			9	SS	16													
			10	SS	19													
			11	SS	15													
			12	SS	17													
	Occasional black and oxide staining below 8.4m		13	SS	14													
176.2																		
9.0	Silty CLAY , trace sand, trace gravel Very Stiff Brown Moist		14	SS	28													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-01

2 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 320.7 E 328 339.4 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.27 - 2016.05.27 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT 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							
							20 40 60 80 100	20 40 60						
	Continued From Previous Page						175							
	Silty CLAY , trace sand, trace gravel Very Stiff Brown Moist		15	SS	18		174							0 0 31 69
							173							
			16	SS	16		172							
	Stiff		17	SS	13		171							
170.9														
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE OPEN TO 14.3m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.													

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

RECORD OF BOREHOLE No 16-01 CN

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 421.9 E 328 383.2 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 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					
								20 40 60 80 100					
187.0	GROUND SURFACE												
0.0	ASPHALT: (113mm)												
0.1	Gravelly SAND , some silt Dense to Very Dense Brown to Grey Moist (FILL)		1	SS	48		186						34 52 14 (SI+CL)
			2	SS	51								
			3	SS	33		185						
184.9													
2.1	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist (FILL)		4	SS	13		184						
			5	SS	14								
			6	SS	14		183						0 0 30 70
			7	SS	18		182						
			8	SS	16		181						
			9	SS	15								
	Clay seams between 6.8m and 7.4m		10	SS	16		180						0 0 100 (SI+CL)
			11	SS	20		179						
			12	SS	12		178						
	Brown and Grey Mottled between 8.5m and 9.1m, contains occasional rootlets and wood fibres		13	SS	17								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-01 CN

2 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 421.9 E 328 383.2 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 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									
	Continued From Previous Page																
176.4	Contains occasional wood fragments and asphalt below 9.9m		14	SS	16												
10.6	Silty CLAY , some sand Very Stiff Brown Moist		15	SS	28											0 11 29 60	
175.7																	
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																

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RECORD OF BOREHOLE No 16-01A

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 378.2 E 328 369.4 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 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						
186.5	GROUND SURFACE							20	40	60	80	100		
0.0	ASPHALT: (88mm)													
0.1	SAND and GRAVEL, some silt Brown/Grey Moist (FILL)		1	GS			186							
185.9														
0.6	Silty CLAY, trace sand, trace gravel, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		2	GS			185							
			1	SS	18									
184.4														
2.1	END OF BOREHOLE AT 2.1m. BOREHOLE OPEN TO 2.1m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.2m, THEN ASPHALT PATCH TO SURFACE.													

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

RECORD OF BOREHOLE No 16-02

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 315.8 E 328 332.3 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 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					
183.2	GROUND SURFACE												
0.0	TOPSOIL: (100mm)												
0.1	Silty CLAY , trace sand, occasional silt lenses, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		1	SS	12								
			2	SS	13								0 0 32 68
			3	SS	23								
			4	SS	20								
			5	SS	22								
			6	SS	15								
			7	SS	21								0 0 30 70
			8	SS	18								
			9	SS	14								
	Trace black organics, slight organic odour Dark Brown below 6.1m		10	SS	22								
176.0													
7.2	Silty CLAY , trace sand Stiff Brown Moist		11	SS	14								
175.0													
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 8.2m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry												

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

RECORD OF BOREHOLE No 16-02 CN

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 403.9 E 328 385.9 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 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						
187.0	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.0	ASPHALT: (113mm)							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>						
0.1		SAND and GRAVEL, some silt Compact Brown Moist (FILL)		1	SS	29		186						
			2	SS	27									
185.6	Silty CLAY, trace sand Stiff to Very Stiff Brown Moist (FILL)		3	SS	11		185							
1.4			4	SS	13									
			5	SS	11		184							
			6	SS	13									
			7	SS	19		183							
			8	SS	19		182							
			9	SS	13		181							
			10	SS	18		180							
			11	SS	17		179							
			12	SS	22									
			13	SS	14		178							
		Occasional rootlets below 9.1m Dark Brown												

Continued Next Page

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

RECORD OF BOREHOLE No 16-02 CN

2 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 403.9 E 328 385.9 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 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									
	Continued From Previous Page																
176.3			14	SS	21												
10.7	Silty CLAY , trace sand, occasional rootlets																
175.7	Very Stiff to Hard		15	SS	30	▽	176										
11.3	Brown Moist																
	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND WATER LEVEL AT 11.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.5m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																

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RECORD OF BOREHOLE No 16-03

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 315.9 E 328 326.3 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.25 - 2016.05.25 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 (%)				
180.8	GROUND SURFACE							20	40	60	80	100					GR	SA	SI	CL		
0.0 0.1	TOPSOIL: (75mm)																					
	Silty CLAY , trace sand, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		1	SS	10									○								
			2	SS	14		180							○	—	—		0	0	30	70	
			3	SS	11									○								
			4	SS	15		179							○								
			5	SS	16									○								
			6	SS	14		178							○				0	0	29	71	
			7	SS	14									○								
176.2																						
4.6	Silty CLAY , trace sand, occasional rootlets Very Stiff Brown Moist		8	SS	15		176							○								
175.6																						
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry																					

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RECORD OF BOREHOLE No 16-04

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 310.5 E 328 348.2 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.24 - 2016.05.24 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					
								20 40 60 80 100					
185.2	GROUND SURFACE												
0.0	ASPHALT: (50mm)												
184.6	SAND and GRAVEL , some silt Dense Brown Moist (FILL)		1	SS	31								50 35 15 (SI+CL)
0.6	Silty CLAY , trace sand, trace gravel, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		2	SS	10								0 0 31 69
			3	SS	14								
			4	SS	15								
			5	SS	16								
			6	SS	17								
			7	SS	18								
			8	SS	19								
			9	SS	20								
			10	SS	16								
			11	SS	14								
			12	SS	15								
			13	SS	14								
176.1	Silty CLAY , trace sand Very Stiff Brown Moist		14	SS	25								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-04

2 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 310.5 E 328 348.2 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.24 - 2016.05.24 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 (%)				
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	W P W W L					
Continued From Previous Page								● QUICK TRIAXIAL × LAB VANE							
170.9 <															





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RECORD OF BOREHOLE No 16-05

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 280.4 E 328 352.7 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.26 - 2016.05.26 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			SHEAR STRENGTH kPa		WATER CONTENT (%)					
183.4	GROUND SURFACE							20 40 60 80 100		W _P W W _L			GR SA SI CL		
0.0	TOPSOIL: (75mm) Silty CLAY , trace to some sand, occasional silty sand lenses in the upper 0.5m zone Stiff to Very Stiff Brown Moist (FILL)		1	SS	11		183							0 14 25 61	
0.1			2	SS	12										
			3	SS	15										
			4	SS	15										
			5	SS	14										
			6	SS	19										
			7	SS	18										
			8	SS	18										
			9	SS	18										
			10	SS	16										
			11	SS	15										
175.9	Trace organics Dark Brown below 6.9m						177								
7.5	Silty CLAY , trace sand Very Stiff Brown Moist		12	SS	28		176						0 0 34 66		
175.2															
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 8.2m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry														

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+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-06

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 296.1 E 328 371.0 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.26 - 2016.05.26 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 (%)		
180.7	GROUND SURFACE							20	40	60	80	100	20	40	60				
0.0 0.1	TOPSOIL: (75mm)																		
	Silty CLAY , trace sand, trace gravel Stiff to Very Stiff Brown Moist (FILL)		1	SS	11								○						
			2	SS	14								○						
			3	SS	17								○	┌───┐		0	0	30	70
			4	SS	14								○						
			5	SS	16								○	┌───┐		0	0	30	70
			6	SS	17								○						
			7	SS	13								○						
176.1																			
4.6	Silty CLAY , trace rootlets, trace of black organics Very Stiff Brown Moist		8	SS	16								○						
175.5																			
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry																		

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RECORD OF BOREHOLE No 16-07

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 238.1 E 328 322.8 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.25 - 2016.05.25 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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _P W W _L				GR	SA	SI	CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE			● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)					
183.0	GROUND SURFACE																			
0.0	SAND and GRAVEL , some silt Dense Grey Moist (FILL)		1	SS	34									○						51 36 13 (SI+CL)
182.4																				
0.6	Silty CLAY , trace sand, trace gravel Stiff to Very Stiff Brown Moist (FILL)		2	SS	13		182							○	├───┤					0 7 25 68
			3	SS	14									○						
			4	SS	22		181							○	├───┤					
			5	SS	15									○						
			6	SS	16		180							○						
			7	SS	22		179							○						
			8	SS	14		178							○						
			9	SS	16									○						
176.9							177													
6.1	Silty CLAY , trace sand, occasional rootlets between 6.1m and 6.5m Very Stiff Brown Moist		10	SS	24		176							○						
			11	SS	20		175							○	├───┤					0 0 27 73
			12	SS	21		174							○						
							173													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 16-07

2 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 238.1 E 328 322.8 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.25 - 2016.05.25 CHECKED BY SKP


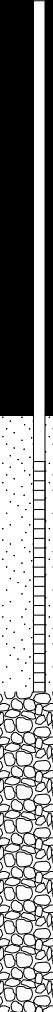

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
171.7			13	SS	23		172										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No 16-08

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 228.9 E 328 331.9 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.26 - 2016.05.26 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										
179.5	GROUND SURFACE																	
0.0	TOPSOIL: (75mm) Silty CLAY , trace sand, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		1	SS	9													
0.1				2	SS		11											
				3	SS		12											
				4	SS		14											
				5	SS		14											
				6	SS		18											
				7	SS		17											
175.2	Silty CLAY , trace sand Very Stiff Brown Moist		8	SS	18													
4.3																		
				9	SS	20												
172.8	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry																	
6.7																		

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

RECORD OF BOREHOLE No 16-09

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 222.7 E 328 339.7 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.25 - 2016.05.25 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							
177.9	GROUND SURFACE														
0.0	TOPSOIL: (75mm) Silty CLAY , trace sand, trace gravel, occasional rootlets Stiff to Very Stiff Brown Moist (FILL) Trace of black organics Dark Brown below 3.0m		1	SS	10										
0.1			2	SS	16										
			3	SS	14										
			4	SS	14										
			5	SS	17										
			6	SS	15										
174.3	Silty CLAY , trace sand Very Stiff Brown Moist														
3.6			7	SS	16										
173.5	END OF BOREHOLE AT 4.4m. BOREHOLE OPEN TO 4.4m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry														
4.4															

RECORD OF BOREHOLE No 16-10

1 OF 2

METRIC

W.P. 2284-13-00 LOCATION N 4 756 222.4 E 328 299.7 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.26 - 2016.05.26 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												
181.4	GROUND SURFACE							20	40	60	80	100								
0.0	SAND and GRAVEL , some silt Dense Brown Moist (FILL)		1	SS	24		181													46 38 16 (SI+CL)
180.8																				
0.6	Silty CLAY , trace sand, trace gravel, occasional rootlets, contains wood fibers between 0.6m and 0.9m depth Stiff to Very Stiff Brown Moist (FILL)		2	SS	10		180													
			3	SS	12															
			4	SS	17		179													
			5	SS	16															
			6	SS	21		178													
			7	SS	18		177													
			8	SS	21															
			9	SS	22		176													0 0 32 68
175.6																				
5.8	Silty CLAY , trace sand, trace gravel Very Stiff to Stiff Brown Moist		10	SS	28		175													
			11	SS	16		174													0 0 33 67
							173													
			12	SS	9		172													
171.6																				
9.8	END OF BOREHOLE AT 9.8m.																			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

[illegible]

RECORD OF BOREHOLE No 16-11

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 224.2 E 328 288.9 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.27 - 2016.05.27 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 (%)
178.5	GROUND SURFACE							20	40	60	80	100	20	40	60		
0.0	TOPSOIL: (63mm) Silty CLAY , trace sand, occasional rootlets Stiff to Very Stiff Brown Moist (FILL)		1	SS	8		178							○			
0.1			2	SS	11									○			
			3	SS	14		177							○			
			4	SS	15									□ ————— □			0 0 32 68
			5	SS	14		176							○			
			6	SS	18		175							○			
174.7	Silty CLAY , occasional rootlets, occasional black staining Very Stiff Brown Moist		7	SS	16		174							○ ————— □			0 0 35 65
3.8			8	SS	26									○			
173.3	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN TO 5.2m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 4.6 173.9																
5.2																	

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RECORD OF BOREHOLE No 16-12

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 227.3 E 328 279.5 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.25 - 2016.05.25 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						
177.1	GROUND SURFACE													
0.0 0.1	TOPSOIL: (75mm) Silty CLAY , trace sand, trace gravel Stiff to Very Stiff Brown Moist (FILL)		1	SS	10									
			2	SS	14									
			3	SS	14									
			4	SS	15									
			5	SS	16									
174.0														
3.0	Silty CLAY , trace sand Very Stiff Brown Moist		6	SS	16									
			7	SS	21									
172.7														
4.4	END OF BOREHOLE AT 4.4m. BOREHOLE OPEN TO 4.4m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 1.5 175.6													



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RECORD OF BOREHOLE No 16-13

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 173.7 E 328 283.8 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.26 - 2016.05.26 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT 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		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				w _P w w _L										
180.4	GROUND SURFACE							20	40	60	80	100										
0.0	Gravelly SAND , some silt Dense Brown/Grey Moist (FILL) Silty CLAY , trace sand Stiff to Very Stiff Brown Moist (FILL)		1	SS	35		180							○					31	51	18 (SI+CL)	
179.8																						
0.6			2	SS	10											○						
			3	SS	13											○						
			4	SS	14											○						
			5	SS	17											○	├───┤				0	0
	6	SS	13											○								
176.7	Silty CLAY , trace sand Very Stiff Brown Moist																					
3.7			7	SS	24										○	├───┤				0	0	27 73
			8	SS	20											○						
173.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																					
6.7																						

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RECORD OF BOREHOLE No 16-14

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 159.4 E 328 295.5 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.24 - 2016.05.24 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									
178.3	GROUND SURFACE						20	40	60	80	100	20	40	60			
0.0 0.1	TOPSOIL: (100mm) Silty CLAY , trace sand, occasional rootlets in the upper 0.5m Stiff to Very Stiff Brown Moist		1	SS	12												
			2	SS	14												
			3	SS	17												
			4	SS	18												
			5	SS	24												
			6	SS	28												
174.6 3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 3.7m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry																

RECORD OF BOREHOLE No 16-15

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 311.1 E 328 314.2 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE											
177.0	GROUND SURFACE							20	40	60	80	100							
0.0 0.1	TOPSOIL: (75mm)																		
176.5 0.5	Silty CLAY , trace sand, trace gravel Stiff Brown Moist (FILL)		1	SS	15										○				
			2	SS	14										○				
175.8 1.2	SAND and GRAVEL , some silt Compact Grey Moist (FILL)		3	SS	18										○				
	Silty CLAY , trace sand Very Stiff Brown Moist		4	SS	20										○				
			5	SS	27										○				
			6	SS	26														
173.3 3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 3.7m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

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RECORD OF BOREHOLE No 16-16

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 231.2 E 328 269.0 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.30 - 2016.05.30 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
177.1	GROUND SURFACE							20 40 60 80 100									
0.0	TOPSOIL: (88mm)							20 40 60 80 100									
0.1	Silty CLAY, trace sand, occasional rootlets in upper 0.5m Stiff to Very Stiff Brown Moist		1	SS	8		177										
			2	SS	13		176										
			3	SS	17												0 0 41 59
			4	SS	16		175										
			5	SS	19												
			6	SS	21		174										
173.4	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 3.7m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 0.7 176.4																

ONTMT4S MTO-11336.GPJ 2015TEMPLATE(MTO).GDT 8/22/16

RECORD OF BOREHOLE No 16-17

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 212.7 E 328 354.5 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.06.01 - 2016.06.01 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						
177.4	GROUND SURFACE							20	40	60	80	100		
0.0	TOPSOIL: (75mm) Silty CLAY , trace sand, occasional rootlets in upper 0.3m Stiff to Very Stiff Brown Moist		1	SS	11									
0.1			2	SS	14									
			3	SS	18									
			4	SS	17									
			5	SS	24									
			6	SS	20									
173.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 3.7m AND DRY. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jun. 01/2016 Dry Jul. 04/2016 Dry													

ONTMT4S MTO-11336.GPJ 2015TEMPLATE(MTO).GDT 8/22/16

RECORD OF BOREHOLE No 16-18

1 OF 1

METRIC

W.P. 2284-13-00 LOCATION N 4 756 285.9 E 328 383.8 ORIGINATED BY GA
 HWY 140 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2016.05.31 - 2016.05.31 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20	40	60	80	100				
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
								WATER CONTENT (%)								
								20	40	60	80	100	20	40	60	
177.5	GROUND SURFACE															
0.0	TOPSOIL: (125mm)															
0.1																
	Silty CLAY , trace sand, trace gravel		1	SS	13		177						○			
176.9	Stiff															
0.6	Brown															
176.6	Moist		2	SS	17								○			
0.9	(FILL)															
	SAND and GRAVEL , some silt															
		Compact														
	Grey		3	SS	17		176						○			
	Moist															
	(FILL)															
	Silty CLAY , trace sand, occasional															
	grey silt seams		4	SS	19		175						○			
	Very Stiff															
	Brown															
	Moist to Wet		5	SS	20											
			6	SS	27		174						○			
173.8																
3.7	BOREHOLE OPEN TO 3.7m AND WATER LEVEL AT 1.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.															
	WATER LEVEL READINGS:															
	DATE DEPTH (m) ELEV. (m)															
	Jun. 01/2016 1.5 176.0															
	Jul. 04/2016 1.1 176.4															



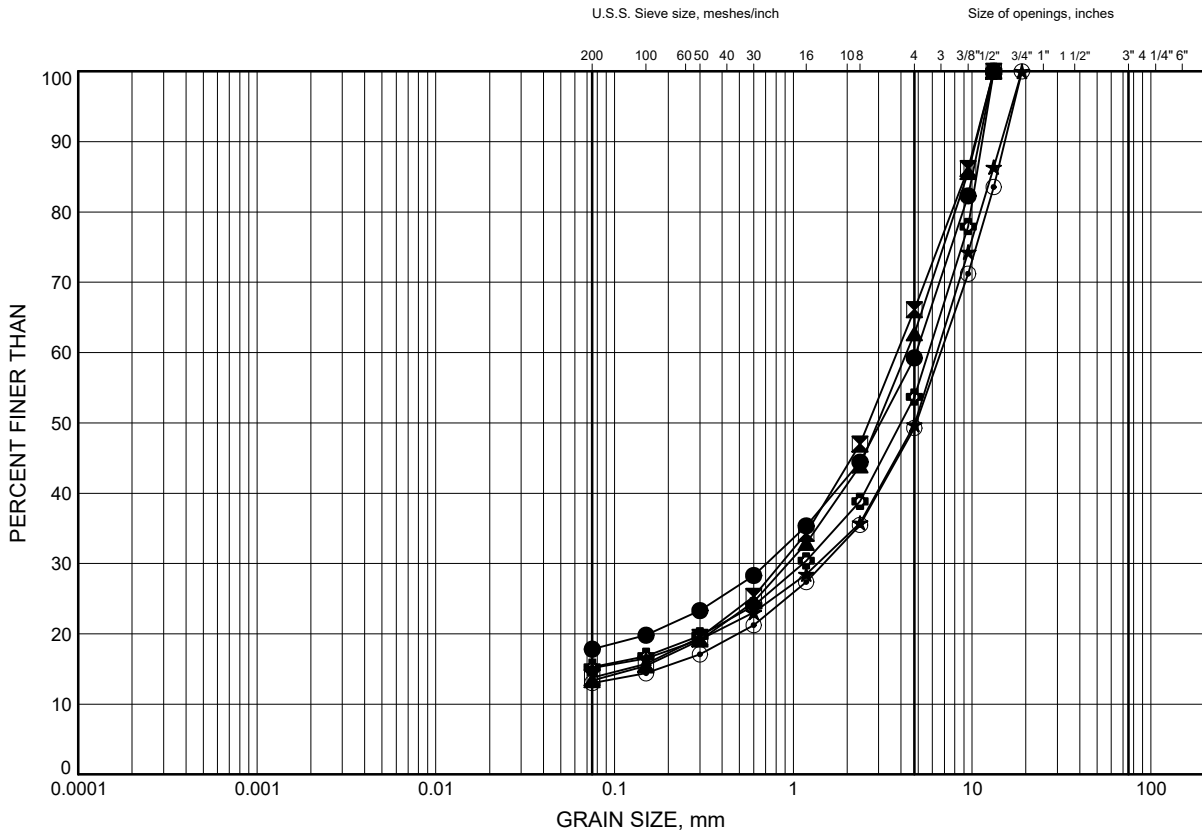
Appendix B

Laboratory Test Results

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND and GRAVEL 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)
●	16-01	0.30	184.90
⊠	16-01 CN	1.07	185.93
▲	16-02 CN	1.07	185.93
★	16-04	0.23	184.97
⊙	16-07	0.30	182.69
⊕	16-10	0.30	181.09

Date August 2016
W.P. 2284-13-00

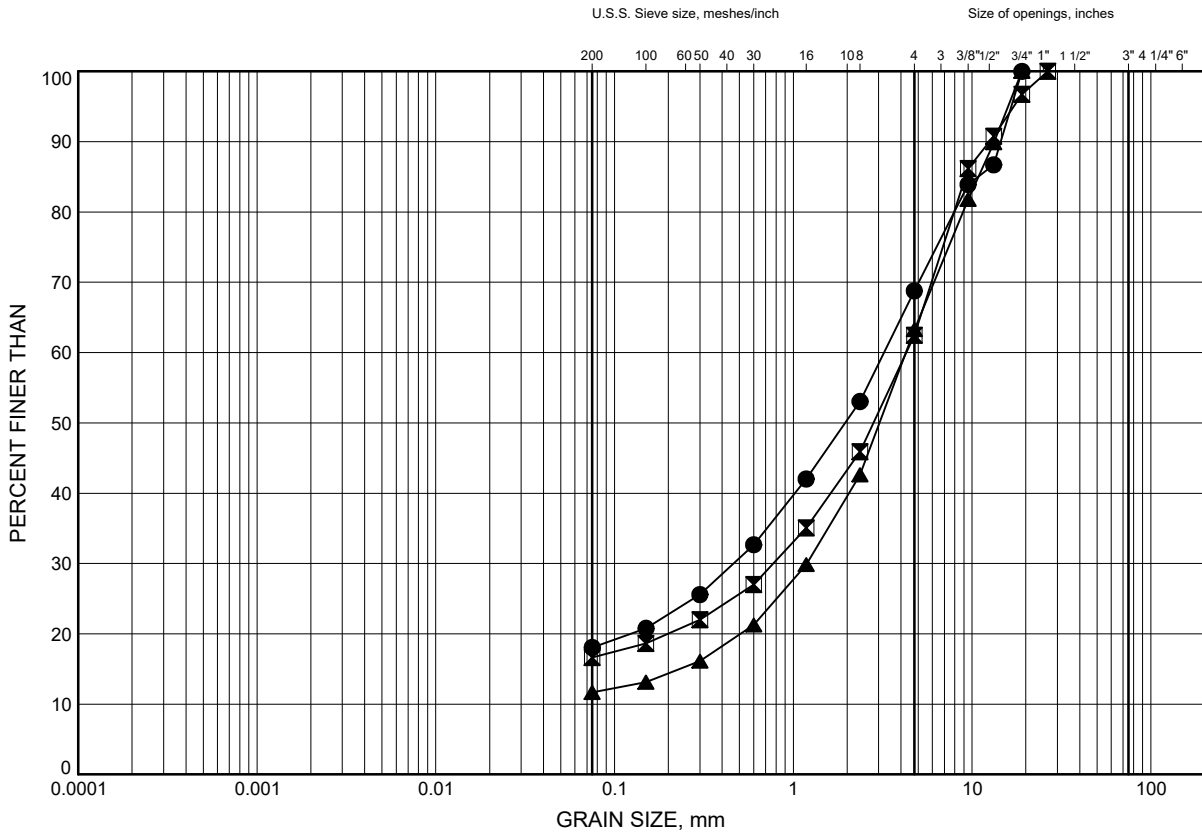


Prep'd AN
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Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND and GRAVEL 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)
●	16-13	0.30	180.10
⊠	16-15	0.91	176.09
▲	16-18	0.91	176.59

Date August 2016
W.P. 2284-13-00

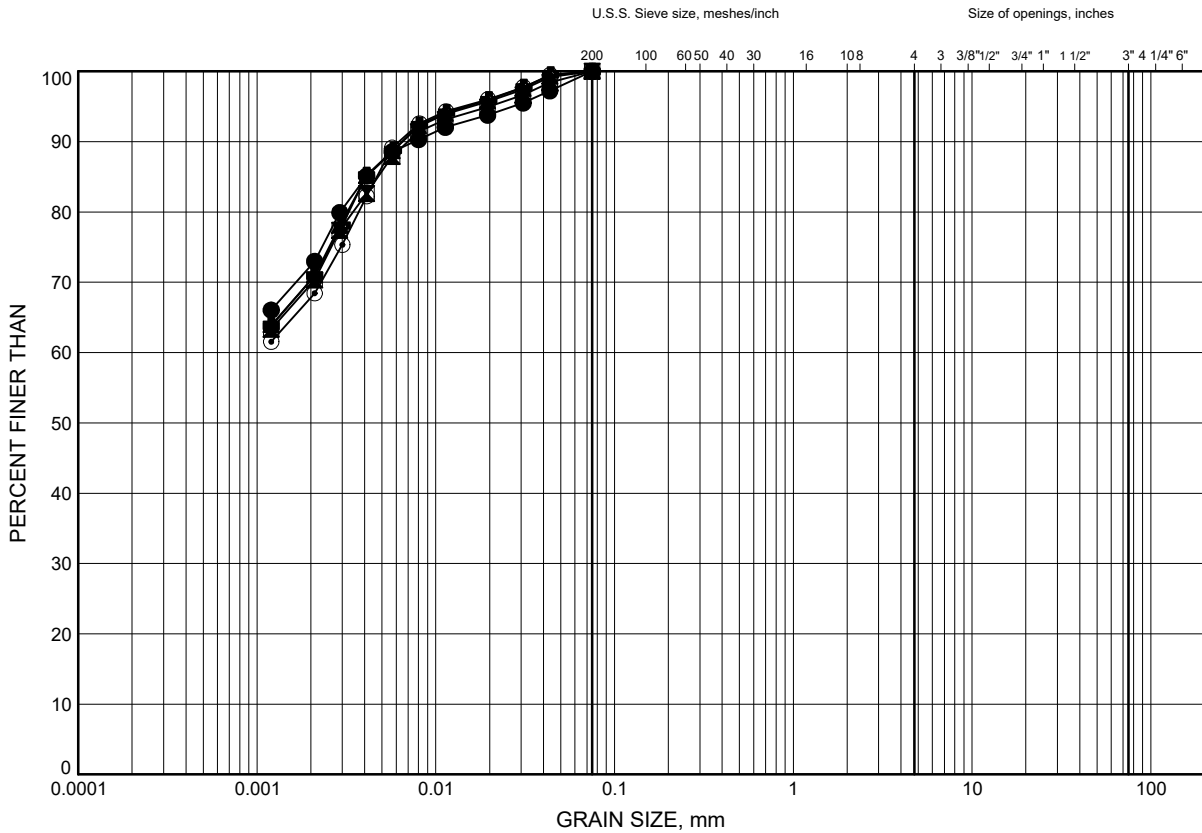


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	1.52	183.68
⊠	16-01	4.88	180.32
▲	16-01 CN	4.11	182.89
★	16-01 CN	7.16	179.84
⊙	16-02	0.91	182.29
⊕	16-02	4.11	179.09

Date August 2016
W.P. 2284-13-00

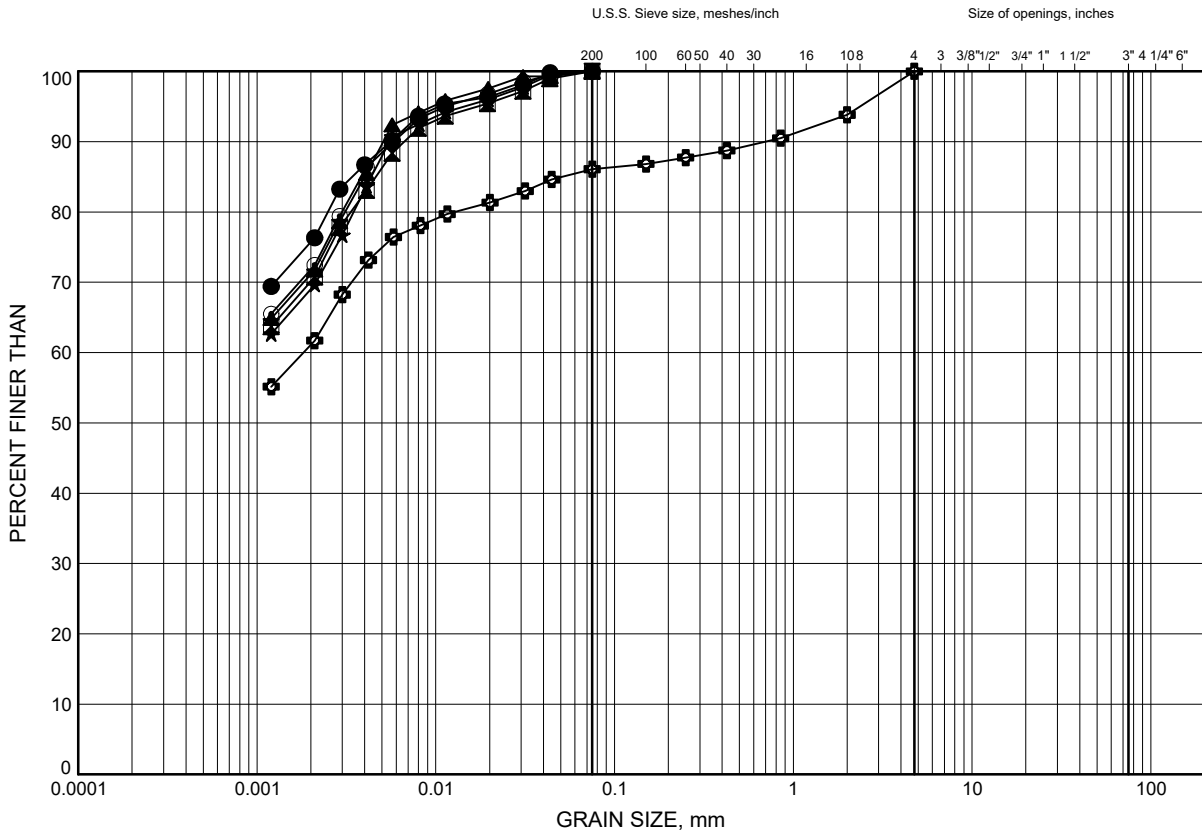


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-02 CN	5.64	181.36
⊠	16-03	0.91	179.89
▲	16-03	2.74	178.06
★	16-04	0.91	184.29
⊙	16-04	6.40	178.80
⊕	16-05	0.91	182.49

Date August 2016
W.P. 2284-13-00

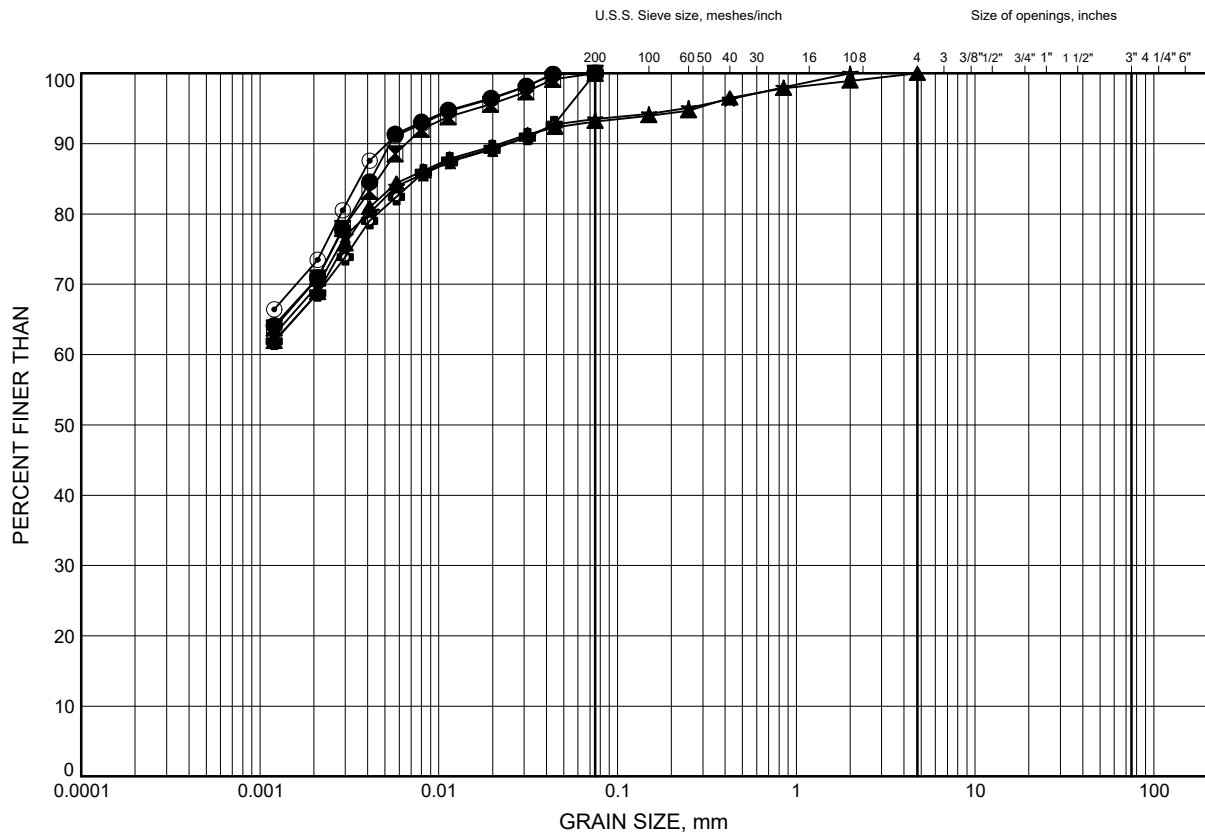


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B5

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-06	1.52	179.18
⊠	16-06	2.74	177.96
▲	16-07	0.91	182.08
★	16-08	0.91	178.58
⊙	16-09	2.13	175.76
⊕	16-10	5.64	175.76

Date August 2016
W.P. 2284-13-00

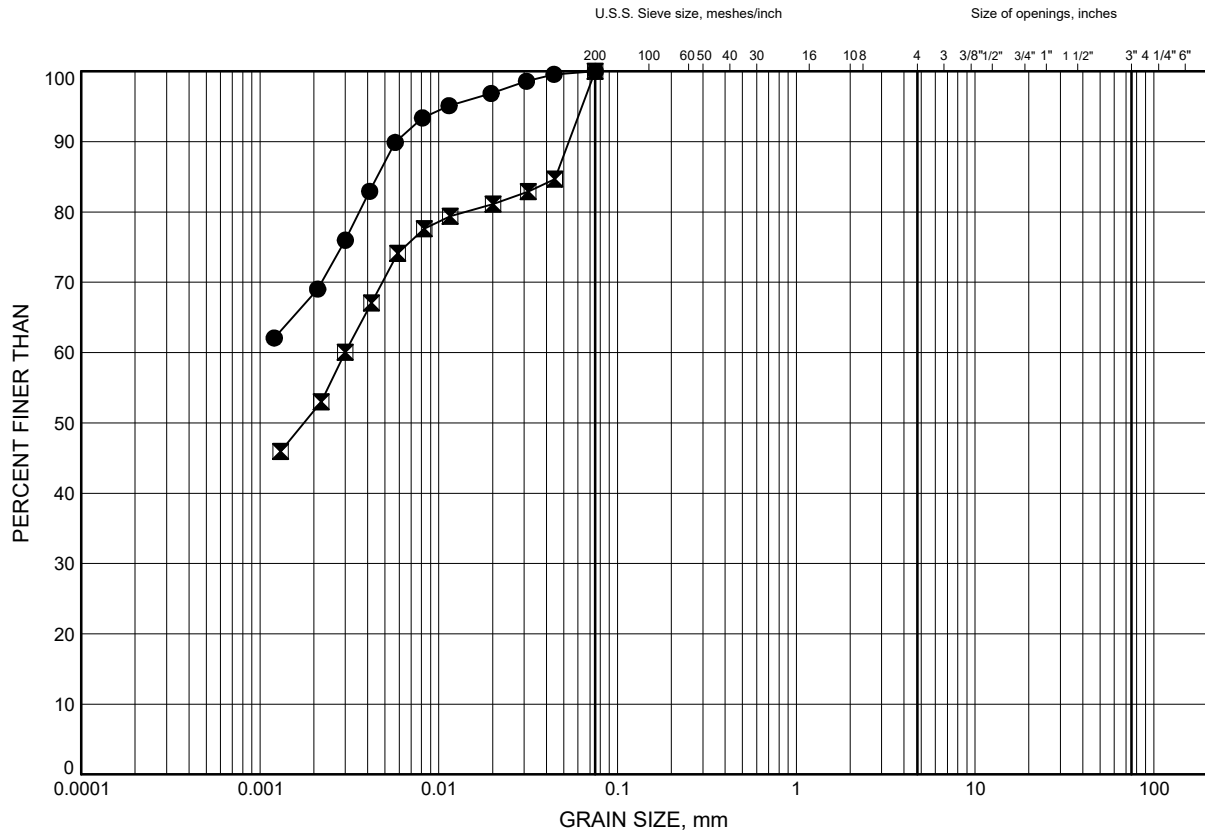


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B6

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	2.13	176.36
⊠	16-13	2.74	177.66

Date August 2016
W.P. 2284-13-00

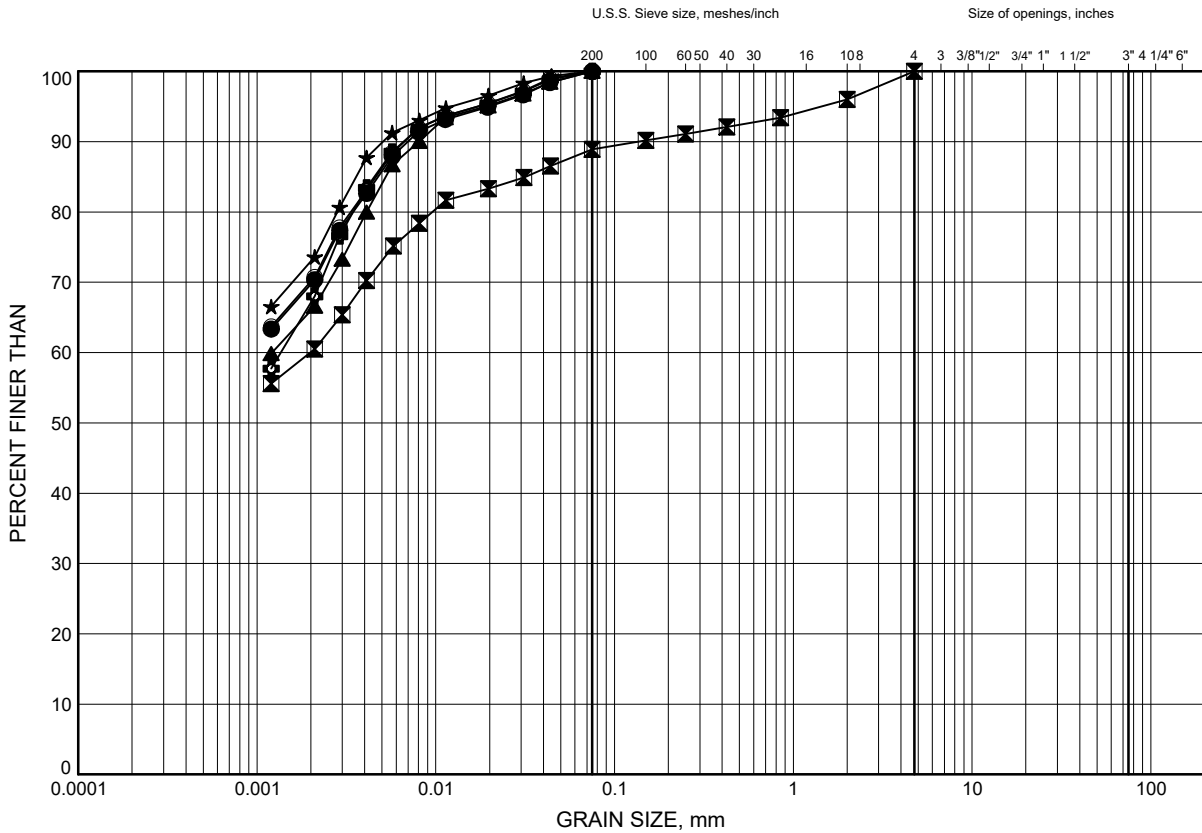


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B7

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	4.88	180.32
⊠	16-01 CN	10.97	176.03
▲	16-05	7.92	175.48
★	16-07	7.92	175.07
⊙	16-08	4.88	174.62
⊕	16-10	7.92	173.47

Date August 2016
W.P. 2284-13-00

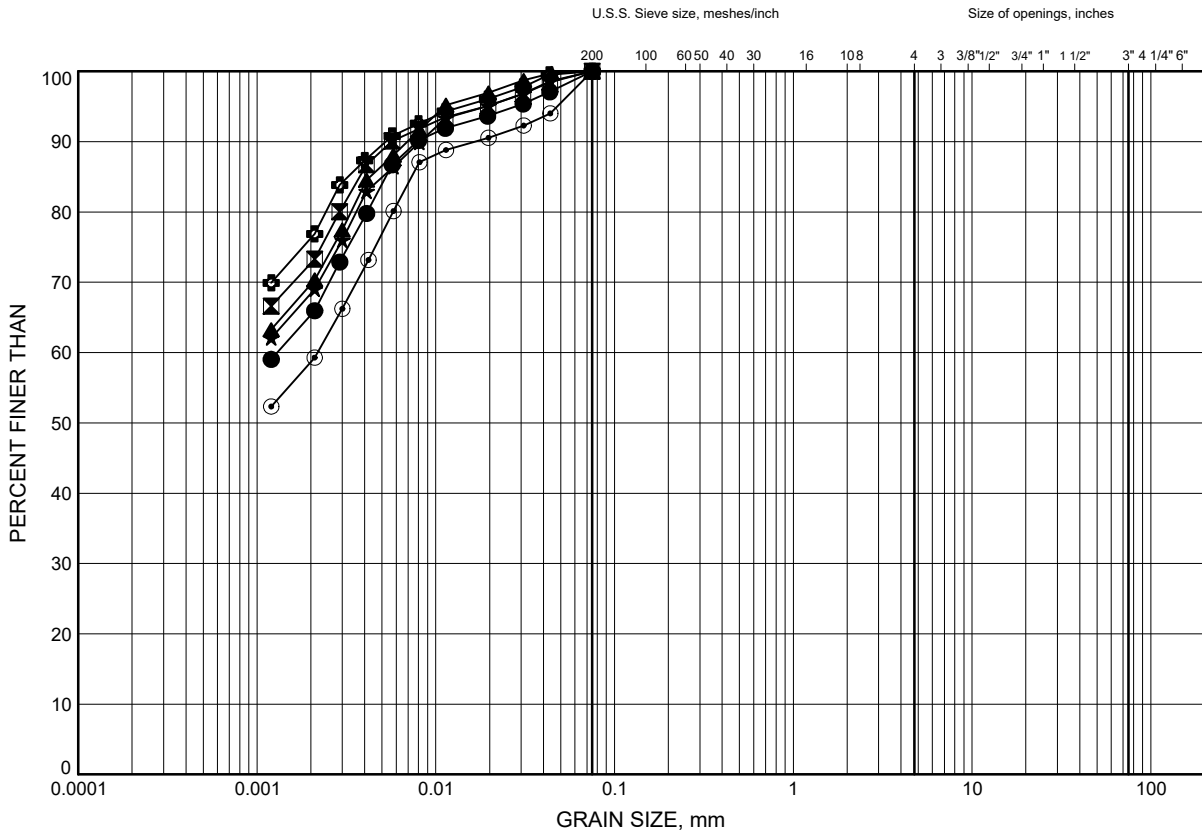


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B8

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	4.11	174.38
⊠	16-13	4.88	175.52
▲	16-14	0.91	177.39
★	16-15	3.35	173.65
⊙	16-16	1.52	175.57
⊕	16-17	1.52	175.87

Date August 2016
W.P. 2284-13-00

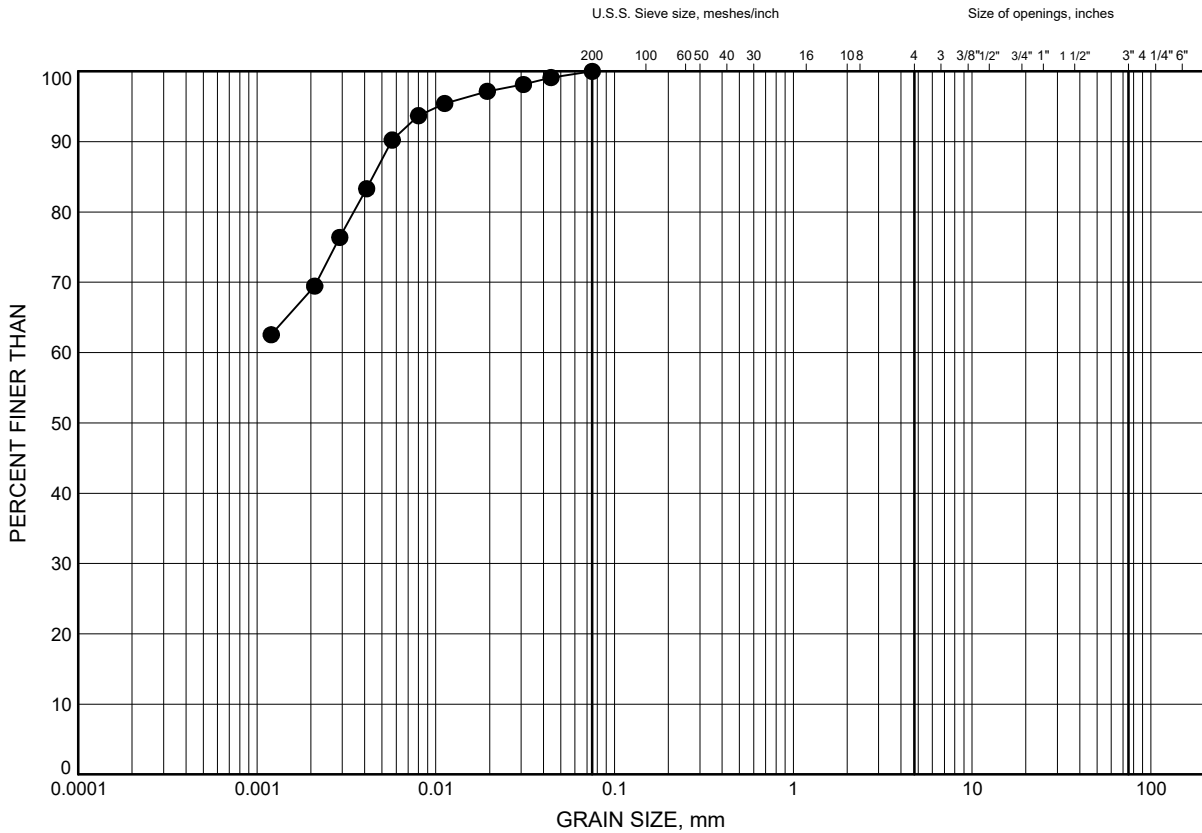


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment GRAIN SIZE DISTRIBUTION

FIGURE B9

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-18	2.13	175.37

Date August 2016
W.P. 2284-13-00

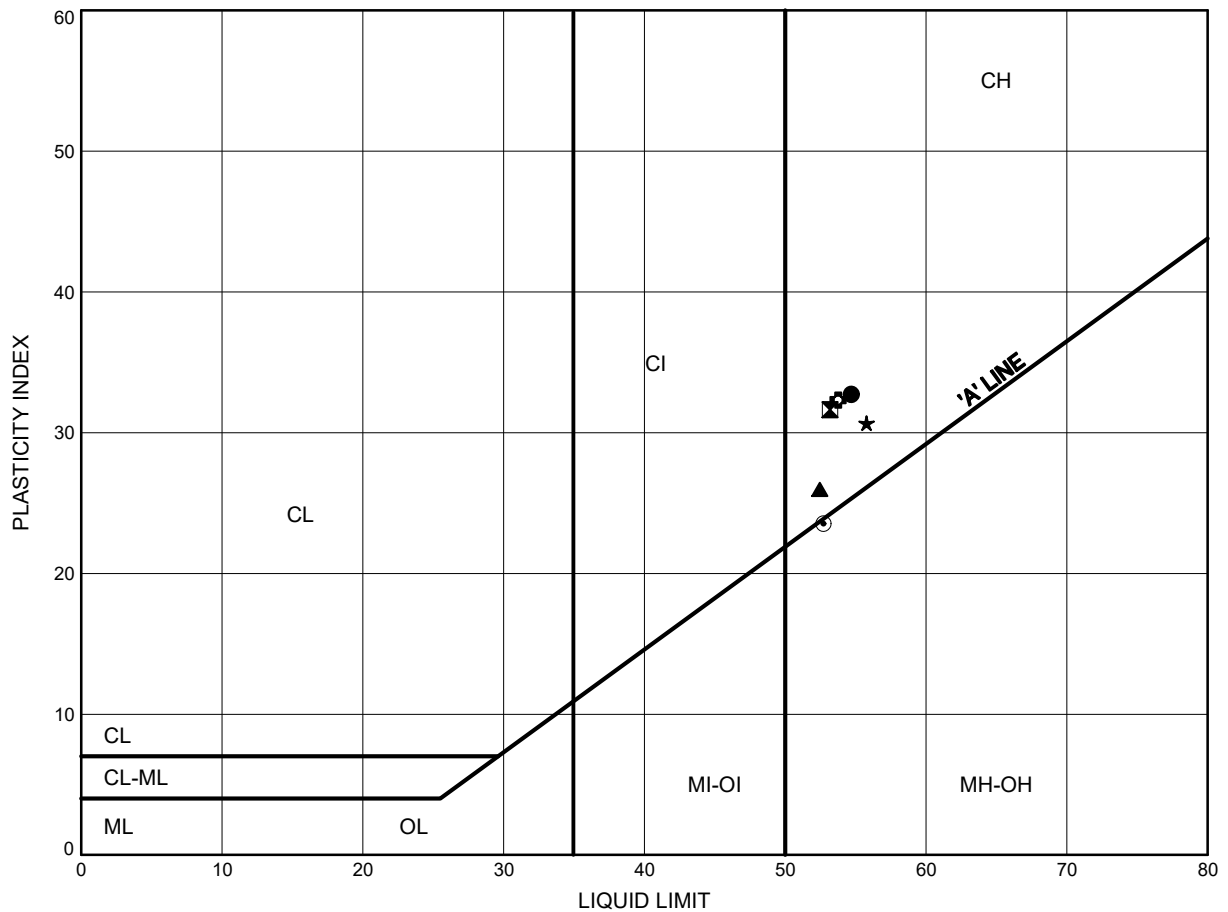


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B10

Silty CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	1.52	183.68
⊠	16-01	4.88	180.32
▲	16-01 CN	4.11	182.89
★	16-01 CN	7.16	179.84
⊙	16-01 CN	7.92	179.08
⊕	16-02	0.91	182.29

Date August 2016
W.P. 2284-13-00

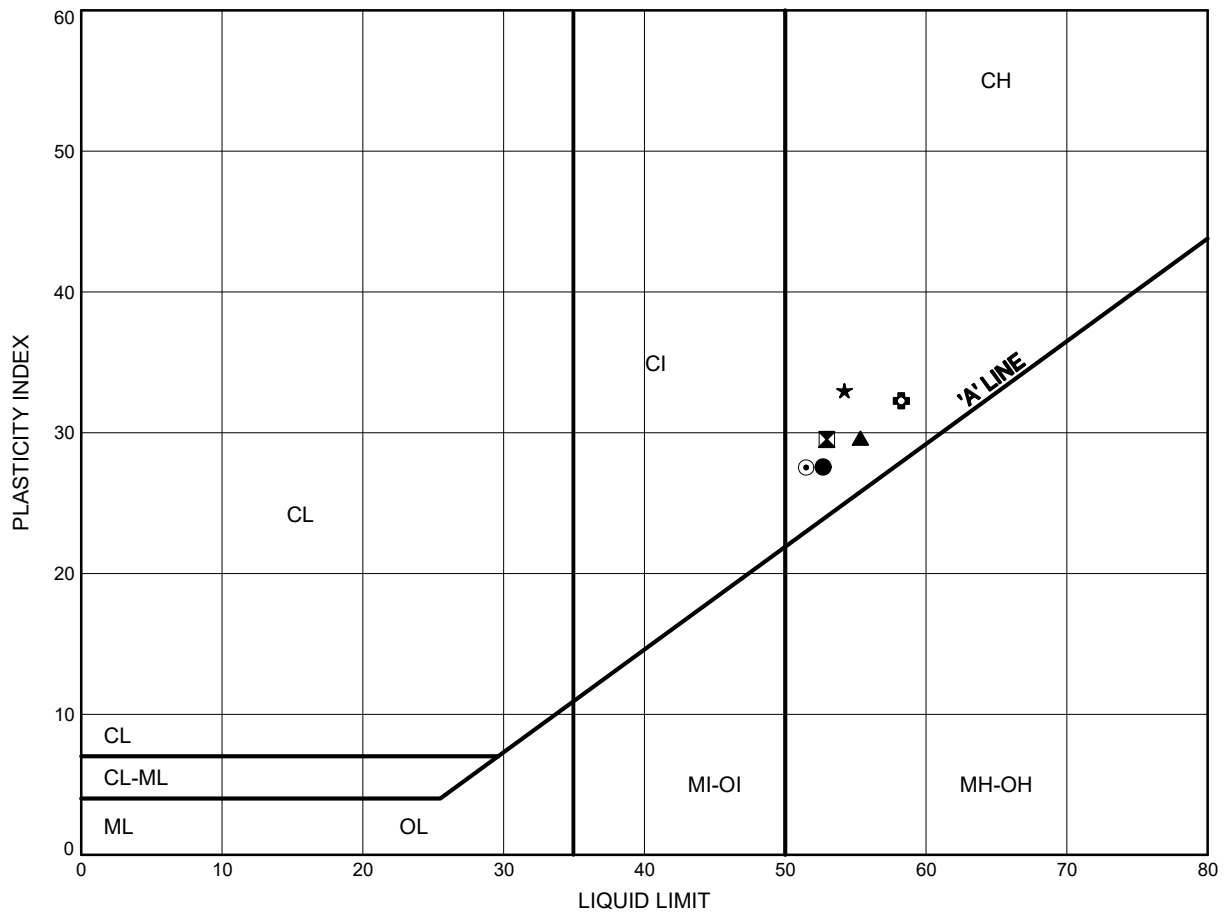


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B11

Silty CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-02	2.13	181.07
⊠	16-02	4.11	179.09
▲	16-02 CN	1.83	185.17
★	16-02 CN	5.64	181.36
⊙	16-02 CN	8.69	178.31
⊕	16-03	0.91	179.89

Date August 2016
W.P. 2284-13-00

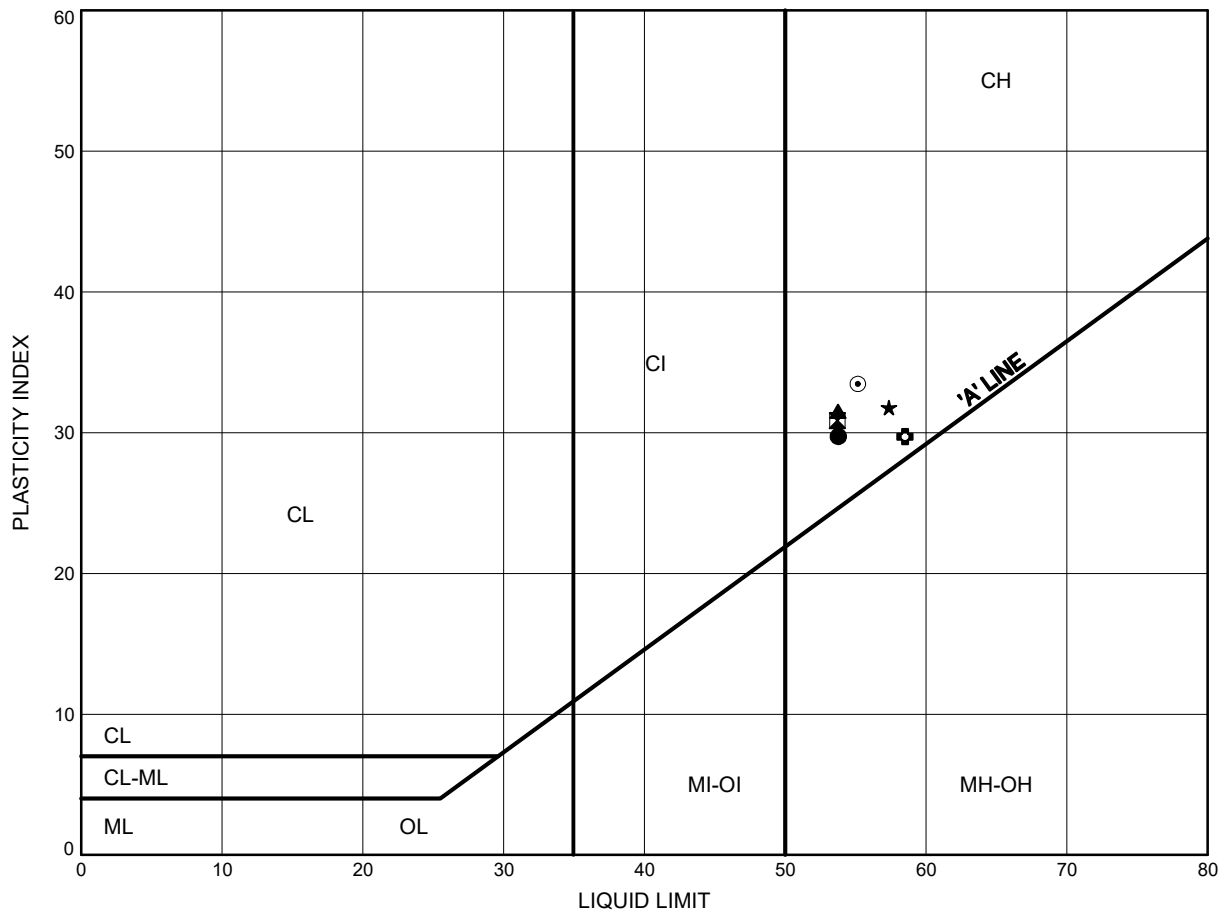


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B12

Silty CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-04	0.91	184.29
⊠	16-04	2.74	182.46
▲	16-04	6.40	178.80
★	16-05	0.91	182.49
⊙	16-05	4.11	179.29
⊕	16-06	1.52	179.18

Date August 2016
W.P. 2284-13-00

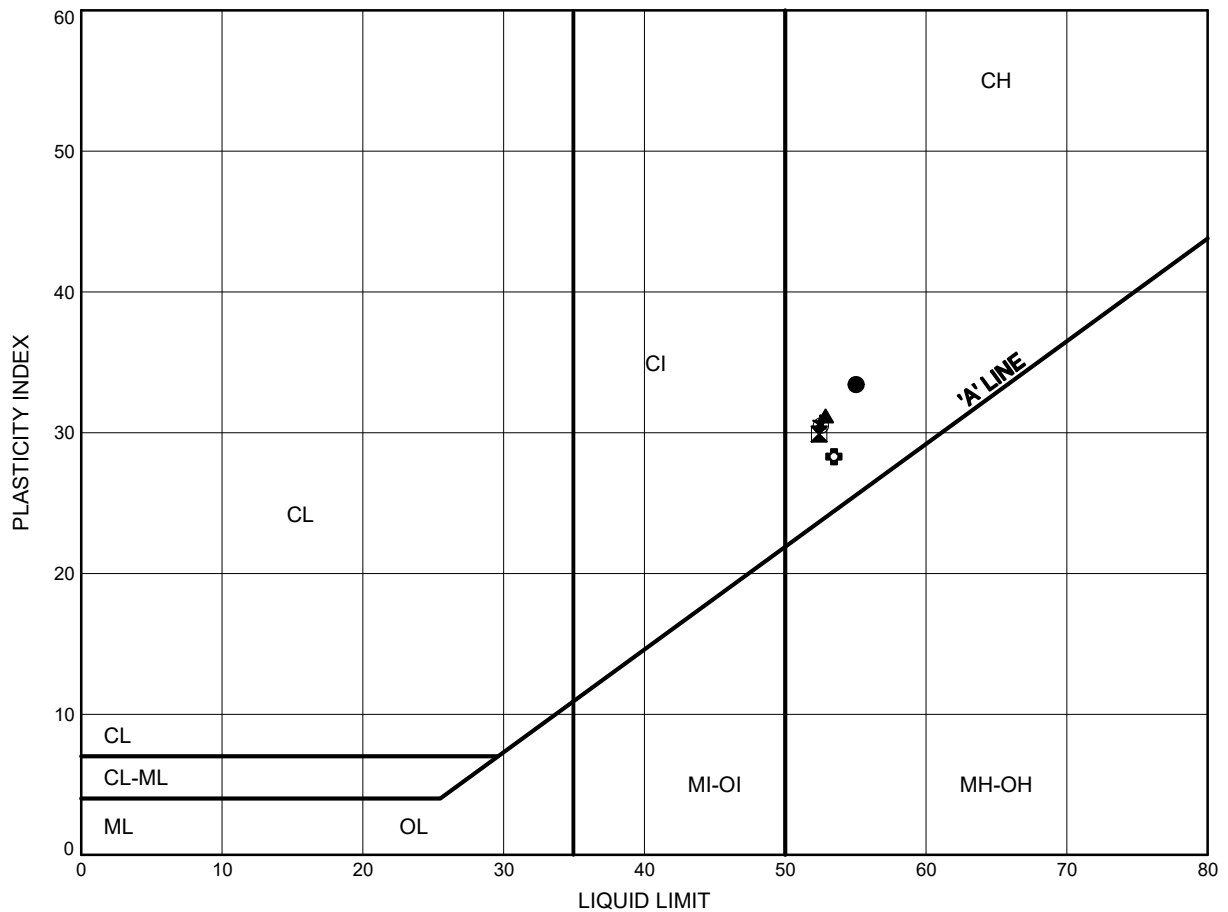


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B13

Silty CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-06	2.74	177.96
⊠	16-07	0.91	182.08
▲	16-07	2.13	180.86
★	16-08	0.91	178.58
⊙	16-09	2.13	175.76
⊕	16-10	0.91	180.48

Date August 2016
W.P. 2284-13-00

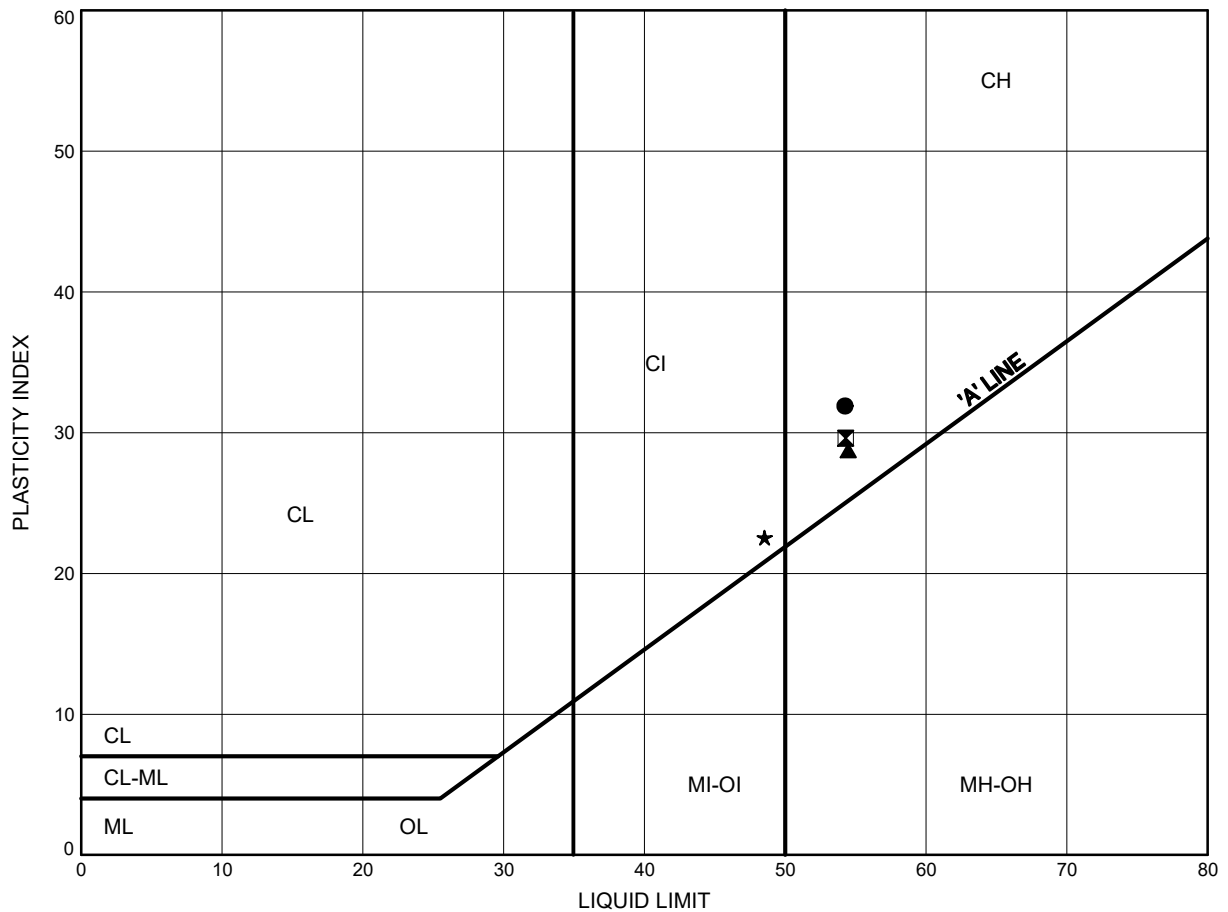


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B14

Silty CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-10	5.64	175.76
⊠	16-11	2.13	176.36
▲	16-12	0.91	176.18
★	16-13	2.74	177.66

Date August 2016
W.P. 2284-13-00

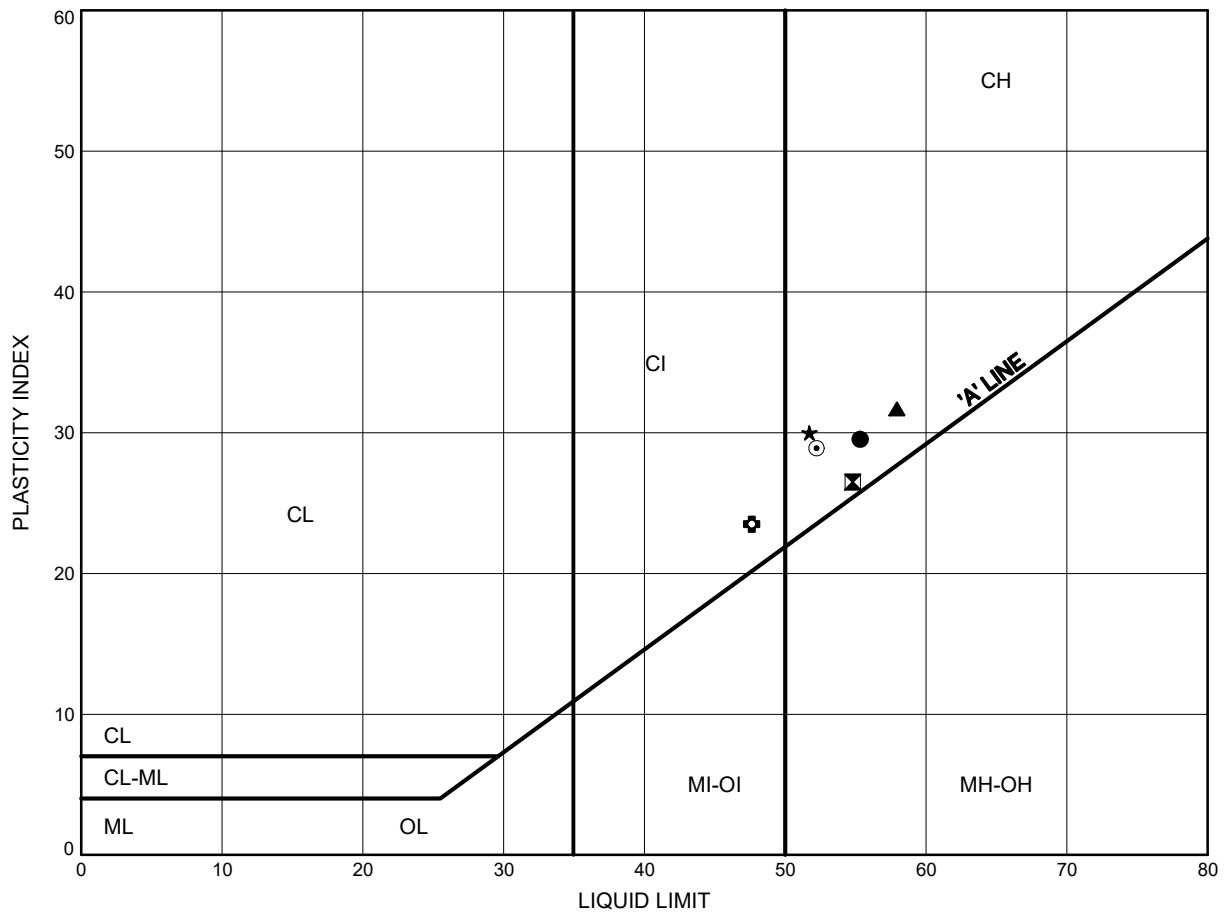


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B15

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-01	9.45	175.75
⊠	16-01	10.97	174.23
▲	16-04	10.97	174.23
★	16-07	7.92	175.07
⊙	16-08	4.88	174.62
⊕	16-09	4.11	173.78

Date August 2016
W.P. 2284-13-00

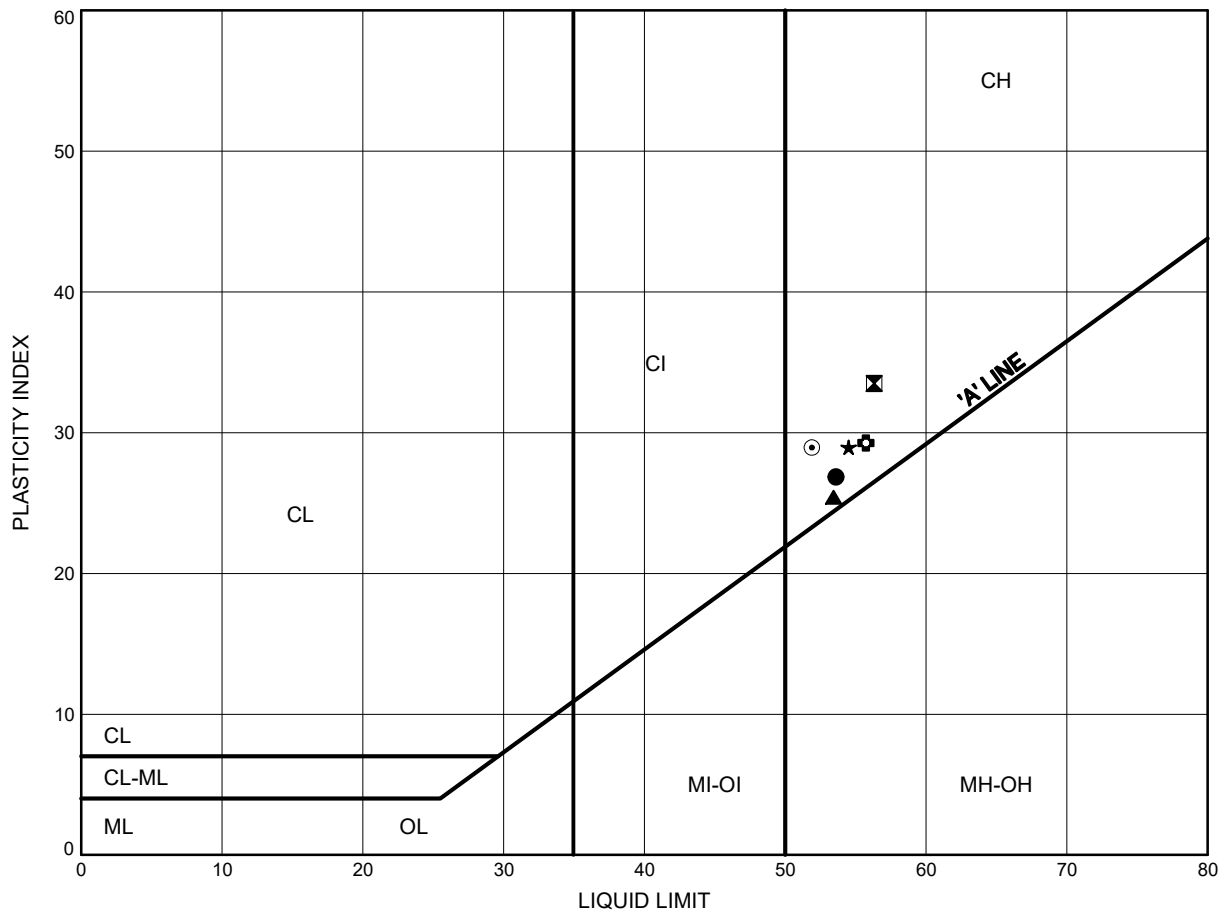


Prep'd AN
Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B16

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-11	4.11	174.38
⊠	16-12	3.35	173.75
▲	16-13	4.88	175.52
★	16-14	0.91	177.39
⊙	16-15	3.35	173.65
⊕	16-17	1.52	175.87

Date August 2016
 W.P. 2284-13-00

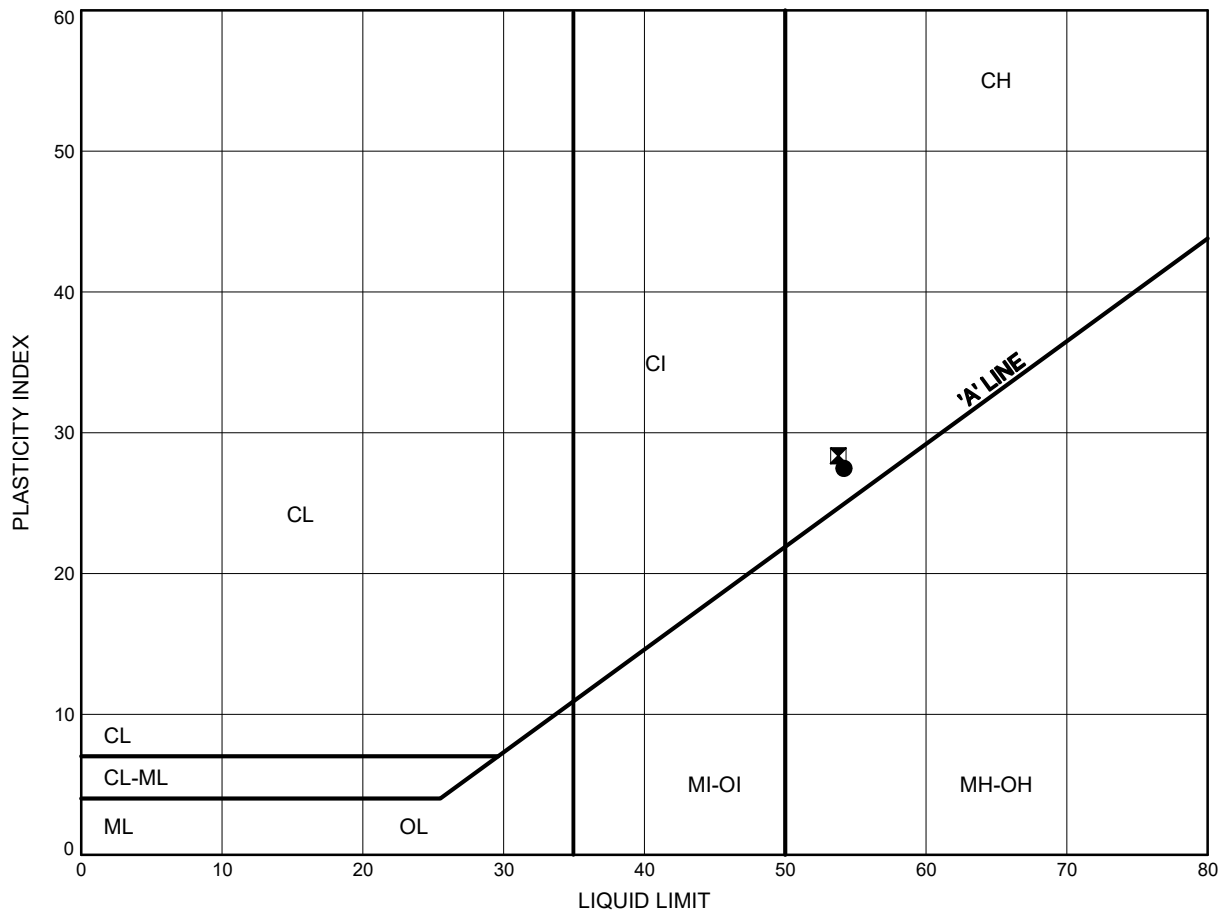


Prep'd AN
 Chkd. SKP

Highway 140 - South Embankment
ATTERBERG LIMITS TEST RESULTS

FIGURE B17

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-17	2.74	174.65
⊠	16-18	2.13	175.37

Date August 2016
W.P. 2284-13-00



Prep'd AN
Chkd. SKP



Appendix C

Selected Site Photographs



Photo 1 Sloughed Granular Materials on Upper Slope near Station 15+300 (east side)



Photo 2 Over-Steepened Slope at South Abutment (east side)



Photo 3 Asphalt Cracks on Road Shoulder near Station 15+500 (east side)



Photo 4 Gravel Shoulder and Guiderail (east side)



Photo 5 Gully at Slope Crest (east side)



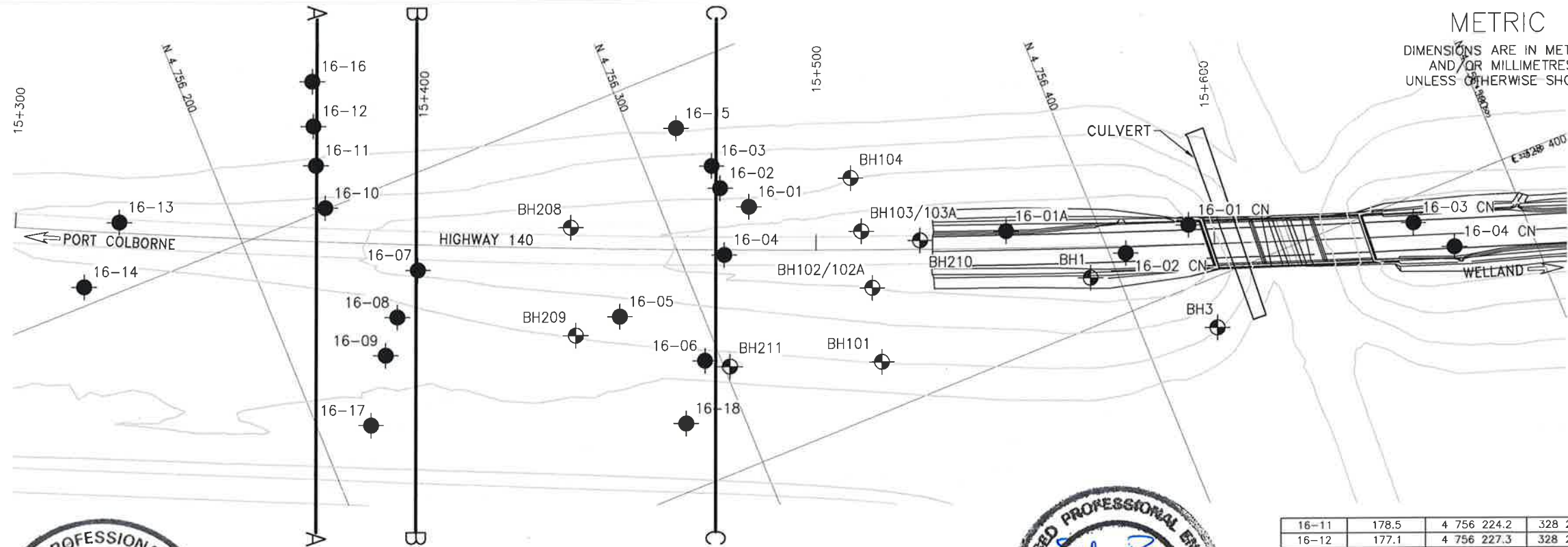
Photo 6 Overall South Embankment (looking easterly)



Appendix D

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



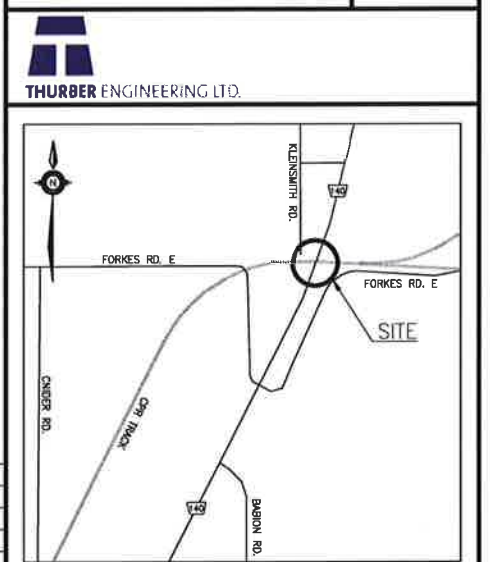
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

16-11	178.5	4 756 224.2	328 288.9
16-12	177.1	4 756 227.3	328 279.5
16-13	180.4	4 756 173.7	328 283.8
16-14	178.3	4 756 159.4	328 295.5
16-15	177.0	4 756 311.1	328 314.2
16-16	177.1	4 756 231.2	328 269.0
16-17	177.4	4 756 212.7	328 354.5
16-18	177.5	4 756 383.8	328 383.8

CONT No
GWP No 2284-13-00

HIGHWAY 140 EMBANKMENTS
OVER CNR OVERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP



KEYPLAN

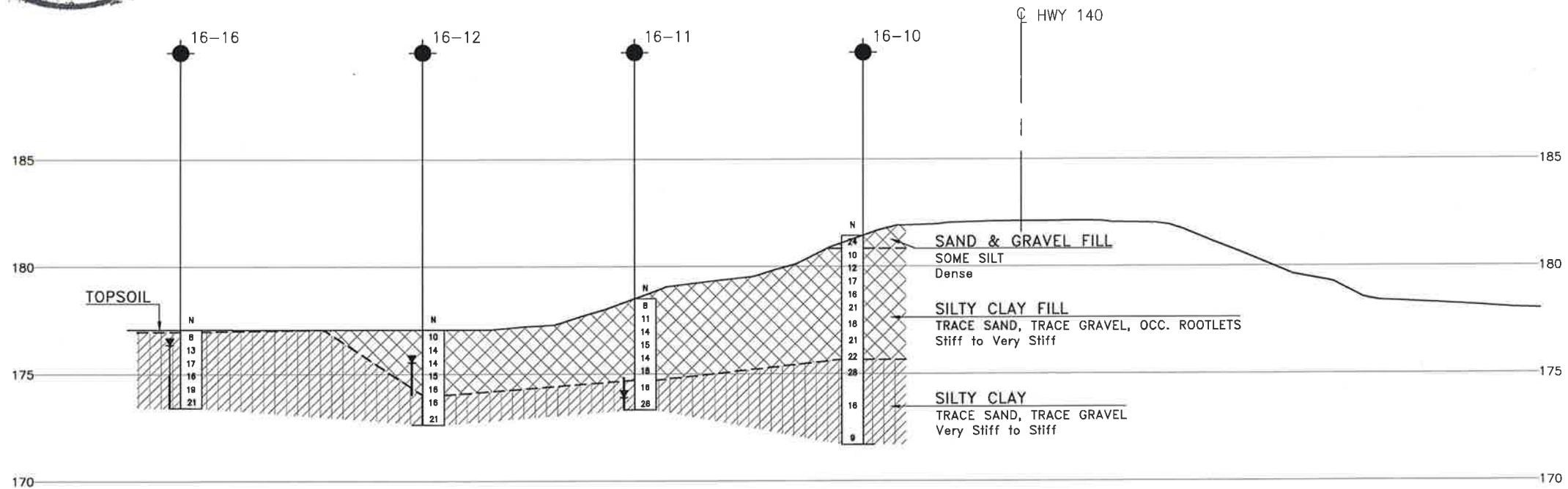
LEGEND

◆	Borehole (Current Investigation By Thurber)
◈	Borehole (Previous Investigation By Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60' Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
↑	Head Artesian Water
⊥	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
16-01 CN	187.0	4 756 421.1	328 385.3
16-02 CN	186.9	4 756 403.9	328 385.9
16-01A	186.5	4 756 378.2	328 369.4
16-01	185.2	4 756 320.7	328 339.4
16-02	183.2	4 756 315.8	328 332.3
16-03	180.8	4 756 315.9	328 326.3
16-04	185.2	4 756 310.5	328 348.2
16-05	183.4	4 756 280.4	328 352.7
16-06	180.7	4 756 196.1	328 371.0
16-07	183.0	4 756 238.1	328 322.8
16-08	179.5	4 756 228.9	328 331.9
16-09	177.9	4 756 222.7	328 339.7
16-10	181.4	4 756 222.4	328 299.7

- 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. 30L14-61



SECTION ALONG A-A
SCALE 1:250

REVISIONS	DATE	BY	DESCRIPTION
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			LOAD
			STRUCT
			DWG 2
			DATE DEC 2016

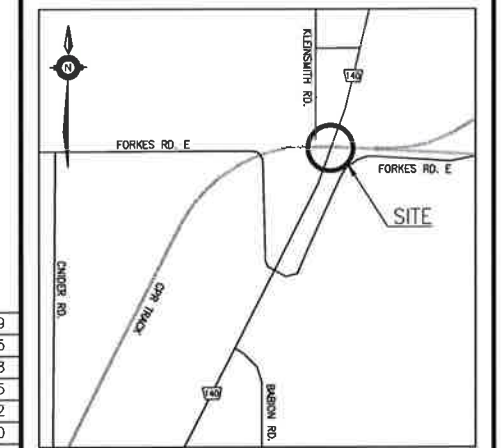
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PLOTDATE: 12/7/2016 10:05 AM

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

CONT No
GWP No 2284-13-00

HIGHWAY 140 EMBANKMENTS
OVER CNR OVERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

- Borehole (Current Investigation By Thurber)
- Borehole (Previous Investigation By Others)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
16-01 CN	187.0	4 756 421.9	328 383.2
16-02 CN	187.0	4 756 403.9	328 385.9
16-01A	186.5	4 756 378.2	328 369.4
16-01	185.2	4 756 320.7	328 339.4
16-02	183.2	4 756 315.8	328 332.3
16-03	180.8	4 756 315.9	328 326.3
16-04	185.2	4 756 310.5	328 348.2
16-05	183.4	4 756 280.4	328 352.7
16-06	180.7	4 756 196.1	328 371.0
16-07	183.0	4 756 238.1	328 322.8
16-08	179.5	4 756 228.9	328 331.9
16-09	177.9	4 756 222.7	328 339.7
16-10	181.4	4 756 222.4	328 299.7

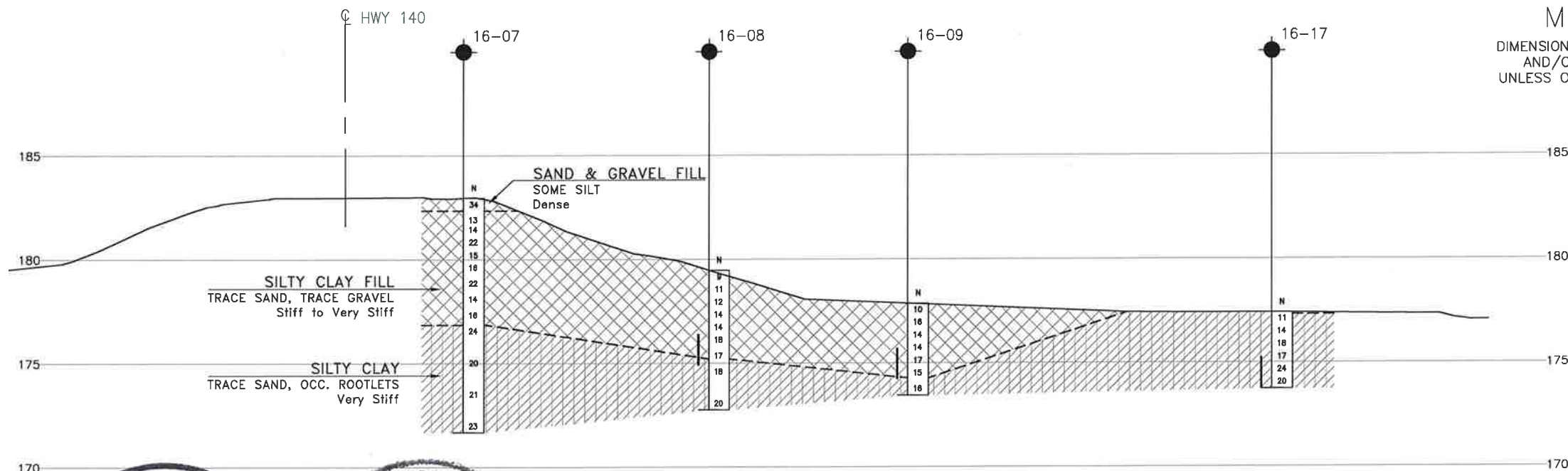
NOTES

- 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. 30L14-61

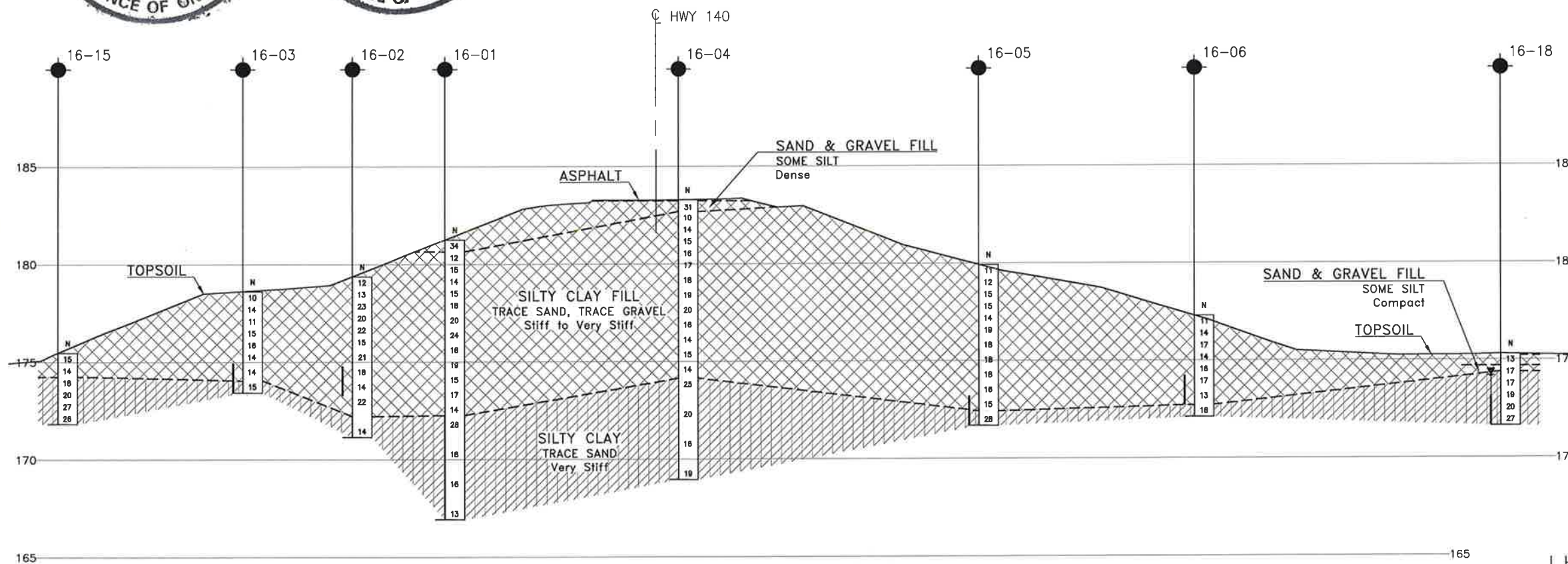
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			DATE
			DEC 2016
			DWG 3

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SECTION ALONG B-B

16-11	178.5	4 756 224.2	328 288.9
16-12	177.1	4 756 227.3	328 279.5
16-13	180.4	4 756 173.7	328 283.8
16-14	178.3	4 756 159.4	328 295.5
16-15	177.0	4 756 311.1	328 314.2
16-16	177.1	4 756 231.2	328 269.0
16-17	177.4	4 756 212.7	328 354.5
16-18	177.5	4 756 383.8	328 383.8



SECTION ALONG C-C

