



January 21, 2016

## FOUNDATION INVESTIGATION REPORT

### TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING FROM HIGHWAY 403/410 INTERCHANGE TO THE CREDIT RIVER CITY OF MISSISSAUGA, REGION OF PEEL G.W.P. 2150-01-00

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REPORT

**GEOCRES No. 30M12-394**

**Report No.: 10-1111-0211-12**

**Distribution:**

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## Table of Contents

### PART A – FOUNDATION INVESTIGATION REPORT

<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DESCRIPTION.....</b>	<b>1</b>
<b>3.0 INVESTIGATION PROCEDURES .....</b>	<b>1</b>
3.1 Current Investigations.....	1
3.2 Previous Investigations.....	2
3.3 Borehole Locations .....	2
<b>4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS .....</b>	<b>3</b>
4.1 Regional Geology .....	3
4.2 Subsurface Conditions.....	4
4.2.1 Culvert No. 3, Station 16+790.....	4
4.2.2 Culvert No. 5, Station 11+274 (Mavis Road).....	5
4.2.3 Culvert No. 6, Station 16+855.....	6
4.2.4 Culvert No. 9, Station 17+446.....	7
4.2.5 Culvert No. 10, Station 16+855.....	8
4.2.6 Culvert No. 11A, Station 11+456 (Mavis Road) .....	9
4.2.7 Culvert No. 12, Station 17+145.....	11
<b>5.0 CLOSURE.....</b>	<b>13</b>

### DRAWINGS

Drawing 1	Index Plan
Drawing 2	Culvert No. 3, Borehole Locations and Soil Strata
Drawing 3	Culvert No. 5, Borehole Locations and Soil Strata
Drawing 4	Culvert No. 6, Borehole Locations and Soil Strata
Drawing 5	Culvert No. 9, Borehole Locations and Soil Strata
Drawing 6	Culvert. No. 10, Borehole Locations and Soil Strata
Drawing 7	Culvert No. 11A, Borehole Locations and Soil Strata
Drawing 8	Culvert No. 12, Borehole Locations And Soil Strata



**APPENDICES**

Symbols and Abbreviations

**APPENDIX A**

Borehole Records and Laboratory Test Results      Culvert No. 3, Station 16+790

BH-2014-8A, TC15-4

Figure A1 to Figure A4

**APPENDIX B**

Borehole Records and Laboratory Test Results      Culvert No. 5, Station 11+274

BH-2014-9A, BH-2014-10A, MR-3, MR-3A, MR-4

Figure B1 to Figure B4-B

**APPENDIX C**

Borehole Records and Laboratory Test Results      Culvert No. 6, Station 16+855

BH-2014-8A, TC15-2, 237-2, 237-4, 237-6

Figure C1 to Figure C4

**APPENDIX D**

Borehole Records and Laboratory Test Results      Culvert No. 9, Station 17+446

TC15-8, TC15-9

Figure D1 to Figure D5

**APPENDIX E**

Borehole Records and Laboratory Test Results      Culvert No. 10, Station 16+855

TC15-1, TC15-3

Figure E1 to Figure E4

**APPENDIX F**

Borehole Records and Laboratory Test Results      Culvert No. 11A, Station 11+456

TC15-3, TC15-5, MR-1, MR-2

Figure F1 to Figure F9

**APPENDIX G**

Borehole Records and Laboratory Test Results      Culvert No. 12, Station 17+145

TC15-6, TC15-7

Figure G1 to Figure G4



## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by AECOM Canada Inc. (AECOM) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the proposed culverts construction associated with the widening of Highway 401 from the Highway 403/410 Interchange to the Credit River in the City of Mississauga, Region of Peel, Ontario.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal (RFP) dated October 5, 2010 and subsequent clarifications, and specifically in Golder Associates Ltd.'s (Golder's) revised scope change letter (Scope Change No. 11) dated October 7, 2015.

The Foundation Investigation for the trenchless methods of culvert installation conducted by Golder involved the advancement of 9 new boreholes along Highway 401 near Mavis Road, supplemented with boreholes advanced for other foundation components of this project (i.e., G.W.P. 2150-01-00) and existing relevant borehole information collected from the MTO GEOCRETS library. This report presents the subsurface conditions at the locations of seven culvert crossings.

## 2.0 SITE DESCRIPTION

The proposed trenchless crossing locations are located within the area at and around the existing Highway 401 and Mavis Road interchange. The west limit of the proposed new trenchless crossings is approximately 200 m west of Mavis Road, and the east limit is approximately 500 m east of Mavis Road.

The topography across the site adjacent to Highway 401 consists of gently undulating terrain which slopes downward to the west towards the Credit River. Vegetation within the right-of-way and the associated interchange loops is sparse, consisting of grass, small shrubs and occasional tree areas further east of the Mavis Road Interchange. Residential properties are present along the Highway 401 corridor west of Mavis Road and commercial facilities are located along Highway 401 east of Mavis Road.

Based on the information provided by AECOM, the proposed trenchless crossing locations are shown on Drawing 1.

## 3.0 INVESTIGATION PROCEDURES

### 3.1 Current Investigations

A total of nine boreholes (Boreholes TC15-1 to TC15-9) were drilled in November, 2015 as part of the site-specific geotechnical investigation program for the proposed trenchless crossing locations, using truck-mounted CME-75 and track-mounted CME-55 drill rigs supplied and operated Davis Drilling Inc. of Milton, Ontario. Use was also made of seven boreholes from earlier stages of Golder's investigation for the widening of Highway 401 (Boreholes BH-2014-8A, BH-2014-9A, BH-2014-10A, MR-1, MR-2, MR-3, MR-3A, and MR-4). The boreholes were generally advanced using 150 mm outside diameter solid stem augers or 108 mm inside diameter hollow stem augers, with soil samples obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (*ASTM D1586-08a, Standard Test Method for Standard Penetration Test*). The specific auger type



and diameter are indicated on the borehole records contained in Appendices A through G, organized by culvert location. The boreholes from the 2015 investigation were advanced to at least three tunnel diameters below the proposed culvert invert.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations. Standpipe piezometers were installed in Boreholes TC15-1, TC15-4, TC15-6, TC15-9, MR-1, MR-4, and 2014-9A; the details of the piezometer installation are shown on the applicable borehole records. All of the open boreholes were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended), with an asphalt patch placed at the highway surface.

The field work was supervised on a full-time basis by members of Golder's engineering staff who located the boreholes in the field, cleared all locations of underground utilities, directed the drilling, sampling and in situ testing operations, and logged the subsurface conditions. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits and grain size distribution were carried out on selected soil samples. The results of the testing program are presented on the Record of Borehole sheets and shown on the laboratory test figures, in Appendices A through G, by crossing location.

### 3.2 Previous Investigations

Three boreholes (Boreholes 237-2, 237-4, 237-6) from a previous investigation by others have been used in the preparation of this report, as follows:

**MTO GEOCREs No. 30M12-237:** Report titled "Foundation Investigation Report for Highway 401 – Mavis Road Underpass, City of Mississauga, MTO W.P. 311-89-00; Site No. 24-736", by Terraprobe, dated February 16, 1998

For this report, these three boreholes have been renamed to show the MTO GEOCREs 30M12-237 reference number followed by the original borehole designation. Therefore, the boreholes have been renamed as 237-X, where X is the original borehole number.

### 3.3 Borehole Locations

The borehole locations were recorded in the field by Golder personnel using a GPS-enabled Tablet connected to a Trimble GPS Booster device, with a horizontal accuracy of approximately 1.0 m. The borehole locations were further refined using local site features and by cross-referencing with the digital terrain models provided by AECOM. The ground surface elevation at each borehole location was estimated from the digital terrain model provided by AECOM. Due to recent construction activities on site, the provided digital terrain model was not considered valid for Boreholes TC15-3, TC15-4, and TC15-5. For these boreholes, the ground surface elevation at the borehole locations was surveyed using an auto-level and rod and tied into locations where the elevation could be estimated from the digital terrain model. The borehole locations (referenced to the MTM NAD83 coordinate system) and approximate ground surface elevations (referenced to Geodetic datum), as well as drilled depths, are provided on the Record of Borehole sheets and shown on Drawings 1 to 8, as summarized below.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

Culvert No. (Station)	Drawing No.	Borehole No.	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Drilled Depth (m)
3 (16+790)	2	TC15-4	4831055.8	287900.1	183.9	8.2
		2014-8A	4831083.8	287904.3	182.2	12.8
5 (11+274, Mavis Road)	3	2014-9A	4831109.3	288020.6	185.6	8.2
		2014-10A	4831175.3	288132.5	189.4	9.8
		MR-3	4831172.8	288079.3	194.6	18.3
		MR-3A	4831173.9	288078.3	194.6	30.9/32.6*
		MR-4	4831158.4	288051.0	195.4	31.1
6 (16+855)	4	TC15-2	4831179.8	287870.8	186.8	12.8
		2014-8A	4831083.8	287904.3	182.2	12.8
		237-2	4831216.8	287990.0	186.6	18.6
		237-4	4831198.6	288001.2	187.5	15.7
		237-6	4831177.4	288025.5	185.2	9.6
9 (17+446)	5	TC15-8	4831457.2	288444.0	189.6	8.2
		TC15-9	4831412.9	288452.3	189.6	8.2
10 (16+855)	6	TC15-1	4831248.9	287859.0	187.3	11.3
		TC15-3	4831238.8	287904.7	185.8	9.8
11A (11+456, Mavis Road)	7	TC15-3	4831238.8	287904.7	185.8	9.8
		TC15-5	4831301.4	288003.9	185.8	8.2
		MR-1	4831249.0	287997.7	194.7	25.2/26.5*
		MR-2	4831239.6	287971.8	195.1	37.2/39.0*
12 (17+145)	8	TC15-6	4831376.5	288156.4	188.4	8.2
		TC15-7	4831351.4	288147.9	189.9	11.3

\*The greater depth represents the bottom of the DCPT (driven from the bottom of the borehole)

The locations of the boreholes from the previous investigation are shown on Drawings 1 and 4 and a copy of the borehole records are presented in Appendix C corresponding to Culvert No. 6.

## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

This section of Highway 401 is located within the Peel Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)<sup>1</sup>.

The Peel Plain physiographic region covers the central portions of the Regional Municipalities of York, Peel and Halton. The general topography of this region consists of level to gently rolling terrain, sloping down gradually

<sup>1</sup> Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P. 2715, Scale 1:600,000.



southward toward Lake Ontario. A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till, which is mapped in this area as the Halton Till, typically consists of clayey silt to silty clay, with occasional sand to silt zones. Shallow, localized deposits of loose sand, silt and/or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial meltwater ponds scattered throughout the Peel Plain and concentrated near river valleys. The recent sand, silt and clay and uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay. The study area, in the western portion of the Peel Plain, is underlain by grey shale of the Georgian Bay Formation which contains limestone layers.

## **4.2 Subsurface Conditions**

The subsurface models at the trenchless crossing locations have been developed based on the results of nine boreholes drilled as part of the 2015 investigation, eight boreholes completed as part of 2012 and 2014 investigations by Golder for the same project, and three boreholes advanced as part of a previous study by others.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the borehole records and laboratory test figures contained in Appendices B through G. These Appendices are organized by proposed crossing location, in order of culvert number.

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profiles on Drawings 2 to 8 are inferred from observations of drilling progress and from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions at the proposed crossing locations consist of asphalt and sand and gravel to gravelly sand road base fill associated with the existing Highway 401 or ramp pavements, underlain by embankment fill materials of variable composition, in places underlain by a thin clayey silt to silty clay deposit. The fill materials and near surface cohesive deposits at each culvert alignment are underlain by a glacial till deposit, which is typically comprised of clayey silt, grading from a sandy clayey silt to a clayey silt with sand.

Although there was no indication of the presents of cobbles and/or boulders in most boreholes during drilling, glacial till deposits in southern Ontario typically contain such materials and should be expected within such glacial deposits, especially near the bedrock interface.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

### **4.2.1 Culvert No. 3, Station 16+790**

The proposed Culvert No. 3 is located on the Highway 401 to Mavis Road W-N/S Ramp at Station 16+790. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 183.9 m. Boreholes TC15-4 and BH-2014-8A were advanced at this location (see Drawing 2) to a depth of 8.2 m and 12.8 m below ground surface (Elevations 175.7 m and 169.4 m).



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

Based on Boreholes TC15-4 and BH-2014-8A, the subsoil conditions consist of: asphalt underlain by cohesive and non-cohesive fill; underlain by native clayey silt till.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix A.

**Boreholes TC15-4 and BH-2014-8A**

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	183.9-183.8	0.1	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (compact to dense)	183.8-181.5	0.7-0.8	11 and 43	-	-	-	-	-
<b>Cohesive Fill</b> (firm to very stiff)	183.0-180.2	2.6	8 to 16	13 to 14	15	30	15	A1; and A2
<b>Silty Clay</b> (firm to stiff)	181.5-180.0	1.5	7 and 10	16	-	-	-	-
<b>Clayey Silt to Sandy Clayey Silt to Clayey Silt with Sand (Till)</b> (stiff to hard)	180.2-169.4**	4.5**-10.6**	10 to 35	9 to 17	13 to 14	20 to 25	7 to 11	A3; and A4

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer

### 4.2.2 Culvert No. 5, Station 11+274 (Mavis Road)

The proposed Culvert No. 5 is located on Mavis Road south of Highway 401 at Station 11+274. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 194.5 m. Boreholes BH-2014-9A, MR-4, MR-3, MR-3A, and BH-2014-10A were advanced at this location (see Drawing 3) to depths between 8.2 m and 32.6 m below ground surface (between Elevations 179.7 m and 162.0 m).

Based on Boreholes BH-2014-9A, MR-4, MR-3, MR-3A, and BH-2014-10A, the subsoil conditions consist of: asphalt underlain by cohesive fill; underlain by native clayey silt till. In Borehole MR-3 a boulder was cored through from a depth of 15.3 m to 15.9 m (Elevation 179.3 to 178.7 m) and the presence of cobbles is also inferred from auger grinding in Borehole MR-4.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix B.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

### Boreholes BH-2014-9A, MR-4, MR-3, MR-3A, and BH-2014-10A

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Non-Cohesive Fill</b>	195.2-194.6	0.6	-	-	-	-	-	-
<b>Cohesive Fill</b> Inferred Cobbles Present (soft to very stiff)	194.6-183.8	0.7-10.8	4 to 36	8 to 16	15 to 17	25 to 34	10 to 19	B1; and B2
<b>Sandy Clayey Silt to Clayey Silt with Sand (Till)</b> Boulder and Inferred Cobbles Present (stiff to hard)	188.7-162.0**	7.6**-19.5**	13 to 93	8 to 24	11 to 17	18 to 28	6 to 13	B3-A, B3-B; and B4-A, B4-B

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer

### 4.2.3 Culvert No. 6, Station 16+855

The proposed Culvert No. 6 is located on Highway 401 at Station 16+855. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 184.5 m. Boreholes TC15-2, BH-2014-8A, 237-2, 237-4, and 237-6 were advanced at this location (see Drawing 4) to depths between 9.6 m and 18.6 m below ground surface (between Elevations 187.5 and 182.2).

Based on Boreholes TC15-2, BH-2014-8A, 237-2, 237-4, 237-6, the subsoil conditions consist of: asphalt underlain by cohesive and non-cohesive fill; underlain by native clayey silt till.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix C.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

### Boreholes TC15-2, BH-2014-8A, 237-2, 237-4, and 237-6

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)*	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	187.5-187.3	0.2	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (compact to very dense)	187.3-181.5	0.2-2.5	11 and 34; and 50 blows per 0.05 m of penetration	***	-	-	-	-
<b>Cohesive Fill</b> (firm to very stiff)	186.9-180.0	1.5-4.6	8 to 20	10 to 18***	20 ***	38***	18***	C1; and C2
<b>Silty Clay</b> (very stiff)	181.5-180.0 and 178.0-176.5	1.5	19	16***	-	-	-	-
<b>Silty Clay to Clayey Silt to Sandy Clayey Silt to Clayey Silt with Sand (Till)</b> (stiff to hard)	185.4-168.0**	8.2**-16.1**	9 to 91; and 85 blows per 0.25 m of penetration to 85 blows per 0.2 m of penetration	11 to 12***	13 to 14***	21 to 25***	8 to 11***	C3; and C4

\*Blows per 0.3 m of penetration unless otherwise noted

\*\*Deposit/layer information limited to the termination of borehole(s) within deposit/layer

\*\*\*Refer to Record of Boreholes in Appendix C for additional lab testing by others

#### 4.2.4 Culvert No. 9, Station 17+446

The proposed Culvert No. 9 is located on Highway 401 at Station 17+446. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 189.6 m. Boreholes TC15-8 and TC15-9 were advanced at this location (see Drawing 5) to a depth of 8.2 m below ground surface (Elevations 181.3 m and 181.4 m).

Based on Boreholes TC15-8 and TC15-9, the subsoil conditions consist of: asphalt underlain by non-cohesive and cohesive fill; underlain by native clayey silt till.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix D.



# FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

## Boreholes TC15-8 and TC15-9

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	189.6-189.5	0.1	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (loose to dense)	189.5-188.7	0.8	26 and 42	4	-	-	-	D1
<b>Cohesive Fill</b> (firm to stiff)	188.7-186.6	1.3-2.1	6 to 12	15-19	15 to 18	32 to 38	16 to 20	D2; and D3
<b>Sandy Clayey Silt to Clayey Silt with Sand Till</b> (stiff to hard)	187.3-181.4**	5.2**-6.0**	11 to 40	9-14	13 to 15	20 to 25	7 to 10	D4; and D5

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer

### 4.2.5 Culvert No. 10, Station 16+855

The proposed Culvert No. 10 is located on the Mavis Road to Highway 401 N-W Ramp at Station 16+855. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 187.3 m. Boreholes TC15-1 and TC15-3 were advanced at this location (see Drawing 6) to a depth of 11.3 m and 9.8 m below ground surface (Elevations 176.0 m ).

Based on Boreholes TC15-1 and TC15-3, the subsoil conditions consist of: asphalt underlain by non-cohesive and cohesive fill; underlain by native clayey silt till.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix E.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

### Boreholes TC15-1 and TC15-3

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)*	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	187.3-187.2	0.1	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (dense)	187.2-186.5	0.7	35	-	-	-	-	-
<b>Cohesive Fill</b> (firm to very stiff)	186.5-181.2	4.5-5.3	7 to 26	9 to 13	15 to 18	29 to 30	11 to 14	E1; and E2
<b>Sandy Clayey Silt to Clayey Silt with Sand Till</b> (firm to very stiff)	181.3-176.0**	5.2**-5.3**	8 to 26	11 to 12	13 to 16	20 to 26	7 to 10	E3; and E4

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer

### 4.2.6 Culvert No. 11A, Station 11+456 (Mavis Road)

The proposed Culvert No. 11A is located on Mavis Road north of Highway 401 at Station 11+456. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 192.5 m. Boreholes TC15-3, TC15-5, MR-1, and MR-2 were advanced near this location (see Drawing 7) to depths between 8.2 m and 39.0 m below ground surface (Elevations 177.6 and 156.1 m).

Based on Boreholes TC15-3, TC15-5, MR-1, and MR-2, the subsoil conditions consist of: asphalt underlain by non-cohesive and cohesive fill; underlain by a layer of silty clay to clayey silt in places; clayey silt till; and layers of silty clay, silty sand and gravel, sand and silt till, and sand and gravel.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix F.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

### Boreholes TC15-3, TC15-5, MR-1, and MR-2

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	195.1-194.5	0.2	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (loose to dense)	194.9-193.9	0.6	-	-	-	-	-	-
<b>Cohesive Fill</b> (firm to hard)	194.3-181.3	2.1-9.9	6 to 45	7 to 17	15 to 20	26 to 35	11 to 16	F1; and F2
<b>Clayey Silt to Silty Clay</b> (stiff to very stiff)	184.4-183.1	0.9	14 and 22	13 and 18	18	43	25	F3; and F4
<b>Sandy Clayey Silt to Clayey Silt with Sand Till</b> (firm to hard)	183.6-168.0	5.3*-15.5	8 to 116; and 89 blows per 0.23 m of penetration	8 to 12	11 to 16	20 to 30	7 to 14	F5; F6-A, and F6-B
<b>Silty Clay</b> (hard)	168.0-167.4	0.6	39	27	-	-	-	-
<b>Silty Sand and Gravel</b> (dense)	167.4-166.4	1.0	39	-	-	-	-	-
<b>Sand and Silt Till</b> (compact to very dense)	166.4-159.1	7.3	29 to 64	9	13	17	4	F7; and F8
<b>Sand and Gravel</b> (compact)	159.1-156.1**	3.0**	11	6	-	-	-	F9

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer and includes 1.8 m of DCPT.



**4.2.7 Culvert No. 12, Station 17+145**

The proposed Culvert No. 12 is located on the Highway 401 to Mavis Road E-N/S Ramp at Station 17+145. The existing ground surface in the vicinity of the proposed culvert location is at about Elevation 189.6 m. Boreholes TC15-6 and TC15-7 were advanced at this location (see Drawing 8) to a depth of 8.2 m and 11.3 m below ground surface (Elevations 180.2 and 178.6 m).

Based on Boreholes TC15-6 and TC15-7, the subsoil conditions consist of: asphalt underlain by non-cohesive and cohesive fill; underlain by native clayey silt till.

A summary of the major stratigraphic units, including laboratory test results, are presented below. Record of Borehole sheets and laboratory test results are presented in Appendix G.

**Boreholes TC15-6 and TC15-7**

Stratigraphic Unit (Consistency or Relative Density)	Top Elevation - Bottom Elevation (m)	Thickness (m)	In Situ Testing Results	Laboratory Testing Results				
			SPT 'N'-values*	Moisture Content (%)	Atterberg Limits			Grain Size Distribution; and Atterberg Limits Figures
					Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	
<b>Asphalt</b>	189.9-189.7	0.2	-	-	-	-	-	-
<b>Non-Cohesive Fill</b> (compact)	189.7-189.1	0.6	23	4	-	-	-	-
<b>Cohesive Fill</b> (firm to stiff)	189.1-186.9	0.6-2.2	7-13	14	16	32	16	G1; and G2
<b>Clayey Silt to Sandy Clayey Silt Till</b> (stiff to hard)	187.7-178.6***	7.5**-8.3**	11-59	10 to 13	13 to 15	21 to 28	8 to 13	G3; and G4

\*Blows per 0.3 m of penetration unless otherwise noted

\*\* Deposit/layer information limited to the termination of borehole(s) within deposit/layer

**4.3 Groundwater Conditions**

The water levels were observed in the open boreholes immediately following completion of drilling, and the depth to water level measurements are recorded on the borehole records contained in Appendices A through G. Additionally, piezometers were installed in Boreholes TC15-1, TC15-4, TC15-6, TC15-9, MR-1, MR-4, 2014-9A, and 237-2 from the previous investigation, the details of which are presented in the corresponding Record of Borehole sheets. It should be noted that details of the piezometer installation in Borehole 237-2 is not provided on the Record of Borehole sheet or the report but the water level information is provided and is included in the summary below.



## FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

The water levels immediately following the completion of drilling and as measured in the piezometers at a later date, is summarized below.

Culvert No. (Station)	Borehole No.	Ground Surface Elevation (m)	Borehole Depth (m)	Depth to Water Level Below Ground Surface (m)	Water Level Elevation (m)	Date
3 (16+790)	TC15-4	183.9	8.2	Dry* 2.6** 2.7**	- 181.3 181.2**	- Nov. 19, 2015 Dec. 16, 2015
	2014-8A	182.2	12.8	Dry*	-	Dec. 15, 2015
5 (11+274, Mavis Road)	2014-9A	185.6	8.2	7.2* 0.8** 1.4**	178.4 184.8** 184.2**	Dec. 16, 2014 June 30, 2015 Dec. 16, 2015
	2014-10A	189.4	9.8	9.4*	180*	Dec. 15, 2014
	MR-3	194.6	18.3	Dry to 15.3m***	-	May 30, 2012
	MR-3A	194.6	30.9	***	-	-
	MR-4	195.4	31.1	21.3* 18.6 to 18.3**	174.1 176.8 to 177.1**	May 28, 2012 May 30 to Nov. 5, 2012
	TC15-2	186.8	12.8	Dry*	-	Nov. 9, 2015
6 (16+835)	2014-8A	182.2	12.8	Dry*	-	Dec. 15, 2015
	237-2	186.6	18.6	8.5* 9.8**	178.1* 176.8**	Dec. 18, 1997 Jan. 8, 1998
	237-4	187.5	15.7	Dry*	-	Dec. 16, 1997
	237-6	185.2	9.6	8.6*	176.6*	Dec. 15, 1997
	TC15-8	189.5	8.2	Dry*	-	Nov. 4, 2015
9 (17+446)	TC15-9	189.6	8.2	Dry* 5.5** 2.2**	- 184.1** 187.4**	Nov. 2, 2015 Nov. 19, 2015 Dec. 16, 2015
	TC15-1	187.3	11.3	10.4* 5.4** 5.3**	176.9* 181.9** 182.0**	Nov. 4, 2015 Nov. 19, 2015 Dec. 15, 2015
10 (16+855)	TC15-3	185.8	9.8	Dry*	-	Nov. 9, 2015
11A (11+456, Mavis Road)	TC15-3	185.8	9.8	Dry*	-	Nov. 9, 2015
	TC15-5	185.8	8.2	Dry*	-	Nov. 9, 2015
	MR-1	194.7	25.2	Dry to 18.0 m*** 10.4 to 10.1**	- 184.3 to 184.6**	June 7, 2012 Aug. 10 to Nov. 5, 2012
	MR-2	195.1	37.2	19.8***	175.3	May 22, 2015
12 (17+145)	TC15-6	188.4	8.2	Dry* 3.4**	- 185**	Nov. 5, 2015 Nov. 19, 2015
	TC15-7	189.9	11.3	Dry*	-	Nov. 5, 2015

\* Water level was obtained upon completion of drilling, water level measured at start of work day.

\*\* Water level was obtained from piezometer reading.

\*\*\*Water level was not recorded upon completion of drilling



# FOUNDATION REPORT - TRENCHLESS CROSSINGS HIGHWAY 401 WIDENING

Groundwater levels provided from measurements taken during or immediately after completion of drilling operations may not represent the stabilized groundwater levels at the site(s).

Groundwater levels in the area are subject to seasonal fluctuations and variations due to precipitation events. Although typically not encountered during drilling and generally not indicated on the existing borehole records prepared by others, "perched" groundwater conditions are expected within the fill soils, above the cohesive till.

## 5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Alex Szot, EIT, and reviewed by Mr. Kevin Bentley, P.Eng., a geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., a Principal of Golder and a Designated MTO Foundations Contact for Golder, conducted an independent review of this report.

**GOLDER ASSOCIATES LTD.**

Alex Szot, EIT  
Geotechnical Engineer In Training



Kevin J. Bentley, P.Eng.  
Geotechnical Engineer, Associate



Jorge M. A. Costa, P.Eng.  
Designated MTO Foundations Contact, Principal

AJS/KJB/JMAC/SJB/sm

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\\golder.gds\gal\mississauga\active\2010\1111\10-1111-0211 aecom-hwy 401 widening-mississauga\9 - reports\12 - trenchless crossings\final\10-1111-0211 fir 2016-1-20 trenchless crossings.docx

**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



HIGHWAY 401  
CULVERTS  
INDEX PLAN

SHEET



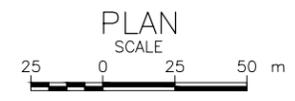
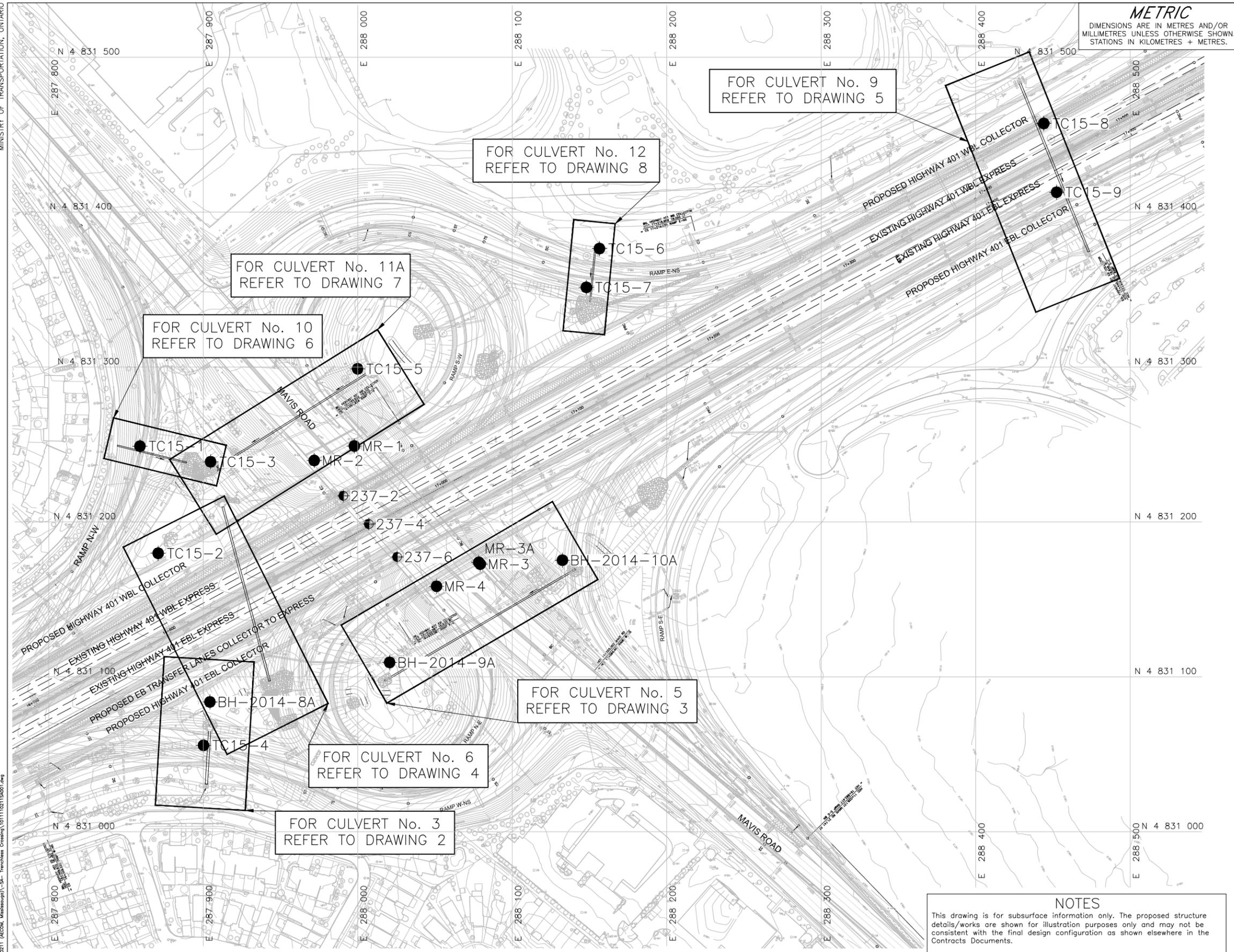
KEY PLAN  
SCALE  
1.5 0 1.5 3 km

**LEGEND**

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation (Terraprobe, 1998)

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
237-2	186.6	4831216.8	287990.7
237-4	187.5	4831198.6	288007.2
237-6	185.2	4831177.4	288025.5
BH-2014-8A	182.2	4831083.8	287904.3
BH-2014-9A	185.6	4831109.3	288020.6
BH-2014-10A	189.4	4831175.3	288132.5
MR-1	194.7	4831249.0	287997.7
MR-2	195.1	4831239.6	287971.8
MR-3	194.6	4831172.8	288079.3
MR-3A	194.6	4831173.9	288078.3
MR-4	195.4	4831158.4	288051.0
TC15-1	187.3	4831248.9	287859.0
TC15-2	186.8	4831179.8	287870.8
TC15-3	185.8	4831238.8	287904.7
TC15-4	183.9	4831055.8	287900.1
TC15-5	185.8	4831298.8	287999.8
TC15-6	188.4	4831376.5	288156.4
TC15-7	189.9	4831351.4	288147.9
TC15-8	189.6	4831457.2	288444.0
TC15-9	189.6	4831412.9	288452.3



**NOTES**

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**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos. X-60213979-C-BA-HWY401\_MAVIS.dwg, X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg, received December 1, 2015, 10cmContours.dwg, received December 21, 2015 and X-60213979-C-DE-HWY401\_MAVIS\_Add4.dwg, received January 19, 2016.

NO.	DATE	BY	REVISION

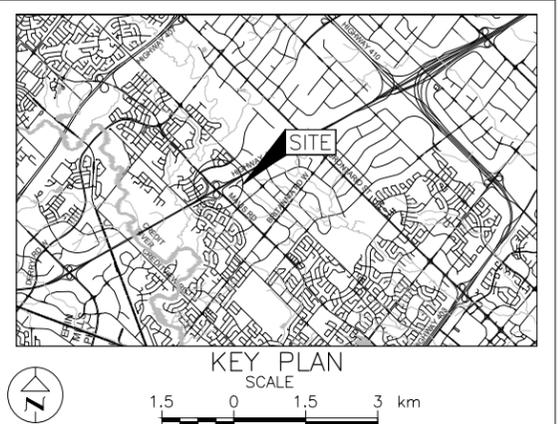
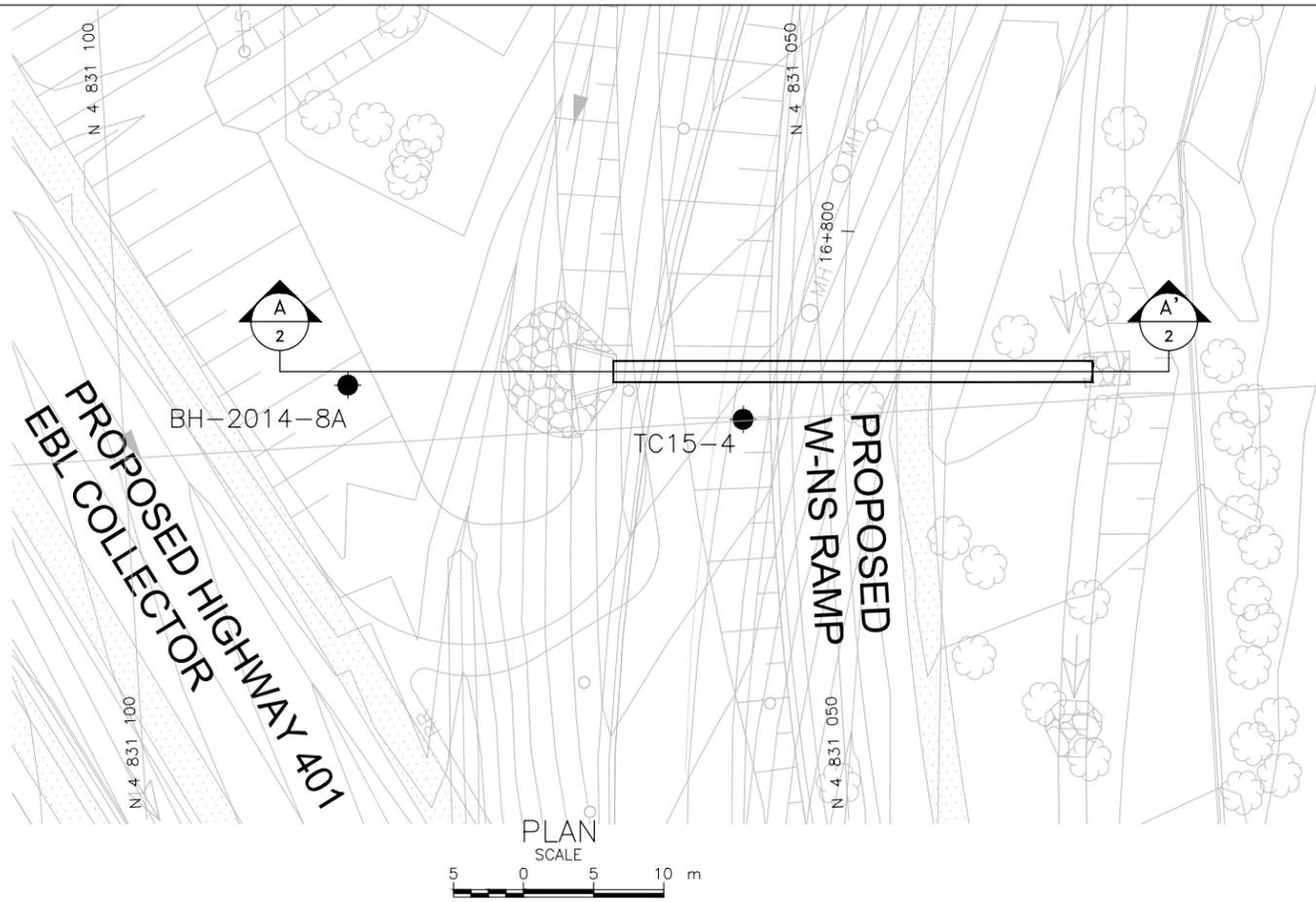
Geocres No. **30M12-394**

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		DWG. 1

**METRIC**  
 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00  
 HIGHWAY 401  
 CULVERT NO. 3  
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

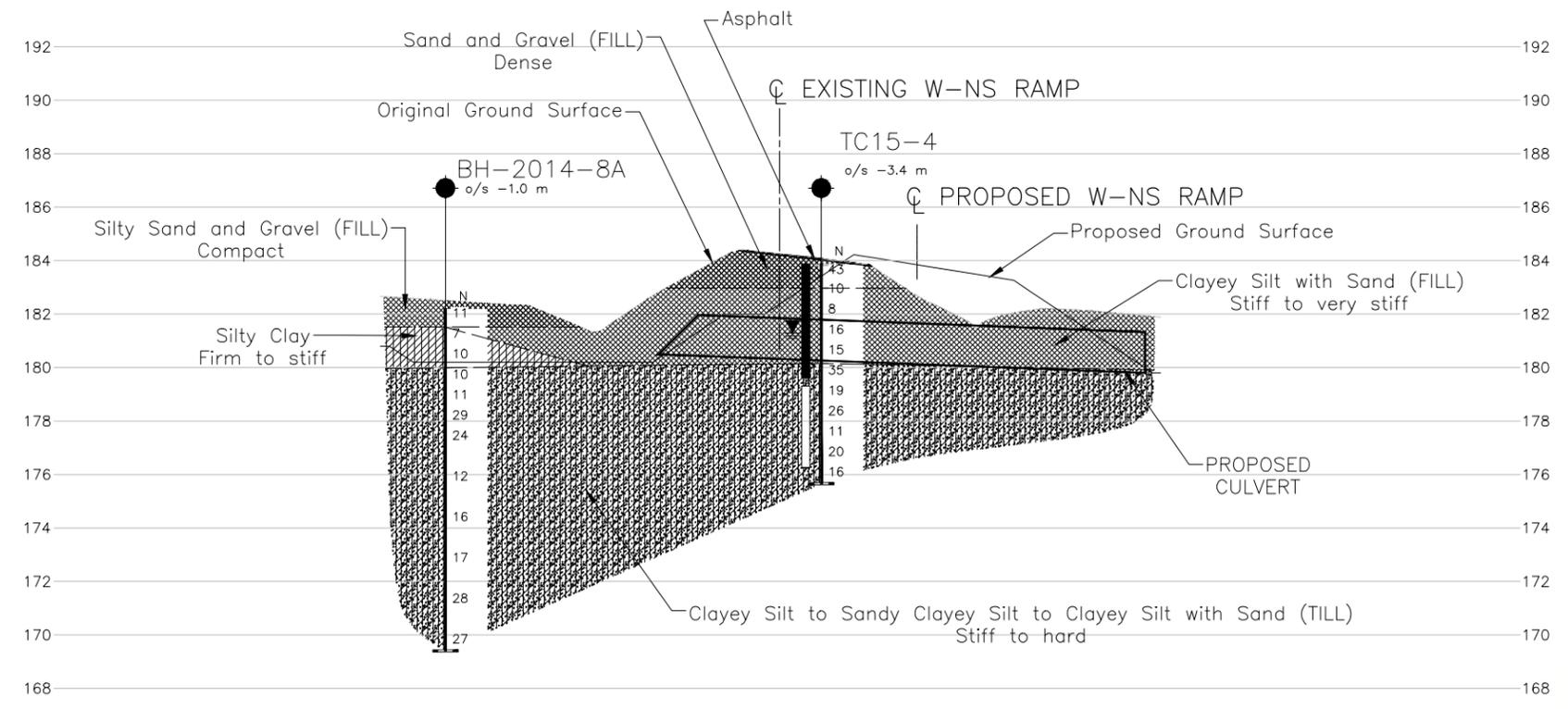


**LEGEND**

- Borehole - Current Investigation
- ⊥ Seal
- ▭ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on December 16, 2015

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
BH-2014-8A	182.2	4831083.8	287904.3
TC15-4	183.9	4831055.8	287900.1



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**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos. X-60213979-C-BA-HWY401\_MAVIS.dwg, X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg and 60213979\_CT-SMP-MAVIS401-RT-1.dwg received December 1, 2015 and 10cmContours.dwg, received December 21, 2015.

**CULVERT No. 3 PROFILE**  
 STATION 16+790

VERTICAL SCALE: 0 to 5 m  
 HORIZONTAL SCALE: 0 to 10 m

NO.	DATE	BY	REVISION

Geocres No. 30M12-394

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG. 2

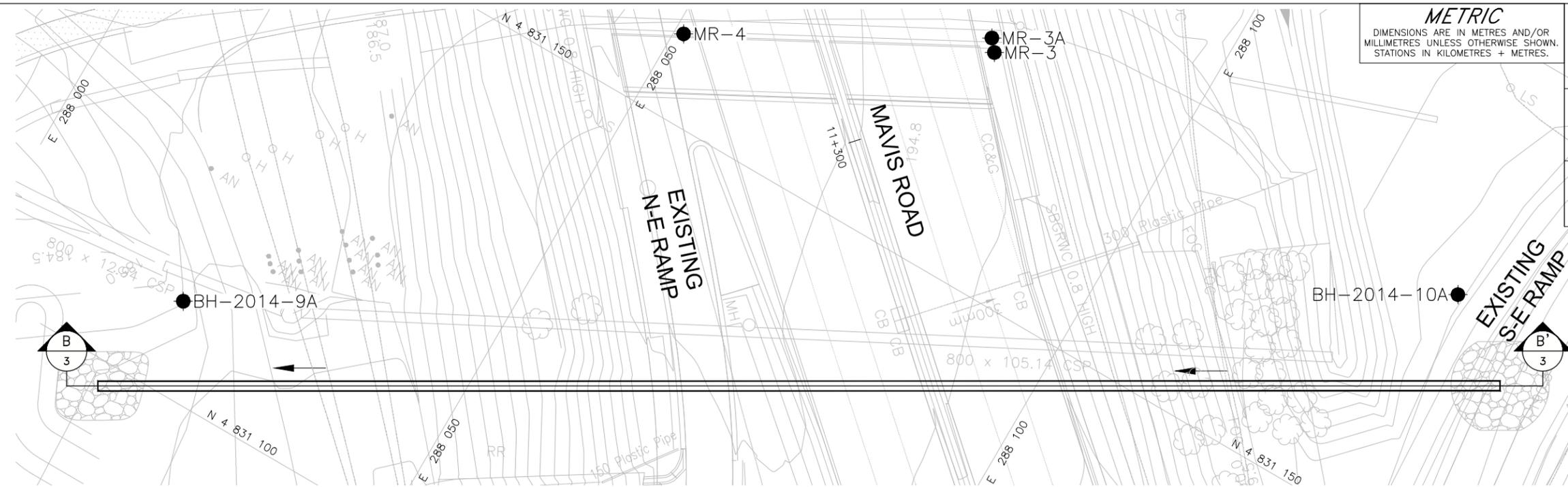
**METRIC**  
 DIMENSIONS ARE IN METRES AND/OR  
 MILLIMETRES UNLESS OTHERWISE SHOWN.  
 STATIONS IN KILOMETRES + METRES.

CONT No.  
 GWP No. 2150-01-00



HIGHWAY 401  
 CULVERT NO. 5  
 BOREHOLE LOCATIONS AND  
 SOIL STRATA

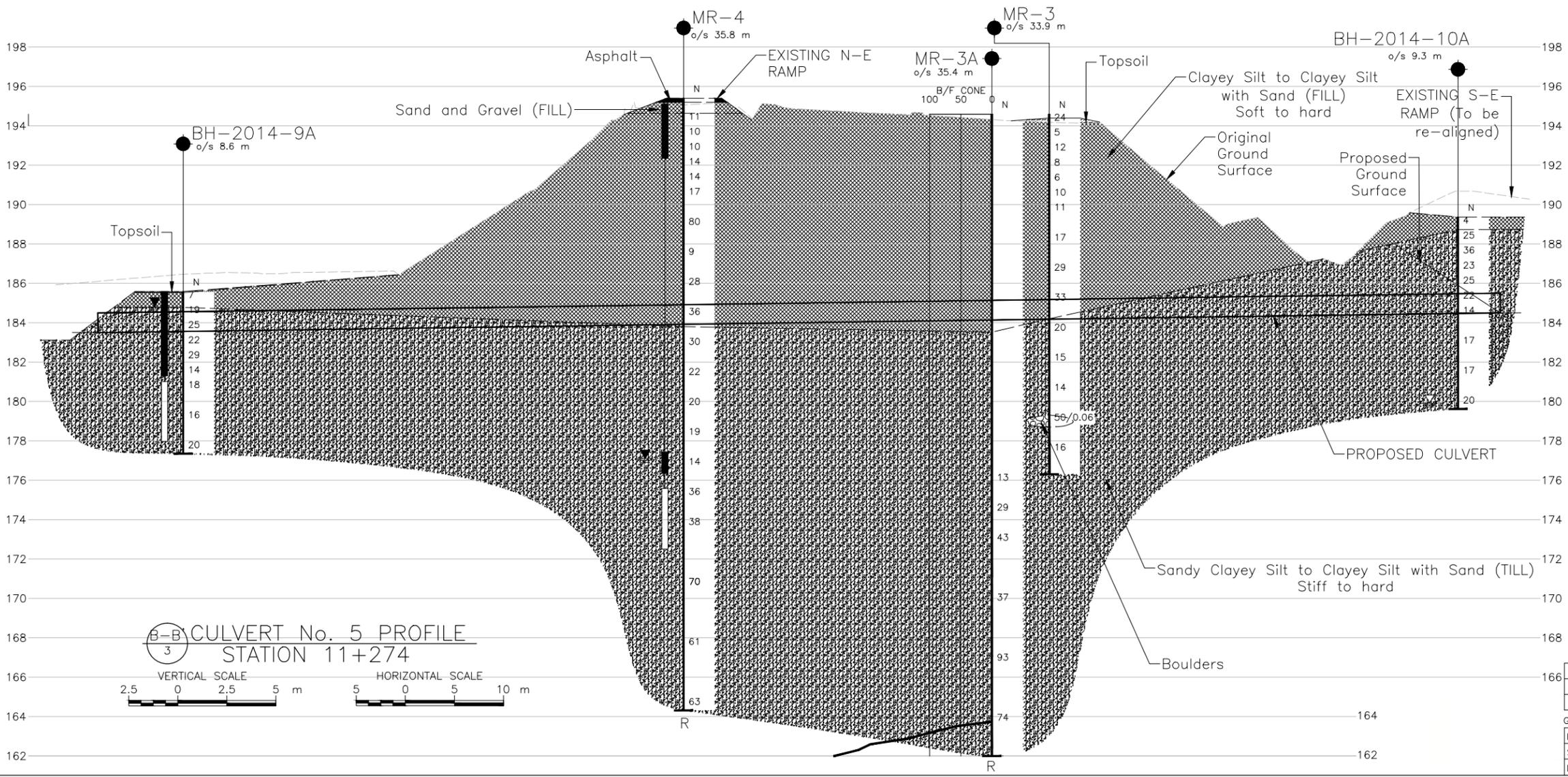
SHEET



PLAN  
 SCALE  
 5 0 5 10 m



KEY PLAN  
 SCALE  
 1.5 0 1.5 3 km



**B-B CULVERT No. 5 PROFILE**  
 STATION 11+274  
 VERTICAL SCALE  
 2.5 0 2.5 5 m  
 HORIZONTAL SCALE  
 5 0 5 10 m

LEGEND

- Borehole - Current Investigation
- ⊥ Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on December 16, 2015 and November 5, 2012
- ≡ WL upon completion of drilling
- R Refusal to Further Penetration

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH-2014-9A	185.6	4831109.3	288020.6
BH-2014-10A	189.4	4831175.3	288132.5
MR-3	194.6	4831172.8	288079.3
MR-3A	194.6	4831173.9	288078.3
MR-4	195.4	4831158.4	288051.0

NOTES

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REFERENCE

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 X-60213979-C-BA-HWY401\_MAVIS.dwg,  
 X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg,  
 60213979\_CT-SMP-MAVIS401-LT-1.dwg and  
 60213979\_CT-SMP-MAVIS401-LT-2.dwg, received December 1, 2015 and  
 10cmContours.dwg, received December 21, 2015.

NO.	DATE	BY	REVISION

Geocres No. \_\_\_\_\_ PROJECT NO. 10-1111-0211 DIST. \_\_\_\_\_  
 HWY. 401  
 SUBM'D. AJS CHKD. AJS DATE: Jan. 2016 SITE: \_\_\_\_\_  
 DRAWN: JFC CHKD. KJB APPD. JMAC DWG. 3

**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



HIGHWAY 401  
CULVERT NO. 6  
BOREHOLE LOCATIONS AND SOIL STRATA

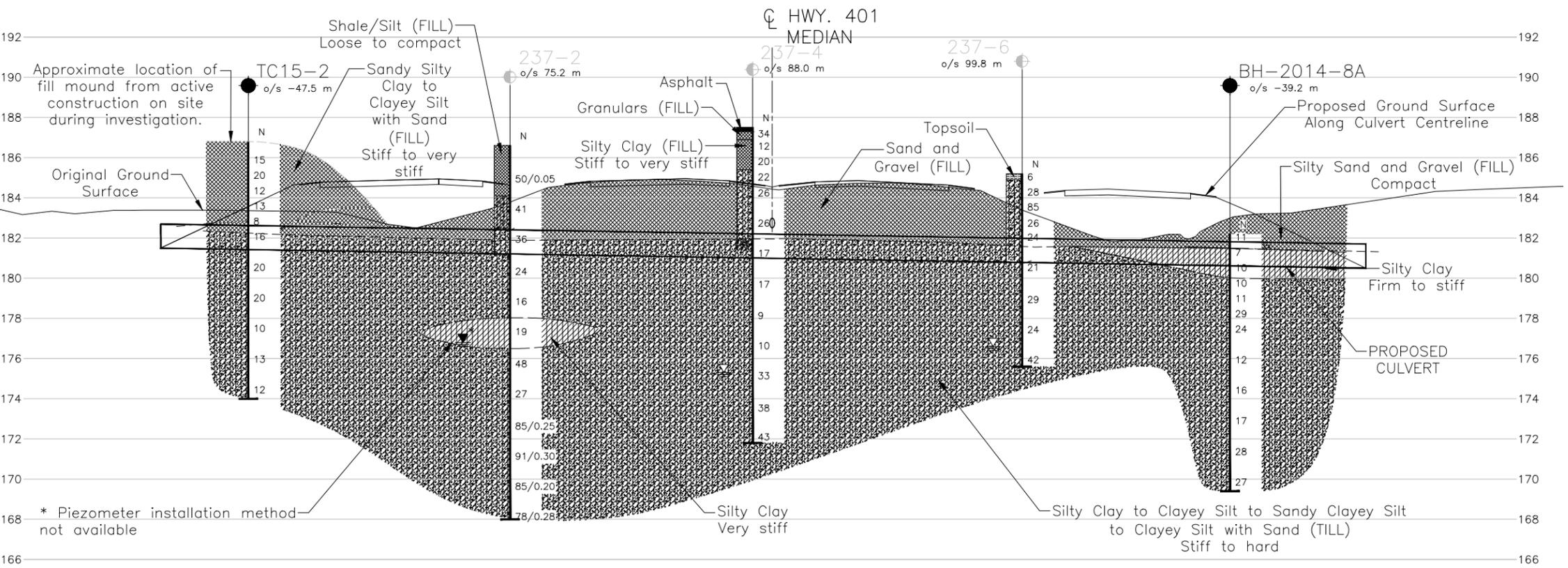
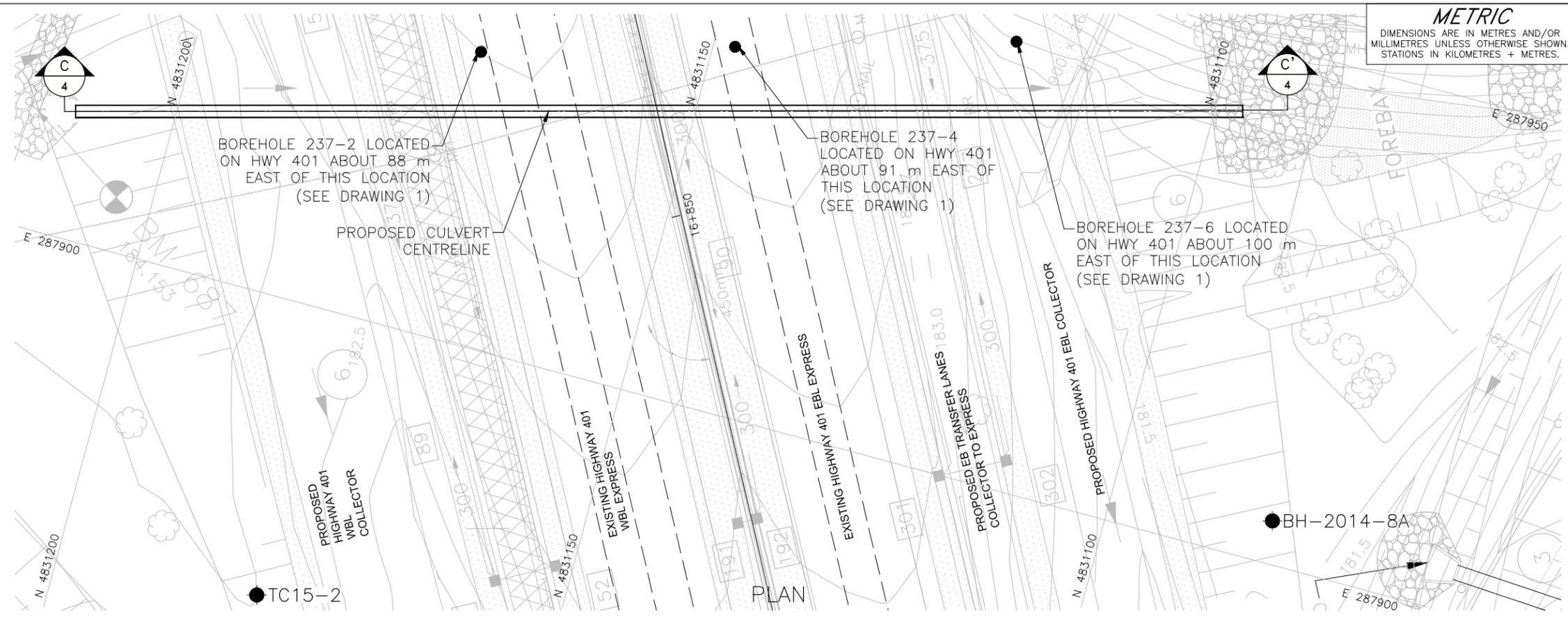
SHEET



KEY PLAN  
SCALE 1:50,000

**LEGEND**

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation (Terraprobe, 1998)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL upon completion of drilling
- ≡ WL in piezometer, measured on January 8, 1998



**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
237-2	186.6	4831216.8	287990.7
237-4	187.5	4831198.6	288007.2
237-6	185.2	4831177.4	288025.5
BH-2014-8A	182.2	4831083.8	287904.3
TC15-2	186.8	4831179.8	287870.8

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**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos. X-60213979-C-BA-HWY401\_MAVIS.dwg, received December 1, 2015 and X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg, received December 1, 2015 and 2015-12-09-401 MavisTrenchless\_5 6 9\_60213979.dwg, received December 9, 2015 and 10cmContours.dwg, received December 21, 2015 and X-60213979-C-DE-HWY401\_MAVIS\_Add4.dwg, 2016-01-19-Updated culvert sections-60213979.dwg, received January 19, 2015.

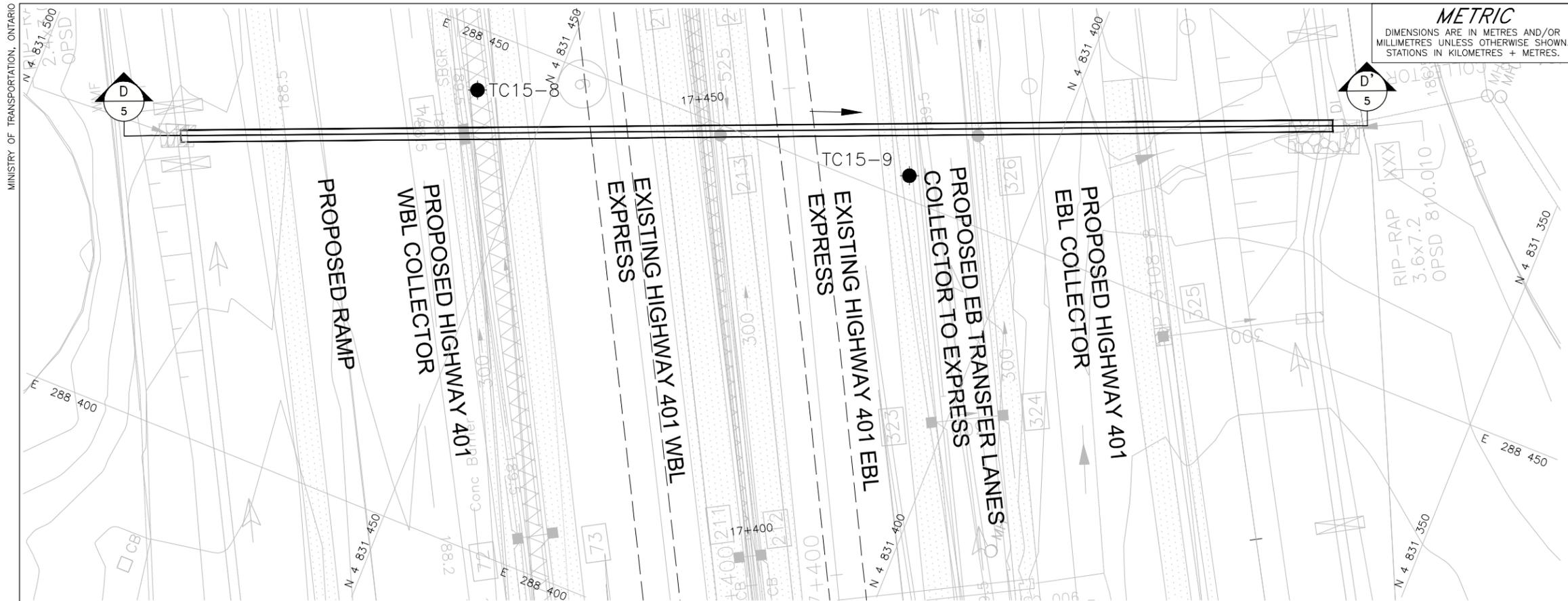
C-C CULVERT No. 6 PROFILE  
STATION 16+85



NO.	DATE	BY	REVISION

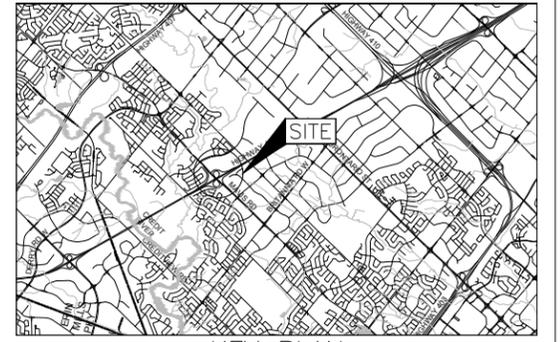
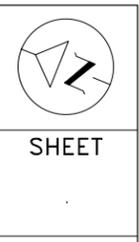
Geocres No. 30M12-394

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG. 4



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00  
HIGHWAY 401 CULVERT NO. 9  
BOREHOLE LOCATIONS AND SOIL STRATA

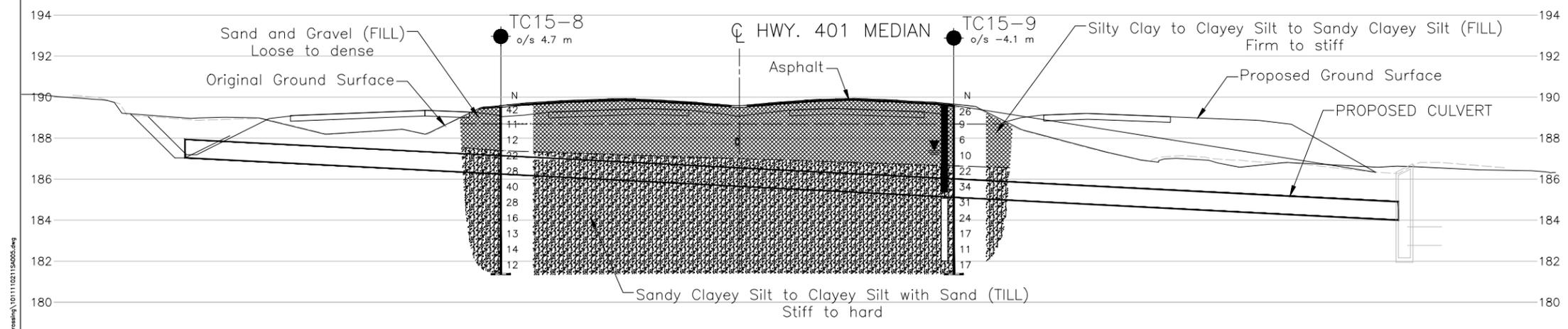


**LEGEND**

- Borehole - Current Investigation
- ⊥ Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on December 16, 2015

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
TC15-8	189.6	4831457.2	288444.0
TC15-9	189.6	4831412.9	288452.3



**NOTES**

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**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos.  
 X-60213979-C-BA-HWY401\_MAVIS.dwg,  
 X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg, received December 1, 2015  
 and 2015-12-09-401\_MavisTrenchless\_5 6 9\_60213979.dwg, received December 9, 2015 and 10cmContours.dwg, received December 21, 2015  
 and X-60213979-C-DE-HWY401\_MAVIS\_Add4.dwg, 2016-01-19-Updated culvert sections-60213979.dwg, received January 19, 2015.

NO.	DATE	BY	REVISION

Geocres No. **30M12-394**

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		DWG. 5

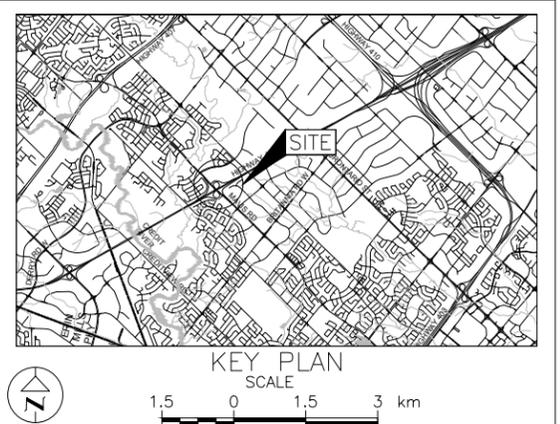
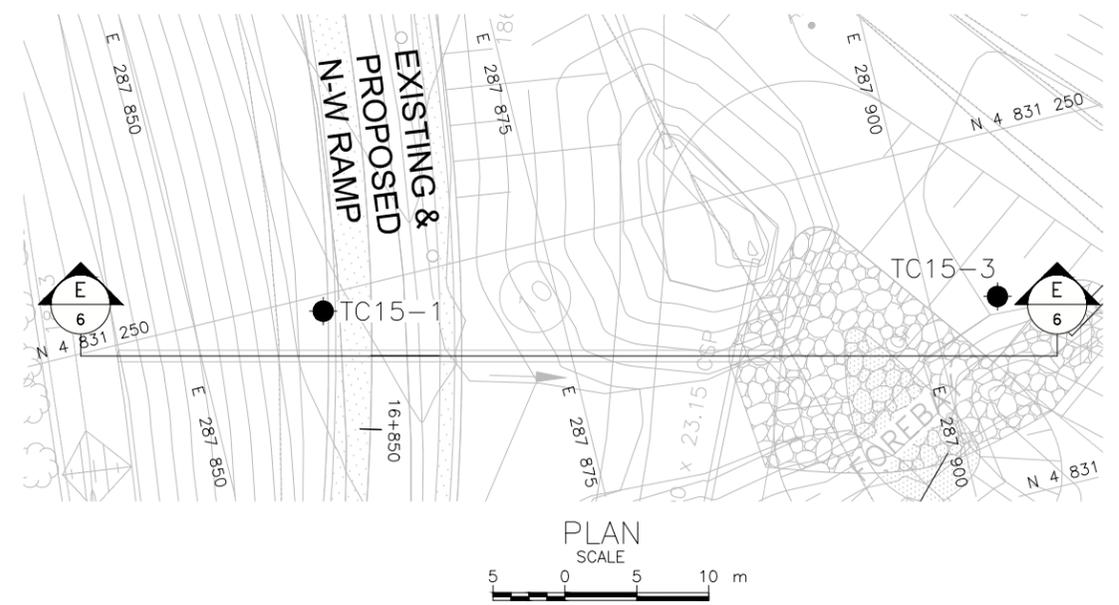
**METRIC**  
 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



HIGHWAY 401  
 CULVERT NO. 10  
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

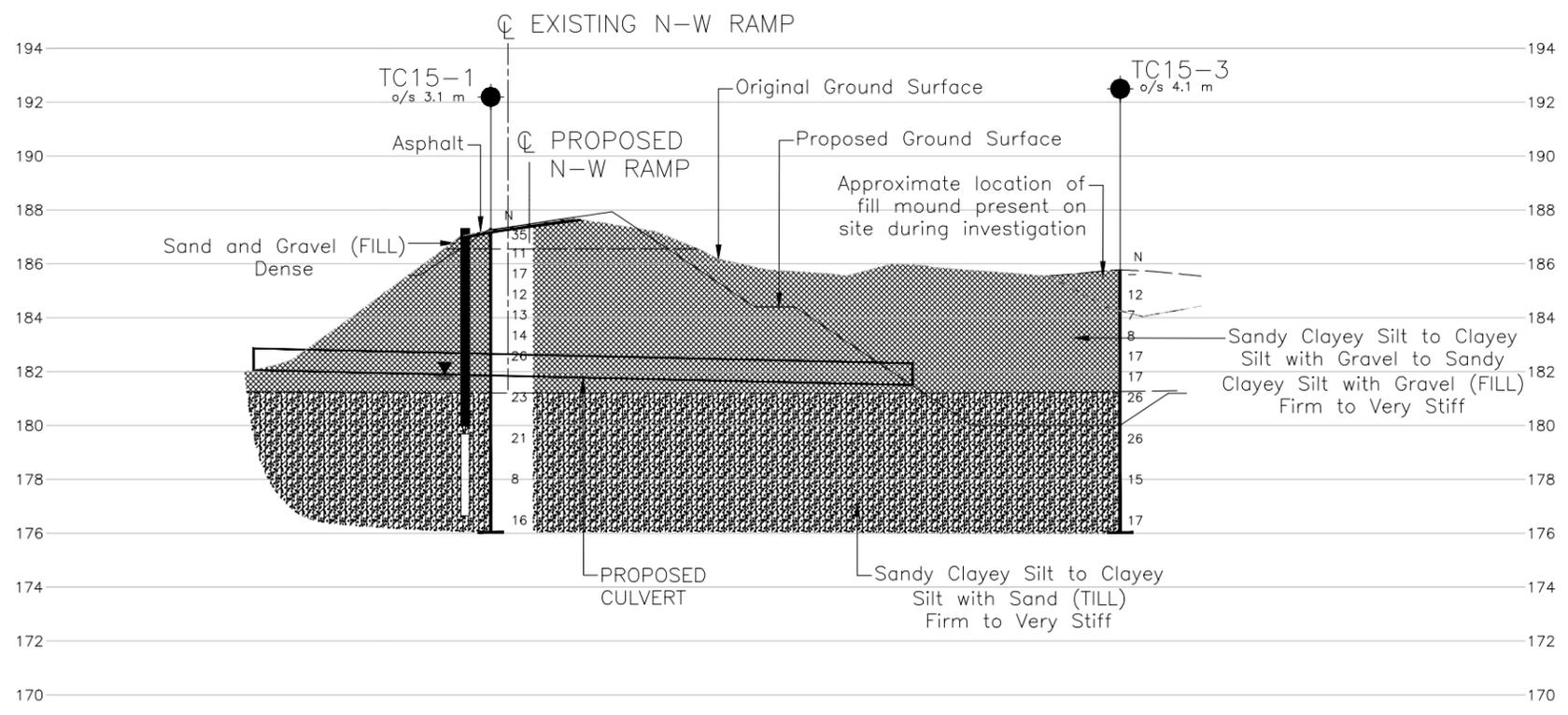


**LEGEND**

- Borehole - Current Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on Dec. 16, 2015

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
TC15-1	187.3	4831248.9	287859.0
TC15-3	185.8	4831238.8	287904.7



**NOTES**

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**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos. X-60213979-C-BA-HWY401\_MAVIS.dwg, X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg and 60213979\_CT-SMP-MAVIS401-LT-1.dwg received December 1, 2015 and 10cmContours.dwg, received December 21, 2015.

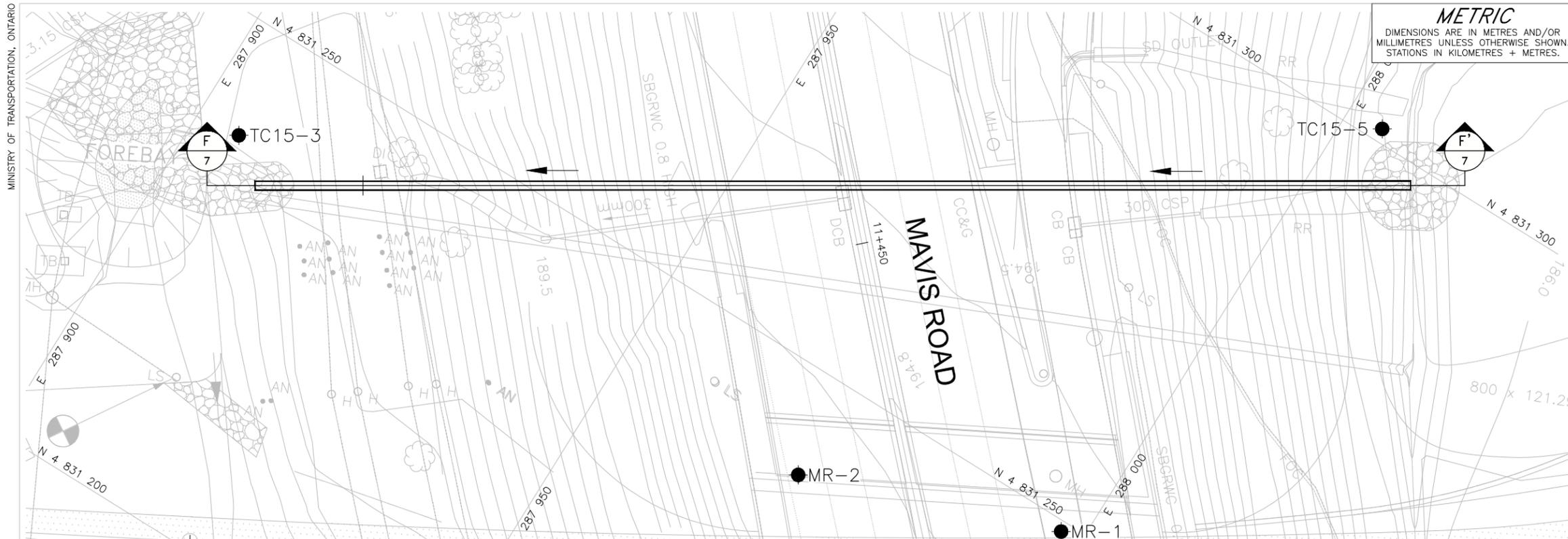
**E-E CULVERT No. 10 PROFILE**  
 STATION 16+855



NO.	DATE	BY	REVISION

Geocres No. \_\_\_\_\_ PROJECT NO. 10-1111-0211 DIST. \_\_\_\_\_

HWY. 401	CHKD. AJS	DATE: Jan. 2016	SITE: _____
SUBM'D. AJS	CHKD. KJB	APPD. JMAC	DWG. 6



**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00  
HIGHWAY 401 CULVERT NO. 11A  
BOREHOLE LOCATIONS AND SOIL STRATA



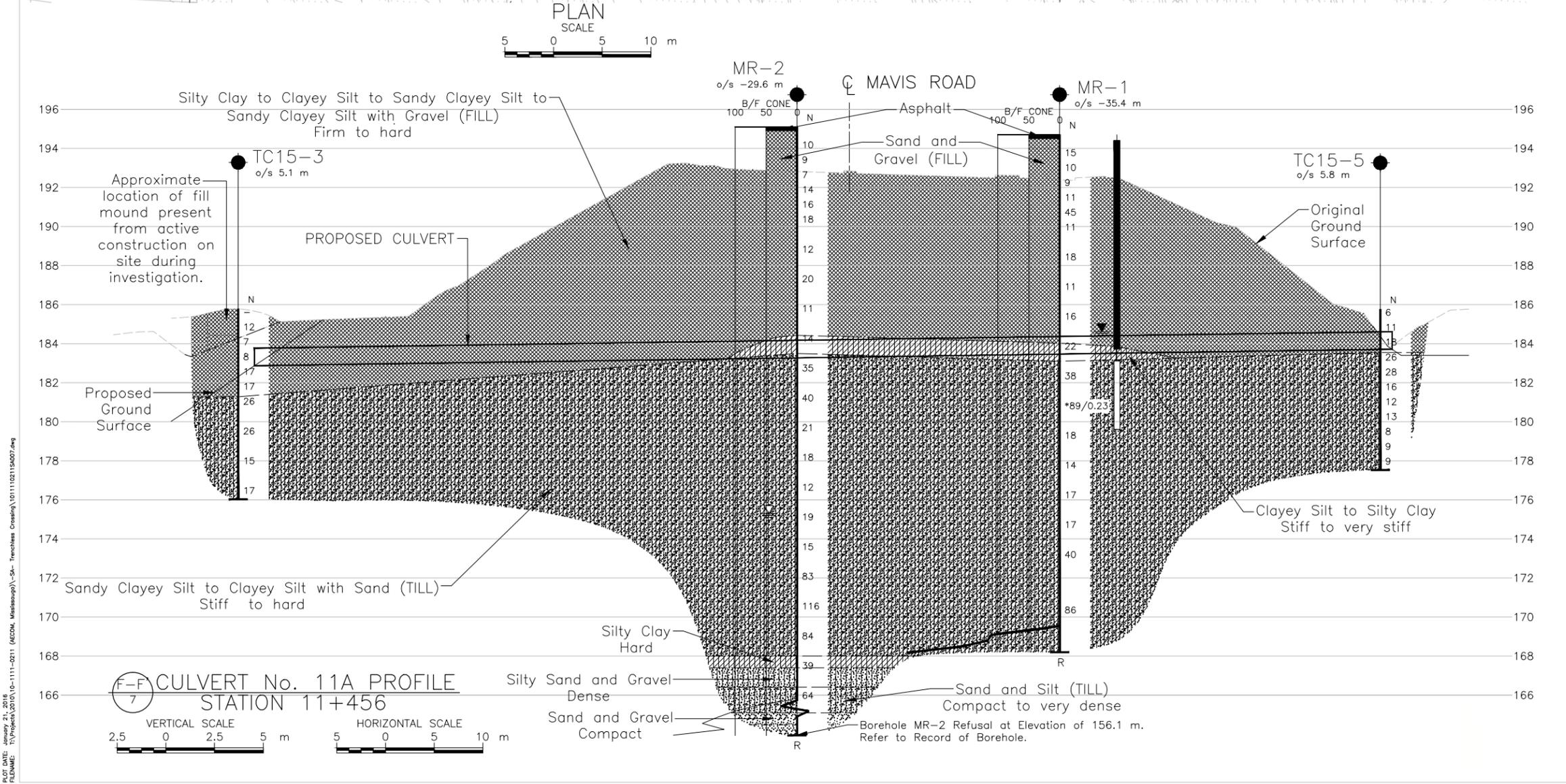
KEY PLAN SCALE 1.5 0 1.5 3 km

**LEGEND**

- Borehole - Current Investigation
- ⊥ Seal
- ▭ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on November 5, 2012
- ≡ WL upon completion of drilling
- R Refusal to Further Penetration

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
MR-1	194.7	4831249.0	287997.7
MR-2	195.1	4831239.6	287971.8
TC15-3	185.8	4831238.8	287904.7
TC15-5	185.8	4831301.4	288003.9



**NOTES**

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos.  
 X-60213979-C-BA-HWY401\_MAVIS.dwg,  
 X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg,  
 60213979\_CT-SMP-MAVIS401-LT-1.dwg and  
 60213979\_CT-SMP-MAVIS401-LT-2.dwg, received December 1, 2015 and  
 10cmContours.dwg, received December 21, 2015.

NO.	DATE	BY	REVISION

Geocres No. **30M12-394**

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG: 7

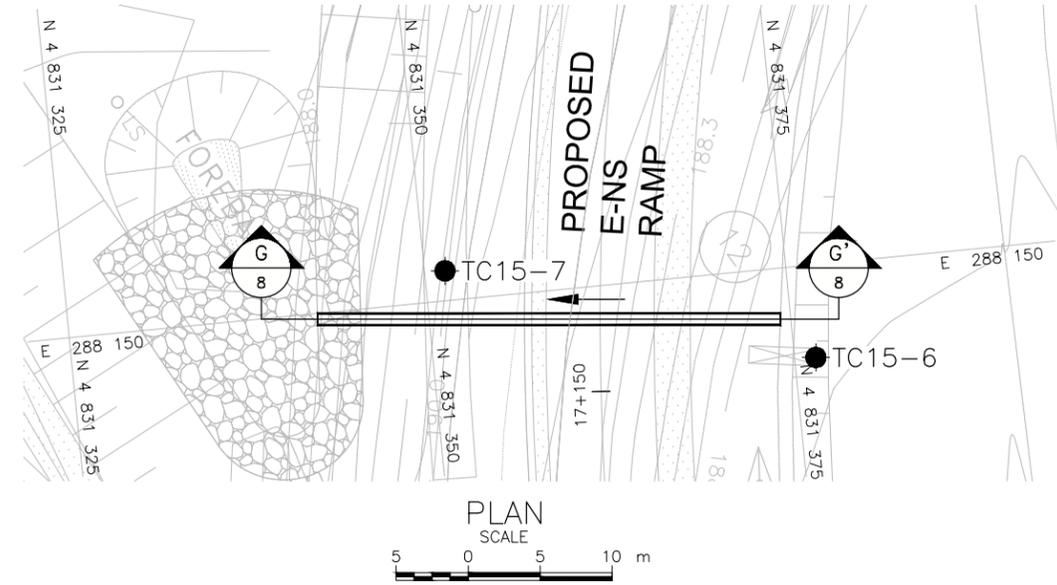
**METRIC**  
 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



HIGHWAY 401  
 CULVERT NO. 12  
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



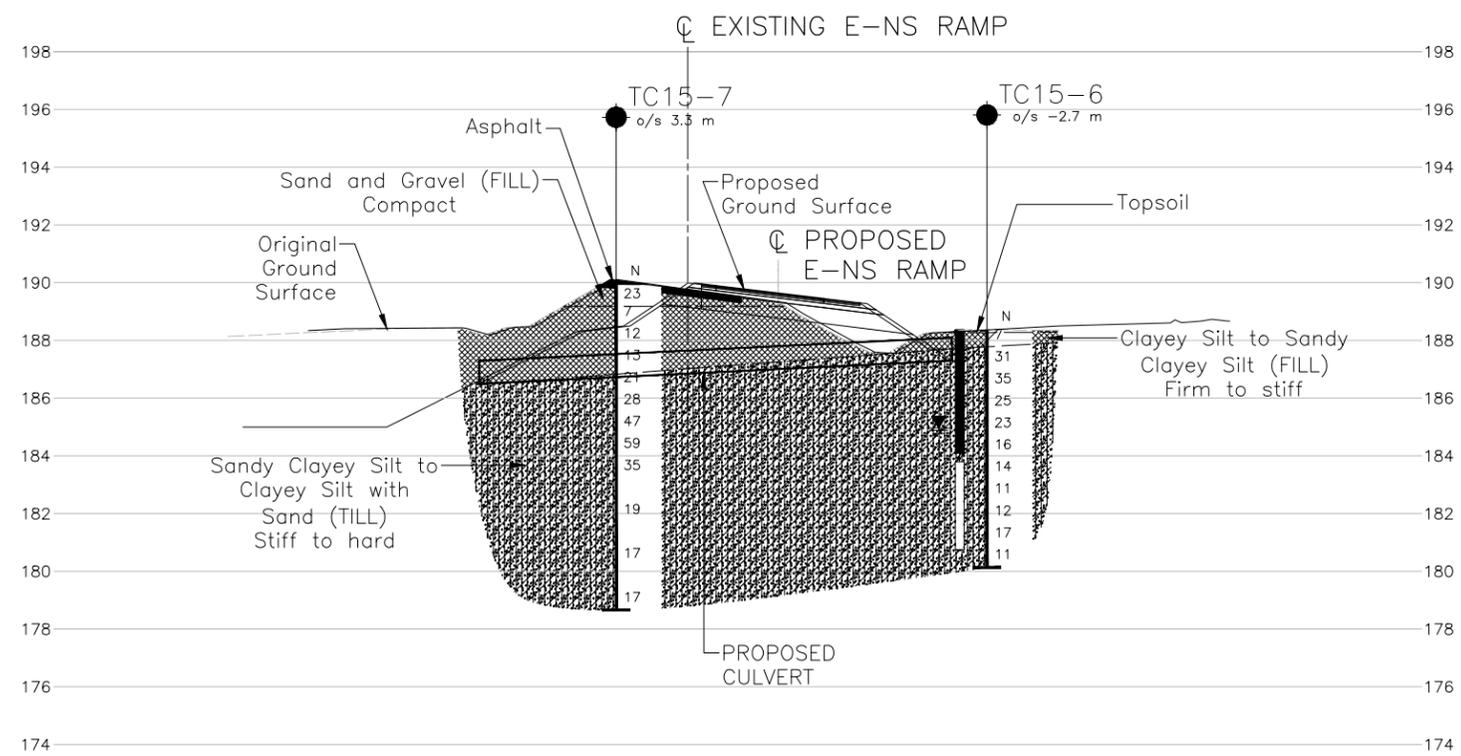
KEY PLAN SCALE 5 0 5 10 m

**LEGEND**

- Borehole - Current Investigation
- ⊥ Seal
- ▭ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on Dec. 16, 2015

**BOREHOLE CO-ORDINATES**

No.	ELEVATION	NORTHING	EASTING
TC15-6	188.4	4831376.5	288156.4
TC15-7	189.9	4831351.4	288147.9



**NOTES**

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

**REFERENCE**

Base plans provided in digital format by AECOM, drawing file nos. X-60213979-C-BA-HWY401\_MAVIS.dwg, X-60213979-C-DE-HWY401\_MAVIS\_Add1.dwg and 60213979\_CT-SMP-MAVIS401-LT-2.dwg received December 1, 2015 and 10cmContours.dwg, received December 21, 2015 and X-60213979-C-DE-HWY401\_MAVIS\_Add4.dwg, 2016-01-19-Updated culvert sections-60213979.dwg, received January 19, 2015.

G-G' CULVERT No. 12 PROFILE  
 STATION 17+145



NO.	DATE	BY	REVISION

Geocres No. **30M12-394**

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. AJS	CHKD. AJS	DATE: Jan. 2016
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG. 8



## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

<b>I.</b>	<b>GENERAL</b>	<b>(a)</b>	<b>Index Properties (continued)</b>
$\pi$	3.1416	w	water content
$\ln x$ ,	natural logarithm of x	$w_l$ or LL	liquid limit
$\log_{10}$	x or log x, logarithm of x to base 10	$w_p$ or PL	plastic limit
g	acceleration due to gravity	$I_p$ or PI	plasticity index = $(w_l - w_p)$
t	time	$w_s$	shrinkage limit
FoS	factor of safety	$I_L$	liquidity index = $(w - w_p) / I_p$
		$I_C$	consistency index = $(w_l - w) / I_p$
		$e_{max}$	void ratio in loosest state
		$e_{min}$	void ratio in densest state
		$I_D$	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)
<b>II.</b>	<b>STRESS AND STRAIN</b>	<b>(b)</b>	<b>Hydraulic Properties</b>
$\gamma$	shear strain	h	hydraulic head or potential
$\Delta$	change in, e.g. in stress: $\Delta \sigma$	q	rate of flow
$\varepsilon$	linear strain	v	velocity of flow
$\varepsilon_v$	volumetric strain	i	hydraulic gradient
$\eta$	coefficient of viscosity	k	hydraulic conductivity (coefficient of permeability)
$\nu$	Poisson's ratio	j	seepage force per unit volume
$\sigma$	total stress	<b>(c)</b>	<b>Consolidation (one-dimensional)</b>
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )	$C_c$	compression index (normally consolidated range)
$\sigma'_{vo}$	initial effective overburden stress	$C_r$	recompression index (over-consolidated range)
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)	$C_s$	swelling index
$\sigma_{oct}$	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$	$C_\alpha$	secondary compression index
$\tau$	shear stress	$m_v$	coefficient of volume change
u	porewater pressure	$C_v$	coefficient of consolidation (vertical direction)
E	modulus of deformation	$C_h$	coefficient of consolidation (horizontal direction)
G	shear modulus of deformation	$T_v$	time factor (vertical direction)
K	bulk modulus of compressibility	U	degree of consolidation
		$\sigma'_p$	pre-consolidation stress
<b>III.</b>	<b>SOIL PROPERTIES</b>	OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$
<b>(a)</b>	<b>Index Properties</b>	<b>(d)</b>	<b>Shear Strength</b>
$\rho(\gamma)$	bulk density (bulk unit weight)*	$\tau_p, \tau_r$	peak and residual shear strength
$\rho_d(\gamma_d)$	dry density (dry unit weight)	$\phi'$	effective angle of internal friction
$\rho_w(\gamma_w)$	density (unit weight) of water	$\delta$	angle of interface friction
$\rho_s(\gamma_s)$	density (unit weight) of solid particles	$\mu$	coefficient of friction = $\tan \delta$
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )	$c'$	effective cohesion
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )	$C_u, S_u$	undrained shear strength ( $\phi = 0$ analysis)
e	void ratio	p	mean total stress $(\sigma_1 + \sigma_3)/2$
n	porosity	$p'$	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
S	degree of saturation	q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
		$q_u$	compressive strength $(\sigma_1 - \sigma_3)$
		$S_t$	sensitivity

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

**Notes:** 1  
2

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (compressive strength)/2



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### III. SOIL DESCRIPTION

#### (a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) Cohesive Soils Consistency

	<u>kPa</u>	<u>C<sub>u</sub>, S<sub>u</sub></u>	<u>psf</u>
Very soft	0 to 12		0 to 250
Soft	12 to 25		250 to 500
Firm	25 to 50		500 to 1,000
Stiff	50 to 100		1,000 to 2,000
Very stiff	100 to 200		2,000 to 4,000
Hard	over 200		over 4,000

### IV. SOIL TESTS

w	water content
w <sub>p</sub>	plastic limit
w <sub>l</sub>	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
D <sub>R</sub>	relative density (specific gravity, G <sub>s</sub> )
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



# **APPENDIX A**

**Borehole Records and Laboratory Test Results  
Culvert No. 3, Station 16+790  
BH-2014-8A, TC15-4  
Figure A1 to Figure A4**

**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No BH-2014-8A SHEET 1 OF 1** **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831083.8 ; E 287904.3 **ORIGINATED BY** AJS  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 150 mm O.D. Solid Stem Augers **COMPILED BY** MP  
**DATUM** GEODETIC **DATE** Dec. 15, 2014 **CHECKED BY** KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL	
182.2	GROUND SURFACE																						
0.0	Silty sand and gravel, some asphalt fragments (FILL) Compact Brown Moist		1	SS	11																		
181.5			2	SS	7																		
0.7	SILTY CLAY, trace to some sand, trace to some gravel Firm to stiff Brown Moist		3	SS	10																		
180.0			4	SS	10																		
2.2	CLAYEY SILT, some sand to CLAYEY SILT with SAND, trace to some gravel, pocket of sandy silt from 3.7 m to 5.2 m depth (TILL) Stiff to very stiff Brown becoming mottled brown and grey at about 3.7 m depth Moist		5	SS	11																		
			6	SS	29															3	35	44	18
			7	SS	24															9	43	32	16
			8	SS	12																		
			9	SS	16																		
			10	SS	17																		
			11	SS	28																		
			12	SS	27																		
169.4	END OF BOREHOLE																						
12.8	NOTE: 1. Open borehole dry upon completion of drilling.																						

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 01/21/16

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No TC15-4** SHEET 1 OF 1 **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831055.8 ; E 287900.1 **ORIGINATED BY** QC  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 150 mm O.D. Hollow Stem Augers **COMPILED BY** AJS  
**DATUM** GEODETIC **DATE** November 3, 2015 **CHECKED BY** KJB

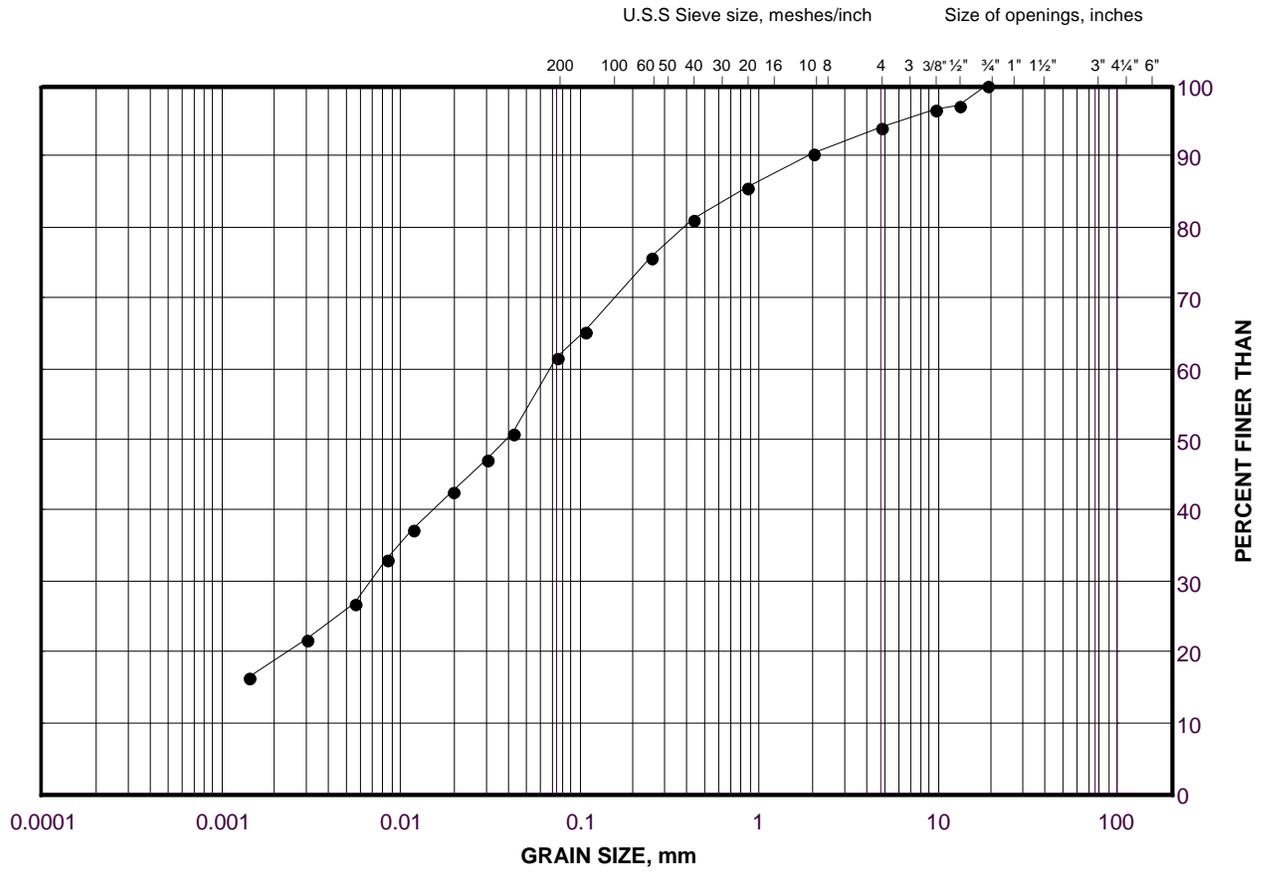
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
183.9	GROUND SURFACE																
0.9	ASPHALT Sand and gravel (FILL) Compact Brown Moist		1	SS	43												
183.0			2A				183										
0.9	Clayey silt with sand, trace to some gravel, contains silt pockets, oxidation staining (FILL) Stiff to very stiff Mottled brown Moist		2B	SS	10												
			3	SS	8		182										
			4	SS	16		181										
			5	SS	15		180										6 32 43 19
180.2			6	SS	35		180										
3.7	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff to hard Brown to grey Moist		7	SS	19		179										
			8	SS	26		178										
			9	SS	11		177										2 22 52 24
			10	SS	20		176										
			11	SS	16		176										
175.7	END OF BOREHOLE																
8.2	NOTES:  1. Borehole dry upon completion of drilling.  2. Water level measured in piezometer:  Date      Depth (m)      Elev. (m) 11/19/15      2.6      181.3 12/16/15      2.7      181.2																

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# GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Fill)

FIGURE A1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

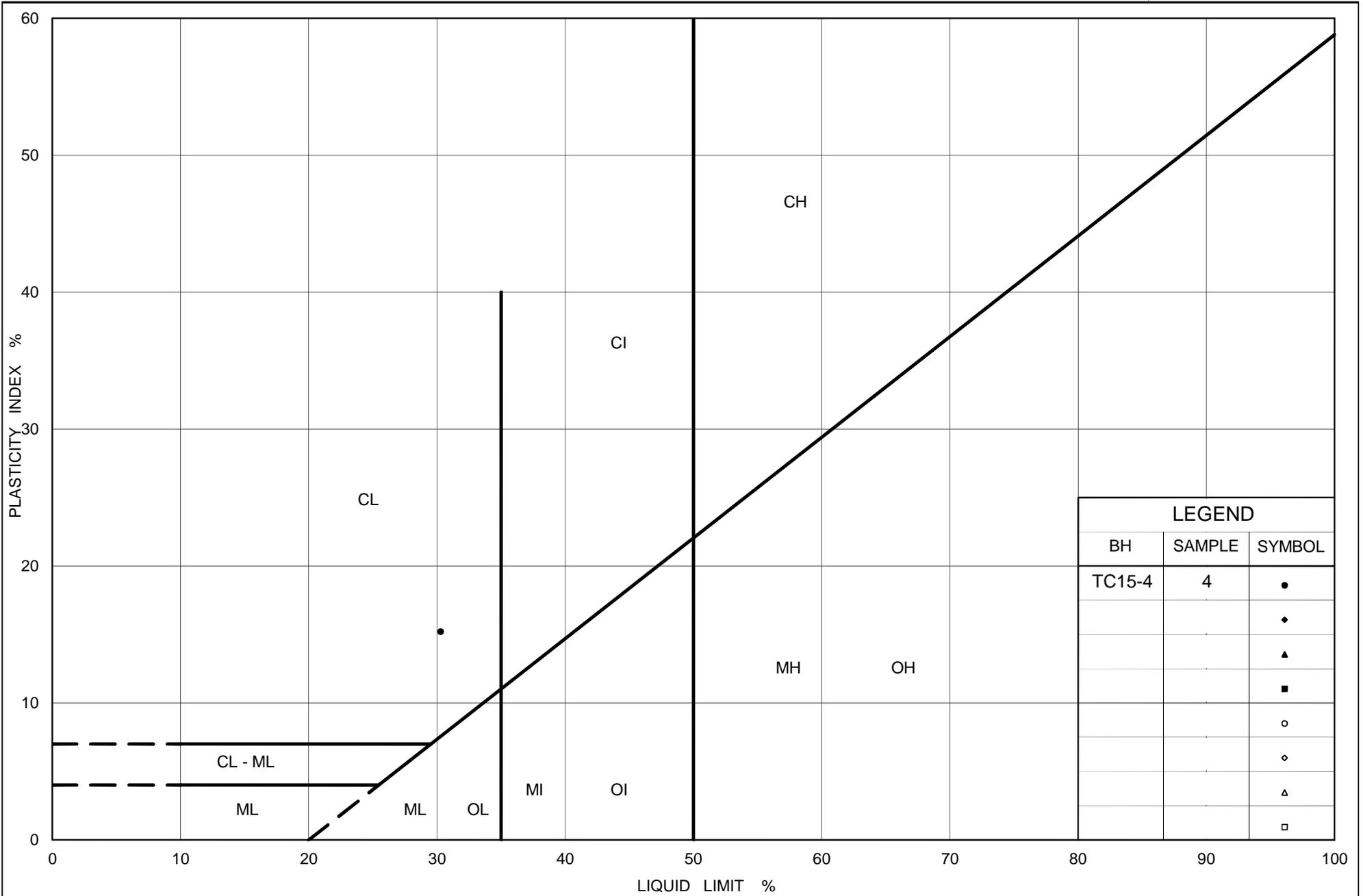
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	TC15-4	5	180.6

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



LEGEND		
BH	SAMPLE	SYMBOL
TC15-4	4	●
		◆
		▲
		■
		○
		◇
		△
		□



Ministry of Transportation

Ontario

# PLASTICITY CHART

## Clayey Silt with Sand (Fill)

Figure No. A2

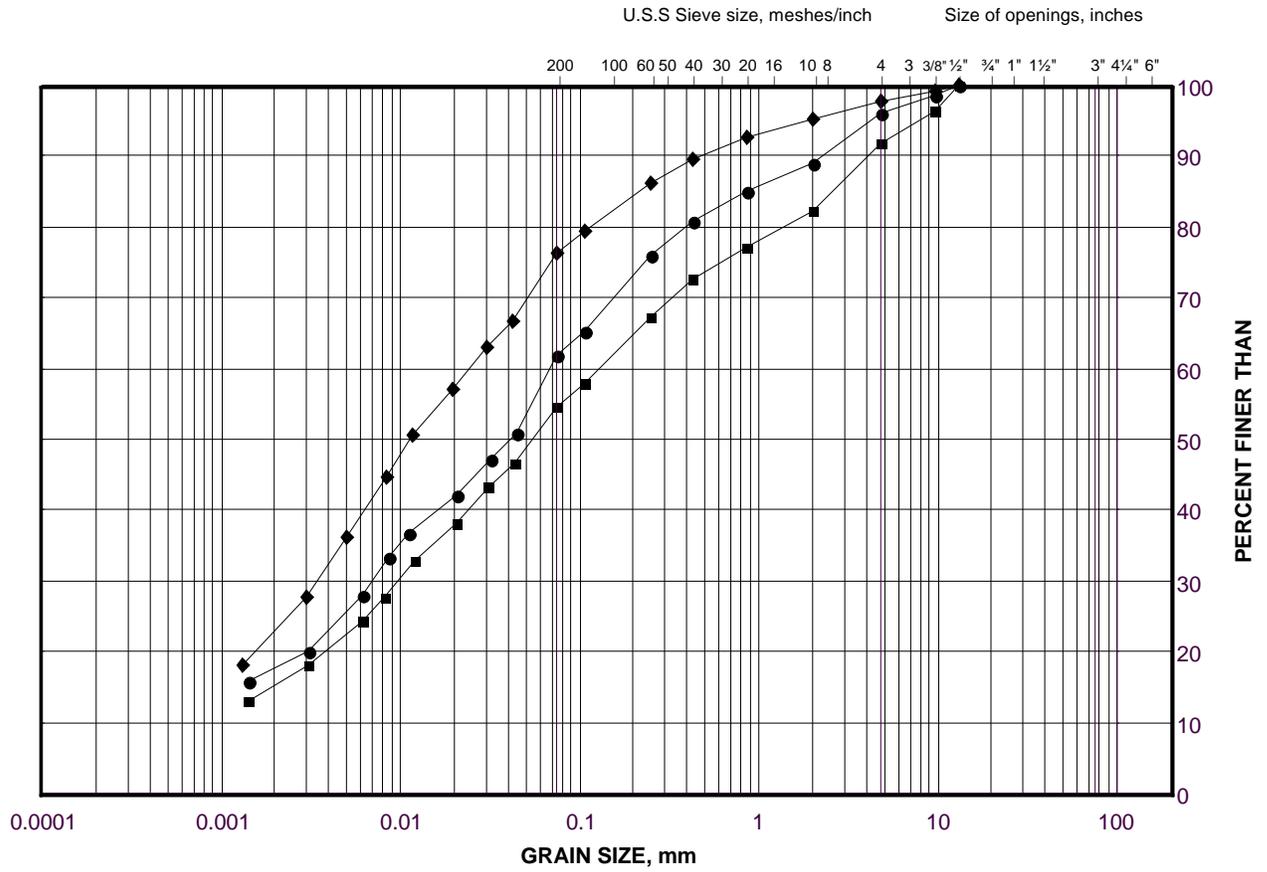
Project No. 10-1111-0211

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE A3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

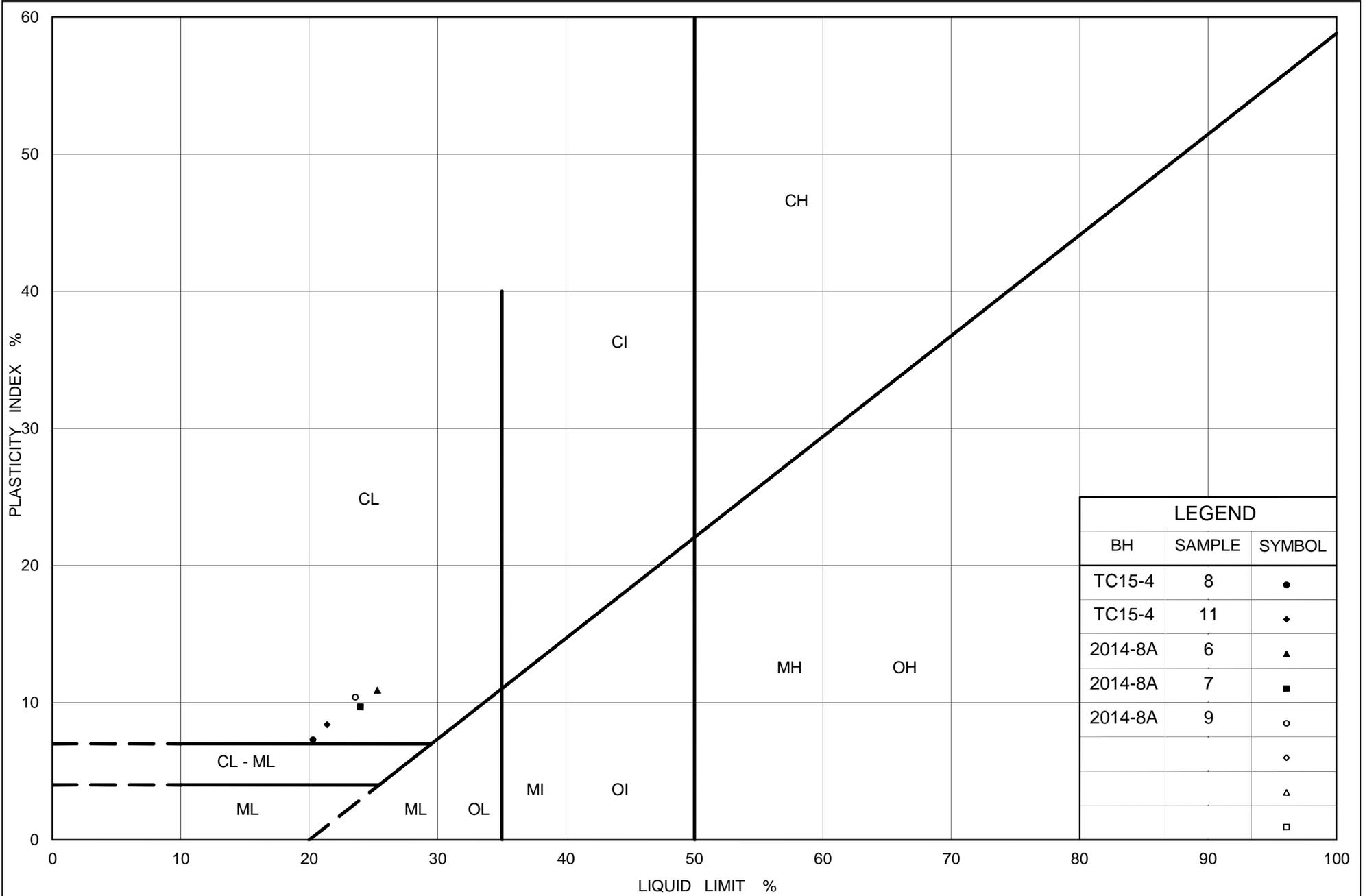
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	2014-8A	6	178.1
■	2014-8A	7	177.3
◆	TC15-4	9	177.6

Project Number: 10-1111-0211

Checked By:                     KJB                    

**Golder Associates**

Date: 05-Jan-16



LEGEND		
BH	SAMPLE	SYMBOL
TC15-4	8	●
TC15-4	11	◆
2014-8A	6	▲
2014-8A	7	■
2014-8A	9	○
		◇
		△
		□



Ministry of Transportation

Ontario

## PLASTICITY CHART

### Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. A4

Project No. 10-1111-0211

Checked By: KJB



# **APPENDIX B**

**Borehole Records and Laboratory Test Results  
Culvert No. 5, Station 11+274  
BH-2014-9A, BH-2014-10A, MR-3, MR-3A, MR-4  
Figure B1 to Figure B4-B**





**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No MR-3** **SHEET 1 OF 2** **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831172.8 ; E 288079.3 **ORIGINATED BY** SB  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 108 mm I.D. Hollow Stem Augers, NW Casing with Tricone **COMPILED BY** CC/TVA  
**DATUM** GEODETIC **DATE** May 29 to 30, 2012 **CHECKED BY** KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80			100	W <sub>p</sub>
194.6	GROUND SURFACE														
0.0	TOPSOIL														
0.2	Clayey silt, some sand, trace to some gravel, containing rootlets, organics, asphalt and shale fragments to a depth of 6.7 m (FILL) Firm to hard Brown to grey Moist  ----- with gravel -----		1	SS	24										
			194	2	SS	5									
			193	3	SS	12									
			192	4	SS	8									
			191	5	SS	6									
			190	6	SS	10									
			189	7	SS	11									
			188	8	SS	17									
			187	9	SS	29									
			186	10	SS	33									
184.2	CLAYEY SILT with SAND, trace to some gravel (TILL) Stiff to very stiff Grey Moist		11	SS	20										
10.4			184	12	SS	15									
			183	13	SS	14									
			182												
	181														
	180														

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/08/16

Continued Next Page

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No MR-3</b>	SHEET 2 OF 2	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831172.8 ; E 288079.3</u>	ORIGINATED BY <u>SB</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing with Tricone</u>	COMPILED BY <u>CC/TVA</u>	
DATUM <u>GEODETIC</u>	DATE <u>May 29 to 30, 2012</u>	CHECKED BY <u>KJB</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
179.3 15.3	BOULDER Grey and black		14	SS	50/0.06		179										
178.7 15.9	CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff Grey Wet		15	SS	16		178										
176.3 18.3	END OF BOREHOLE CASING REFUSAL  NOTES:  1. Casing refusal on boulder at 15.3 m depth, cored through boulder using NQ size core barrel and continued sampling using NW Casing & Tricone.  2. Unable to advance borehole beyond a depth of 18.3 m due to casing refusal. Backfilled borehole, moved drilling 1.5 m north, and advanced Borehole MR-3A and continued sampling below 18.3 m depth.  3. Borehole dry (inside augers) at start of work day on May 30, 2012.						177										

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/08/16







**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No MR-4** **SHEET 1 OF 3** **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831158.4 ; E 288051.0 **ORIGINATED BY** SB/CC  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 108 mm I.D. Hollow Stem Augers **COMPILED BY** CC/TVA  
**DATUM** GEODETIC **DATE** May 24 to 28, 2012 **CHECKED BY** KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20
195.4	GROUND SURFACE																	
0.0	ASPHALT																	
0.2	Sand and gravel, (FILL)																	
194.6	Brown Moist																	
0.8	Clayey silt, trace to some sand, trace gravel, containing wood fragments, (FILL)		1	SS	11													
	Stiff to hard Brown Moist		2	SS	10													
			3	SS	10													
			4	SS	14													
			5	SS	14													
			6	SS	17													
			7	SS	80													
	inferred cobbles		8	SS	9								3 36 40 21					
	with sand		9	SS	28													
			10	SS	36													
183.8	CLAYEY SILT with SAND, trace to some gravel, (TILL)		11	SS	30													
11.6	Very stiff to hard Brown to grey Moist		12	SS	22								10 29 42 19					

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 01/08/16

Continued Next Page

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No MR-4**      SHEET 2 OF 3      **METRIC**

PROJECT 10-1111-0211      G.W.P. 2150-01-00      LOCATION N 4831158.4 ; E 288051.0      ORIGINATED BY SB/CC

DIST Central      HWY 401      BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers      COMPILED BY CC/TVA

DATUM GEODETIC      DATE May 24 to 28, 2012      CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)							
						20	40	60	80	100	20	40	60	80	100	10	20	30	kN/m <sup>3</sup>	GR	SA	SI	CL	
	--- CONTINUED FROM PREVIOUS PAGE ---																							
	CLAYEY SILT with SAND, trace to some gravel, (TILL) Very stiff to hard Brown to grey Moist																							
	inferred cobbles																							
	wet																							
			13	SS	20																			
			14	SS	19																			
			15	SS	14																			1 21 49 29
			16	SS	36																			
			17	SS	38																			11 40 37 12
			18	SS	70																			
			19	SS	61																			7 27 46 20

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 01/08/16

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No MR-4</b>	SHEET 3 OF 3	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831158.4 ; E 288051.0</u>	ORIGINATED BY <u>SB/CC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>CC/TVA</u>	
DATUM <u>GEODETIC</u>	DATE <u>May 24 to 28, 2012</u>	CHECKED BY <u>KJB</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)																	
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10	20	30									
164.3 31.1	CLAYEY SILT with SAND, trace to some gravel, (TILL) Very stiff to hard Brown to grey Moist --- CONTINUED FROM PREVIOUS PAGE --- containing shale fragments END OF BOREHOLE NOTES: 1. Difficulties advancing auger was observed between depths of 15.2 m and 16.8 m (Elev. 180.2 m and 178.6 m) below ground surface. 2. Water level inside augers at a depth of 0.9 m below ground surface (Elev. 194.5 m), measured at start of work day on May 25, 2012. 3. Water level inside augers at a depth of 21.3 m below ground surface (Elev. 174.1 m) upon completion of sampling on May 28, 2012. 4. Piezometer installation consists of 50 mm diameter PVC pipe with a 3.0 m slotted screen. Water Level Readings <table style="margin-left: 20px;"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>05/28/12</td> <td>18.3</td> <td>177.1</td> </tr> <tr> <td>05/30/12</td> <td>18.6</td> <td>176.8</td> </tr> <tr> <td>08/10/12</td> <td>18.4</td> <td>177.0</td> </tr> <tr> <td>10/09/12</td> <td>18.4</td> <td>177.0</td> </tr> <tr> <td>11/05/12</td> <td>18.3</td> <td>177.1</td> </tr> </table>	Date	Depth (m)	Elev. (m)	05/28/12	18.3	177.1	05/30/12	18.6	176.8	08/10/12	18.4	177.0	10/09/12	18.4	177.0	11/05/12	18.3	177.1	20	SS	63		165										
Date	Depth (m)	Elev. (m)																																
05/28/12	18.3	177.1																																
05/30/12	18.6	176.8																																
08/10/12	18.4	177.0																																
10/09/12	18.4	177.0																																
11/05/12	18.3	177.1																																

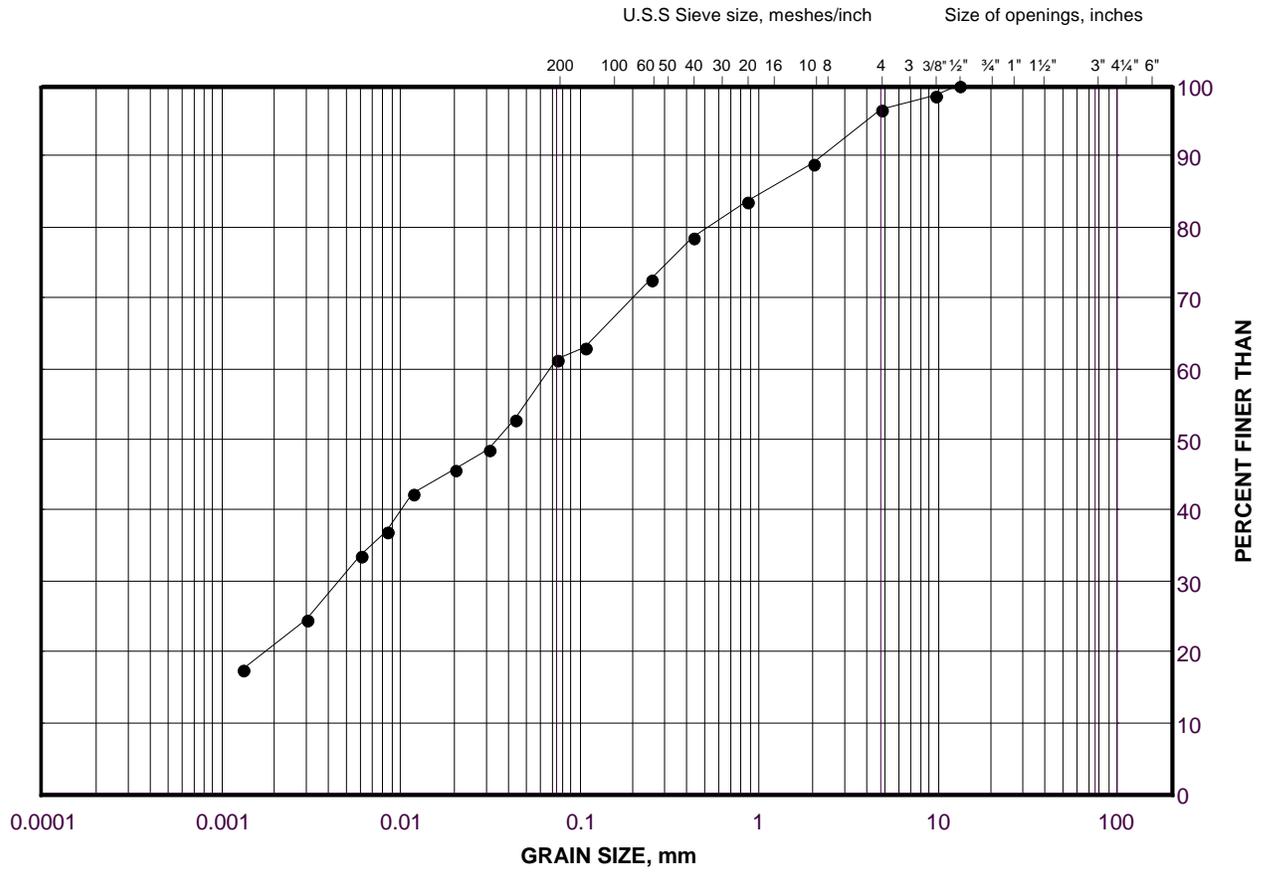
GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 01/08/16

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Fill)

FIGURE B1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

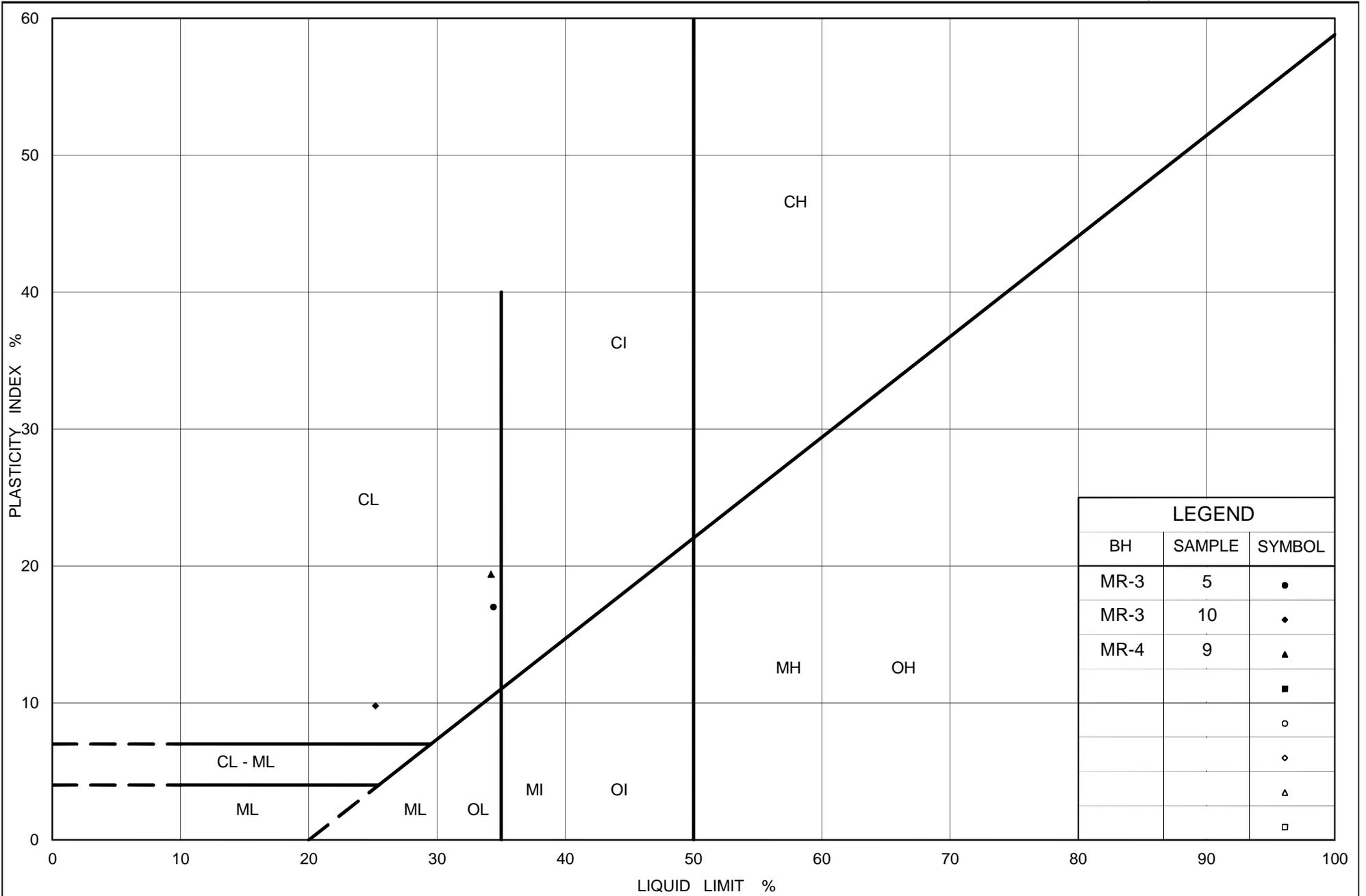
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	MR-4	8	187.5

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



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## PLASTICITY CHART Clayey Silt (Fill)

Figure No. B2

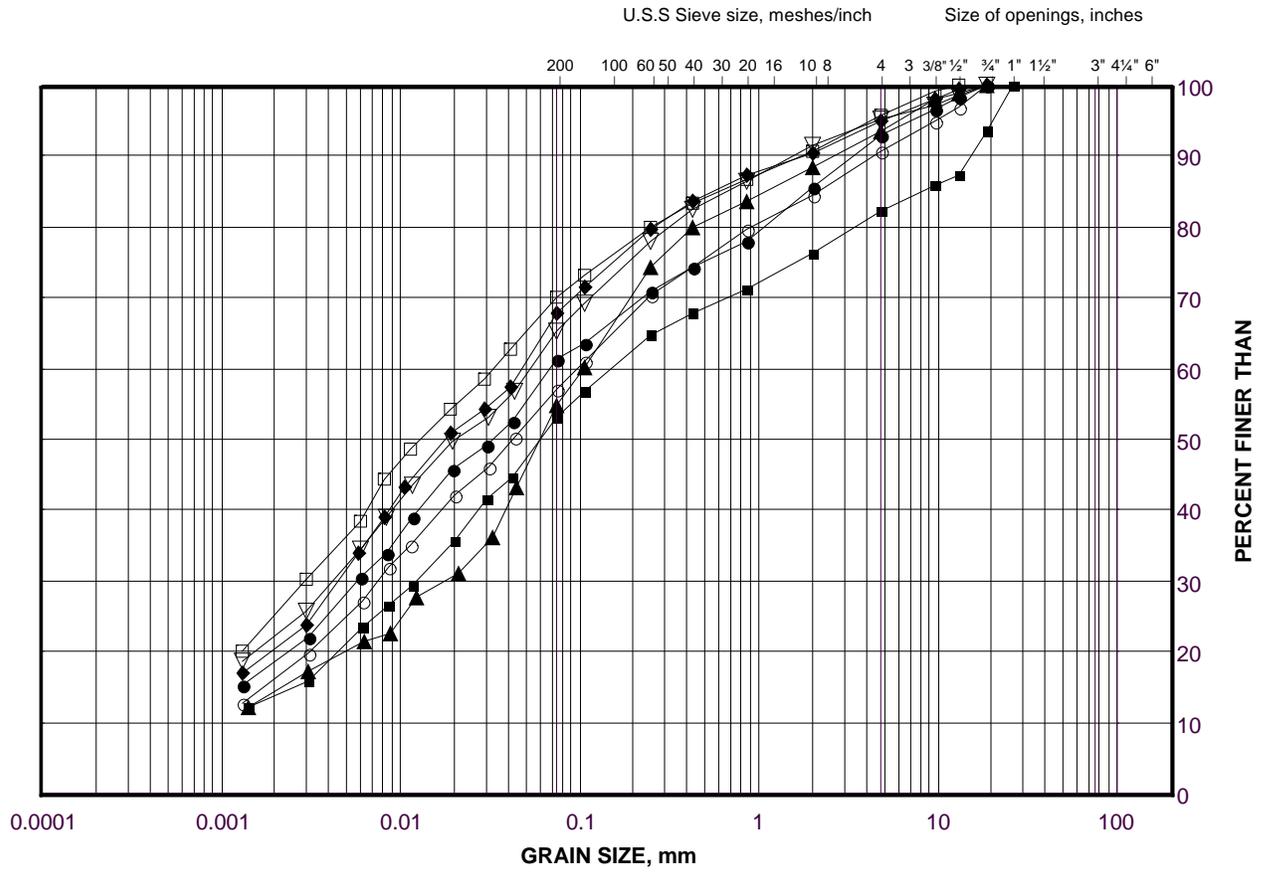
Project No. 10-1111-0211

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE B3-A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	MR-3	11	183.6
■	MR-3A	18	172.9
◆	2014-9A	2	184.5
▲	MR-3A	21	163.8
▽	2014-10A	4	186.8
○	2014-9A	5	182.2
□	2014-10A	7	184.6

Project Number: 10-1111-0211

Checked By:           KJB          

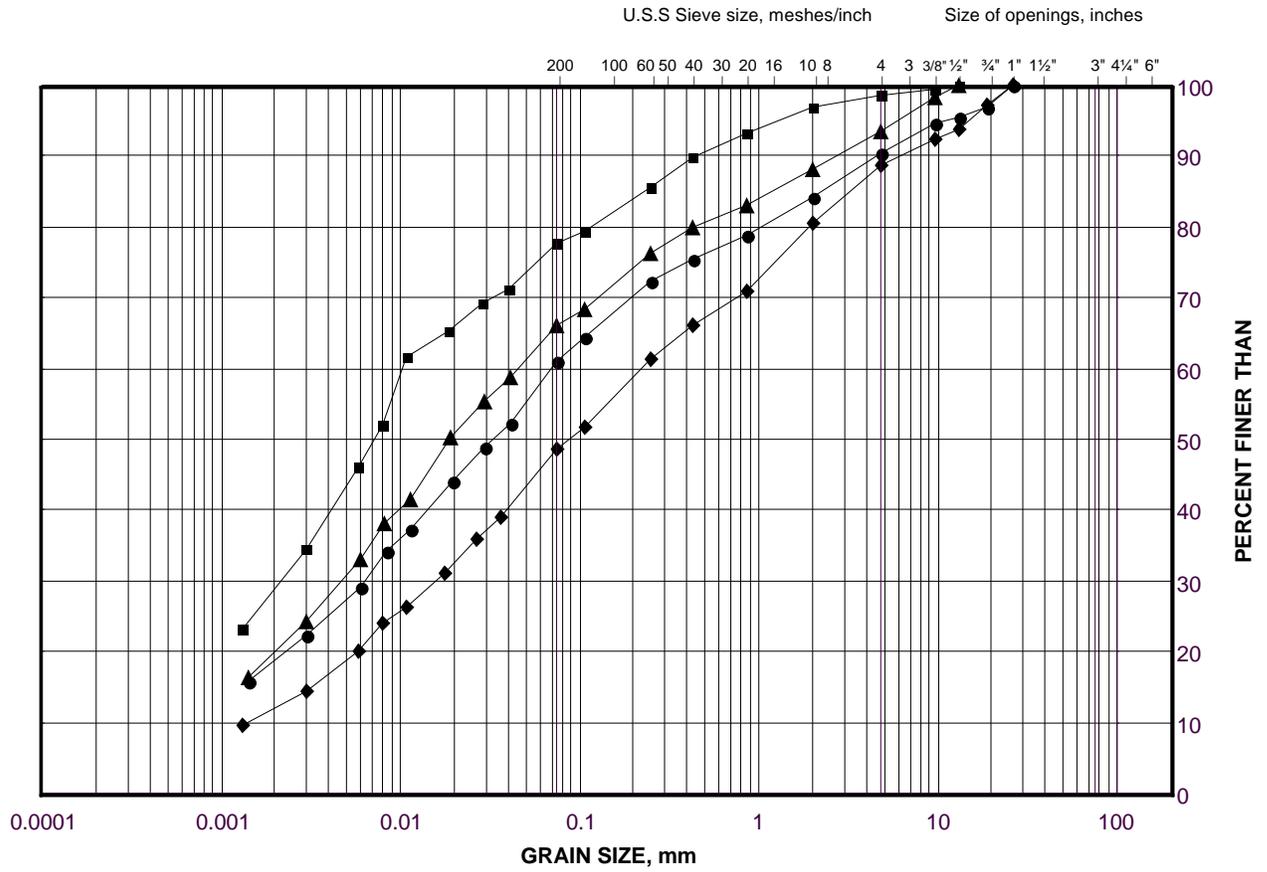
**Golder Associates**

Date: 05-Jan-16

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE B3-B



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

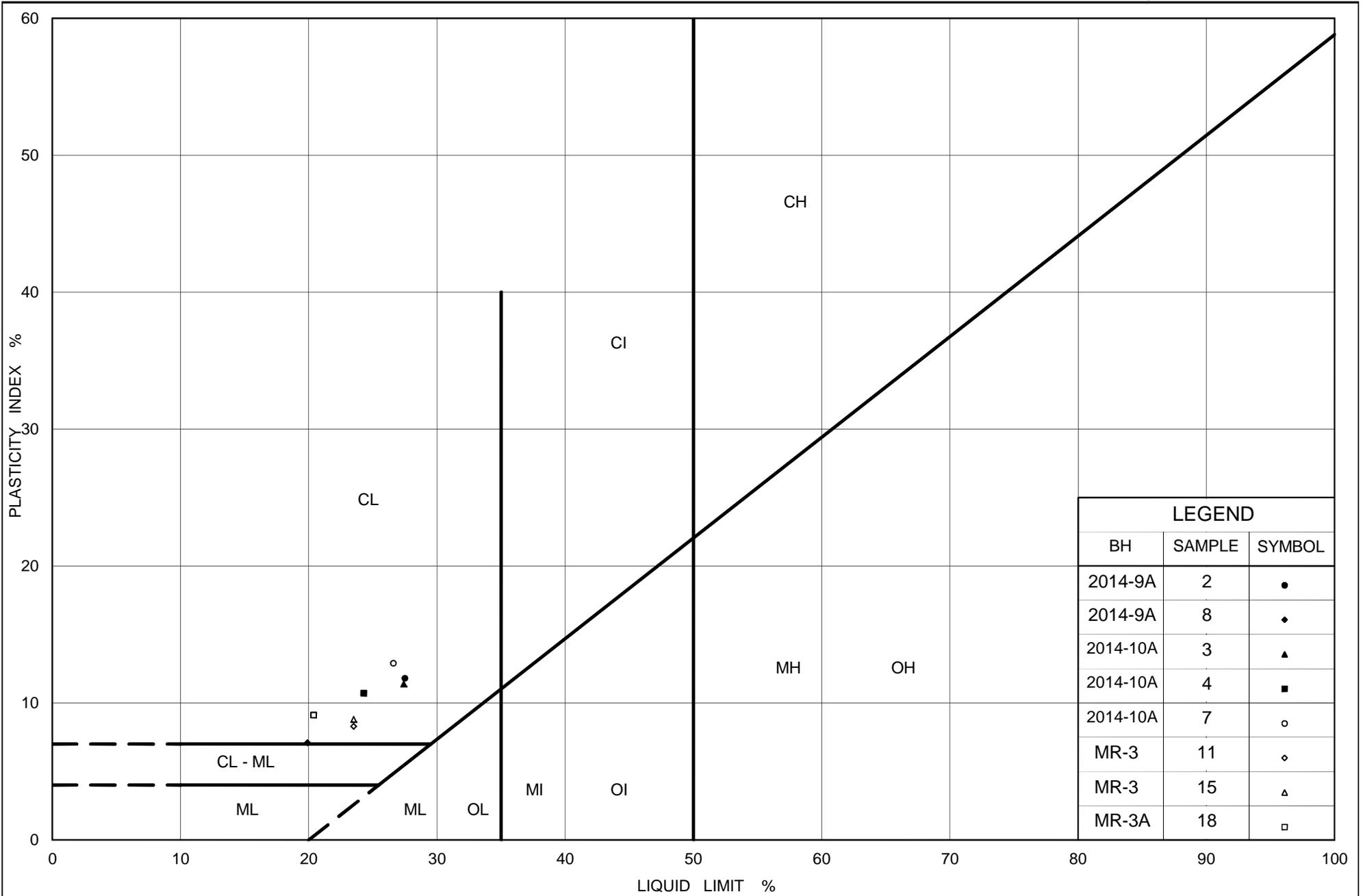
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	MR-4	12	181.4
■	MR-4	15	176.8
◆	MR-4	17	173.7
▲	MR-4	19	167.7

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



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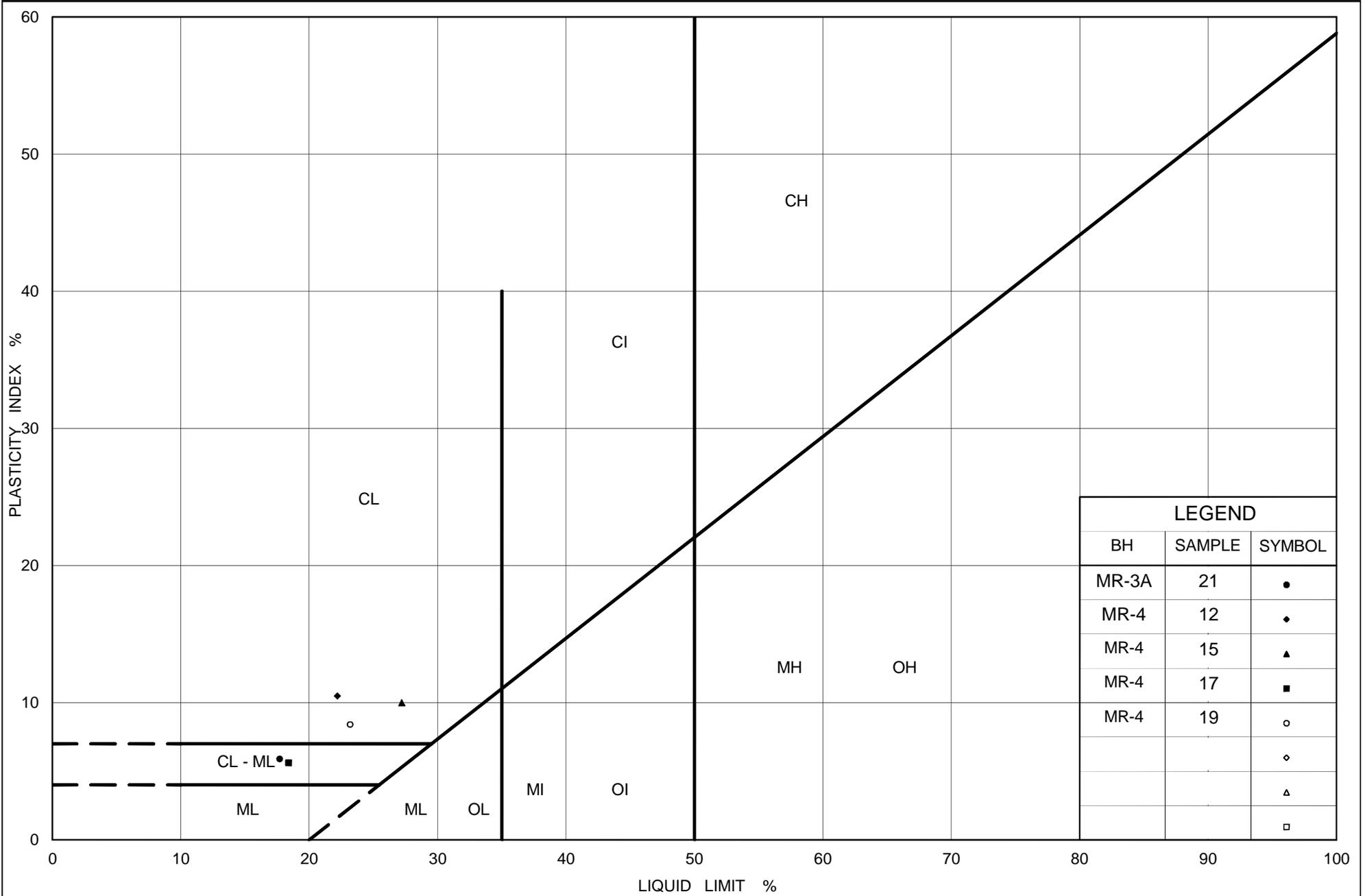
# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. B4-A

Project No. 10-1111-0211

Checked By: KJB



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# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. B4-B

Project No. 10-1111-0211

Checked By: KJB



# **APPENDIX C**

**Borehole Records and Laboratory Test Results**

**Culvert No. 6, Station 16+855**

**BH-2014-8A, TC15-2, 237-2, 237-4, 237-6**

**Figure C1 to Figure C4**

**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No BH-2014-8A SHEET 1 OF 1** **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831083.8 ; E 287904.3 **ORIGINATED BY** AJS  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 150 mm O.D. Solid Stem Augers **COMPILED BY** MP  
**DATUM** GEODETIC **DATE** Dec. 15, 2014 **CHECKED BY** KJB

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10
182.2	GROUND SURFACE																						
0.0	Silty sand and gravel, some asphalt fragments (FILL) Compact Brown Moist		1	SS	11																		
181.5			2	SS	7																		
0.7	SILTY CLAY, trace to some sand, trace to some gravel Firm to stiff Brown Moist		3	SS	10																		
180.0			4	SS	10																		
2.2	CLAYEY SILT, some sand to CLAYEY SILT with SAND, trace to some gravel, pocket of sandy silt from 3.7 m to 5.2 m depth (TILL) Stiff to very stiff Brown becoming mottled brown and grey at about 3.7 m depth Moist		5	SS	11																		
			6	SS	29																		3 35 44 18
			7	SS	24																		9 43 32 16
			8	SS	12																		
			9	SS	16																		
			10	SS	17																		
			11	SS	28																		
			12	SS	27																		
169.4	END OF BOREHOLE																						
12.8	NOTE: 1. Open borehole dry upon completion of drilling.																						

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PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No TC15-2</b>	SHEET 1 OF 1	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831179.8 ; E 287870.8</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>November 9, 2015</u>	CHECKED BY <u>KJB</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
186.8 0.0	GROUND SURFACE Sandy silty clay to clayey silt with sand, trace to some gravel (FILL) Stiff to very stiff Mottled dark brown Moist		1	SS	15												
			2	SS	20											12 39 31 18	
			3	SS	12												
			4	SS	13												
			5	SS	8											4 20 56 20	
182.2 4.6	Sandy CLAYEY SILT, trace to some gravel, some silt and sand pockets (TILL) Stiff to very stiff Brown becoming grey below 7.2 m depth Moist		6	SS	16												
			7	SS	20												
			8	SS	20											10 25 48 17	
			9	SS	10												
			10	SS	13												
			11	SS	12												
174.0 12.8	END OF BOREHOLE  NOTE: 1. Borehole dry upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/21/16

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No-97-2-237-2 2 OF 2

METRIC

W.P. 311-89-00 LOCATION Co-ordinates 4 830 334.4 N; 804 208.7 E. ORIGINATED BY JR  
 DIST 6 HWY 401 BOREHOLE TYPE 100mm diameter Solid Stem Auger COMPILED BY JB  
 DATUM Geodetic DATE 12.18.97 - 12.18.97 CHECKED BY IC

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 <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	w <sub>p</sub>	w	w <sub>L</sub>
168.0	Sandy Clayey Silt, traces of gravel (T.H)  Hard Grey		10	SS	81/ 98cm															
171																				
170																				
169			11	SS	85/ 28cm															
168.0			12	SS	79/ 20cm															
18.6	End of Borehole																			
	Groundwater measured at 8.53m below ground surface upon completion of drilling.																			

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 97-4 1 OF 2 METRIC

W.P. 311-89-00 LOCATION Co-ordinates 4 830 318.5 N; 604 225.5 E. 237-4  
 DIST 6 HWY 401 BOREHOLE TYPE 100mm diameter Solid Stem Auger  
 DATUM Geodetic DATE 12.16.87  
 ORIGINATED BY TR  
 COMPILED BY JB  
 CHECKED BY IC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10
187.5	Ground Level																					
188.6	Asphalt																					
186.9	0.2																					
186.9	0.6																					
	Granular	1	SS	34																		
	Fill - Silty Clay, some sand traces of gravel	2	SS	12																		
	Stiff to Very Stiff Brown & Grey	3	SS	20																		2 11 34 53
185.4	2.1																					
	Sandy Clayey Silt, traces of gravel (Till)	4	SS	22																		
	Very Stiff Brown	5	SS	26																		
	Grey	6	SS	26																		
		7	SS	17																		8 39 31 22
		8	SS	17																		
178.9	8.6																					
	Silty Clay, some sand, traces of gravel (Till)	9	SS	9																		
	Stiff Grey	10	SS	10																		
176.1	11.4																					
	Sandy Clayey Silt, traces of gravel (Till)	11	SS	33																		
	Hard Grey	12	SS	38																		

Continued Next Page

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity ○<sup>3</sup>: STRAIN AT FAILURE

RECORD OF BOREHOLE No 97-4 2 OF 2 METRIC

W.P. 311-89-00 LOCATION Co-ordinates 4 830 316.5 N; 604 225.5 E. 237-4  
 DIST 6 HWY 401 BOREHOLE TYPE 100mm diameter Solid Stem Auger ORIGINATED BY TR  
 DATUM Geodetic DATE 12.16.97 - COMPILED BY JB  
 CHECKED BY IC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
171.8	Sandy Clayey Silt, trace of gravel (Till)	13	SS	43												
15.7	End of Borehole															
	Borehole dry upon completion of drilling.															

+<sup>3</sup>.x<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No-97-6

1 OF 1

METRIC

W.P. 311-89-00 LOCATION Co-ordinates 4 830 295.7 N; 604 244.2 E. **237-6**  
 DIST 6 HWY 401 BOREHOLE TYPE 100mm diameter Solid Stem Auger  
 DATUM Geodetic DATE 12.15.97 - 12.15.97  
 ORIGINATED BY TR  
 COMPILED BY JB  
 CHECKED BY IC

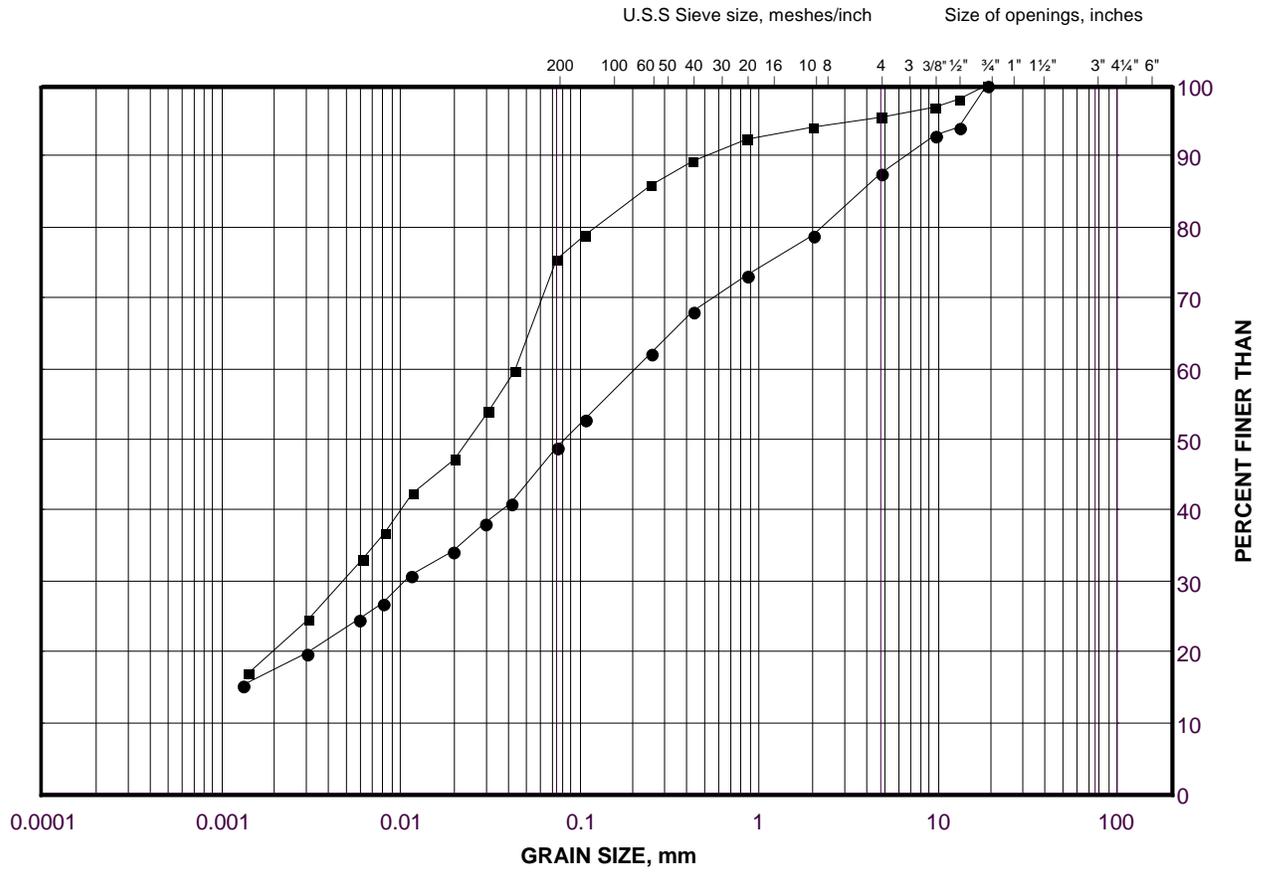
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	10
185.2	Ground Level																	
184.9	Topsoil																	
0.3	Sandy Clayey silt, traces of gravel (Till) Very Stiff Brown to Hard  Grey		1	SS	6													
			2	SS	28													
			3	SS	85													
			4	SS	26													
			5	SS	24													
			6	SS	21													
			7	SS	29													
			8	SS	24													
176.7	Sandy Clayey Silt, traces of gravel (Till) Hard Grey																	
8.5																		
175.6	End of Borehole		9	SS	42													
9.6	Groundwater measured at 8.57m below ground surface upon completion of drilling.																	

+<sup>3</sup>, x<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand to Sandy Silty Clay (Fill)

FIGURE C1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

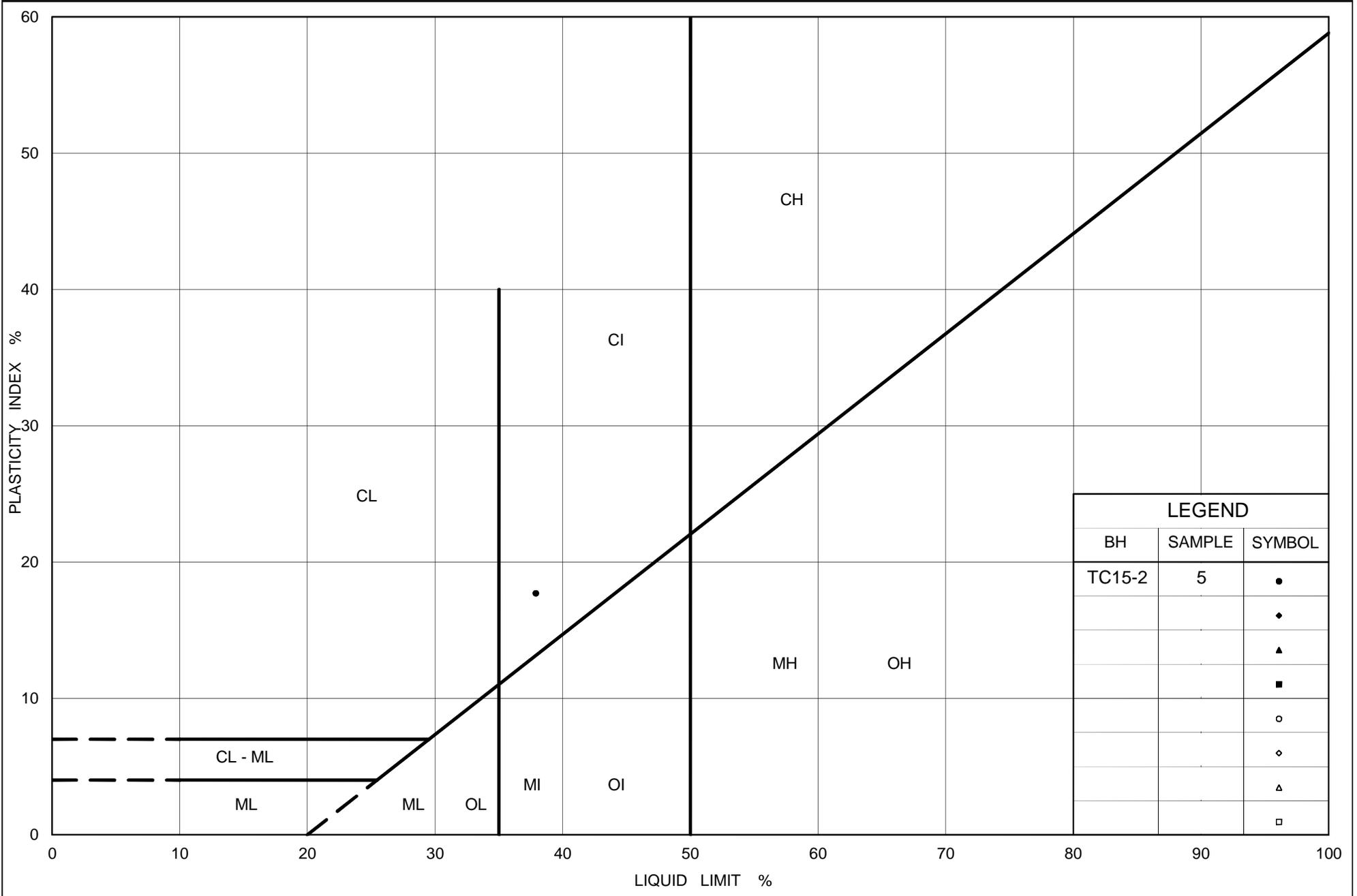
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-2	2	185.0
■	TC15-2	5	182.7

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



LEGEND		
BH	SAMPLE	SYMBOL
TC15-2	5	•
		◊
		▲
		■
		○
		◊
		▲
		□



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# PLASTICITY CHART

## Sandy Silty Clay (Fill)

Figure No. C2

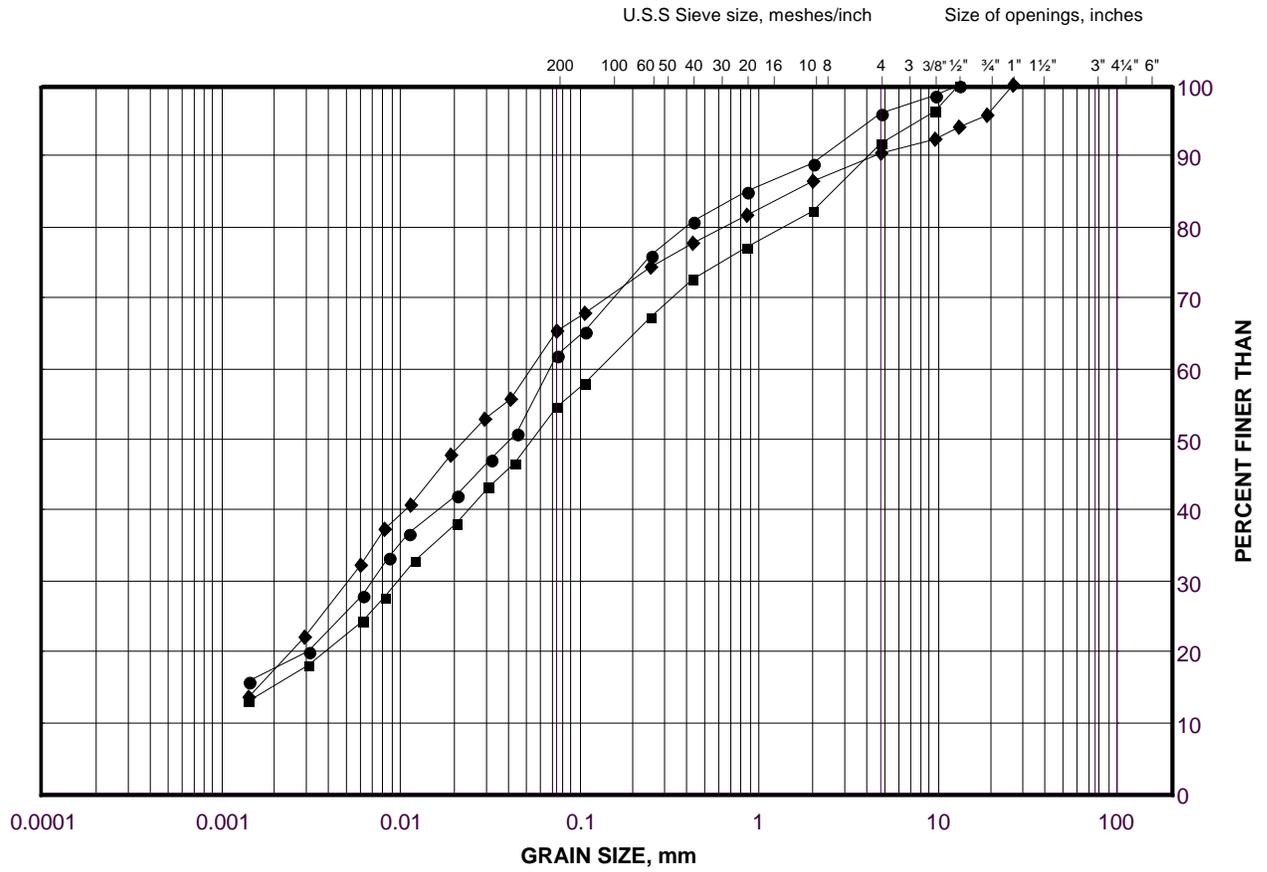
Project No. 10-1111-0211

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE C3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

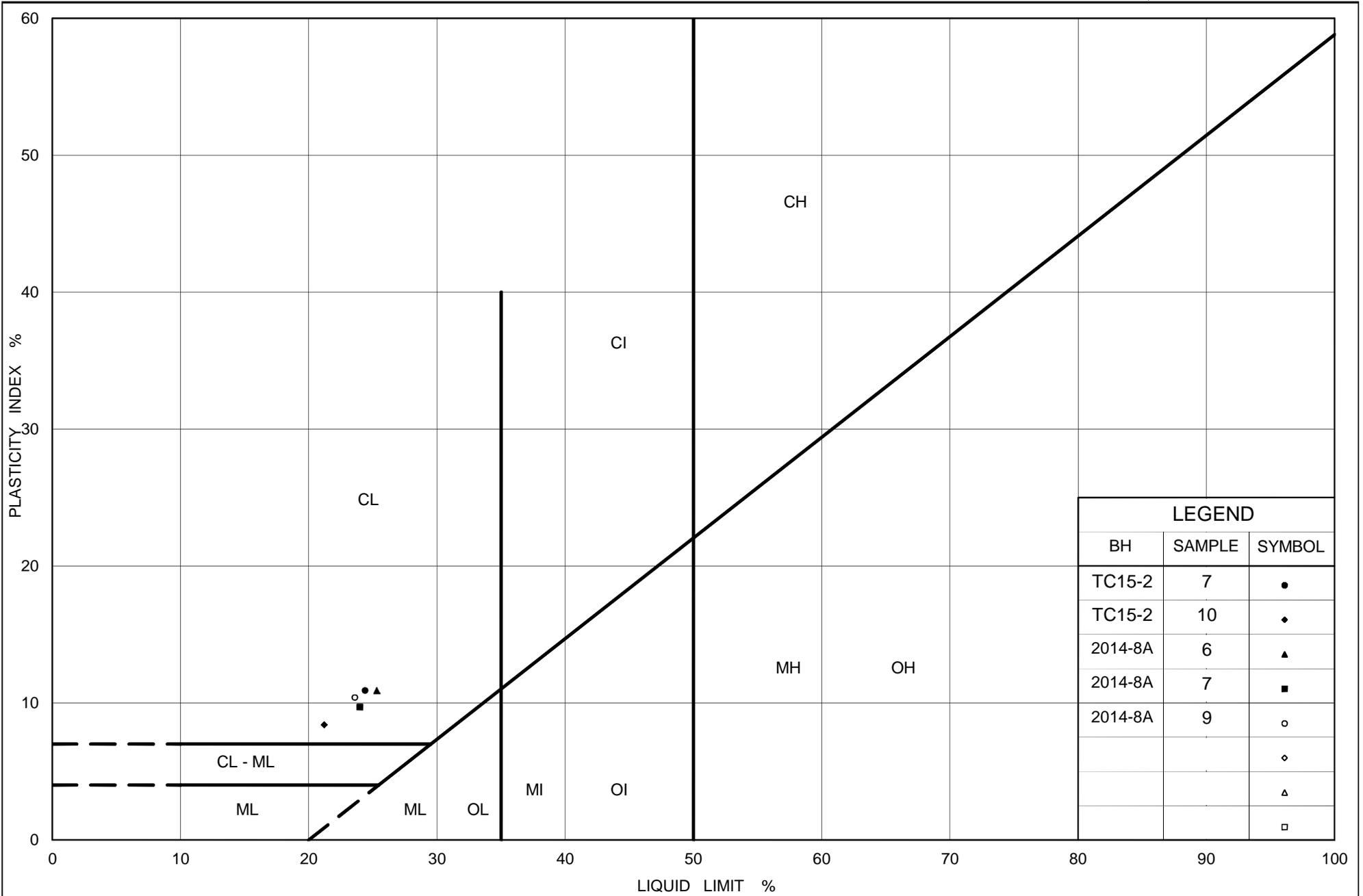
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	2014-8A	6	178.1
■	2014-8A	7	177.3
◆	TC15-2	8	178.9

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



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# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. C4

Project No. 10-1111-0211

Checked By: KJB



# **APPENDIX D**

**Borehole Records and Laboratory Test Results  
Culvert No. 9, Station 17+446  
TC15-8, TC15-9  
Figure D1 to Figure D5**

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No TC15-8</b>	SHEET 1 OF 1	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831457.2 ; E 288444.0</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>November 4, 2015</u>	CHECKED BY <u>KJB</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
189.6	GROUND SURFACE																
0.0	ASPHALT																
188.7	Sand and gravel, trace silt (FILL) Compact to dense Brown Moist		1	SS	42		189										
0.9	Clayey silt, some sand to sandy clayey silt, trace to some gravel, some silt seams (FILL) Stiff Dark brown Moist		2	SS	11		188										2 21 51 26
187.4	Sandy CLAYEY SILT to CLAYEY SILT with SAND, trace to some gravel, some silt seams, oxidation staining to a depth of 5.3 m (TILL) Stiff to hard Brown becoming grey below 4.4 m depth Moist		3	SS	12		187										4 26 50 20
2.2			4	SS	22		186										
			5	SS	28		185										
			6	SS	40		184										3 35 46 16
			7	SS	28		183										
			8	SS	16		182										
			9	SS	13												
			10	SS	14												
			11	SS	12												
181.4	END OF BOREHOLE																
8.2	NOTE: 1. Borehole dry upon completion of drilling.																

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No TC15-9</b>	SHEET 1 OF 1	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831412.9; E 288452.3</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>November 2, 2015</u>	CHECKED BY <u>KJB</u>	

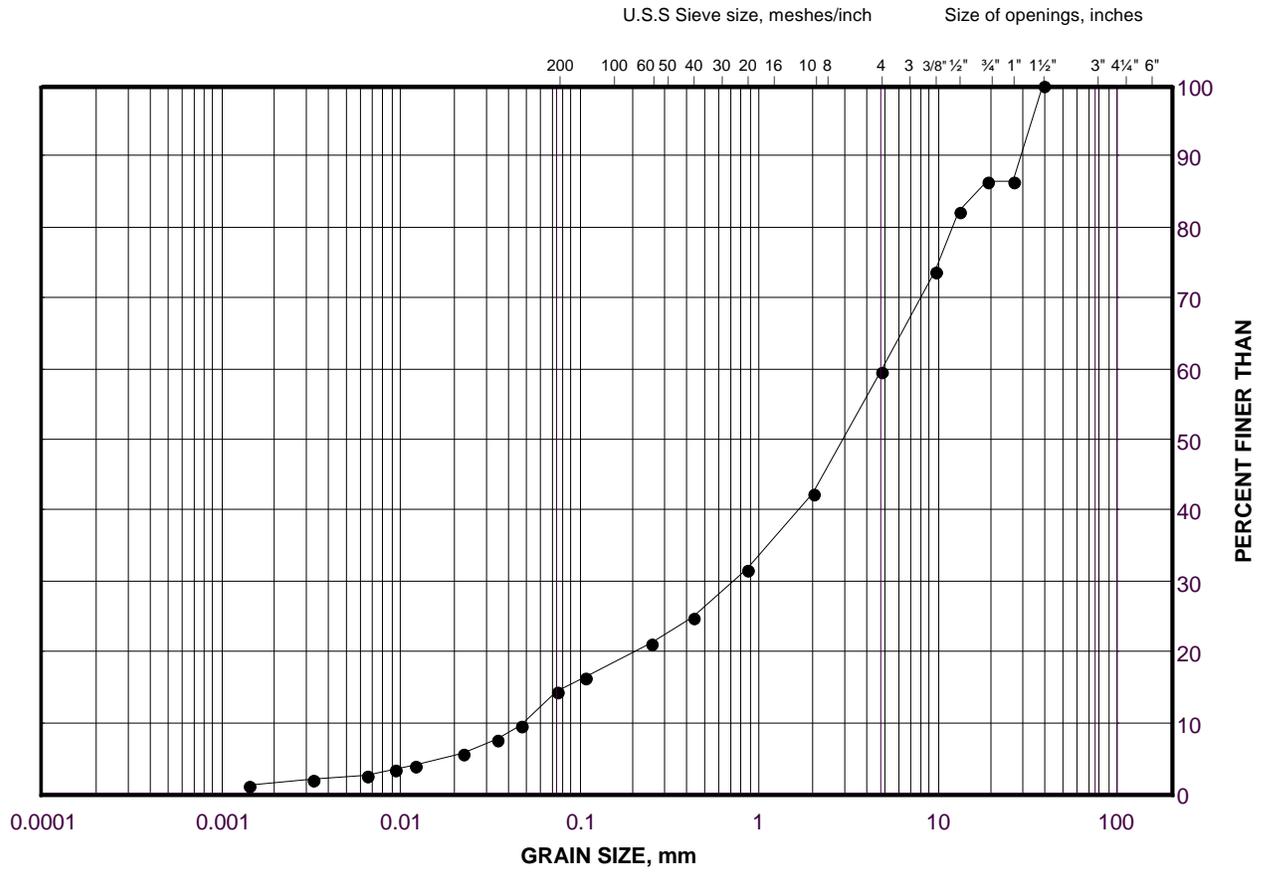
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40					
189.6	GROUND SURFACE													
0.0	ASPHALT													
	Sand and gravel, some silt (FILL) Compact Brown Moist		1	SS	26									40 45 13 2
188.7			2	SS	9									
0.9	Clayey silt to silty clay, trace to some sand, trace to some gravel (FILL) Firm to stiff Brown Moist		3	SS	6									
			4	SS	10									
186.6			5	SS	22									
3.0	Sandy CLAYEY SILT, some gravel (TILL) Stiff to hard Brown Moist		6	SS	34									9 29 45 17
			7	SS	31									
			8	SS	24									
			9	SS	17									
			10	SS	11									9 27 44 20
			11	SS	17									
181.4	END OF BOREHOLE													
8.2	NOTES:  1. Borehole dry upon completion of drilling.  2. Water level measured in piezometer:  Date      Depth (m)      Elev. (m) 11/19/15      5.5      184.1 12/16/15      2.2      187.4													

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# GRAIN SIZE DISTRIBUTION

Sand and Gravel (Fill)

FIGURE D1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	TC15-9	1	189.1

Project Number: 10-1111-0211

Checked By:           KJB          

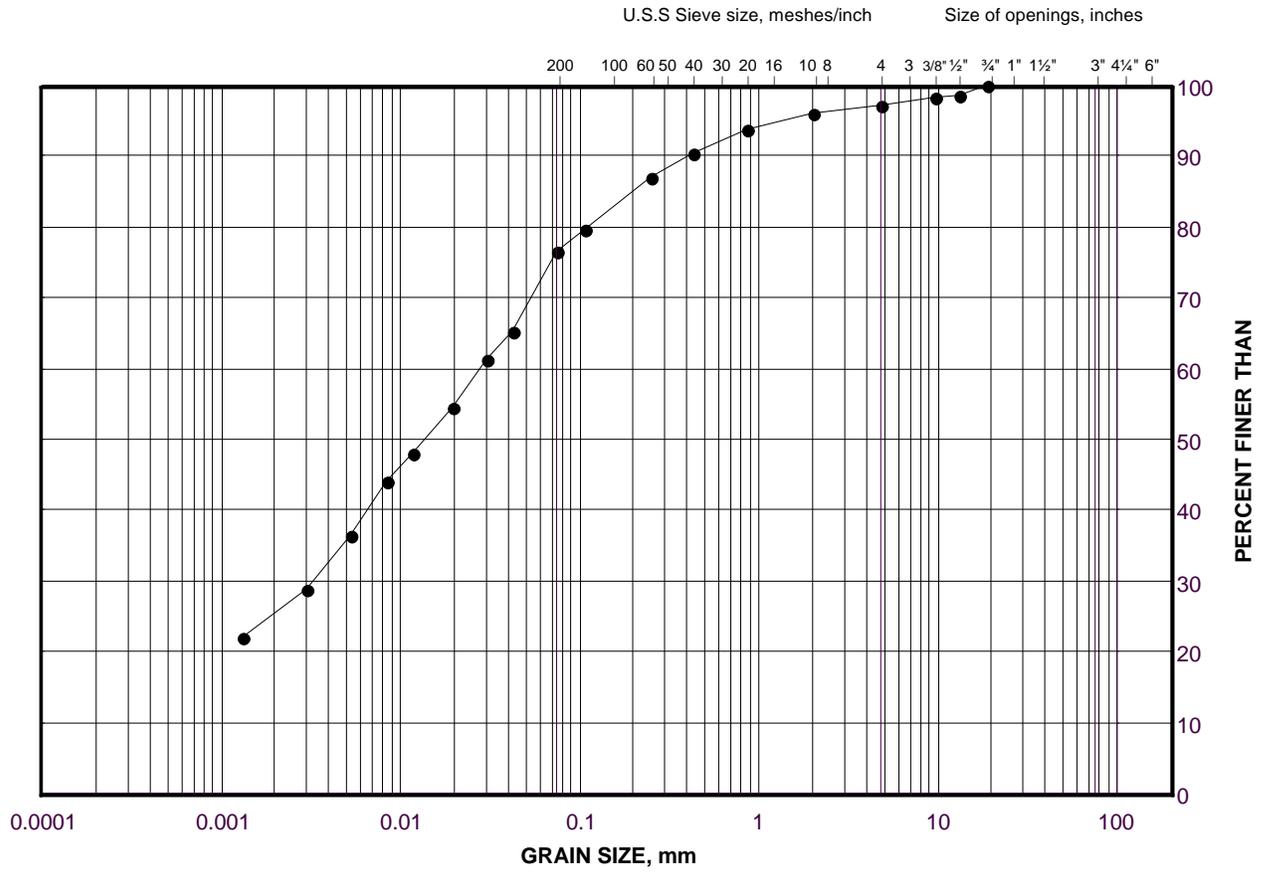
**Golder Associates**

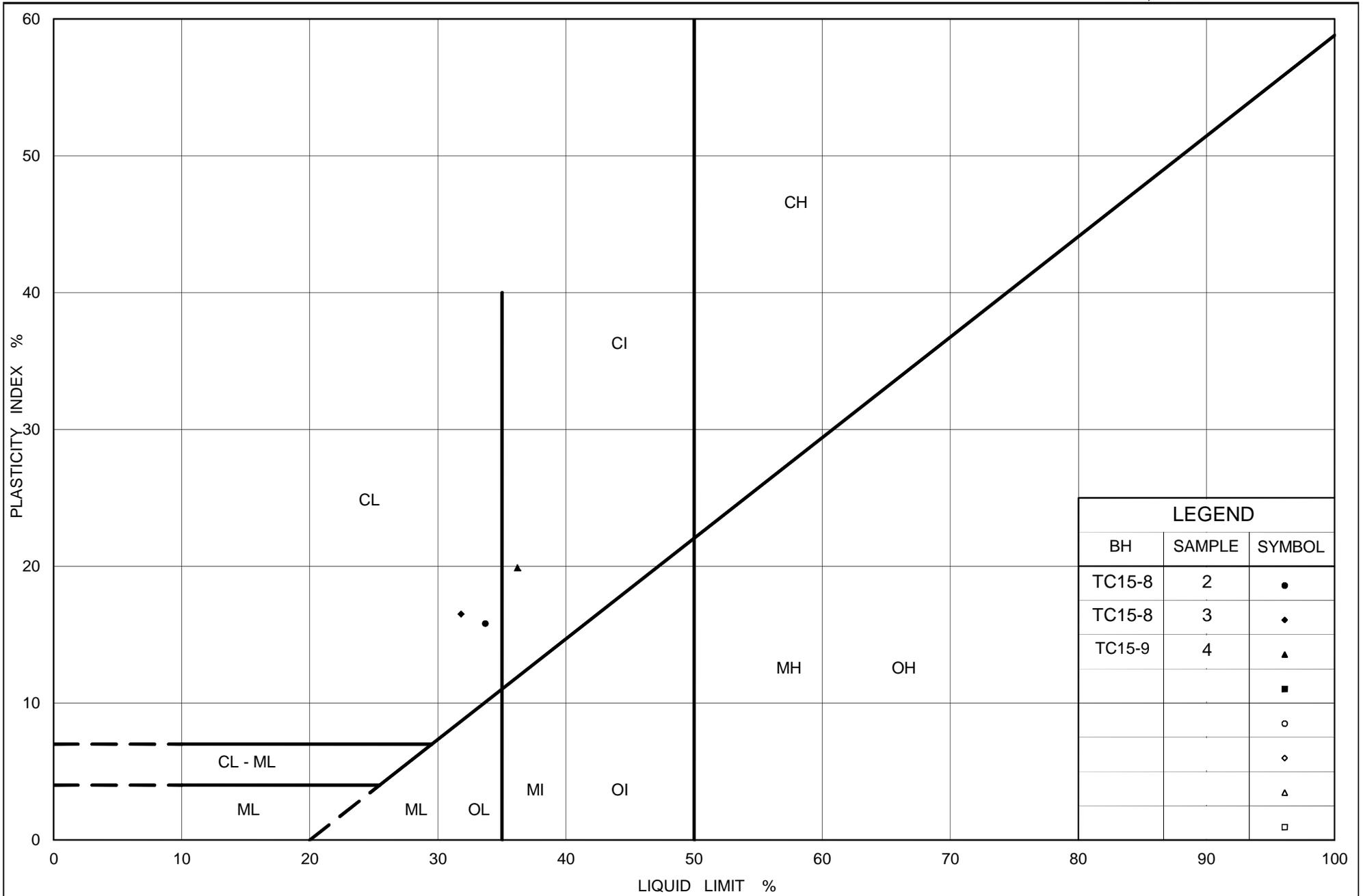
Date: 05-Jan-16

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

FIGURE D2





LEGEND		
BH	SAMPLE	SYMBOL
TC15-8	2	●
TC15-8	3	●
TC15-9	4	▲
		■
		○
		◇
		△
		□



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## PLASTICITY CHART

### Sandy Clayey Silt to Silty Clay (Fill)

Figure No. D3

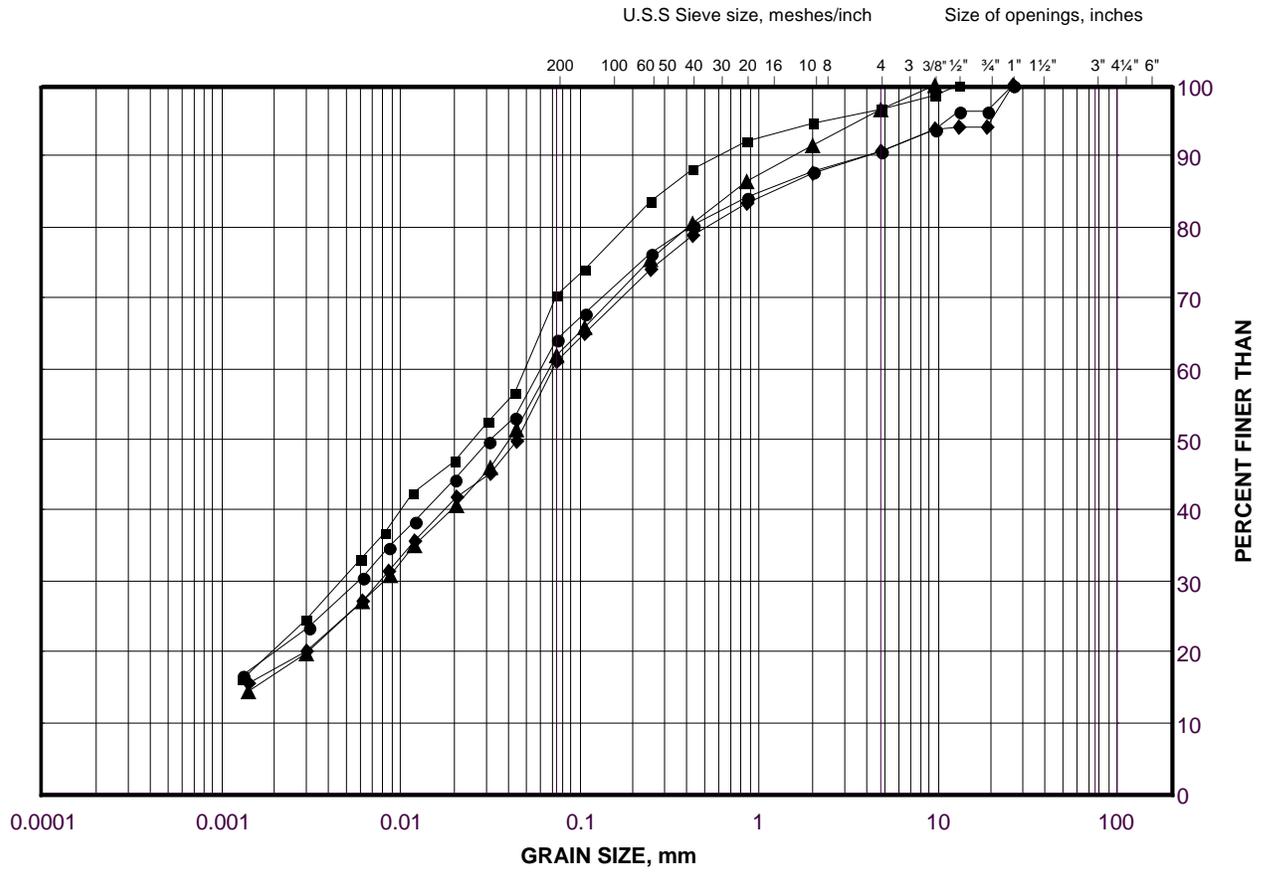
Project No. 10-1111-0211

Checked By: KJB

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE D4



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

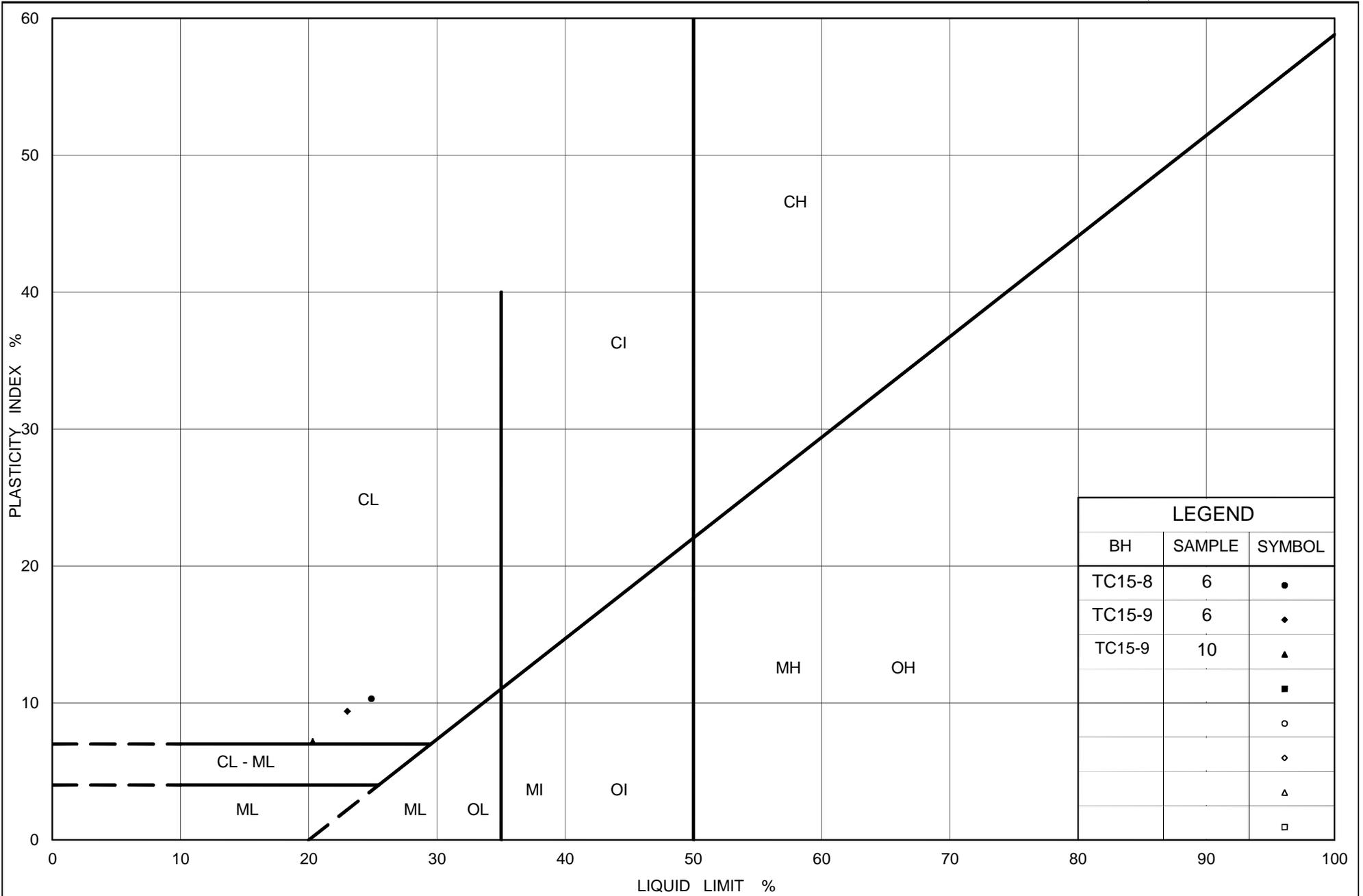
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-9	10	182.4
■	TC15-8	4	186.9
◆	TC15-9	6	185.5
▲	TC15-8	8	183.9

Project Number: 10-1111-0211

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Date: 05-Jan-16



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# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. D5

Project No. 10-1111-0211

Checked By: KJB



# **APPENDIX E**

**Borehole Records and Laboratory Test Results  
Culvert No. 10, Station 16+855  
TC15-1, TC15-3  
Figure E1 to Figure E4**

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No TC15-1</b>	SHEET 1 OF 1	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831248.9; E 287859.0</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>November 4, 2015</u>	CHECKED BY <u>KJB</u>	

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
							20	40	60	80	100	PLASTIC LIMIT $W_p$	NATURAL MOISTURE CONTENT $W$	LIQUID LIMIT $W_L$	GR	SA	SI	CL		
187.3	GROUND SURFACE																			
0.0	ASPHALT																			
186.5	Sand and gravel, trace silt (FILL) Dense Brown Moist		1	SS	35															
0.8	Clayey silt with gravel, some sand to sandy clayey silt with gravel, trace shale fragments, oxidation staining (FILL) Stiff to very stiff Grey Moist		2	SS	11															
			3	SS	17							○	┌───┐						35 23 30 12	
			4	SS	12							○								
			5	SS	13															
			6	SS	14							○							48 19 24 9	
			7	SS	26							○	┌───┐							
181.2	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff to very stiff Mottled grey/brown to grey Moist		8	SS	23															
6.1			9	SS	21							○	┌───┐						7 29 46 18	
			10	SS	8															
			11	SS	16							○								
176.0	END OF BOREHOLE																			
11.3	NOTES: 1. Water level at a depth of 10.4 m (Elev. 176.9 m) upon completion of drilling. 2. Water level measured in piezometer.  Date      Depth (m)      Elev. (m) 11/19/15      5.4      181.9 12/15/15      5.3      182.0																			

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 10-1111-0211 **RECORD OF BOREHOLE No TC15-3** SHEET 1 OF 1 **METRIC**  
 G.W.P. 2150-01-00 LOCATION N 4831238.8 ; E 287904.7 ORIGINATED BY QC  
 DIST Central HWY 401 BOREHOLE TYPE 150 mm O.D. Solid Stem Augers COMPILED BY AJS  
 DATUM GEODETIC DATE November 9, 2015 CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL	
185.8	GROUND SURFACE																						
0.0	Sandy clayey silt, trace to some gravel to sandy clayey silt with gravel, some silt pockets, oxidation staining (FILL) Firm to very stiff Brown to grey Moist		1	AS	-											○							
			2	SS	12											○							35 25 26 14
			3	SS	7																		
			4	SS	8																		
			5	SS	17											○	—	—					
			6	SS	17											○							8 27 46 19
181.3	CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff Brown becoming grey below 6.4 m depth Moist		7	SS	26											○	—	—					
4.5			8	SS	26																		
			9	SS	15																		
			10	SS	17											○	—	—					10 33 39 18
176.0	END OF BOREHOLE																						
9.8	NOTE: 1. Borehole dry upon completion of drilling.																						

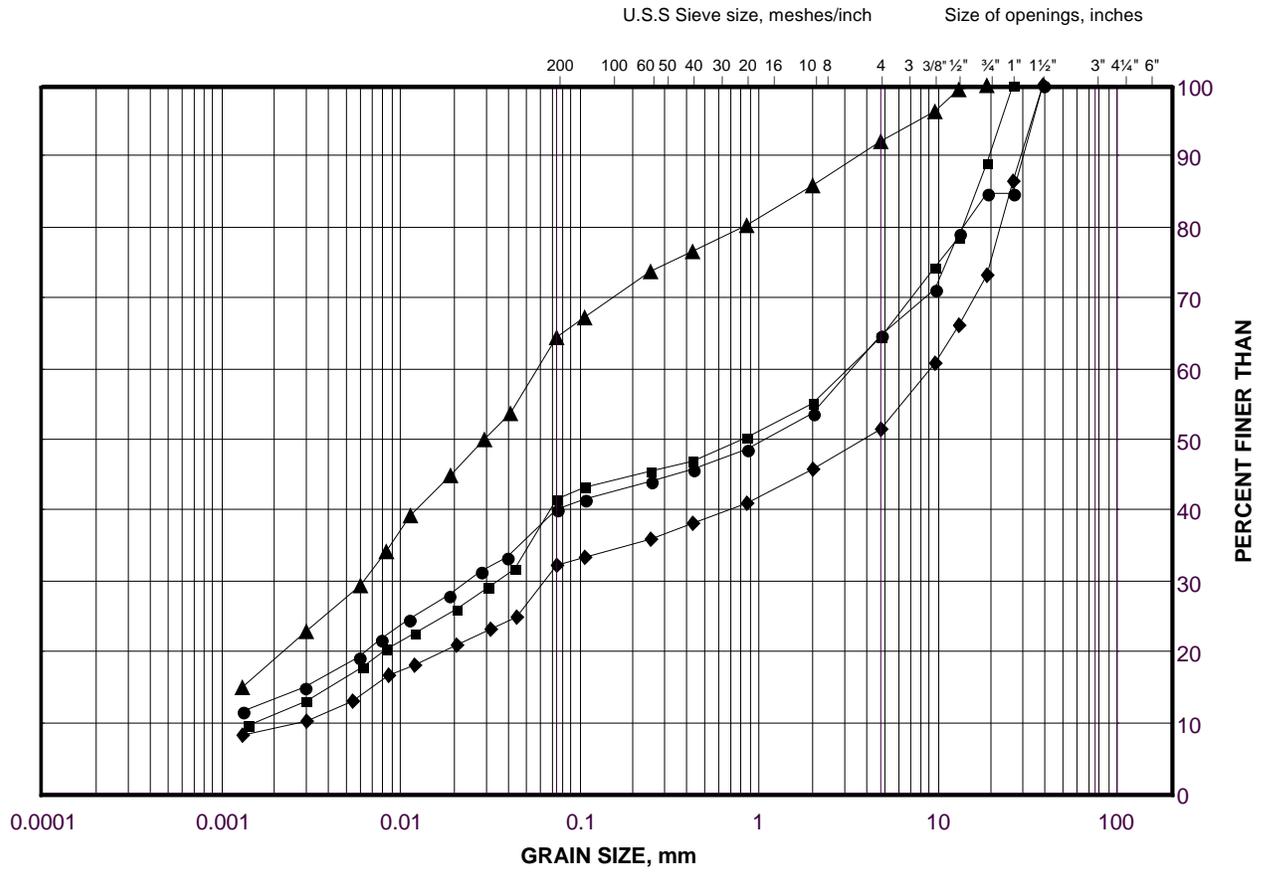
GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/21/16

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Gravel (Fill)

FIGURE E1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

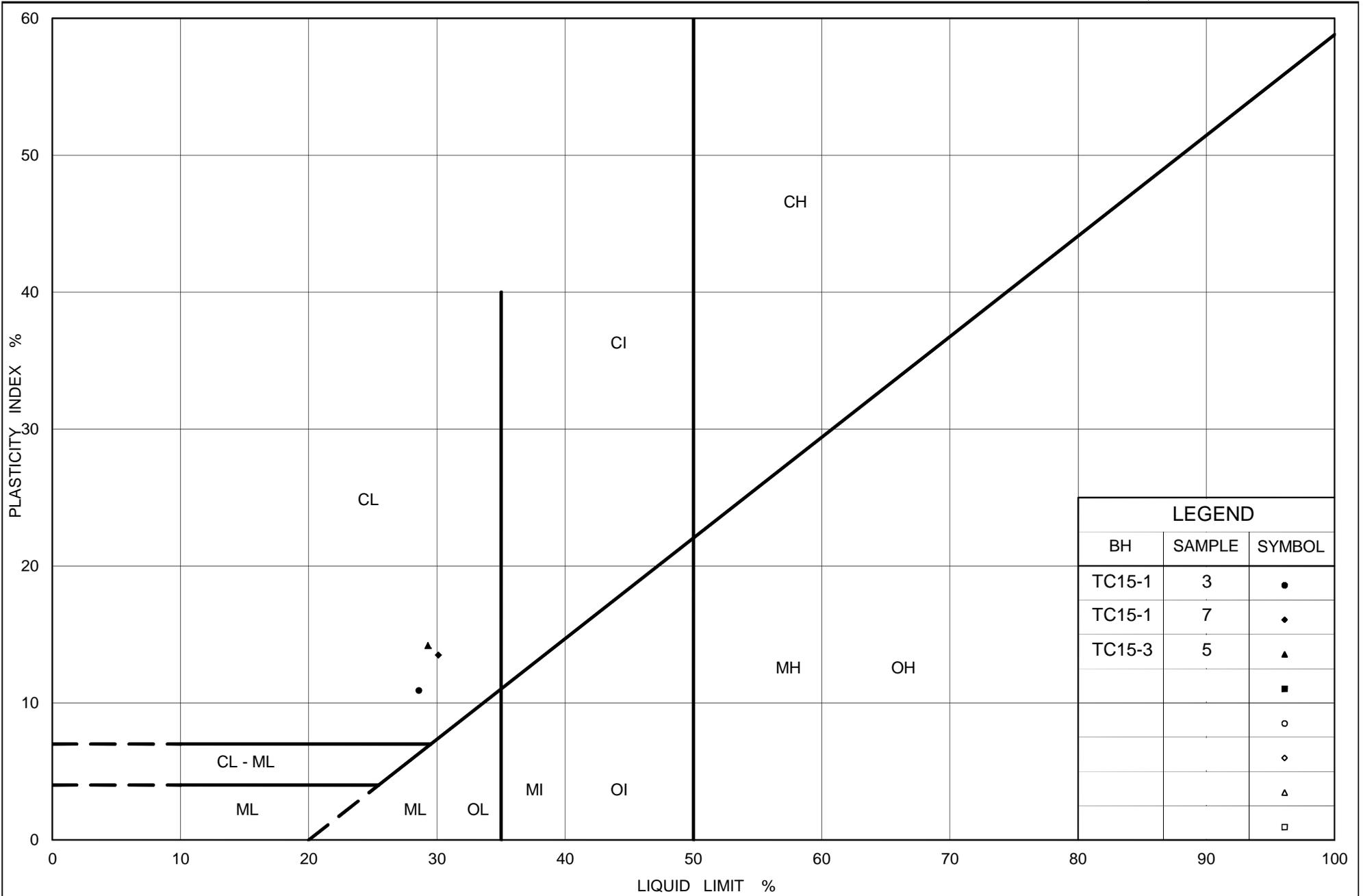
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-3	2	184.7
■	TC15-1	3	185.8
◆	TC15-1	6	183.6
▲	TC15-3	6	181.7

Project Number: 10-1111-0211

Checked By:           KJB          

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Date: 05-Jan-16



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## PLASTICITY CHART

### Sandy Clayey Silt to Clayey Silt with Gravel (Fill)

Figure No. E2

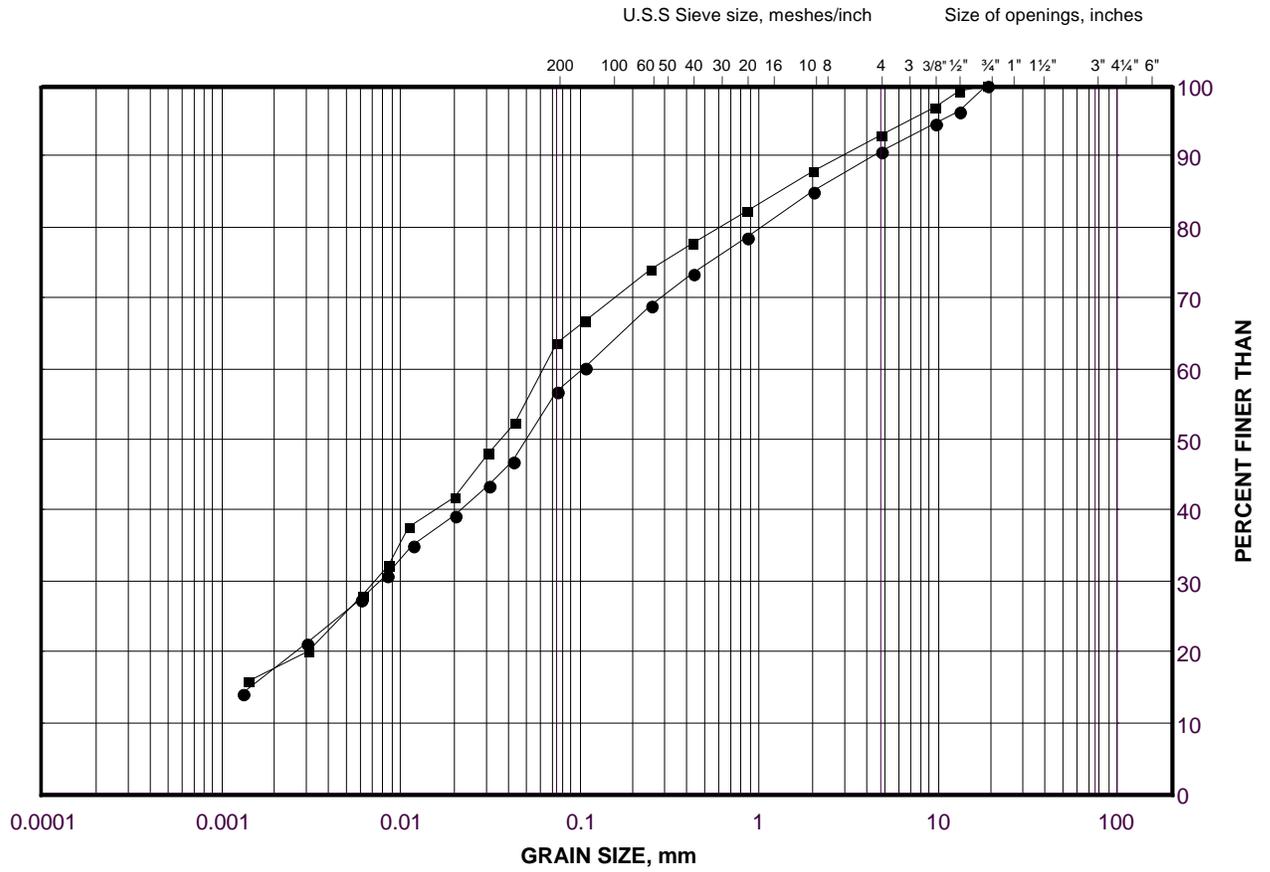
Project No. 10-1111-0211

Checked By: **KJB**

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE E3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

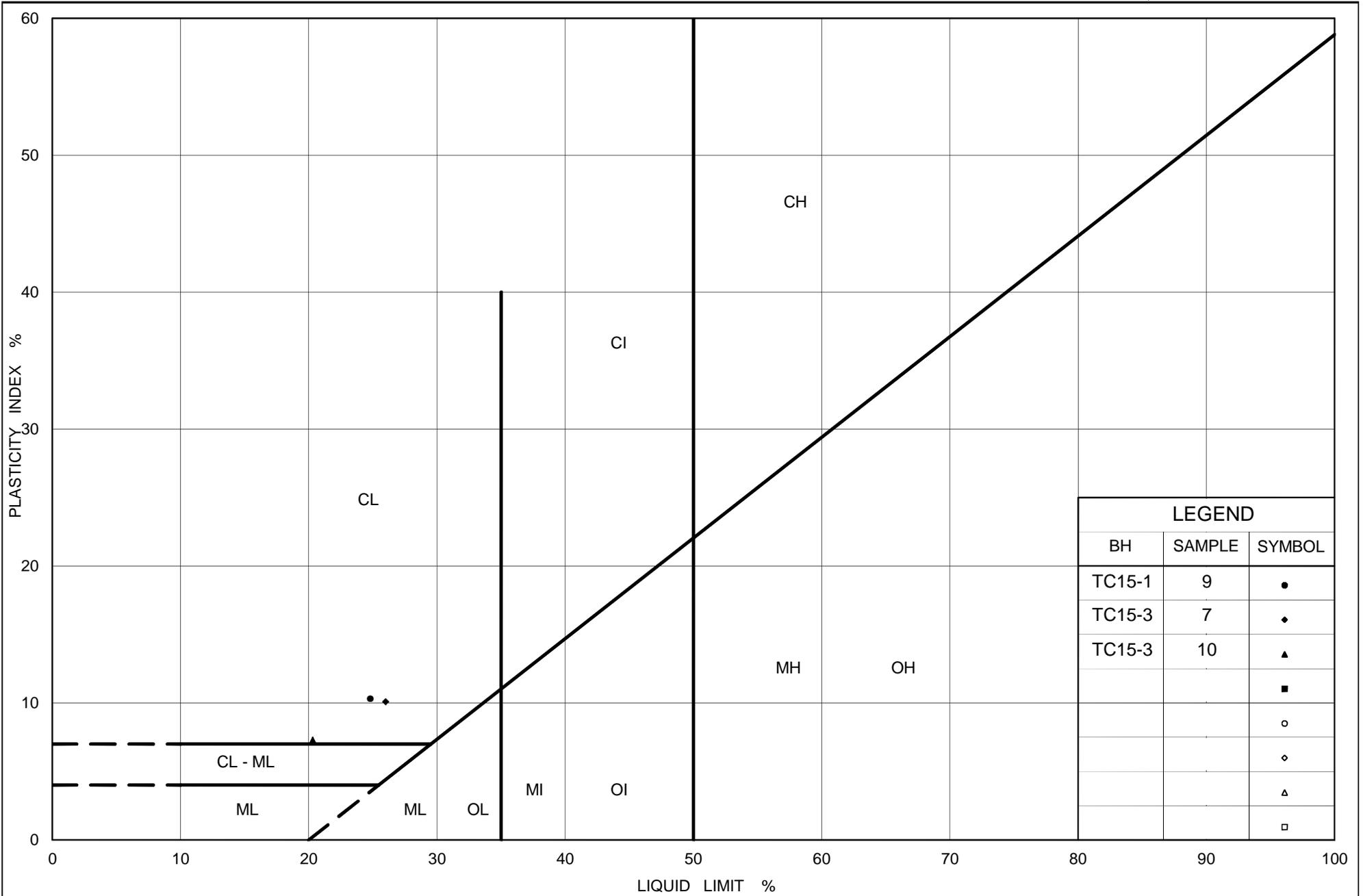
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-3	10	176.4
■	TC15-1	9	179.8

Project Number: 10-1111-0211

Checked By:           KJB          

**Golder Associates**

Date: 05-Jan-16



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# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. E4

Project No. 10-1111-0211

Checked By: **KJB**



# **APPENDIX F**

**Borehole Records and Laboratory Test Results  
Culvert No. 11A, Station 11+456  
TC15-3, TC15-5, MR-1, MR-2  
Figure F1 to Figure F9**

PROJECT 10-1111-0211 **RECORD OF BOREHOLE No TC15-3** SHEET 1 OF 1 **METRIC**  
 G.W.P. 2150-01-00 LOCATION N 4831238.8 ; E 287904.7 ORIGINATED BY QC  
 DIST Central HWY 401 BOREHOLE TYPE 150 mm O.D. Solid Stem Augers COMPILED BY AJS  
 DATUM GEODETIC DATE November 9, 2015 CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
185.8 0.0	GROUND SURFACE Sandy clayey silt, trace to some gravel to sandy clayey silt with gravel, some silt pockets, oxidation staining (FILL) Firm to very stiff Brown to grey Moist		1	AS	-											
			2	SS	12										35 25 26 14	
			3	SS	7											
			4	SS	8											
			5	SS	17											
			6	SS	17										8 27 46 19	
181.3 4.5	CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff Brown becoming grey below 6.4 m depth Moist		7	SS	26											
			8	SS	26											
			9	SS	15											
			10	SS	17										10 33 39 18	
176.0 9.8	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling.															

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No TC15-5** SHEET 1 OF 1 **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831301.4 ; E 288003.9 **ORIGINATED BY** QC  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 150 mm O.D. Solid Stem Augers **COMPILED BY** AJS  
**DATUM** GEODETIC **DATE** November 9, 2015 **CHECKED BY** KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20	40	60	80	100	10	20
185.8	GROUND SURFACE																							
8.9	TOPSOIL																							
	Clayey silt, some sand, trace to some gravel, contains silt pockets (FILL) Firm to very stiff Mottled grey and brown Moist		1	SS	6																			
			2	SS	11																			2 10 48 40
			3	SS	18																			
183.6																								
2.2	Sandy CLAYEY SILT, some gravel (TILL) Stiff to very stiff Brown becoming grey below 4.0 m depth Moist		4	SS	26																			12 29 43 16
			5	SS	28																			
			6	SS	16																			
			7	SS	12																			
			8	SS	13																			
			9	SS	8																			
			10	SS	9																			
			11	SS	9																			
177.6	END OF BOREHOLE																							
8.2	NOTE: 1. Borehole dry upon completion of drilling.																							

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 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



**RECORD OF BOREHOLE No MR-1**      SHEET 2 OF 3      **METRIC**

PROJECT 10-1111-0211      G.W.P. 2150-01-00      LOCATION N 4831249.0; E 287997.7      ORIGINATED BY SB

DIST Central      HWY 401      BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers      COMPILED BY CC/TVA

DATUM GEODETIC      DATE June 6 and 7, 2012      CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
	--- CONTINUED FROM PREVIOUS PAGE ---															
	CLAYEY SILT with SAND, trace to some gravel (TILL) Stiff to hard Brown Moist	[Hatched Pattern]	13	SS	18											
179																
178																
177																
176																
175																
174																
173																
170			18	SS	86											
169.6 25.2	END OF BOREHOLE															
	Dynamic Cone Penetration Test (DCPT)															
168.2 26.5	END OF DCPT Refusal to Further Penetration (246 Blows / 0.3 m)															

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/08/16

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE





**RECORD OF BOREHOLE No MR-2**      SHEET 2 OF 3      **METRIC**

PROJECT 10-1111-0211      G.W.P. 2150-01-00      LOCATION N 4831239.6 ; E 287971.8      ORIGINATED BY SB

DIST Central      HWY 401      BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers      COMPILED BY CC/TVA

DATUM GEODETIC      DATE May 22 to 23, 2012      CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10	20
-- CONTINUED FROM PREVIOUS PAGE --																							
	CLAYEY SILT with SAND, trace to some gravel (TILL) Stiff to hard Brown Moist	13	SS	21		180																	
		14	SS	18		179																	
		15	SS	12		178																	
		16	SS	19		177																	
		17	SS	15		176																	
		18	SS	83		175																	
		19	SS	116		174																	
		20	SS	84		173																	
		21A	SS	39		172																	
		21B	SS	39		171																	
	22	SS	64		170																		
168.0	27.1	SILTY CLAY, trace sand, trace gravel Hard Grey Wet				168																	
167.4	27.7	Silty SAND and GRAVEL, trace clay Dense Grey Wet				167																	
166.4	28.7	SAND and SILT, trace to some gravel, trace to some clay (TILL) Compact to very dense Grey Wet				166																	

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Continued Next Page

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT 10-1111-0211 **RECORD OF BOREHOLE No MR-2** SHEET 3 OF 3 **METRIC**  
 G.W.P. 2150-01-00 LOCATION N 4831239.6; E 287971.8 ORIGINATED BY SB  
 DIST Central HWY 401 BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers COMPILED BY CC/TVA  
 DATUM GEODETIC DATE May 22 to 23, 2012 CHECKED BY KJB

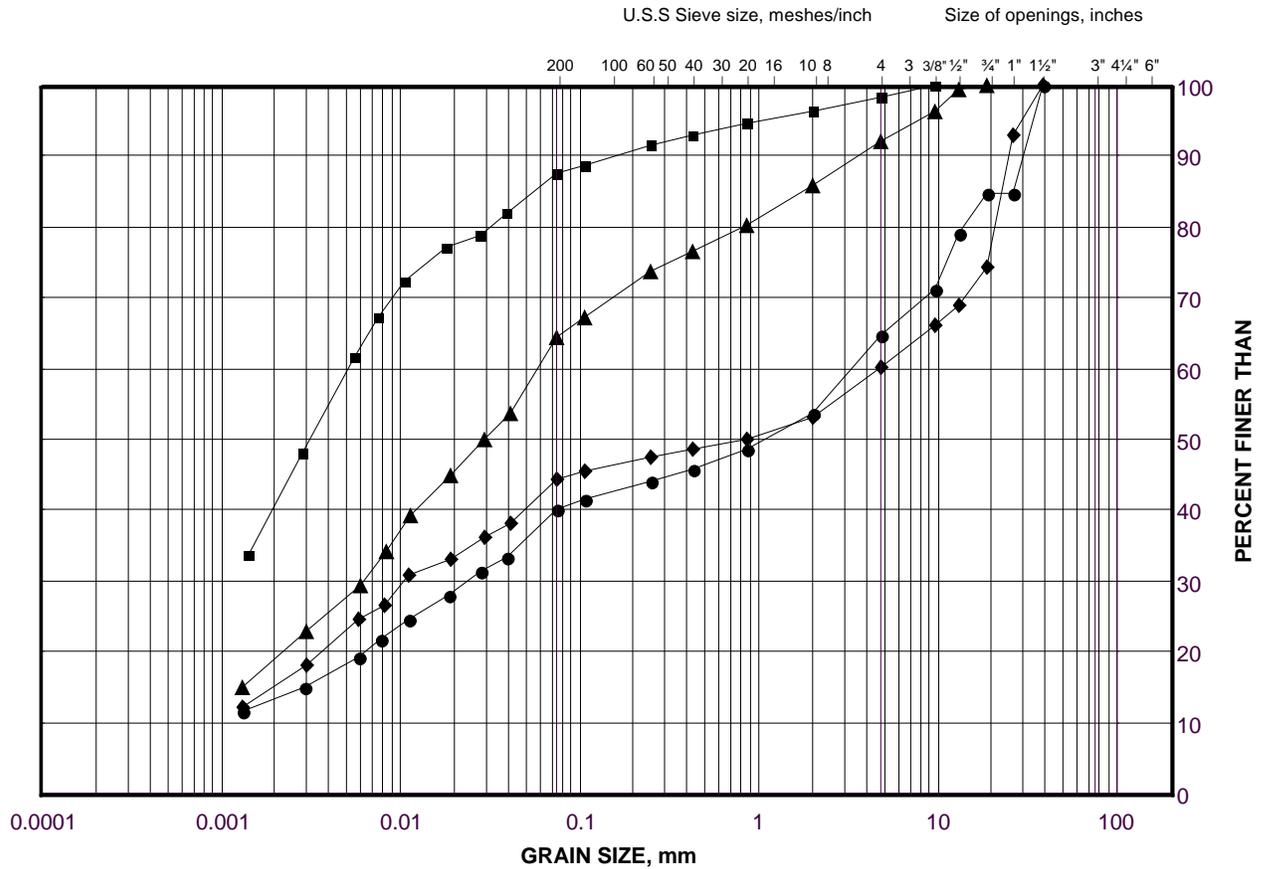
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
--- CONTINUED FROM PREVIOUS PAGE ---																	
	SAND and SILT, trace to some gravel, trace to some clay (TILL) Compact to very dense Grey Wet Frequent shale fragment inclusions below a depth of 30.5 m		23	SS	61		165									9 38 43 10	
			24	SS	29		164										
159.1 36.0	SAND and GRAVEL, some silt, trace clay Compact Grey Wet		25	SS	11		159									32 51 15 2	
157.9 37.2	END OF BOREHOLE  Dynamic Cone Penetration Test (DCPT)						158										
156.1 39.0	END OF DCPT Refusal to Further Penetration (200 Blows / 0.15 m)  NOTE: 1. Water level inside augers at a depth of 19.8 m below ground surface (Elev. 175.3 m), measured at the start of work day on May 22, 2012.						157										

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/08/16

# GRAIN SIZE DISTRIBUTION

Silty Clay with Gravel to Clayey Silt to Sandy Clayey Silt to Sandy  
Clayey Silt with Gravel (Fill)

FIGURE F1



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

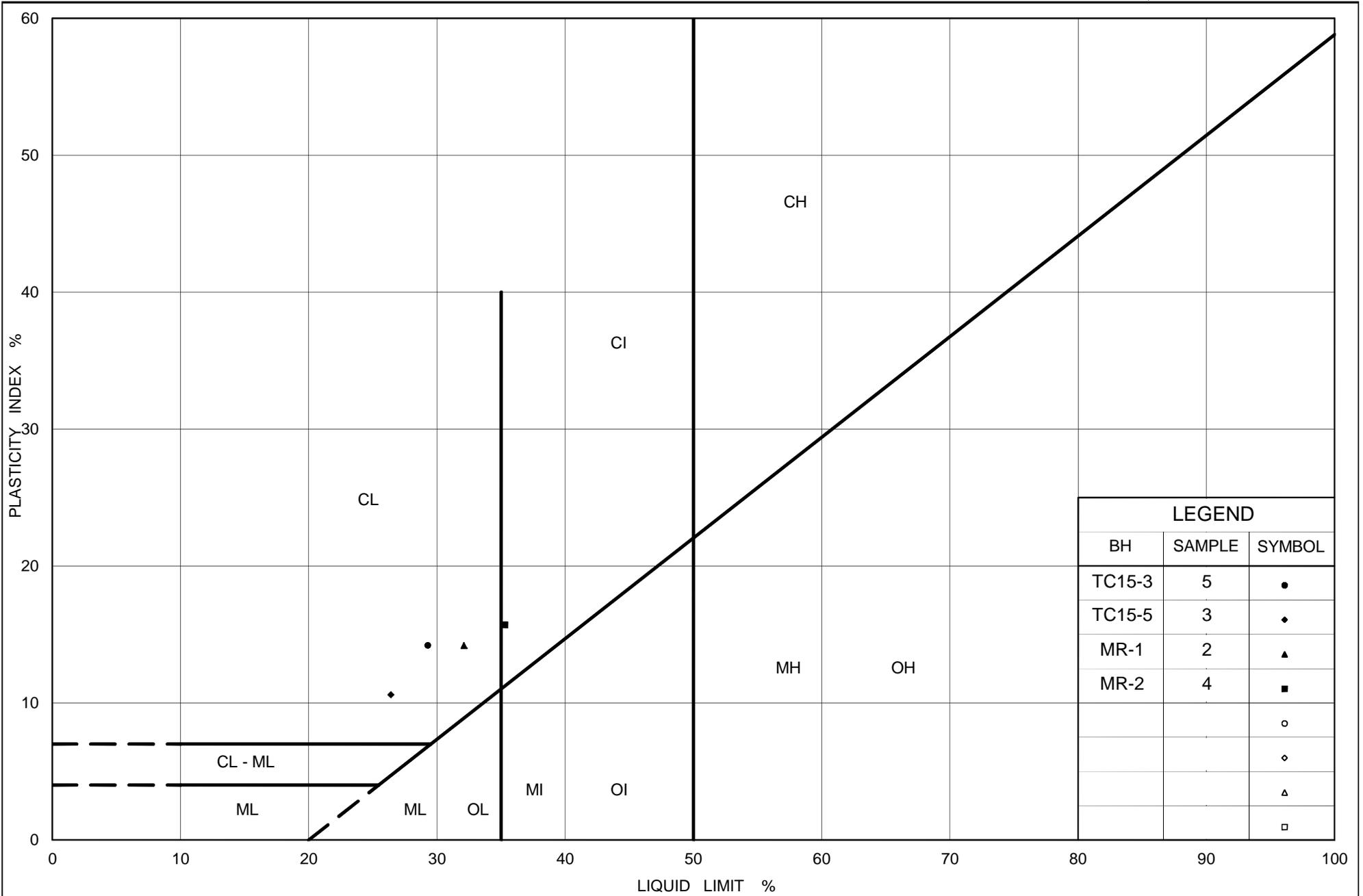
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-3	2	184.7
■	TC15-5	2	184.7
◆	MR-2	4	191.7
▲	TC15-3	6	181.7

Project Number: 10-1111-0211

Checked By:           KJB          

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# PLASTICITY CHART

## Silty Clay with Gravel to Clayey Silt to Sandy Clayey Silt (Fill)

Figure No. F2

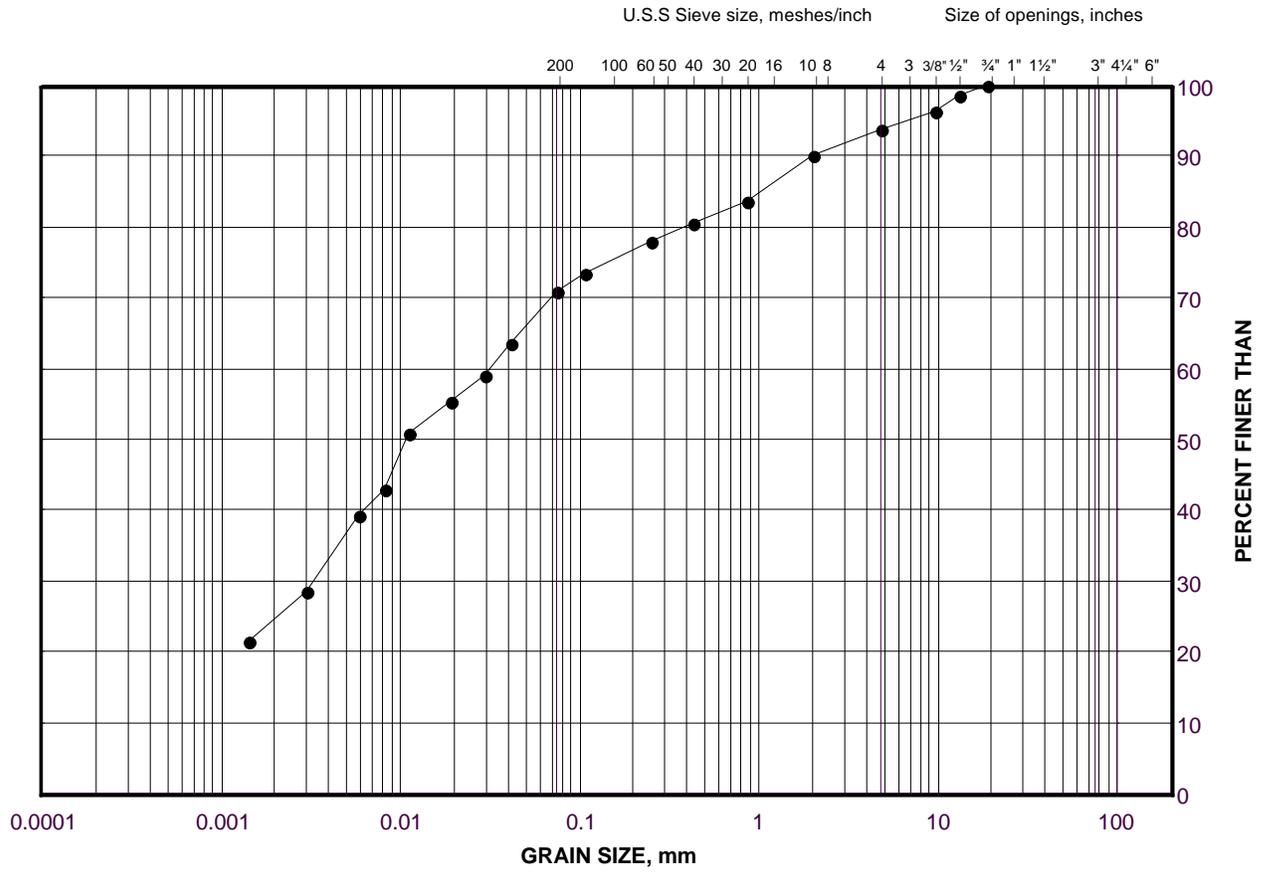
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# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE F3



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

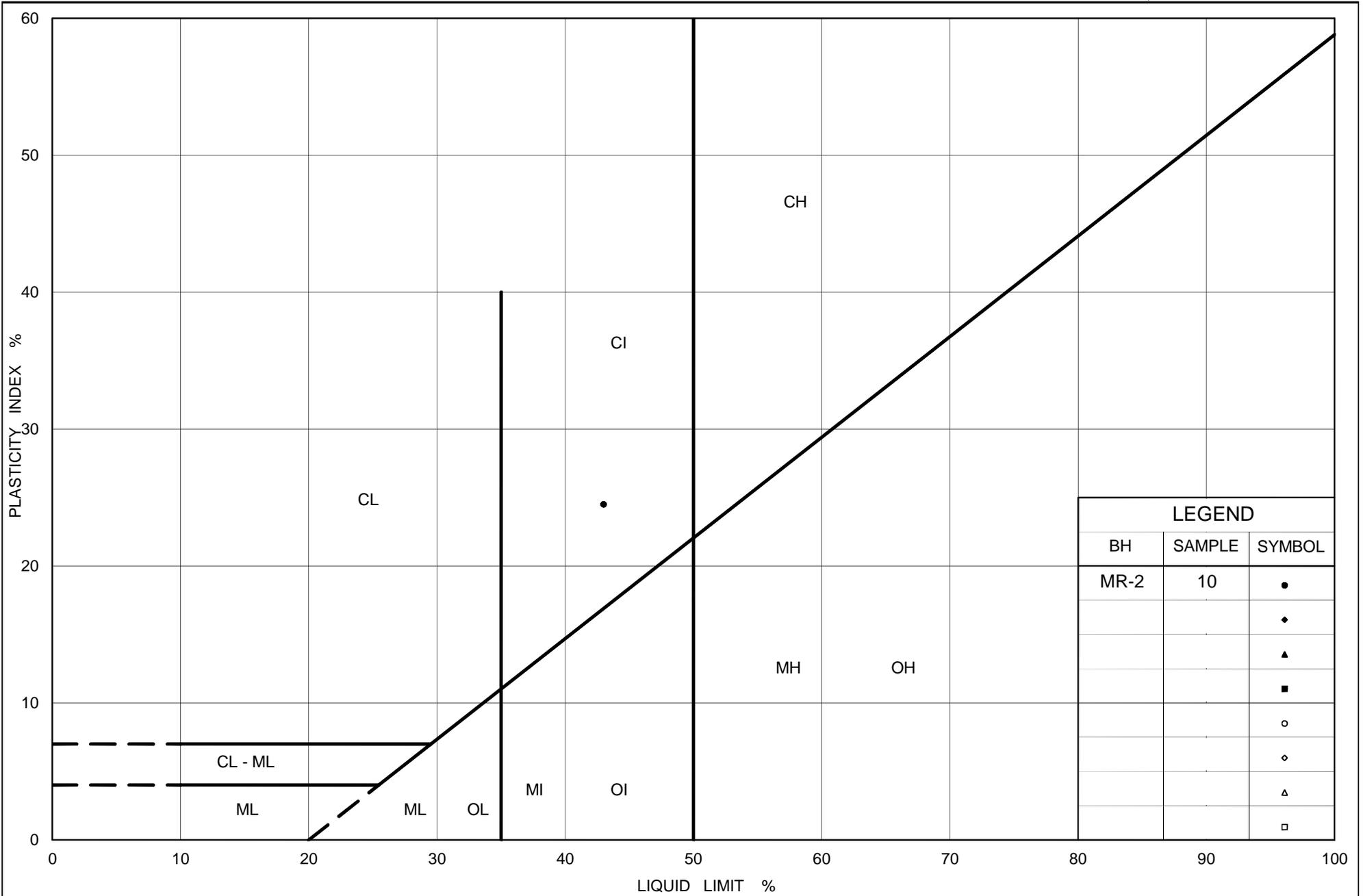
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	MR-1	10	183.7

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# PLASTICITY CHART

## Silty Clay

Figure No. F4

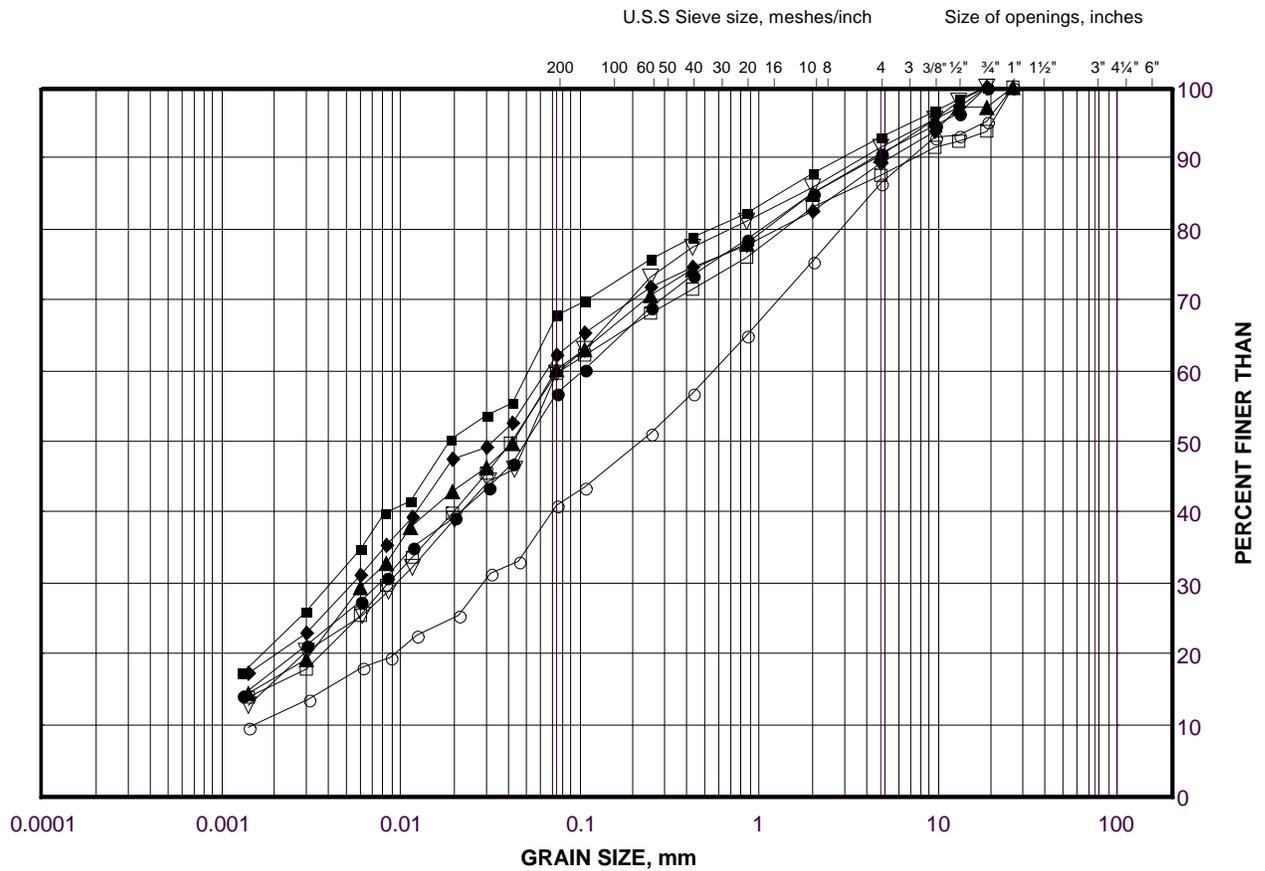
Project No. 10-1111-0211

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# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

## FIGURE F5



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

### LEGEND

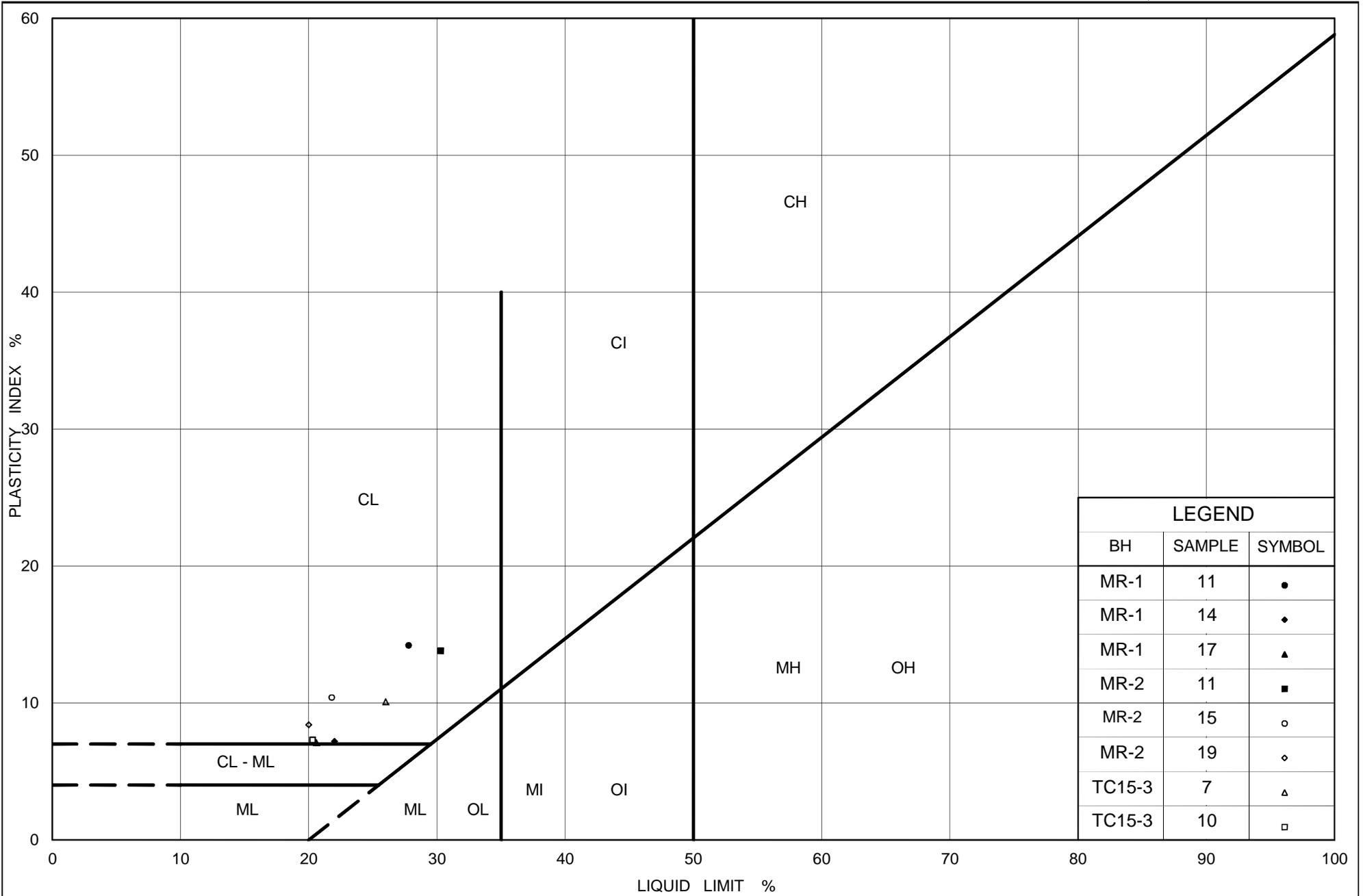
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-3	10	176.4
■	MR-1	11	182.2
◆	MR-2	11	182.6
▲	MR-2	15	176.5
▽	MR-1	17	173.1
○	MR-2	19	170.5
□	TC15-5	4	183.2

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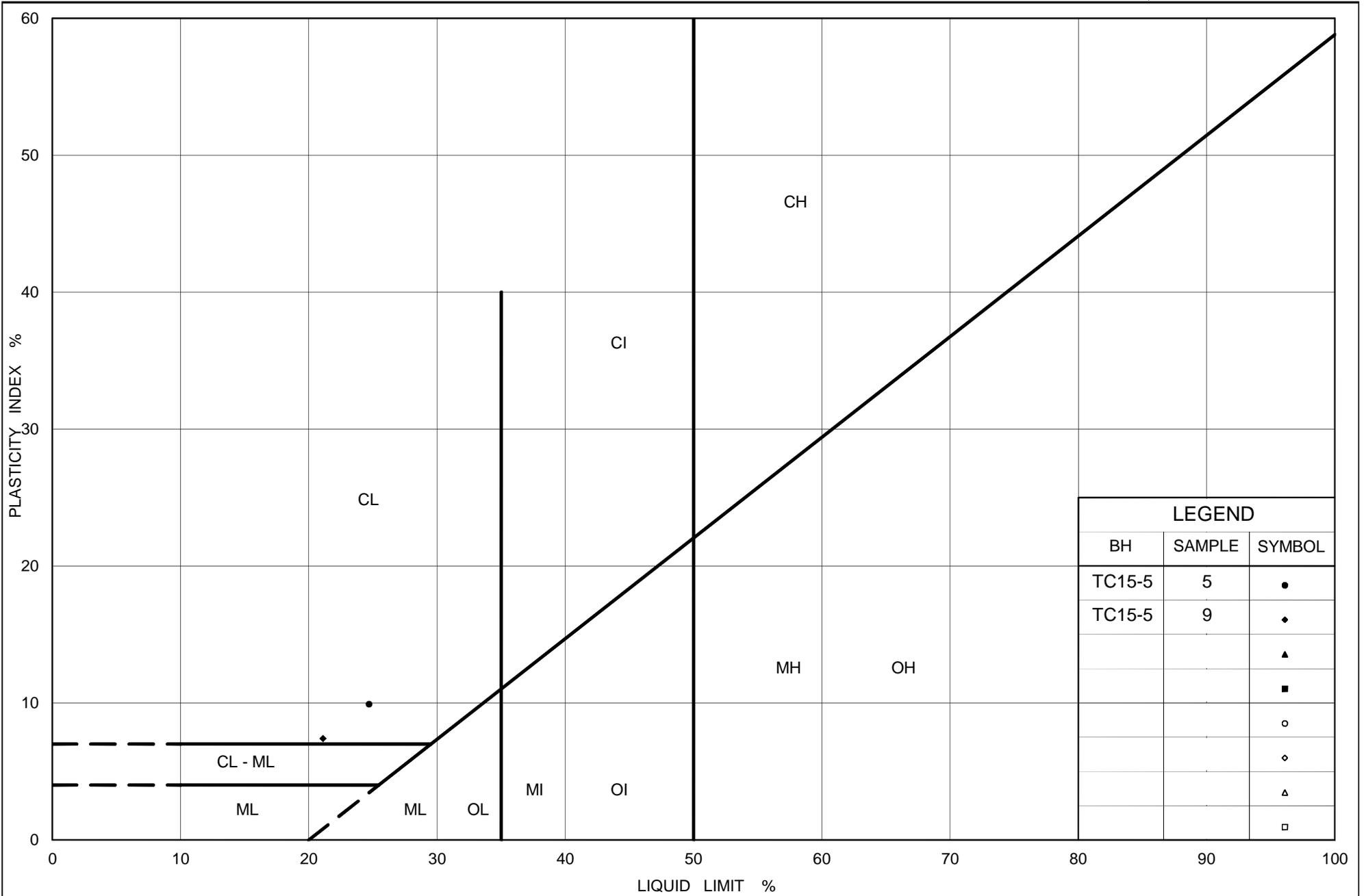
# PLASTICITY CHART

## Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. F6-A

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## PLASTICITY CHART Sandy Clayey Silt (Till)

Figure No. F6-B

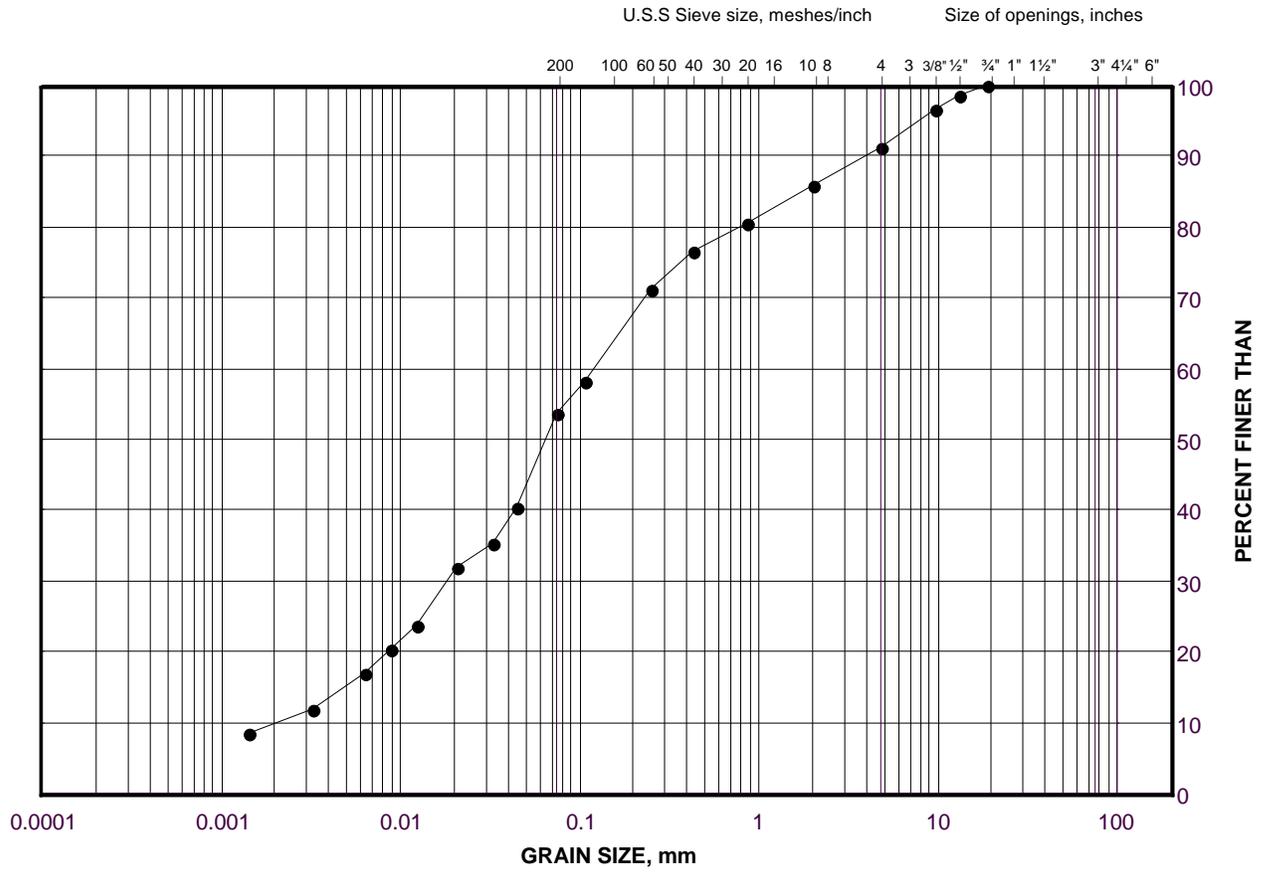
Project No. 10-1111-0211

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# GRAIN SIZE DISTRIBUTION

Sand and Silt (Till)

FIGURE F7



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

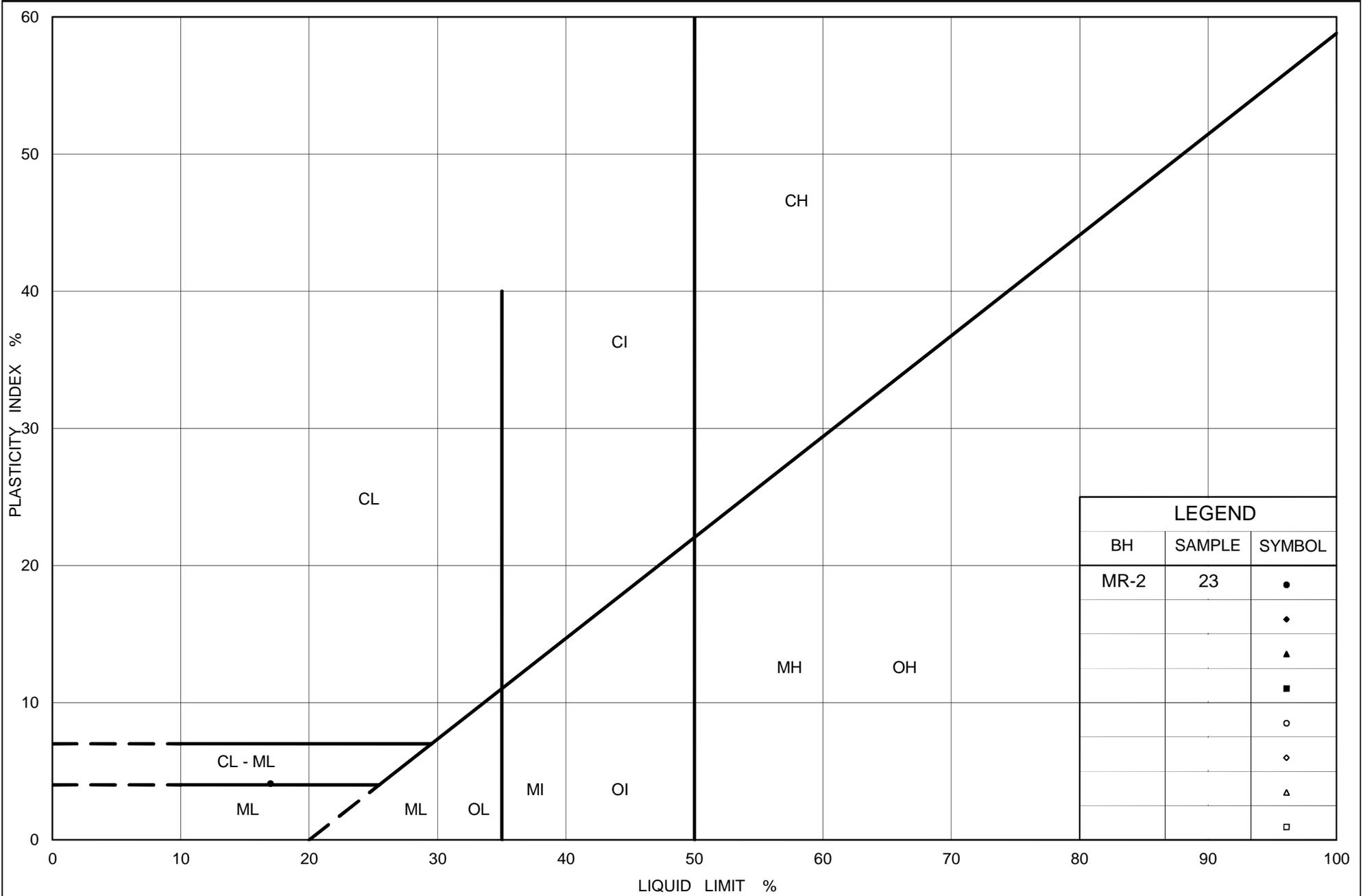
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	MR-2	23	164.3

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LEGEND		
BH	SAMPLE	SYMBOL
MR-2	23	●
		◆
		▲
		■
		○
		◇
		△
		□



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# PLASTICITY CHART

## Sand and Silt (Till)

Figure No. F8

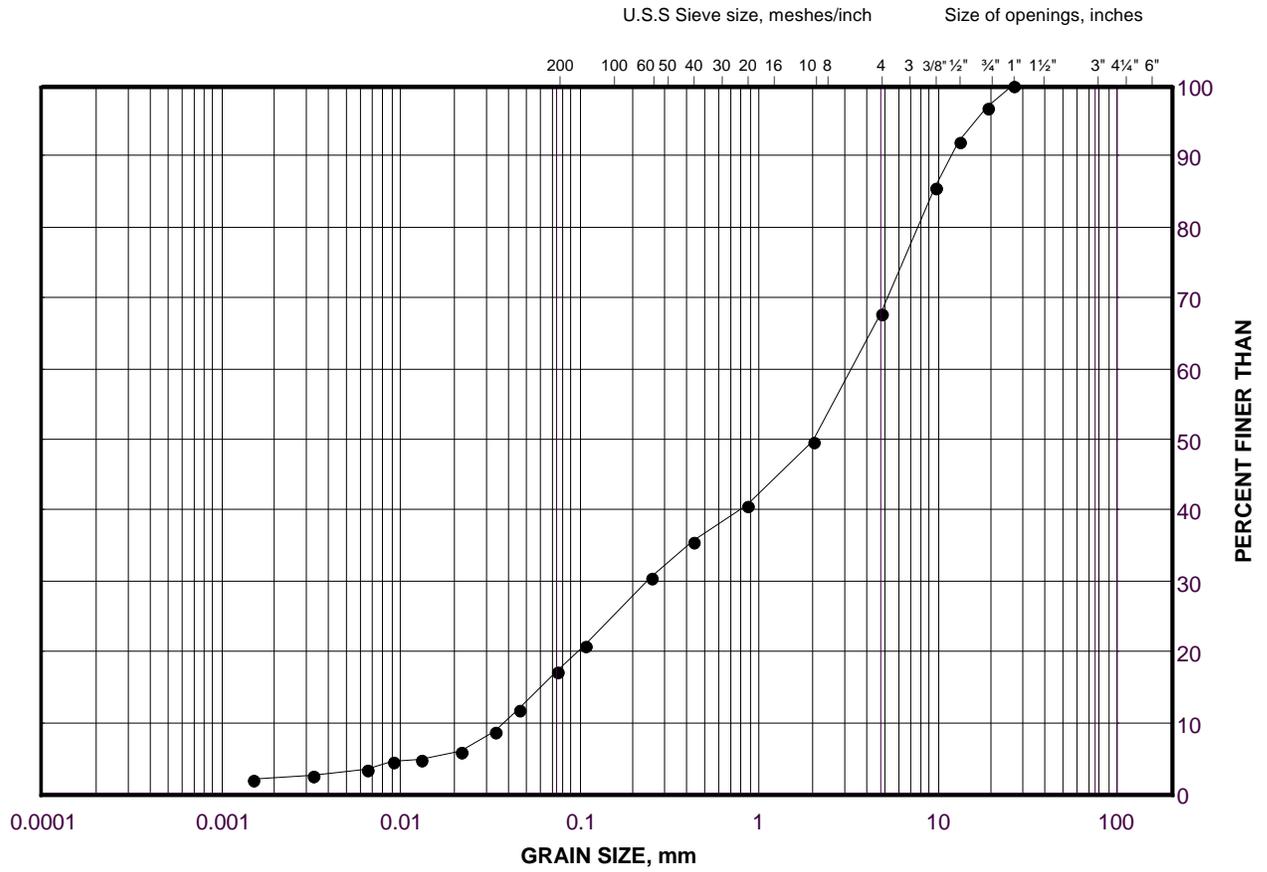
Project No. 10-1111-0211

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# GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE F9



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	MR-2	25	158.2

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# **APPENDIX G**

**Borehole Records and Laboratory Test Results  
Culvert No. 12, Station 17+145  
TC15-6, TC15-7  
Figure G1 to Figure G4**

**PROJECT** 10-1111-0211 **RECORD OF BOREHOLE No TC15-6** **SHEET 1 OF 1** **METRIC**  
**G.W.P.** 2150-01-00 **LOCATION** N 4831376.5 ; E 288156.4 **ORIGINATED BY** QC  
**DIST** Central **HWY** 401 **BOREHOLE TYPE** 150 mm O.D. Solid Stem Augers **COMPILED BY** AJS  
**DATUM** GEODETIC **DATE** November 5, 2015 **CHECKED BY** KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10
188.4	GROUND SURFACE																					
0.0	TOPSOIL																					
187.7	Clayey silt, some sand, trace gravel, some rootlets (FILL) Firm	1	SS	7																		
0.7	Mottled brown Moist																					
	Sandy CLAYEY SILT to CLAYEY SILT with SAND, trace to some gravel (TILL) Stiff to hard	2	SS	31																		
	Mottled brown to grey Moist																					
		3	SS	35																		5 25 47 23
		4	SS	25																		
		5	SS	23																		
		6	SS	16																		7 31 45 17
		7	SS	14																		
		8	SS	11																		
		9	SS	12																		
		10	SS	17																		9 32 44 15
		11	SS	11																		
180.2	END OF BOREHOLE																					
8.2	NOTES: 1. Borehole dry upon completion of drilling. 2. Water level measured in piezometer.  Date 11/19/15    Depth (m) 3.4    Elev. (m) 185.0																					

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 01/21/16

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity    ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	<b>RECORD OF BOREHOLE No TC15-7</b>	SHEET 1 OF 1	<b>METRIC</b>
G.W.P. <u>2150-01-00</u>	LOCATION <u>N 4831351.4 ; E 288147.9</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Hollow Stem Augers</u>	COMPILED BY <u>AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>November 5, 2015</u>	CHECKED BY <u>KJB</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
189.9	GROUND SURFACE													
0.0	ASPHALT													
0.2	Sand and gravel (FILL) Compact Brown Moist		1	SS	23									
189.1	Sandy clayey silt, trace to some gravel, containing silt seams and pockets, oxidation staining (FILL) Firm to stiff Mottled brown		2	SS	7		189							
0.8			3	SS	12		188							
			4	SS	13		187						5	24 47 24
186.9	Sandy CLAYEY SILT to CLAYEY SILT with SAND, some gravel, oxidation staining to a depth of 8.2 m (TILL) Very stiff to hard Mottled grey to brown becoming grey below 6.1 m depth Moist		5	SS	21		186							
3.0			6	SS	28		185							
			7	SS	47		184							
			8	SS	59		183							
			9	SS	35		182							
			10	SS	19		181							
			11	SS	17		180							
			12	SS	17		179							
178.6	END OF BOREHOLE													
11.3	NOTE: 1. Borehole dry upon completion of drilling.													

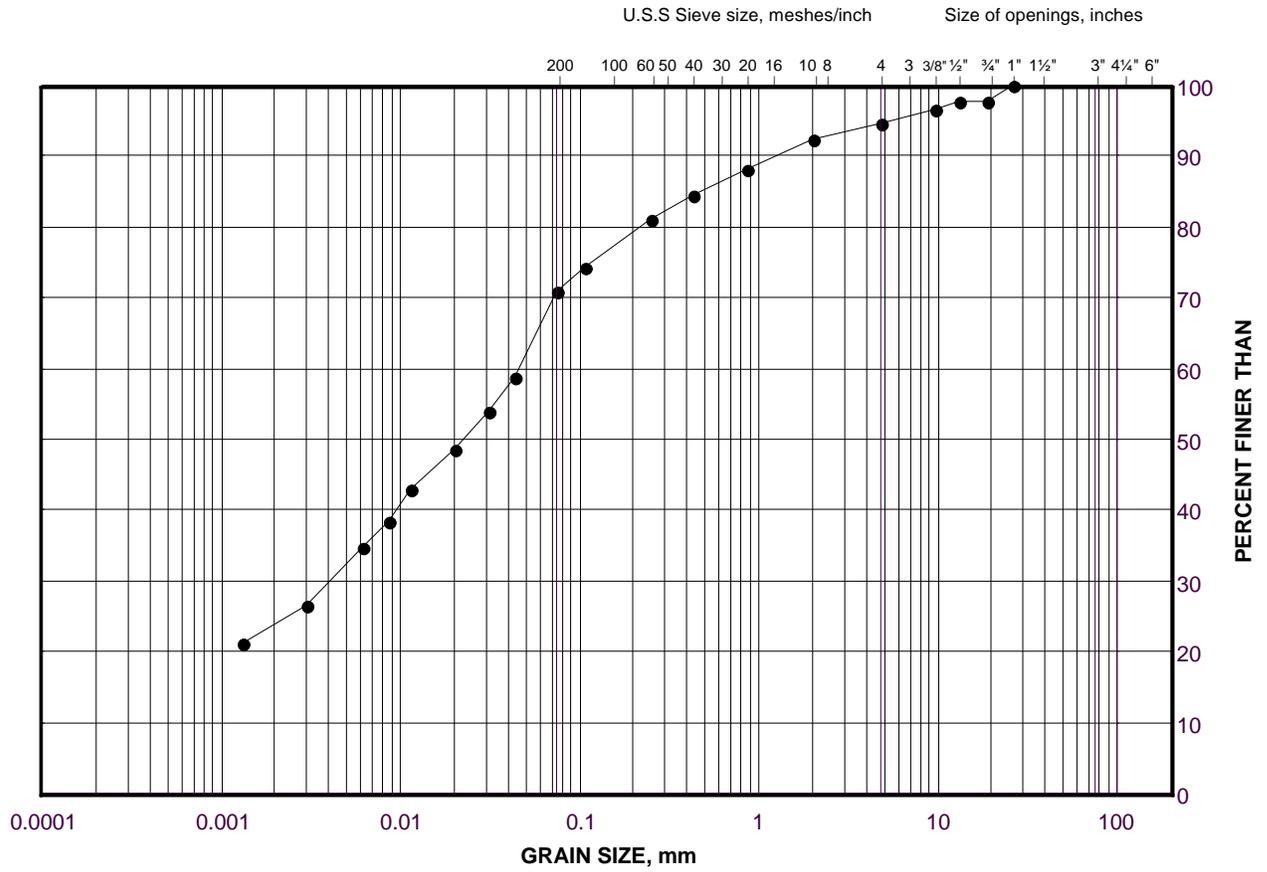
GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\1011110211.GPJ GAL-GTA.GDT 01/21/16

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

FIGURE G1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

## LEGEND

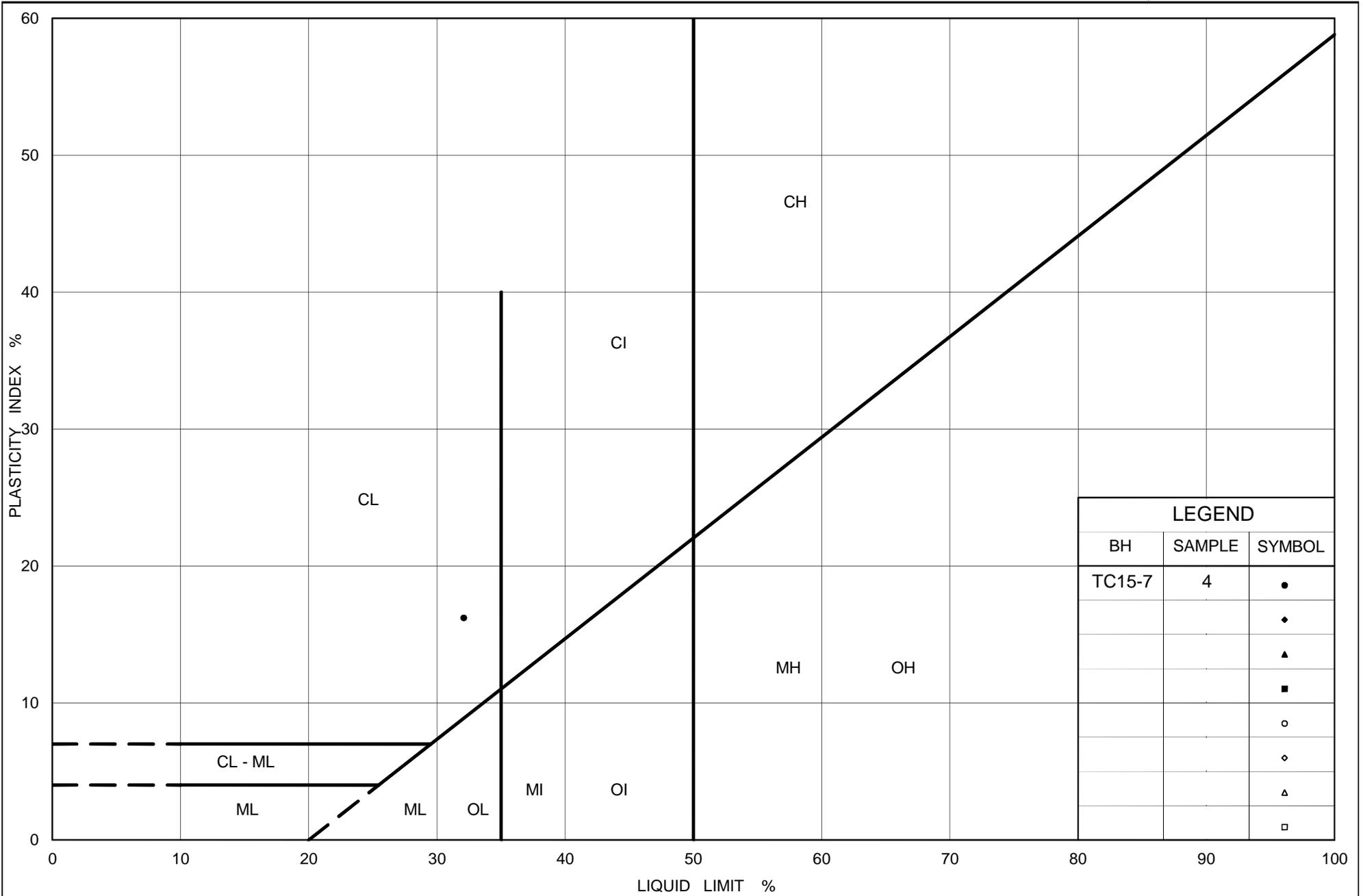
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	TC15-7	4	187.3

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# PLASTICITY CHART

## Sandy Clayey Silt (Fill)

Figure No. G2

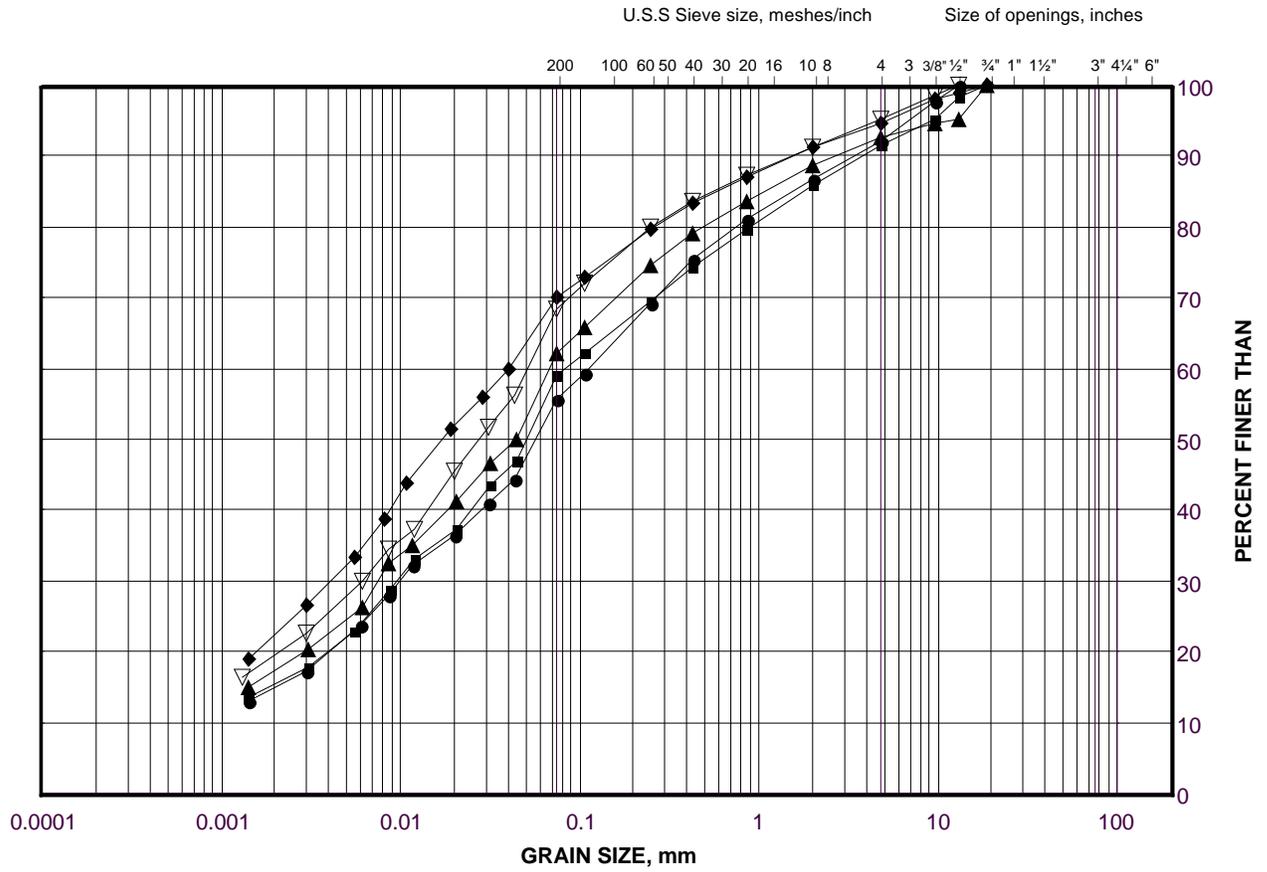
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# GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand (Till)

FIGURE G3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

**LEGEND**

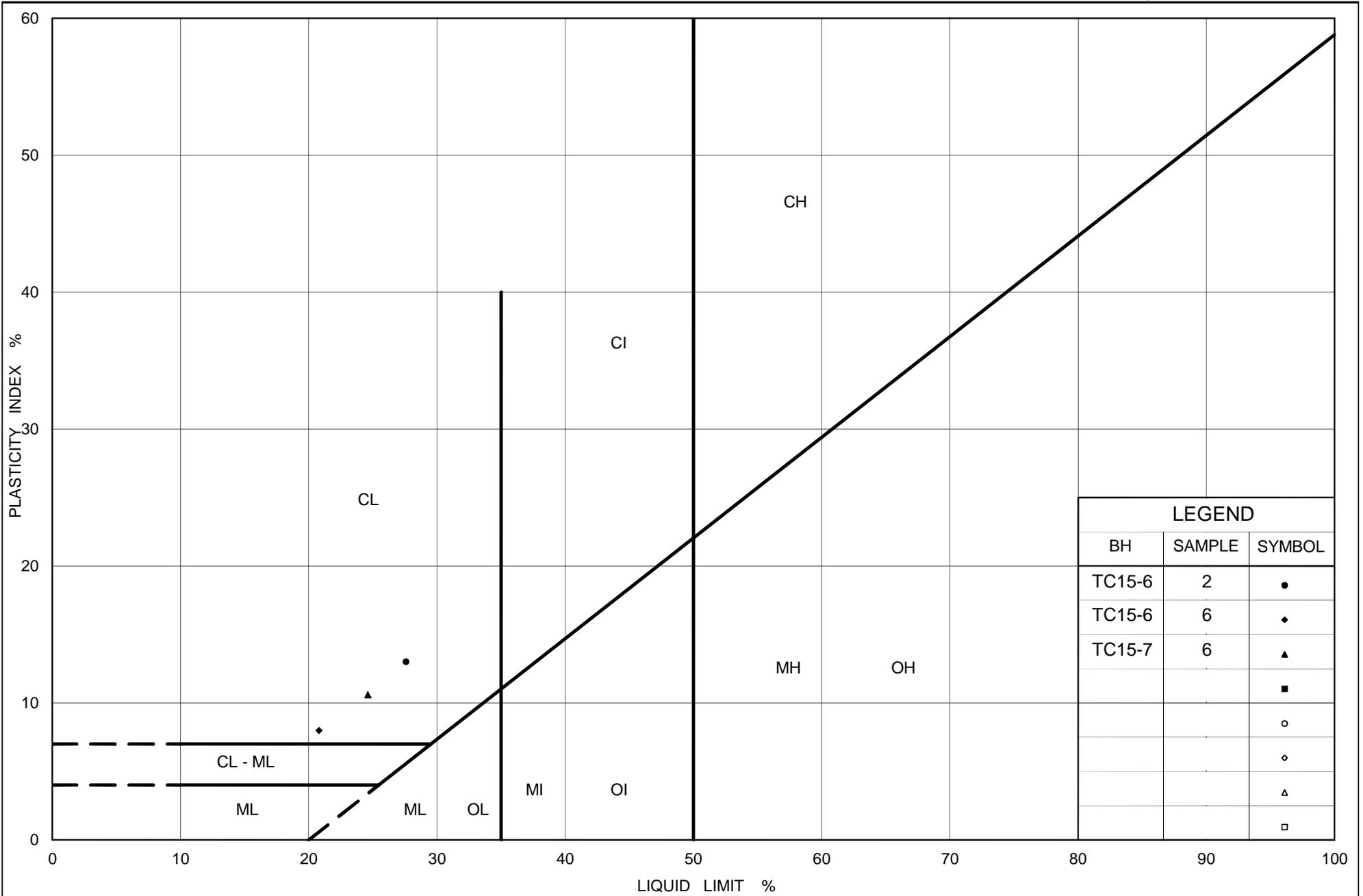
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	TC15-7	10	182.0
■	TC15-6	10	181.1
◆	TC15-6	3	186.5
▲	TC15-6	6	184.2
▽	TC15-7	6	185.8

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LEGEND		
BH	SAMPLE	SYMBOL
TC15-6	2	●
TC15-6	6	◆
TC15-7	6	▲
		■
		○
		◇
		△
		□



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## PLASTICITY CHART

### Sandy Clayey Silt to Clayey Silt with Sand (Till)

Figure No. G4

Project No. 10-1111-0211

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