



August 12, 2015

FOUNDATION INVESTIGATION REPORT

**RETAINING WALLS
HIGHWAY 401 WIDENING FROM HIGHWAY 403/410
INTERCHANGE TO CREDIT RIVER
CITY OF MISSISSAUGA, REGION OF PEEL
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 2150-01-00**

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REPORT





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1.0 INTRODUCTION

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

This report addresses the foundation investigation carried out for the retaining walls along Highway 401 to accommodate the proposed Highway 401 widening. The purpose of this investigation is to establish the subsurface conditions at the retaining wall locations along the length of the proposed highway widening by borehole drilling, in situ testing and laboratory testing on selected samples.

The Terms of Reference for the foundation engineering services are outlined in MTO's Request for Proposal dated October 2010 and the associated MTO Clarification Packages No. 1 to 3 issued between October and November 2010, which forms part of the Consultant's Agreement Number 2010-E-0003 for this project. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for this project, dated April 2011. Foundation engineering services for three of the retaining walls along Highway 401, added to the scope subsequent to MTO's original Request for Proposal, are outlined in Golder's Revised Scope Change Request No. 8 dated November 10, 2014.

2.0 SITE DESCRIPTION

The proposed retaining walls are located along the length of the proposed Highway 401 widening between Mavis Road and Credit River in the City of Mississauga, Ontario. There are five (5) retaining walls, designated as Retaining Wall 1 through 5, which are generally in order of increasing chainage, along the proposed highway, as shown on Drawing 1, following the text of this report. Retaining Walls 1 to 3 are located west of Second Line West and Retaining Walls 4 and 5 are located east of Second Line West. We understand that Retaining Walls 4 and 5 are no longer required.

The topography across the site adjacent to Highway 401 consists of undulating terrain which generally slopes downward to the west towards the Credit River. Vegetation within the project limits generally varies, consisting of grass, shrubs and trees with the Highway cutting through deciduous forest and wetland areas between the Credit River and Second Line West. Fletcher's Creek is located within the flat floodplain and low-lying valley that traverses through the dense forest areas and the creek flows in a north-south direction, perpendicular to Highway 401. Fletcher's Creek has been identified as having areas of "quicksand" (i.e. loose sands with high groundwater pressures) and there are areas of high hydrostatic pressures (artesian conditions) within the floodplain bordering the creek. Residential properties are present along the Highway 401 corridor between Second Line West and Mavis Road, and commercial facilities are located along Highway 401 east of Mavis Road.

A detailed description of each area is presented in Sections 4.3 to 4.7.



3.0 INVESTIGATION PROCEDURES

The field work specifically for the retaining walls was carried out between July 5, 2014 and January 12, 2015 during which time a total of six (6) sampled boreholes (designated as Boreholes RW-1 to RW-4, SC8-3, and SC8-4) were advanced at the locations of the Retaining Walls 2, 4 and 5. In addition, the following boreholes advanced by Golder were utilized to supplement the current investigation: six (6) boreholes (designated as Boreholes FC-1 to FC-4, FC-13 and FC-13A) advanced as part of the field investigation work for the Fletcher's Creek Bridges¹; and seven (7) boreholes (designated as Boreholes DC-7 and DC-9 to DC-14) advanced as part of the field investigation work for the deep cut / high fill areas². The Record of Borehole sheets and the results of the laboratory testing for the boreholes are presented in Appendix A to Appendix E.

The details of each retaining wall and the locations of the boreholes advanced at each site are provided below and the borehole locations are shown on Drawings 2 to 7.

Retaining Wall Designation	Reference Drawing	Approximate Station	Boreholes Advanced	Appendix
Retaining Wall 1	Drawing 2	15+830 to 15+945	3 Boreholes (DC-9 to DC-11)	A
Retaining Wall 2	Drawing 3	15+985 to 16+142	4 Boreholes (SC8-3, SC8-4, FC-2, FC-4)	B
Retaining Wall 3	Drawing 4 and 5	16+179 to 16+250	5 Boreholes (FC-1, FC-3, FC-13, FC-13A, DC-12)	C
Retaining Wall 4	Drawing 6	16+315 to 16+480	4 Boreholes (RW-1, RW-2, DC-13, DC-14)	D
Retaining Wall 5	Drawing 7	16+345 to 16+445	3 Boreholes (RW-3, RW-4, DC-7)	E

The various field investigations were carried out using CME 55 track-mounted and CME 75 truck-mounted drill rigs supplied and operated by Geo-Environmental Drilling Inc. of Halton Hills, Ontario. The boreholes were advanced through the overburden using 57 mm, 76 mm or 108 mm inner diameter (I.D.) hollow-stem augers, 150 mm outer diameter (O.D.) solid-stem augers, and / or 'NW' casing using Tricone and wash boring techniques as required. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with Standard

¹ Golder Associates Ltd. March 2013. *Foundation Investigation Report, Fletcher's Creek Bridges, Highway 401 Widening from Highway 403/410 Interchange to the Credit River, City of Mississauga, Region of Peel, GWP 2150-01-00.* GEOCREs No. 30M12-356.

² Golder Associates Ltd. December 2013. *Foundation Investigation Report, Deep Cut / High Fill Areas 1 to 9, Highway 401 Widening from Highway 403/410 Interchange to the Credit River, City of Mississauga, Region of Peel, GWP 2150-01-00.* GEOCREs No. 30M12-364.



Penetration Test (SPT) procedures (ASTM D1586)³. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths using a MTO standard 'N' size vane (ASTM D2573)⁴.

The boreholes advanced during the current investigation were extended to a depth of about 8.2 m below existing ground surface, while the boreholes utilized to supplement this investigation were extended to depths between about 5.2 m and 17.8 m below ground surface. Some boreholes were terminated in very dense relative density conditions. Additionally, one borehole was terminated due to refusal to further casing advancement and a dynamic cone penetration test (DCPT) driven from the bottom of the borehole which may be inferred to indicate the potential presence of boulders or proximity to the bedrock surface.

The groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. Standpipe piezometers were installed in selected boreholes to permit monitoring of the water level pertinent to the retaining wall sites. The installed piezometers consist of a 50 mm diameter PVC pipe, with a 1.5 m slotted screen sealed within a filter sand pack at a select depth within the borehole. The borehole and annulus surrounding the piezometer pipe above the filter sand pack were backfilled to the ground surface with bentonite pellets. Piezometer installation details and water level readings are described on the Record of Borehole sheets included in Appendices A to E that correspond to Retaining Walls 1 to 5, respectively. All boreholes in which standpipe piezometers were not installed were backfilled to ground surface with bentonite upon completion, in accordance with Ontario Regulation 903, Wells (as amended). The boreholes advanced through the Second Line West roadway asphalt were sealed at the surface with cold patch asphalt, up to approximately 0.3 m thick.

The field work was monitored on a full-time basis by a member of Golder's technical staff who located the boreholes in the field, directed the sampling and in situ testing operations, logged the boreholes and examined and cared for the soil samples.

The recovered soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for visual identification. Selected samples were subjected to a laboratory testing program consisting of natural moisture content, Atterberg limits and grain size distribution analyses conducted in our Whitby and Mississauga Laboratories in accordance with MTO and / or ASTM Standards as applicable. The results of this testing program are shown on the Record of Borehole sheets and the laboratory test figures contained in Appendices A to E.

The borehole locations were staked / marked in the field by Golder personnel relative to the proposed centreline of the new highway and ramp alignments, and the site features. The staked and as-drilled boreholes were surveyed by J.D. Barnes Ltd, a licensed surveying company retained by AECOM. The as-drilled borehole locations (referenced to MTM NAD83 northing and easting coordinates) and ground surface elevations (referenced to Geodetic datum) are provided on the individual Record of Borehole sheets, on Drawings 2 to 7 and are summarized below.

³ ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

⁴ ASTM D2573 – Standard Test Method for Field Vane Shear Test in Cohesive Soil.



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Retaining Wall Site	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
Retaining Wall 1 15+830 to 15+945	DC-9	4,830,722.1	287,015.8	171.1	9.8
	DC-10	4,830,738.9	287,051.3	170.5	12.8
	DC-11	4,830,761.2	287,082.8	173.1	8.2
Retaining Wall 2 15+985 to 16+142	SC8-3	4,830,771.3	287,144.6	164.7	8.1
	SC8-4	4,830,812.3	287,208.7	164.5	10.8
	FC-2	4,830,851.3	287,283.0	163.8	10.4
	FC-4	4,830,837.9	287,276.8	164.4	5.8
Retaining Wall 3 16+179 to 16+250	FC-1	4,830,867.9	287,311.4	163.7	15.9
	FC-3	4,830,871.4	287,325.3	165.9	5.2
	FC-13	4,830,881.8	287,336.5	167.1	10.8
	FC-13A	4,830,881.8	287,335.0	167.1	17.8
	DC-12	4,830,923.2	287,393.6	176.3	12.8
Retaining Wall 4 16+315 to 16+480	RW-1	4,831,002.0	287,527.6	175.2	8.2
	RW-2	4,831,027.1	287,570.9	176.0	8.2
	DC-13	4,830,934.4	287,419.4	174.7	11.3
	DC-14	4,830,962.3	287,473.2	175.4	8.2
Retaining Wall 5 16+345 to 16+445	RW-3	4,830,889.5	287,546.9	173.7	8.2
	RW-4	4,830,913.2	287,595.9	174.4	8.2
	DC-7	4,830,868.9	287,506.4	175.1	11.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located in the Peel Plain close to the border of the South Slope physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)⁵.

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 gradually 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 and silt and / or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial melt water 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 overburden within the majority of the Peel Plain area is underlain by shale bedrock of the Georgian Bay Formation which contains limestone interlayers.

⁵ 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.



4.2 General Overview of Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of the in situ and laboratory tests are provided on the Record of Borehole sheets. The results of the in situ field tests (i.e., SPT “N”-values and field vane undrained shear strength values) as presented on the Record of Borehole sheets, on the stratigraphic profiles and in Section 4 are uncorrected.

The stratigraphic boundaries shown on the borehole records and on the interpreted stratigraphic profiles on Drawings 2, 3 and 5 to 7 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected, however, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. The orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north and/or up-chainage along the proposed highway widening and new ramp alignments.

In general, the stratigraphy encountered at the various borehole locations typically consists of surficial layers of asphalt, topsoil and fill underlain by alternating layers and interlayers of cohesive and / or non-cohesive soils and cohesive and / or non-cohesive glacial till deposits.

Detailed descriptions of the subsurface conditions at each investigated retaining wall are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.

4.3 Highway 401 – STA. 15+830 to STA. 15+945 (Retaining Wall 1)

The plan and profile along the proposed retaining wall showing the borehole locations and interpreted stratigraphy between about STA. 15+830 and STA. 15+945 are shown on Drawing 2. The Record of Borehole sheets (Boreholes DC-9-DC-11) and the laboratory test results for this area are presented in Appendix A. The proposed alignment within this section of the highway is in a cut, located along the north side of the existing Highway 401 WBL about 250 m west of Fletcher’s Creek. The topography of this section of the site is an undulating densely treed hill that slopes to the west towards a relatively flat, open area leading to the Credit River and a plateau to the east towards Fletcher’s Creek.

The subsurface soils encountered along the proposed alignment in this area consist of a surficial layer of topsoil and near surface layers of clayey silt and silty sand, underlain by upper and lower deposits of clayey silt till which are separated by a deposit of clayey silt. Interlayers of sandy silt, and sand and silt till were encountered overlying or within the lower clayey silt till deposit.

4.3.1 Topsoil

An approximately 100 mm to 200 mm thick surficial layer of topsoil was encountered at the ground surface in all the boreholes advanced at this site.



4.3.2 Clayey Silt (Near Surface)

A near surface layer of brown clayey silt, trace sand, trace gravel and roots was encountered underlying the topsoil in Borehole DC-11. The surface of the clayey silt layer is at about Elevation 172.9 m and the thickness of the layer is about 0.6 m.

A Standard Penetration Test (SPT) “N”-value of 12 blows per 0.3 m of penetration was recorded within this layer, suggesting that the clayey silt layer has a stiff consistency.

4.3.3 Silty Sand (Near Surface)

An approximately 0.7 m thick layer of brown silty sand, trace clay and trace gravel was encountered underlying the clayey silt layer at about Elevation 172.3 m in Borehole DC-11.

A SPT “N”-value of 50 blows per 0.05 m of penetration was recorded within this layer, indicating a very dense relative density. The natural water content measured on one (1) sample of this deposit is about 7 per cent.

4.3.4 Clayey Silt to Sandy Clayey Silt Till (Upper Deposit)

An upper deposit of brown to grey cohesive till was encountered underlying the topsoil in Boreholes DC-9 and DC-10 and below the near surface layer of silty sand in Borehole DC-11. The top of this deposit ranges from about Elevations 171.6 m to 170.3 m and the thickness of this upper cohesive till deposit ranges from about 3.6 m to 4.4 m. The cohesive till deposit is comprised of clayey silt, some sand to sandy, and trace gravel. The upper 0.6 m and 1.5 m portions of the cohesive deposit in Boreholes DC-9 and DC-10 contain roots.

The SPT “N”-values measured within the upper cohesive till deposit range from 7 blows to 37 blows per 0.3 m of penetration, and typically are greater than 15 blows per 0.3 m of penetration, suggesting a firm to hard (but typically very stiff to hard) consistency.

Grain size distribution tests were carried out on three (3) selected samples of the deposit and the results are shown on Figure A1 in Appendix A. Atterberg limits tests were carried out on three (3) samples of this cohesive till deposit and measured liquid limits ranging from about 25 per cent to 35 per cent, plastic limits ranging from about 15 per cent to 19 per cent, and plasticity indices ranging from about 10 per cent to 16 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figure A2 in Appendix A, and indicate that the till deposit is clayey silt of low plasticity. The natural water content measured on seven (7) samples of this cohesive till deposit ranges from about 8 per cent to 16 per cent.

4.3.5 Clayey Silt

A deposit of clayey silt, trace sand and trace gravel was encountered underlying the upper cohesive till deposit in all the boreholes advanced at this site; this layer separated the upper and lower cohesive till deposits. The surface of the clayey silt deposit ranges from about Elevations 167.4 m to 165.9 m and the thickness of this deposit is between about 1.4 m and 2.4 m, generally becoming thinner towards the eastern limit of the investigated area.



The SPT “N”-values recorded within the clayey silt deposit range from 2 blows to 11 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about greater than 135 kPa to 170 kPa, and the sensitivity is calculated to be about 1 and 2. The field vane tests results together with the SPT “N”-values suggest that the clayey silt deposit has a soft to very stiff (but typically very stiff) consistency.

Atterberg limits tests were carried out on three (3) selected samples of the clayey silt deposit and measured liquid limits ranging from about 28 per cent to 32 per cent, plastic limits ranging from about 16 per cent to 17 per cent and plasticity indices ranging from about 12 per cent to 15 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A3 in Appendix A, and indicate that the deposit consists of clayey silt of low plasticity. The natural water content measured on three (3) samples of this deposit ranges from about 20 per cent to 23 per cent.

4.3.6 Sandy Silt (Interlayer)

Underlying the clayey silt deposit in Borehole DC-9, an approximately 1.2 m thick interlayer of grey sandy silt, trace to some clay, was encountered at about Elevation 165.0 m.

A SPT “N”-value of 28 blows per 0.3 m of penetration was measured within this layer, indicating a compact relative density.

The result of the grain size distribution test carried out on one (1) sample of the sandy silt layer is presented on Figure A4 in Appendix A. The measured water content on one (1) sample of this layer is about 14 per cent.

4.3.7 Clayey Silt to Sandy Clayey Silt Till (Lower Deposit)

A lower cohesive till deposit was encountered underlying the sandy silt interlayer in Borehole DC-9 and below the clayey silt deposit in Boreholes DC-10 and DC-11. The top of this cohesive till deposit was encountered at depths between about 7.0 m and 7.3 m below ground surface, between about Elevations 165.9 m and 163.5 m. The thickness of the lower cohesive till deposit encountered in the boreholes ranges from about 1.0 m to 4.3 m. All boreholes were terminated within this deposit between about Elevations 164.9 m and 157.7 m.

The cohesive till deposit consists of clayey silt, trace to some sand to sandy, and trace to some gravel, with a silt and sand till interlayer encountered within the cohesive till deposit in Borehole DC-10.

The SPT “N”-values recorded within this lower cohesive till deposit range from 16 blows to 32 blows per 0.3 m of penetration, suggesting that the clayey silt till has a very stiff to hard consistency.

Grain size distribution tests were carried out on two (2) selected samples of the cohesive till deposit and the results are provided on Figure A5 in Appendix A. Atterberg limits tests were performed on two (2) samples of the cohesive till and measured liquid limits of about 19 per cent and 20 per cent, plastic limits of about 13 per cent and 14 per cent, and corresponding plasticity indices of about 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A6 in Appendix A and indicate that this till deposit consists of clayey silt of low plasticity. The measured water content on three (3) selected samples of this till deposit is between about 9 per cent and 10 per cent.



4.3.8 Silt and Sand Till (Interlayer)

In Borehole DC-10, an approximately 1.5 m thick interlayer of silt and sand till, trace to some clay and trace to some gravel, was encountered within the lower clayey silt till deposit between about Elevations 160.1 m and 158.6 m.

A SPT “N”-value of 26 blows per 0.3 m of penetration was recorded within this till interlayer, indicating a compact relative density. The result of a grain size distribution test carried out on a sample of this till interlayer is shown on Figure C7 in Appendix C. The natural water content measured on one (1) sample of the sand and silt till is about 11 per cent.

4.3.9 Groundwater Conditions

The samples taken in the boreholes were generally moist to wet. The groundwater levels in the open boreholes were measured upon completion of drilling operations. A standpipe piezometer was installed in Borehole DC-10 to permit monitoring of the groundwater level at this site. Details of the piezometer installation and the measured groundwater levels are shown on the Record of Borehole sheets in Appendix A. The groundwater levels recorded in the open boreholes and piezometer are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
DC-9	171.1	2.3	168.8	September 07, 2012	Open Borehole
DC-10	170.5	12.0	158.5	September 11, 2012	Piezometer
		1.9	168.6	October 09, 2012	
		2.0	168.5	November 05, 2012	
DC-11	173.1	Dry	--	September 7, 2012	Open Borehole

The groundwater level observations at this site are short term and will be subject to seasonal fluctuations and precipitation events, therefore the water levels should be expected to be higher during the spring season or during any period of heavy precipitation.

4.4 Highway 401 – STA. 15+985 to STA. 16+142 (Retaining Wall 2)

The plan and profile along the proposed retaining wall showing the borehole locations and interpreted stratigraphy between about STA. 15+985 and STA. 16+142 are presented on Drawing 3. The Record of Borehole sheets (Boreholes FC-2, FC-4, SC8-3 and SC8-4) and the laboratory test results on soil samples for this area are presented in Appendix B. The proposed alignment of the retaining wall within this section of the highway is located north of the existing Highway 401 WBL immediately west of Fletcher’s Creek. The topography of this section of the site is a relatively flat plateau of the top of a densely treed hill that slopes to the west towards a relatively flat open area leading to the Credit River and to the east towards Fletcher’s Creek.



The subsurface conditions generally consist of a surficial layer of topsoil, underlain by fill in places, further underlain by a clayey silt to silty clay deposit. The clayey silt to silty clay deposit is underlain by a non-cohesive to cohesive till deposit.

4.4.1 Topsoil

A 50 mm to 200 mm thick surficial layer of topsoil was encountered at the ground surface in all of the boreholes.

4.4.2 Fill

A 1.3 m thick fill layer was encountered underlying the topsoil in Borehole FC-2 and FC-4 at about Elevation 163.6 m and Elevation 164.2 m, respectively.

The fill is comprised of clayey silt containing some gravel and some sand. Organics and rootlets were also encountered within this layer.

The SPT "N"-values measured within the clayey silt fill range are 5 blows and 6 blows per 0.3 m of penetration, suggesting that the deposit has a firm consistency.

4.4.3 Clayey Silt to Silty Clay

A cohesive deposit of brown to grey clayey silt to clayey silt with sand to silty clay was encountered below the fill in Boreholes FC-2 and FC-4 and below the topsoil in Boreholes SC8-3 and SC8-4. The deposit was encountered between about Elevations 164.6 m and 162.3 m and the thickness of the deposit was between about 2.0 m and 3.8 m. In Borehole SC8-4, the deposit is interlayered with clayey silt with sand till from about Elevation 162.2 m to 160.9 m as described in Section 4.4.4.

The cohesive deposit is generally comprised of clayey silt to silty clay containing some sand to with sand and trace to some gravel. Rootlets were encountered in Boreholes SC8-3, SC8-4 and FC-4 in the upper 2.2 m of the deposit. The presence of cobbles is also inferred from difficulties advancing augers (auger grinding) in Borehole FC-4 at a depth of about 5.2 m (about Elevation 159.2 m) during the drilling operations.

The SPT "N"-values measured within the silty clay to clayey silt deposit range from 0 blows (weight of hammer) to 23 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit in Boreholes FC-2 and FC-4 measured undrained shear strengths ranging from about 8 kPa to 95 kPa, with the sensitivity calculated to be between about 1 and 9. The field vane tests together with the SPT "N"-value results suggest that the deposit generally has a very soft to stiff consistency.

A grain size distribution test was carried out on one (1) samples of the clayey silt portion of the deposit and the result is provided on Figure B1 in Appendix B.

Atterberg limits tests were carried out on five (5) samples of this deposit. The liquid limits range from about 20 per cent to 46 per cent, the plastic limits range from about 15 per cent to 27 per cent and the plasticity indices range from about 5 per cent to 19 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figure B2 in Appendix B, and indicate that this deposit consists of clayey silt of low plasticity to silty clay



of intermediate plasticity. The natural water content measured on seven (7) samples of this silty clay to clayey silt deposit ranges from about 11 per cent to 34 per cent.

4.4.4 Clayey Silt (Till)

A cohesive till deposit was encountered underlying the silty clay deposit in Borehole SC8-3 and interlayered in the silty clay to clayey silt deposit in Borehole SC8-4. The till deposit generally consists of grey silty clay to clayey silt containing trace to with sand and trace to some gravel. The deposit was encountered at about Elevation 162.5 m and 162.2 m in Boreholes SC8-3 and SC8-4, respectively, and the thickness of the deposit is of about 3.4 m and 1.3 m, respectively.

The SPT “N”-values measured within the cohesive till range from 3 blows to 11 blows per 0.3 m of penetration, indicating a soft to stiff relative density.

Grain size distribution tests were carried out on two (2) samples of the till deposit and the results are provided on Figure B3 in Appendix B.

Atterberg limits tests were carried out on three (3) samples of this deposit. The liquid limits range from about 19 per cent to 28 per cent, the plastic limits range from about 13 per cent to 15 per cent and the plasticity indices range from about 6 per cent to 13 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figure B4 in Appendix B, and indicate that the till consists of clayey silt of low plasticity. The natural water content measured on five (5) samples of the till ranges from about 12 per cent to 20 per cent.

4.4.5 Gravelly Silty Sand to Sand and Gravel (Till)

A non-cohesive till deposit was encountered underlying the silty clay to clayey silt deposit in Boreholes SC8-4, FC-2 and FC-4 and underlying the cohesive till deposit in Borehole SC8-3. The deposit was encountered at depths ranging from about 5.2 m to 5.6 m below ground surface corresponding to between about Elevations 158.6 m and 159.1 m. These boreholes were terminated within this deposit at depths of about 5.8 m to 10.8 m below the ground surface (Elevations 158.6 m to 153.4 m), penetrating the deposit for a thickness ranging from about 0.5 m to 5.2 m.

The non-cohesive till deposit varies in composition from sand and gravel containing trace to some silt and trace clay; to gravelly sand containing trace to some silt and trace clay; to gravelly silty sand containing trace clay; to sand and silt containing some gravel and trace to some clay; to sandy silt and gravel containing trace clay. The presence of cobbles or boulders is also inferred from difficulties advancing augers (auger grinding) in Borehole SC8-3 at a depth of about 6.6 m (about Elevation 158.1 m) during the drilling operations.

The SPT “N”-values measured within the non-cohesive till generally range from 45 blows to 93 blows per 0.3 m of penetration, indicating a dense to very dense relative density. SPT “N”-values as high as 100 blows per 0.2 m of penetration were recorded within the non-cohesive till.

Grain size distribution tests were carried out on five (5) selected samples of the non-cohesive till deposit and the results are shown on Figures B5 in Appendix B. The natural water content measured on six (6) selected samples of the non-cohesive till deposit ranges from about 5 per cent to 11 per cent.



4.4.6 Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. The groundwater levels in the open boreholes were measured upon completion of drilling operations. Details of the measured groundwater levels are shown on the Record of Borehole sheets in Appendix B. Artesian groundwater conditions were observed during the drilling operations in Boreholes FC-2 where the groundwater level measured above the ground surface. The groundwater levels recorded in the open boreholes are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
SC8-3	164.7	4.6	160.1	January 11, 2015	Open Borehole
SC8-4	164.5	1.8	162.7	January 12, 2015	Open Borehole
FC-2 ¹	163.8	Above 0.02	Higher than 163.8 ²	May 8, 2012	Inside Casing
FC-4 ³	164.4	2.0	162.4	May 9, 2014	Inside Augers

1. Water level not considered stabilized as water was flowing out of the top of the casing.
2. Artesian Conditions
3. Water level not considered stabilized given that wash boring methods were used and water was introduced into the borehole.

Based on the groundwater levels recorded during this investigation, high hydrostatic pressures are present at this site. The artesian hydrostatic head present in the cohesionless layers at this site is estimated to be higher than Elevation 164 m. Perched water conditions will also be present and the estimated perched groundwater level is inferred to be equivalent to the Fletcher’s Creek water level. Based on the 1957 drawing, the creek high water level is at approximately Elevation 164.5 m and the normal water level is at Elevation 162.9 m.

The groundwater level observations at this site are short term and will be subject to seasonal fluctuations and precipitation events, therefore the water levels should be expected to be higher during the spring season or during any period of heavy precipitation.

4.5 Highway 401 – STA. 16+179 to STA. 16+250 (Retaining Wall 3)

The plan and profile along the proposed retaining wall showing the borehole locations and interpreted stratigraphy between about STA. 16+179 and STA. 16+250 are shown on Drawings 4 and 5, respectively. The Record of Borehole sheets (Boreholes FC-1, FC-3, FC-13/13A and DC-12) and the laboratory test results on soil samples from the boreholes for this site are presented in Appendix C. The proposed retaining wall alignment within this section of the highway is located north of the existing Highway 401 WBL, east of Fletcher’s Creek and west of the Second Line West bridge underpass.

The subsurface conditions at the site consist of a surficial layer of asphalt or topsoil over a deposit of fill associated with the Highway 401 embankments. The fill is underlain by either a deposit of clayey silt to clayey silt with sand or sandy clayey silt till. The cohesive/cohesive till deposit is underlain by non-cohesive till deposits consisting of sandy silt to gravelly silt and sand, and gravelly sand to sand and gravel.



4.5.1 Asphalt

An approximately 200 mm thick layer of asphalt was encountered in Borehole DC-12, advanced through the roadway pavement on Second Line West.

4.5.2 Topsoil

A 200 mm thick surficial layer of topsoil was encountered at the ground surface in Borehole FC-1.

4.5.3 Fill

Fill materials were encountered underlying the topsoil in Borehole FC-1, immediately below the ground surface in Borehole FC-3, and underlying the asphalt in Borehole DC-12. The thickness of the fill deposit is variable across the site, ranging from about 0.9 m in Borehole FC-3 to 5.6 m in Borehole DC-12 and was encountered between about Elevations 165.9 m to 163.5 m and at Elevation 176.1 m. In Borehole DC-12, the fill is comprised of silty sand, trace clay and trace gravel (inferred to comprise the base / subbase for the pavement structure) below the asphalt layer underlain by cohesive fill consisting of sandy clayey silt, trace gravel, and in Boreholes FC-1 and FC-3 the fill consists of clayey silt some sand, trace to some gravel, and rootlets.

A SPT "N"-value of 12 blows per 0.3 m of penetration was measured within the non-cohesive portion of the fill, indicating a compact relative density. SPT "N"-values measured within the cohesive fill range from 3 blows to 22 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency.

A grain size distribution test was carried out on one (1) selected sample of the clayey silt fill and the result is provided on Figure C1 in Appendix C.

An Atterberg limits test was carried out on one (1) sample of the clayey silt fill and measured a liquid limit of about 27 per cent, a plastic limit of about 16 per cent, and a corresponding plasticity index of about 11 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure C2 in Appendix C and indicates that the fill material consists of clayey silt of low plasticity. The natural water content measured on four (4) samples of the clayey silt fill ranges between about 5 per cent and 20 per cent.

4.5.4 Sandy Clayey Silt (Till) (Upper Deposit)

A predominantly cohesive till deposit consisting of brown sandy clayey silt with trace gravel was encountered underlying the fill materials in Borehole DC-12. The surface elevation of the cohesive till deposit is at about Elevation 170.5 m. The deposit is about 3 m thick.

The SPT "N"-values measured within the sandy clayey silt till are 25 blows to 32 blows per 0.3 m of penetration, suggesting that the clayey silt till has a very stiff to hard consistency.

A grain size distribution test was carried out on one (1) selected sample of the sandy clayey silt till and the result is provided on Figure C3 in Appendix C.



An Atterberg limits test carried out on one (1) sample of the sandy clayey silt till and measured a liquid limit of about 29 per cent, a plastic limit of about 18 per cent, and a corresponding plasticity index of about 11 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure C4 in Appendix C and indicates that the fill material consists of clayey silt of low plasticity. The natural water content measured on one (1) sample of the clayey silt till was about 14 per cent.

4.5.5 Clayey Silt with Sand to Clayey Silt

A cohesive deposit of brown to grey clayey silt with sand to clayey silt was encountered in all of the boreholes either below the fill and sandy clayey silt deposit or below the ground surface. The cohesive deposit was encountered between Elevation 167.5 m to 162.2 m and the thickness of this deposit ranges from about 1.6 m to 6.6 m. Borehole FC-3 was terminated within this deposit at a depth of about 5.2 m below the ground surface at about Elevation 160.7 m.

The cohesive deposit is comprised of clayey silt with trace to some sand and trace to some gravel to clayey silt with sand containing trace to some gravel. A silt layer (0.8 m thick) was encountered at a depth of 3.7 m below ground surface in FC-3. The upper 0.6 m portion of the cohesive deposit in Borehole FC-13 contains rootlets.

The SPT "N"-values measured within the clayey silt to clayey silt with sand deposit generally range from 3 blows to 22 blows per 0.3 m of penetration, suggesting that the cohesive deposit has a soft to very stiff consistency at these locations. In situ field vane tests were also performed in this layer in Borehole FC-13 and measured undrained shear strengths greater than 136 kPa and 144 kPa, and the sensitivity is calculated to be about 1. The results of the SPT "N"- values and the field vane tests suggest that the cohesive deposit generally has a stiff to very stiff consistency.

Grain size distribution tests were carried out on five (5) samples of the clayey silt to clayey silt with sand deposit and the results are shown on Figure C5 in Appendix C.

Atterberg limits tests were carried out on seven (7) samples of this deposit. The liquid limits range from about 21 per cent to 31 per cent, the plastic limits range from about 13 per cent to 18 per cent and the plasticity indices range from about 5 per cent to 14 per cent. The results of the Atterberg limits tests are shown on a plasticity chart on Figure C6 in Appendix C, and indicate that this deposit consists of clayey silt of low plasticity. The natural water content measured on nine (9) selected samples of the clayey silt to clayey silt with sand deposit ranges from about 10 per cent to 27 per cent.

4.5.6 Silty Sand to Sand and Gravel Till

A non-cohesive till deposit was encountered underlying the clayey silt with sand to clayey silt deposit in Boreholes FC-1, FC-13 / 13A, and DC-12. The top of the deposit was encountered at a depths ranging from about 4.5 m to 10.4 m below ground surface (Elevation 165.9 m to 159.2 m). Boreholes FC-1 and FC-13 / 13A were terminated within the non-cohesive till deposit between about Elevation 149.3 m to 147.9 m, after penetrating between about 11 m to 11.2 m into the deposit. In Borehole DC-12, the non-cohesive till deposit was measured to be about 1.5 m thick.



The non-cohesive till deposit varies in composition from silty sand, trace to some gravel; to silt and sand, trace gravel; to gravelly sand, some silt; to silty sand and gravel; to sand and gravel, trace silt; all containing trace to some clay. In Borehole FC-1, refusal to auger or casing advancement was encountered during the drilling operations at a depth of 12.8 m below ground surface, at about Elevation 150.9 m). The borehole was cored between the depths of 12.8 m and 15.5 m (Elevations 150.9 m and 148.2 m) and was terminated within the non-cohesive till due to poor recovery. Cobbles were inferred to be present within the lower portion (below Elevation 155.0 m) of the non-cohesive till in Borehole FC-13A.

The SPT "N"-values measured within the non-cohesive till generally range from 23 blows to 68 blows per 0.3 m of penetration, indicating a dense to very dense relative density. SPT "N"-values ranging from 86 blows per 0.25 m of penetration to 65 blows per 0.03 m of penetration were recorded within the lower portion of the non-cohesive till. A SPT "N"-value of 9 blows per 0.3 m of penetration was recorded within the till deposit in Borehole FC-13A at a depth of about 13.0 m below ground surface, inferred to be a result of soil disturbance due to difficulties advancing augers/casing to this depth.

A Dynamic Cone Penetration Test (DCPT) was advanced from the bottom of the sampled Borehole FC-1 at a depth of about 15.5 m below ground surface; the DCPT was terminated on effective refusal (greater than 163 blows per 0.3 m of penetration) at a depth of about 15.9 m (Elevation 147.9 m).

Grain size distribution tests were carried out on five (5) samples of the non-cohesive till deposits and the results are shown on Figures C7 in Appendix C. The natural water content measured on eight (8) samples of the non-cohesive till deposit ranges from about 6 per cent to 13 per cent.

4.5.7 Clayey Silt (Till) (Lower Deposit)

A lower deposit of cohesive till comprised of grey clayey silt, trace sand, trace gravel was encountered underlying the silty sand till deposit in Borehole DC-12. The surface of the cohesive till deposit is at about Elevations 164.4 m, and the deposit was penetrated for a thickness of about 0.9 m.

A SPT "N"-value of 34 blows per 0.3 m of penetration was measured within the clayey silt till, suggesting that the deposit has a hard consistency.

4.5.8 Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Details of the groundwater levels measured in the open boreholes upon completion of drilling are shown on the Record of Borehole sheets in Appendix C. Artesian groundwater conditions were observed during the drilling operations in Boreholes FC-1 and FC13 / 13A located on higher ground (outside the floodplain and low-lying valley) approximately 55 m west of Second Line West Road. The groundwater levels recorded in the open boreholes are summarized below.



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Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
FC-1 ¹	163.7	1.8 -1.0	161.9 164.7 ²	May 01, 2012 May 02, 2012	Inside Augers Inside Casing
FC-3	165.9	Dry	--	May 7, 2012	Inside Augers
FC-13 / 13A	167.1	2.7 2.1 -0.6 -2.1 -3.5 -4.8	164.4 165.0 167.7 ² 169.2 ² 170.6 ² 171.9 ²	September 05, 2012 (4:16 pm) September 06, 2012 (7:00 am) September 06, 2012 (12:30 pm) September 06, 2012 (12:36 pm) September 06, 2012 (12:41 pm) September 06, 2012 (1:30 pm)	Inside Augers Inside Augers Inside Casing Inside Casing Inside Casing Inside Casing
DC-12	176.3	Dry	--	September 12, 2012	Inside Augers

1. Water level not considered stabilized as water was flowing out of the top of the casing.
2. Artesian conditions

During the field investigation the ground surface in the areas adjacent to the abandoned Borehole FC-1 was monitored for the presence of groundwater seepage. Groundwater seepage was observed in the area prior to drilling activities; however, additional seepage areas were noticed shortly after the borehole was abandoned by sealing the borehole with cement grout. Although groundwater was not observed emanating from the borehole, localized areas adjacent to the borehole were observed to exhibit water seepage. Although the saturated surficial sand layers (previously referred to as “quick sand” at the MTO start-up meeting) were not encountered in the boreholes advanced near the creek, visual examination and probing of the areas adjacent to the creek using a steel rod confirmed the presence of these surficial saturated layers/zones.

Based on the groundwater levels recorded during this investigation and our observation of the presence of surficial saturated sand layers, high hydrostatic pressures are present at this site. The artesian hydrostatic head present in the cohesionless layers at this site is estimated to be at approximately Elevation 172 m. Perched water conditions will also be present and the estimated perched groundwater level is inferred to be equivalent to the Fletcher’s Creek water level. Based on the 1957 drawing, the creek high water level is at approximately Elevation 164.5 m and the normal water level is at Elevation 162.9 m.

The groundwater level observations at this site are short term and will be subject to seasonal fluctuations and precipitation events, therefore the water levels should be expected to be higher during the spring season or during any period of heavy precipitation.

4.6 Highway 401 – STA. 16+315 to STA. 16+480 (Retaining Wall 4)

The plan and profile along the centerline of the proposed widened embankment showing the borehole locations and interpreted stratigraphy between about STA. 16+315 and STA. 16+480 on the north side of Highway 401



are presented on Drawing 6. The Record of Borehole sheets (Boreholes RW-1, RW-2, DC-13 and DC-14) and the laboratory test results for this area are presented in Appendix D. The proposed retaining wall alignment within this section of the highway is located north of the existing Highway 401 WBL and east of the Second Line West bridge underpass. Second Line West crosses Highway 401 in a north-south direction via a 3-span bridge on the west end of the site. Residential properties are present at the northeast quadrant of Second Line West.

The subsurface conditions generally consist of a surficial layer of topsoil, underlain by fill in places, underlain by upper and lower units of a deposit of clayey silt till interlayered with a deposit of sand.

4.6.1 Topsoil

A 200 mm thick surficial layer of topsoil was encountered at the ground surface in all four boreholes.

4.6.2 Fill

Fill materials were encountered underlying the topsoil along the eastern extent of the site in Boreholes RW-1 and RW-2 at about Elevation 175.0 m and Elevation 175.8 m, respectively, and the fill deposit is about 0.6 m to 1.2 m thick. The fill is comprised of sandy clayey silt, trace gravel, trace organics and rootlets.

A SPT "N"-value of 19 blows per 0.3 m of penetration was measured within the sandy clayey silt fill, indicating a very stiff relative density.

A grain size distribution test was carried out on one (1) selected sample of the sandy clayey silt fill and the result is provided on Figure D1 in Appendix D. The natural water content measured on one (1) sample of the sandy clayey silt fill was about 12 per cent.

4.6.3 Sandy Clayey Silt to Clayey Silt (Till) (Upper Deposit)

A predominantly cohesive till deposit was encountered underlying the fill materials in Boreholes RW-1 and RW-2 and directly below the topsoil in Boreholes DC-13 and DC-14. The surface of the cohesive till deposit ranges from about Elevations 175.2 m to 174.4 m and the thickness of the deposit ranges from about 4.2 m to 7.1 m. The cohesive till deposit generally consists of brown to grey sandy clayey silt to clayey silt, some sand, trace to some gravel to gravelly in some places. The upper 0.6 m to 1.1 m portion of the cohesive till deposit in Boreholes RW-1, DC-13 and DC-14 contains roots.

The SPT "N"-values measured within the sandy clayey silt to clayey silt till range from 5 blows to 45 blows per 0.3 m of penetration, but are typically greater than 10 blows per 0.3 m of penetration, suggesting that the deposit has a firm to hard (but generally stiff to hard) consistency. A SPT "N"-value of 50 blows per 0.15 m of penetration was measured within the cohesive till deposit, inferred to be on cobbles.

Grain size distribution tests were carried out on five (5) samples of the cohesive till deposit and the results are provided on Figure D2 in Appendix D. Atterberg limits tests were carried out on seven (7) selected samples of this cohesive till deposit and measured liquid limits ranging from about 24 per cent to 31 per cent, plastic limits ranging from about 13 per cent to 18 per cent and plasticity indices ranging from about 9 per cent to 14 per cent.



These results, which are plotted on a plasticity chart on Figure D3 in Appendix D, indicate that the till deposit generally consists of clayey silt of low plasticity. The natural water content measured on 12 selected samples of the till ranges from about 9 per cent to 18 per cent.

4.6.4 Clayey Silt

An interlayer of grey clayey silt, trace sand was encountered underlying the clayey silt till deposit in Borehole DC-13. The thickness of the clayey silt interlayer is about 0.6 m, extending from a depth of about 7.3 m below ground surface (Elevation 167.4 m).

A SPT “N”-value of 9 blows per 0.3 m of penetration was measured across the boundary of the clayey silt interlayer and the underlying lower till unit, indicating a stiff relative density.

An Atterberg limits test was carried out on one (1) sample of the clayey silt interlayer and measured a liquid limit of about 22 per cent, a plastic limit of about 15 per cent, and a corresponding plasticity index of about 7 per cent. The result of the Atterberg limits test is shown on a plasticity chart on Figure D4 in Appendix D and indicates that this interlayer consists of clayey silt of low plasticity. The natural water content measured on one (1) selected sample of the clayey silt is about 36 per cent.

4.6.5 Silt to Sandy Silt to Silt and Sand

Underlying the upper clayey silt till deposit in Boreholes RW-1, RW-2 and DC-14 and underlying the clayey silt interlayer in Borehole DC-13, the boreholes penetrated a deposit of silt to sandy silt to silt and sand, trace to some clay and trace gravel. The deposit was encountered at depths between about 5.6 m and 7.3 m below ground surface, corresponding to between about Elevations 170.4 m and 168.1 m. The thickness of the silt to silt and sand deposit ranges from about 0.9 m to about 1.6 m but was not fully penetrated in Borehole DC-14 advanced at the eastern limit of the site which was terminated within the deposit at a depth of about 8.2 m below ground surface (Elevation 167.2 m).

The SPT “N”-values measured within the deposit range between 9 blows and 28 blows per 0.3 m of penetration, indicating a loose to compact relative density.

Grain size distribution tests were carried out on three (3) samples of the silt to silt and sand deposit and the results are shown on Figure D5 in Appendix D. The natural water content measured on four (4) samples of this deposit is about 18 per cent and 29 per cent.

4.6.6 Sandy Clayey Silt to Clayey Silt (Till) (Lower Deposit)

A lower deposit of cohesive till comprised of grey clayey silt with sand to clayey silt, trace sand, trace gravel, was encountered underlying the silt to silt and sand deposit in Boreholes RW-1, RW-2 and DC-13. The surface of the cohesive till deposit was encountered at depths between about 7.2 m and 8.8 m below ground surface corresponding to between about Elevations 168.8 m and 165.9 m, and the thickness of the deposit ranges from about 1.0 m to 2.5 m. The boreholes were terminated within this deposit at depths of about 8.2 m and 11.3 m below the ground surface, between Elevations 167.8 m and 163.4 m.



The SPT “N”-values recorded within the lower unit of the clayey silt till deposit range between 18 blows and 66 blows per 0.3 m of penetration, suggesting that the clayey silt till has a very stiff to hard consistency.

Atterberg limits tests were carried out on two (2) samples of the till deposit and measured liquid limits of about 16 per cent and 19 per cent, plastic limits of about 10 per cent and 12 per cent and corresponding plasticity indices of about 6 per cent to 7 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D6 in Appendix D and indicates that the till deposit consists of clayey silt of low plasticity. The natural water content measured on two (2) samples of the cohesive till deposit is about 11 per cent.

4.6.7 Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. The groundwater levels in the open boreholes were measured upon completion of drilling operations and a standpipe piezometer was installed in each of Borehole RW-1 and DC-13 to permit monitoring of the groundwater level at this site. Details of the piezometer installation and measured groundwater levels are shown on the Record of Borehole sheets in Appendix D and are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
RW-1	175.2	7.0	168.2	July 7, 2014	Open Borehole
		3.1	172.1	August 8, 2014	Piezometer
		3.1	172.1	August 27, 2014	Piezometer
		3.1	172.1	September 15, 2014	Piezometer
RW-2	176.0	6.9	169.1	July 7, 2014	Open Borehole
DC-13	174.7	Dry	--	September 13, 2012	Piezometer
		6.2	168.5	October 09, 2012	
		6.3	168.4	November 05, 2012	
DC-14	175.4	7.0	168.4	September 12, 2012	Inside Augers

Based on the observed groundwater levels in the open boreholes and standpipe piezometers, the groundwater level fluctuates from about Elevations 168 m to 172 m. The groundwater level observations at this site are short term and will be subject to seasonal fluctuations and precipitation events, therefore the water levels should be expected to be higher during the spring season or during any period of heavy precipitation.

4.7 Highway 401 – STA. 16+345 to STA. 16+445 (Retaining Wall 5)

The plan and profile along the centerline of the proposed widened embankment showing the borehole locations and interpreted stratigraphy between about STA. 16+345 and STA. 16+445 are shown on Drawings 7. The Record of Borehole sheets (Boreholes RW-3, RW-4 and DC-7) and the laboratory test results for this area are presented in Appendix E. The proposed retaining wall alignment within this section of the highway is located south of the existing Highway 401 EBL and east of the Second Line West bridge underpass. Second Line West



crosses Highway 401 in a north-south direction via a 3-span bridge on the west end of the site. Residential properties are present at the southeast quadrant of the Second Line West.

The subsurface soils encountered along the proposed alignment in this area consist of a surficial layer of topsoil (where present) underlain either by a deposit of fill or clayey silt till or clayey silt to a silty clay deposit, underlain by a silt to silt and sand deposit. The silt to silt and sand deposit is in turn underlain by a cohesive till deposit comprised of clayey silt.

4.7.1 Topsoil

A 100 mm thick surficial layer of topsoil was encountered at the ground surface in Boreholes DC-7, RW-3 and RW-4.

4.7.2 Fill

A deposit of fill material was encountered underlying the topsoil in Boreholes RW-3 and RW-4 at about Elevation 173.6 m and Elevation 174.3 m, respectively, and the deposit is about 1.3 m thick. The fill is comprised of sandy clayey silt, trace gravel, trace rootlets and is interlayered with sand lenses.

The SPT "N"-values measured within the sandy clayey silt fill are from 12 blows and 15 blows per 0.3 m of penetration, suggesting a stiff relative density.

A grain size distribution test was carried out on one (1) selected sample of the sandy clayey silt fill and the result is provided on Figure E1 in Appendix E. An Atterberg limits test was performed on one (1) selected sample of the fill and measured a liquid limit of about 28 per cent, a plastic limit of about 15 per cent and a corresponding plasticity index of about 13 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure E2 in Appendix E, and indicates the fill material to be a clayey silt of low plasticity. The natural water content measured on three (3) samples of the sandy clayey silt fill ranges between about 13 per cent and 18 per cent.

4.7.3 Clayey Silt (Till) (Upper Deposit)

A cohesive till deposit was encountered underlying the fill material in Boreholes RW-3 and RW-4 and below the topsoil in Borehole DC-7. The surface of the till deposit ranges from about Elevations 175.0 m to 172.3 m at the boreholes and the thickness of the till deposit ranges from about 4.2 m to 6.0 m. The till generally consists of brown to grey clayey silt with sand to sandy clayey silt, trace to some gravel

The SPT "N"-values recorded within the till deposit range from 6 blows to 29 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

The results of grain size distribution tests carried out on two (2) samples of the sandy clayey silt till deposit are presented on Figure E3 in Appendix E. Atterberg limits tests were carried out on four (4) samples of this cohesive till deposit and measured liquid limits between about 23 per cent and 31 per cent, plastic limits between about 14 per cent to 16 per cent, and corresponding plasticity indices between about 9 per cent and 15 per cent.



The results of the Atterberg limits tests are shown on a plasticity chart on Figure E4 in Appendix E, and indicate that the till deposit is clayey silt of low plasticity. The natural water content measured on seven (7) samples of this cohesive till deposit ranges between about 9 per cent and 17 per cent.

4.7.4 Silty Clay

A cohesive deposit of grey silty clay was encountered below the upper deposit of sandy clayey silt till in Borehole DC-7. The surface of the silty clay deposit is at about Elevation 169.0 m and the thickness of this deposit is about 2.0 m. The silty clay deposit generally contains trace sand and trace gravel.

A SPT "N"-value of 7 blows per 0.3 m of penetration was measured within the silty clay deposit, suggesting a firm consistency. An in situ field vane test carried out within this deposit measured an undrained shear strength of about 170 kPa and the sensitivity is calculated to be about 1. The field vane test together with the SPT "N" values results suggest that the deposit generally has a firm to very stiff consistency.

4.7.5 Silt to Silt and Sand

Underlying the upper clayey silt till deposit in Boreholes RW-3 and RW-4 and underlying the silty clay deposit in Borehole DC-7, a deposit of silt to silt and sand was encountered at depths of between about 5.6 m and 8.1 m below the ground surface, corresponding to between Elevations 168.8 m and 167.0 m. The thickness of the silt to silt and sand deposit ranges from about 0.7 m to 1.0 m.

The SPT "N"-values recorded within this deposit range from 7 blows to 25 blows per 0.3 m of penetration, suggesting that the deposit has a loose to compact relative density.

The results of grain size distribution tests carried out on two (2) samples of the silt to silt and sand layer is shown on Figure E5 in Appendix E. The natural water content measured on seven (7) samples of this cohesive till deposit ranges between about 9 per cent and 17 per cent.

4.7.6 Clayey Silt with Sand to Clayey Silt (Till) (Lower Deposit)

A lower deposit of cohesive till comprised of clayey silt with sand to sandy clayey silt to clayey silt, trace sand, trace to some gravel, was encountered underlying the silt to silt and sand deposit in Boreholes DC-7, RW-3, and RW-4. The surface of the cohesive till deposit ranges from about Elevations 168.0 m to 166.3 m at the boreholes, and the thickness of the deposit ranged from about 1.6 m to 2.5 m. These borehole were terminated within the till deposit at depths of between about 8.2 m and 11.3 m below ground surface, corresponding to between Elevations 166.2 m and 163.8 m.

The SPT "N"-values measured within the lower clayey silt till deposit range between 13 blows and 28 blows per 0.3 m of penetration, suggesting that the cohesive till has a stiff to very stiff consistency.

A grain size distribution test was carried out on one (1) selected sample of the clayey silt till deposit and the result is provided on Figure E6 in Appendix E. An Atterberg limits test conducted on one (1) sample of the clayey silt till deposit measured a liquid limit of about 21 per cent, a plastic limit of about 14 per cent, and a



corresponding plasticity index of about 7 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure E7 in Appendix E and indicates that the till deposit consist of clayey silt of low plasticity. The natural water content measured on three (3) samples of the cohesive till deposit is about 11 per cent.

4.7.7 Groundwater Conditions

The samples taken in the boreholes were generally moist to wet. The groundwater levels in the open boreholes were measured upon completion of drilling operations and a standpipe piezometer was installed in each of Boreholes RW-3 and DC-7 to permit monitoring of the groundwater level at this site. Details of the piezometer installation and measured groundwater levels are shown on the Record of Borehole sheets in Appendix E. The groundwater levels recorded in the open boreholes and piezometers are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date	Comments
DC-7	175.1	Dry	--	August 30, 2012	Piezometer
		5.6	169.5	October 09, 2012	
		5.5	169.6	November 05, 2012	
RW-3	173.7	2.5	171.2	August 8, 2014	Piezometer
		2.5	171.2	August 27, 2014	Piezometer
		2.2	171.2	September 15, 2014	Piezometer
RW-4	174.4	Dry	--	July 5, 2014	Open Borehole

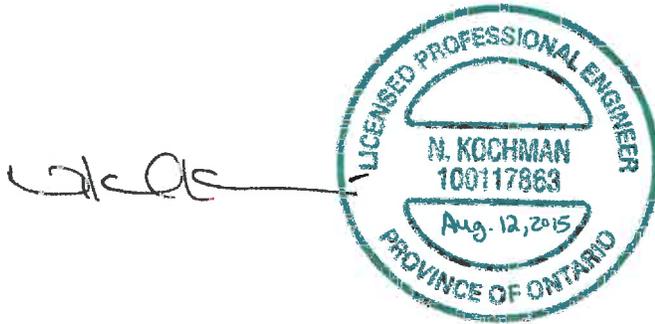
Based on the observed groundwater levels in the open boreholes and standpipe piezometers, the groundwater level fluctuates from about Elevations 169.5 m to 171 m. The groundwater level observations at this site are short term and have not stabilized. The groundwater levels will be subject to seasonal fluctuations and precipitation events and therefore should be expected to be higher during the spring season or during any period of heavy precipitation.



5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Haley Schafer and reviewed by Ms. Nikol Kochmanová, P.Eng., a geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Designated MTO Foundations Contact and Principal Golder, conducted an independent quality control review of this report.

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Geotechnical Engineer



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

NK/KJB/JMAC/sm

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LIST OF SYMBOLS

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

I.	GENERAL	(a)	Index Properties (continued)
π	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)
II.	STRESS AND STRAIN	(b)	Hydraulic Properties
γ	shear strain	h	hydraulic head or potential
Δ	change in, e.g. in stress: $\Delta \sigma$	q	rate of flow
ε	linear strain	v	velocity of flow
ε_v	volumetric strain	i	hydraulic gradient
η	coefficient of viscosity	k	hydraulic conductivity (coefficient of permeability)
ν	Poisson's ratio	j	seepage force per unit volume
σ	total stress	(c)	Consolidation (one-dimensional)
σ'	effective stress ($\sigma' = \sigma - u$)	C_c	compression index (normally consolidated range)
σ'_{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
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$	C_α	secondary compression index
τ	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
III.	SOIL PROPERTIES	σ'_p	pre-consolidation stress
(a)	Index Properties	OCR	over-consolidation ratio = σ'_p / σ'_{vo}
$\rho(\gamma)$	bulk density (bulk unit weight)*	(d)	Shear Strength
$\rho_d(\gamma_d)$	dry density (dry unit weight)	τ_p, τ_r	peak and residual shear strength
$\rho_w(\gamma_w)$	density (unit weight) of water	ϕ'	effective angle of internal friction
$\rho_s(\gamma_s)$	density (unit weight) of solid particles	δ	angle of interface friction
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)	μ	coefficient of friction = $\tan \delta$
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)	c'	effective cohesion
e	void ratio	C_u, S_u	undrained shear strength ($\phi = 0$ analysis)
n	porosity	p	mean total stress $(\sigma_1 + \sigma_3)/2$
S	degree of saturation	p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
		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 ρ . Unit weight symbol is γ 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 cm² 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.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier
0 to 5	Trace
5 to 12	Trace to Some (or Little)
12 to 20	Some
20 to 30	(ey) or (y)
over 30	And (non-cohesive (cohesionless)) or With (cohesive)

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

	kPa	C_u, S_u	psf
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 _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
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 ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

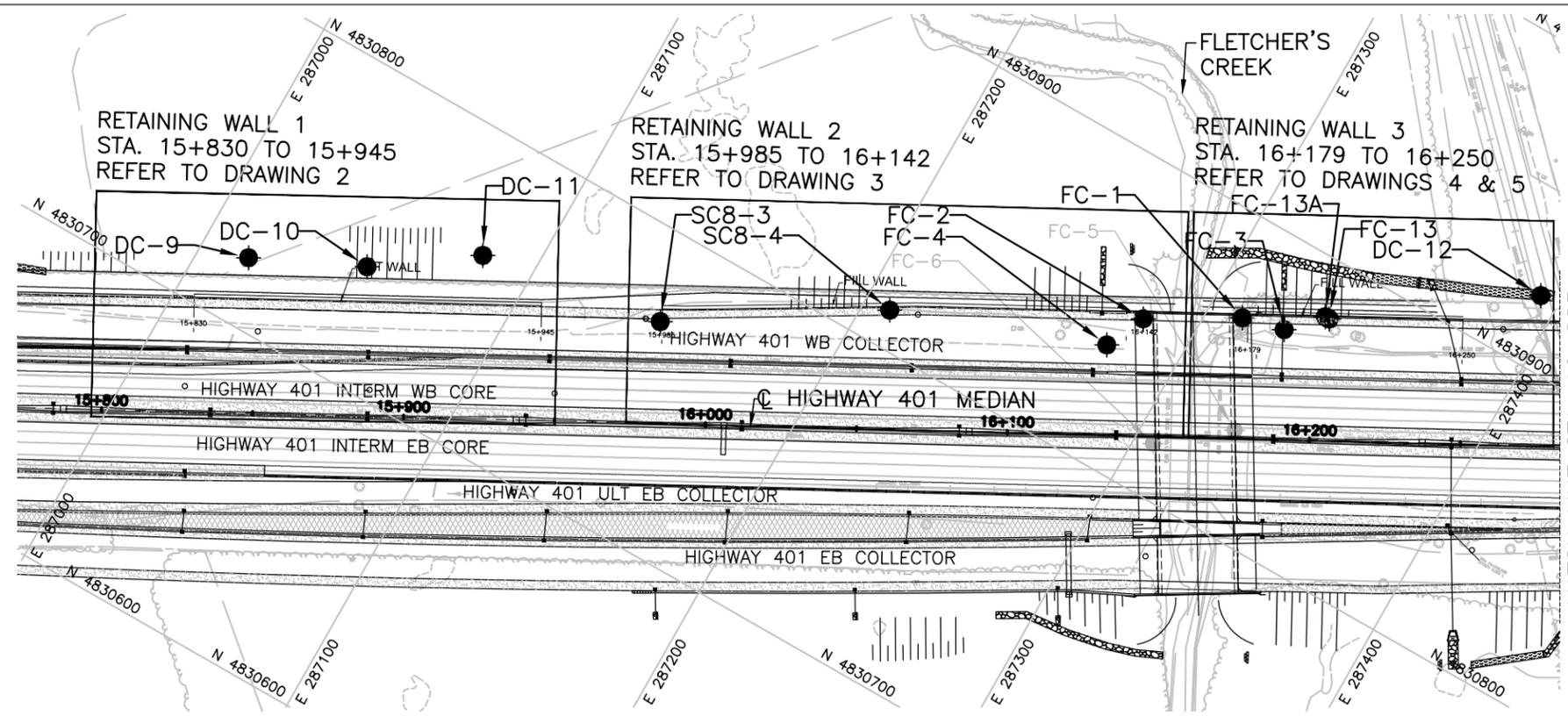
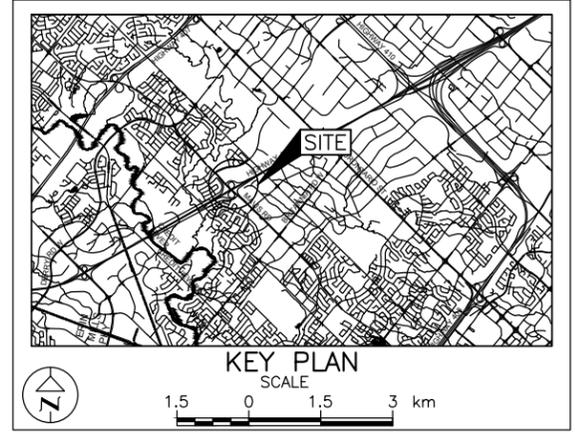
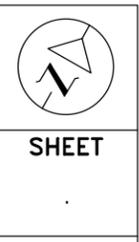
Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

Example

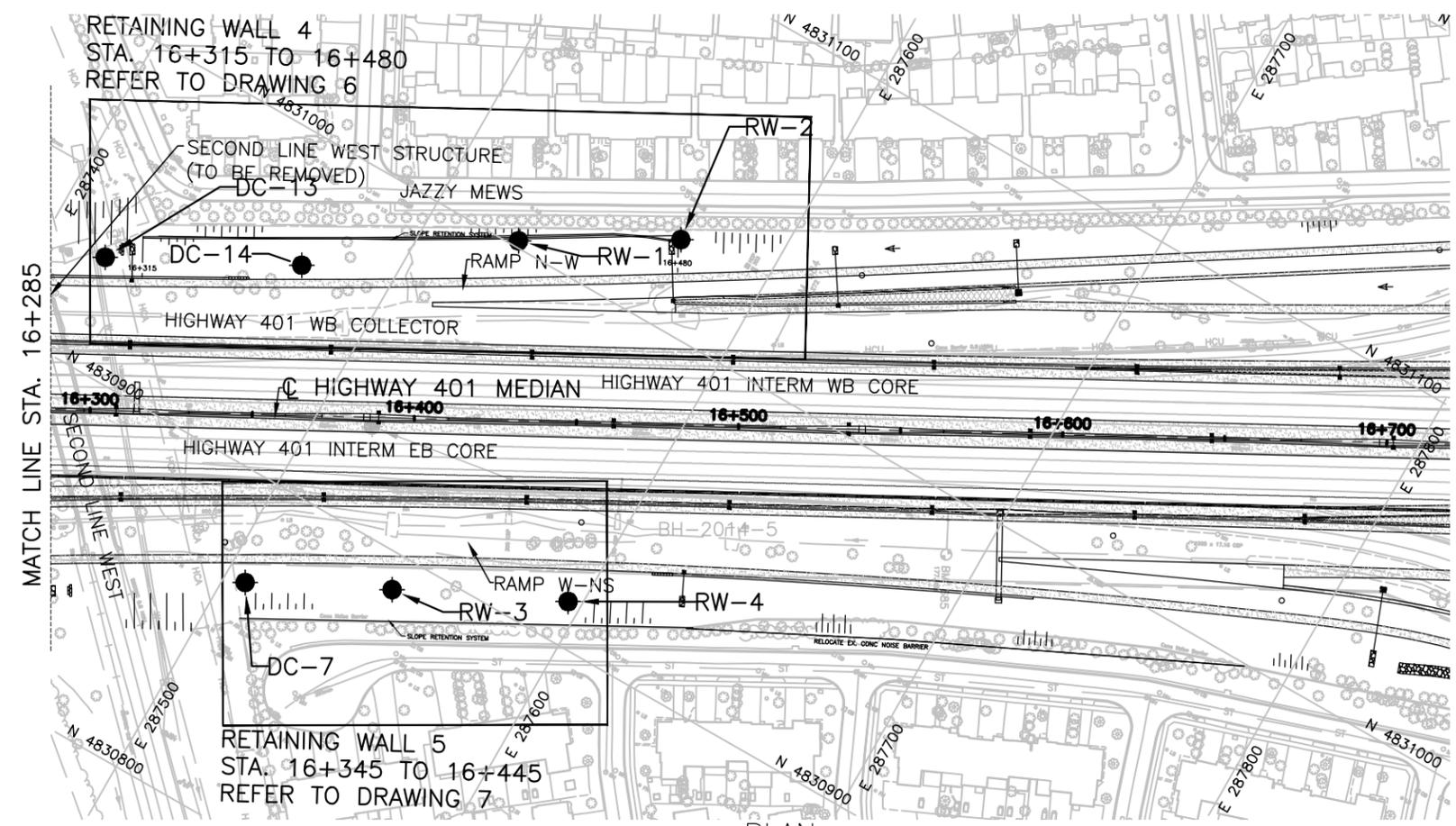
Trace sand
Trace to some sand
Some sand
Sandy
Sand and Gravel
Silty Clay with sand / Clayey Silt with sand

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

CONT No. GWP No. 2150-01-00
HIGHWAY 401
RETAINING WALLS
INDEX PLAN



PLAN
SCALE
20 0 20 40 m



PLAN
SCALE
20 0 20 40 m

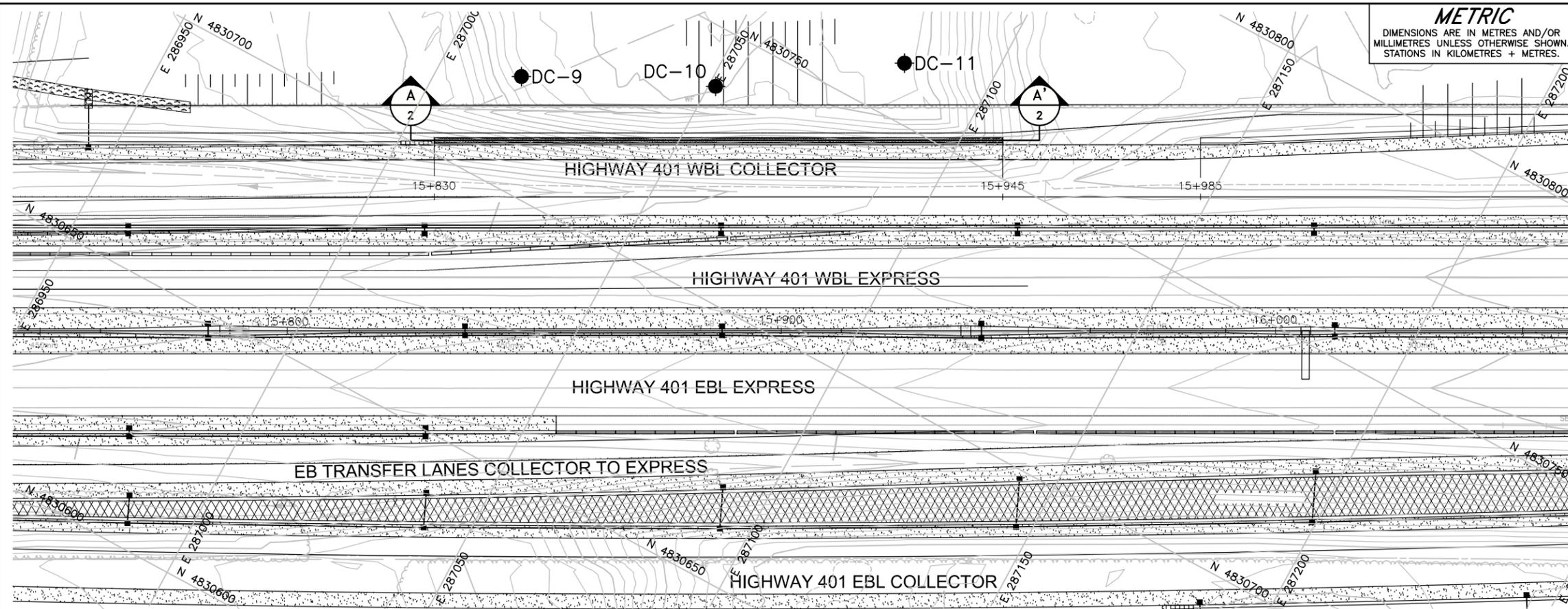
NOTES
This drawing is for general layout information only. The extent and location of the proposed structures are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.
The complete Foundation Investigation and 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-DE-HWY401_FLTCH_CRK - RW Plan.dwg, X-60213979-C-DE-NB & SLOPE.dwg, received February 25, 2015 and X-60213979-C-DE-HWY401_MAVIS.dwg, received September 24, 2014.

NO.	DATE	BY	REVISION

Geocres No. 30M12-388

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. KJB	CHKD. NK	DATE: July 2015
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		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
RETAINING WALL 1 STA. 15+830 TO 15+945
BOREHOLE LOCATIONS AND SOIL STRATA

Golden Associates

SHEET



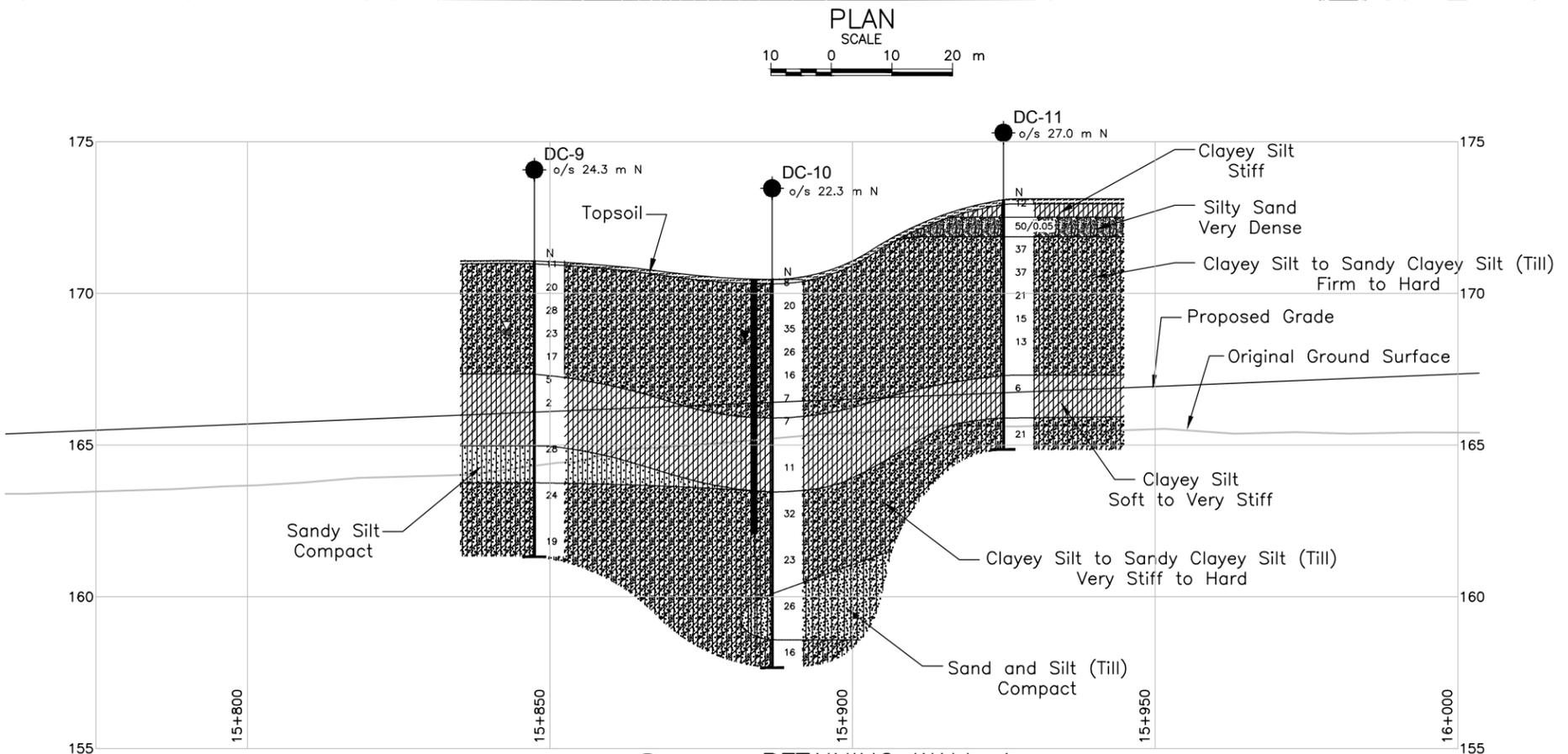
KEY PLAN
SCALE
10 0 10 20 m

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 November 05, 2012
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
DC-9	171.1	4830722.1	287015.8
DC-10	170.5	4830738.9	287051.3
DC-11	173.1	4830761.2	287082.8



A-A'
2
RETAINING WALL 1
STA. 15+830 TO 15+945
VERTICAL SCALE
2 0 2 4 m
HORIZONTAL SCALE
10 0 10 20 m

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.

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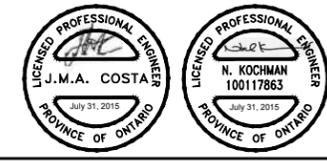
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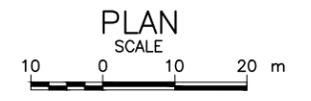
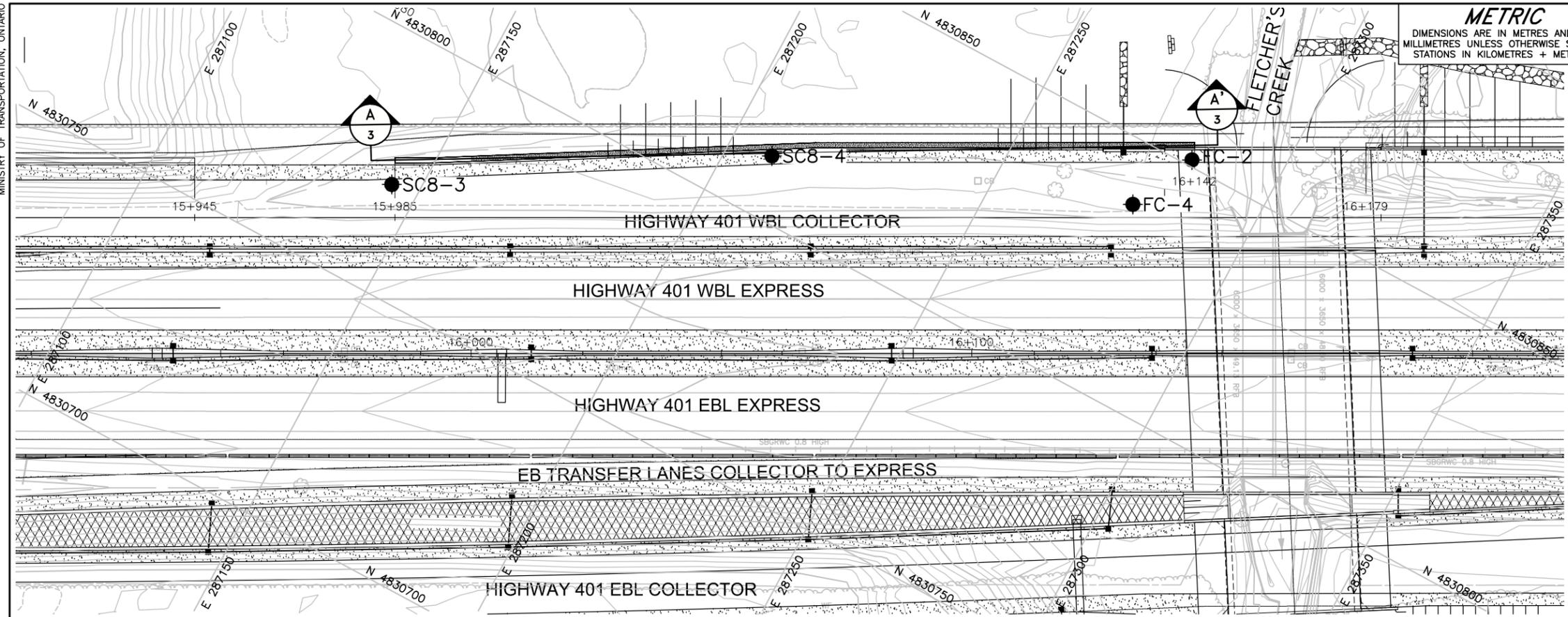
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NO.	DATE	BY	REVISION

Geocres No. 30M12-388

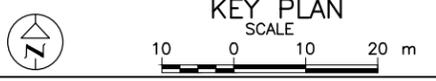
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SUBM'D. KJB	CHKD. NK	DATE: July 2015
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG. 2





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

CONT No. GWP No. 2150-01-00
HIGHWAY 401
RETAINING WALL 2 STA. 15+985 TO 16+142
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 November 05, 2012
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
SC8-3	164.7	4830771.3	287144.6
SC8-4	164.5	4830812.3	287208.7
FC-2	163.8	4830851.3	287283.0
FC-4	164.4	4830837.9	287276.8

NOTES

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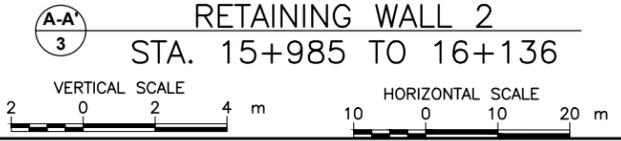
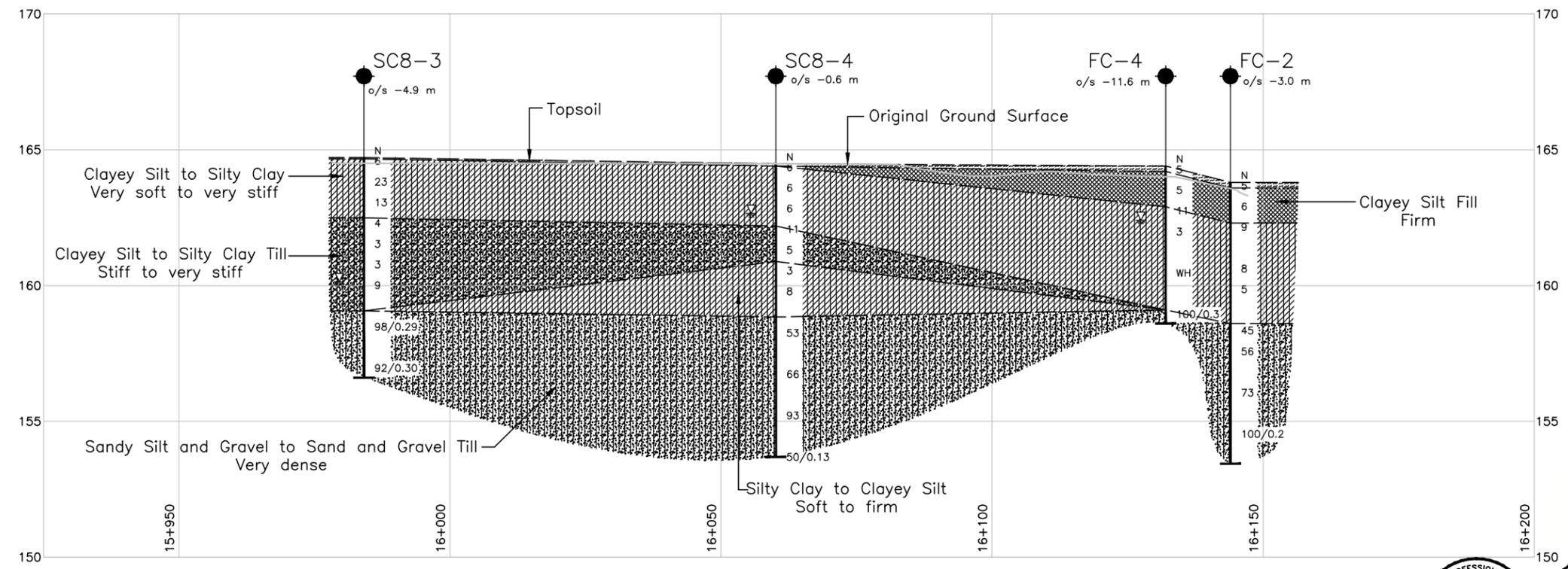
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NO.	DATE	BY	REVISION

Geocres No. 30M12-388

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. KJB	CHKD. NK	DATE: July 2015
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		DWG. 3



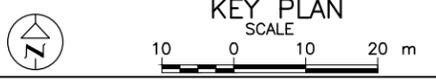
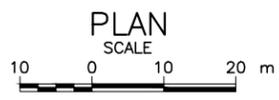
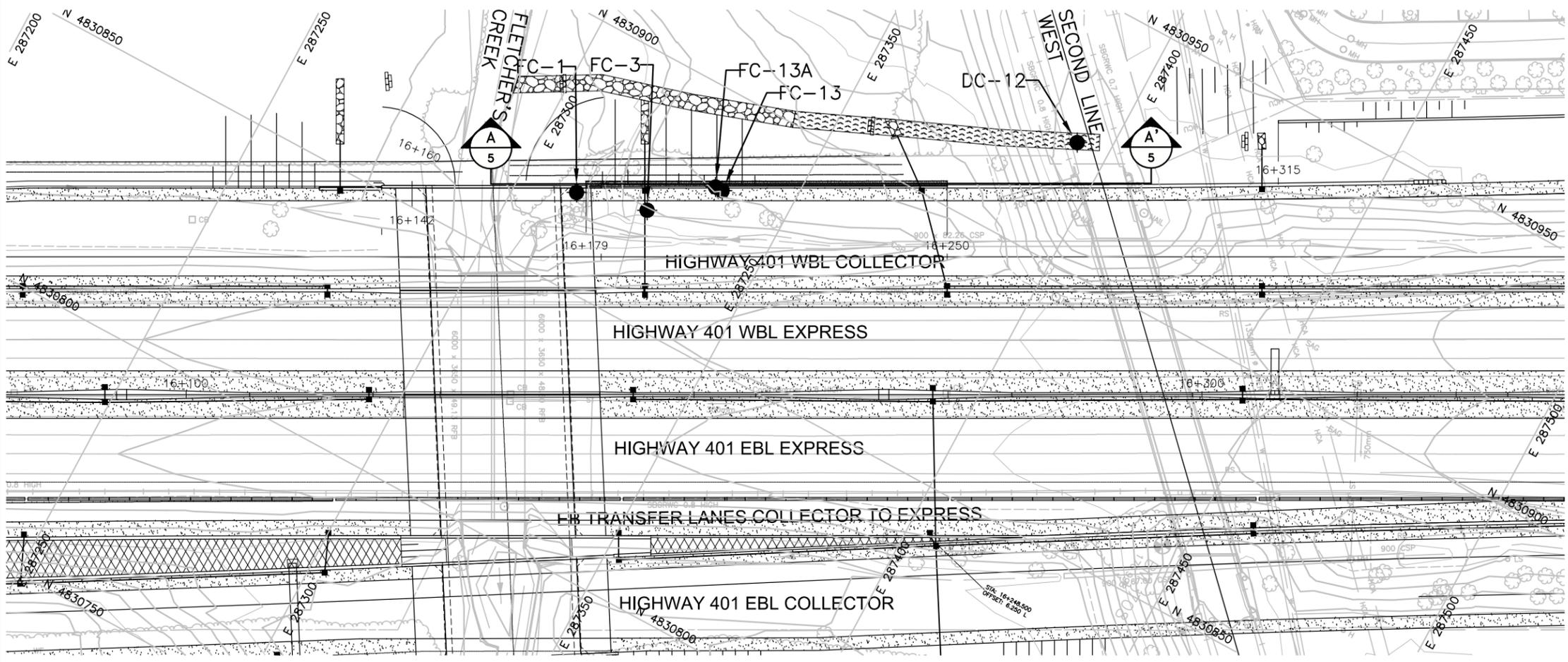
METRIC
 DIMENSIONS ARE IN METRES AND/OR
 MILLIMETRES UNLESS OTHERWISE SHOWN.
 STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



HIGHWAY 401
 RETAINING WALL 3 STA. 16+179 TO 16+250
 BOREHOLE LOCATIONS

SHEET



LEGEND
 ● Borehole - Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
DC-12	176.3	4830923.2	287393.6
FC-1	163.7	4830867.9	287311.4
FC-3	165.9	4830871.4	287325.3
FC-13	167.1	4830881.8	287336.5
FC-13A	167.1	4830881.8	287335.0

NOTES
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REFERENCE
 Base plans provided in digital format by AECOM, drawing file nos.
 X-60213979-C-DE-HWY401_FLTCH_CRK - RW Plan.dwg,
 X-60213979-C-DE-NB & SLOPE.dwg, received February 25, 2015 and
 X-60213979-C-DE-HWY401_MAVIS.dwg, received September 24, 2014.

NO.	DATE	BY	REVISION

Geocres No. 30M12-388		PROJECT NO. 10-1111-0211		DIST. .
HWY. 401	CHKD. NK	DATE: July 2015	SITE: .	
SUBM'D. KJB	CHKD. KJB	APPD. JMAC	DWG. 4	



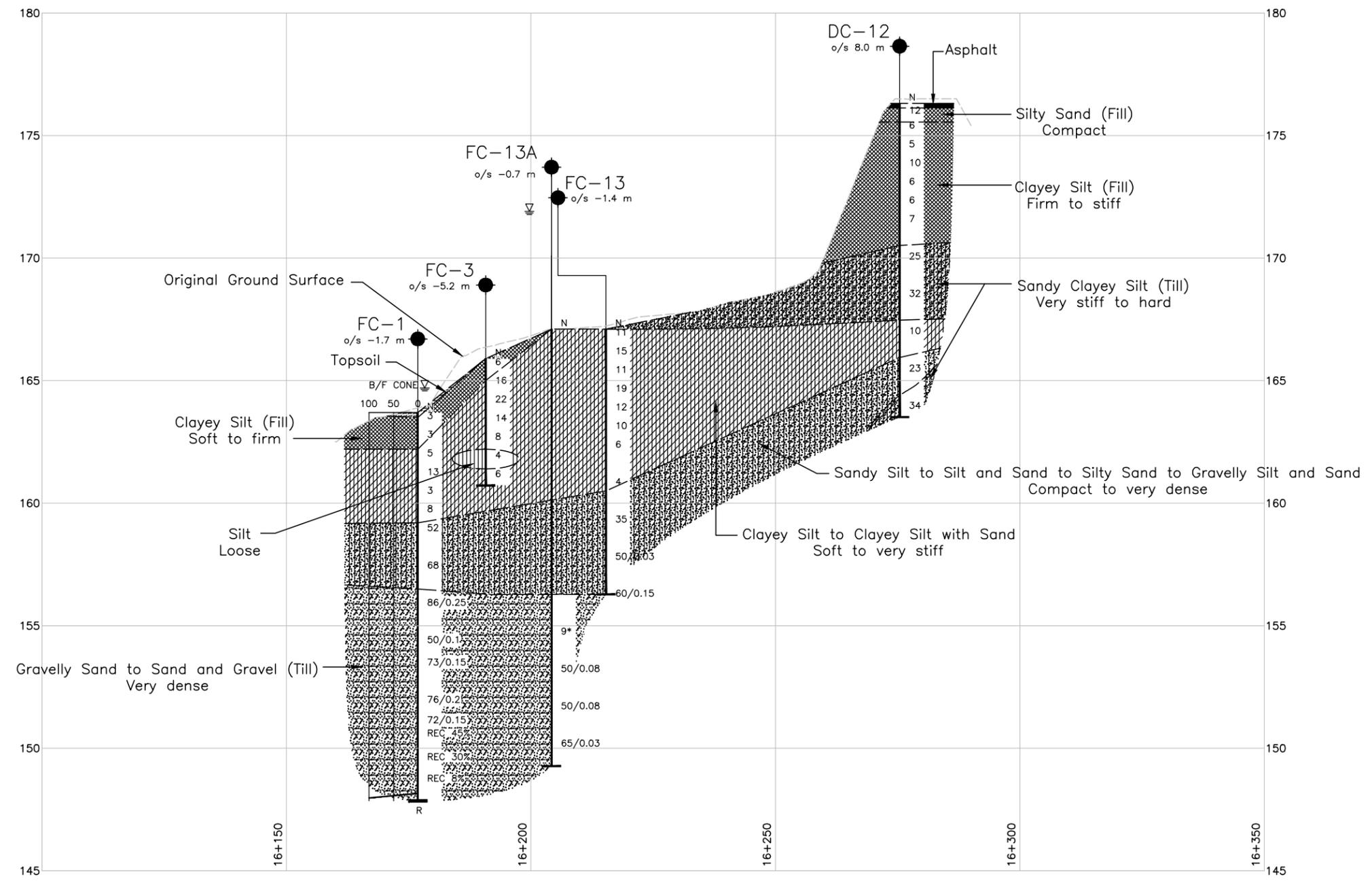
METRIC
 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2150-01-00

HIGHWAY 401
 RETAINING WALL 3 STA. 16+179 TO 16+250

SOIL STRATA

SHEET



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- REC % Recovery
- ∇ WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
DC-12	176.3	4830923.2	287393.6
FC-1	163.7	4830867.9	287311.4
FC-3	165.9	4830871.4	287325.3
FC-13	167.1	4830881.8	287336.5
FC-13A	167.1	4830881.8	287335.0

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.

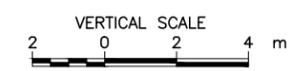
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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-DE-HWY401_FLTCH_CRK - RW Plan.dwg, X-60213979-C-DE-NB & SLOPE.dwg, received February 25, 2015 and X-60213979-C-DE-HWY401_MAVIS.dwg, received September 24, 2014.

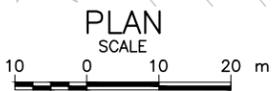
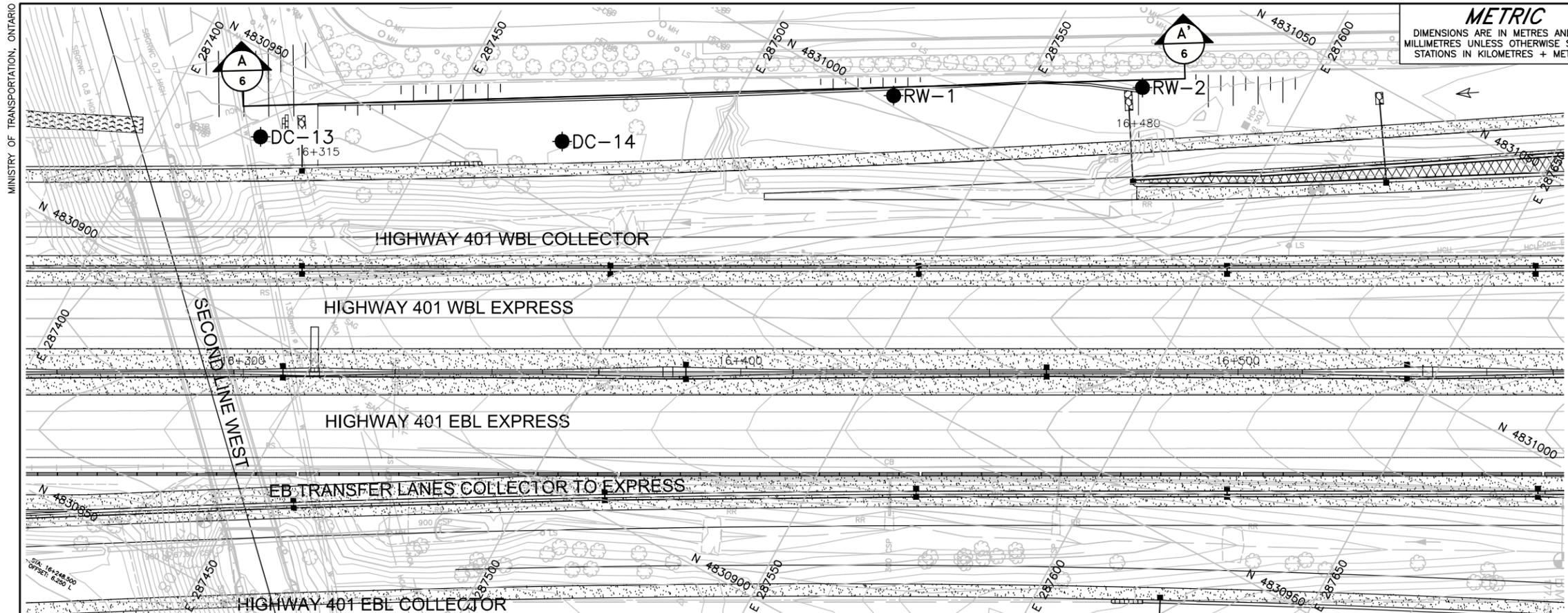
A-A
4 **RETAINING WALL 3**
STA. 16+182 TO 16+250



NO.	DATE	BY	REVISION

Geocres No. 30M12-388

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. KJB	CHKD. NK	DATE: July 2015
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		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
RETAINING WALL 4 STA. 16+315 TO 16+480
BOREHOLE LOCATIONS AND SOIL STRATA

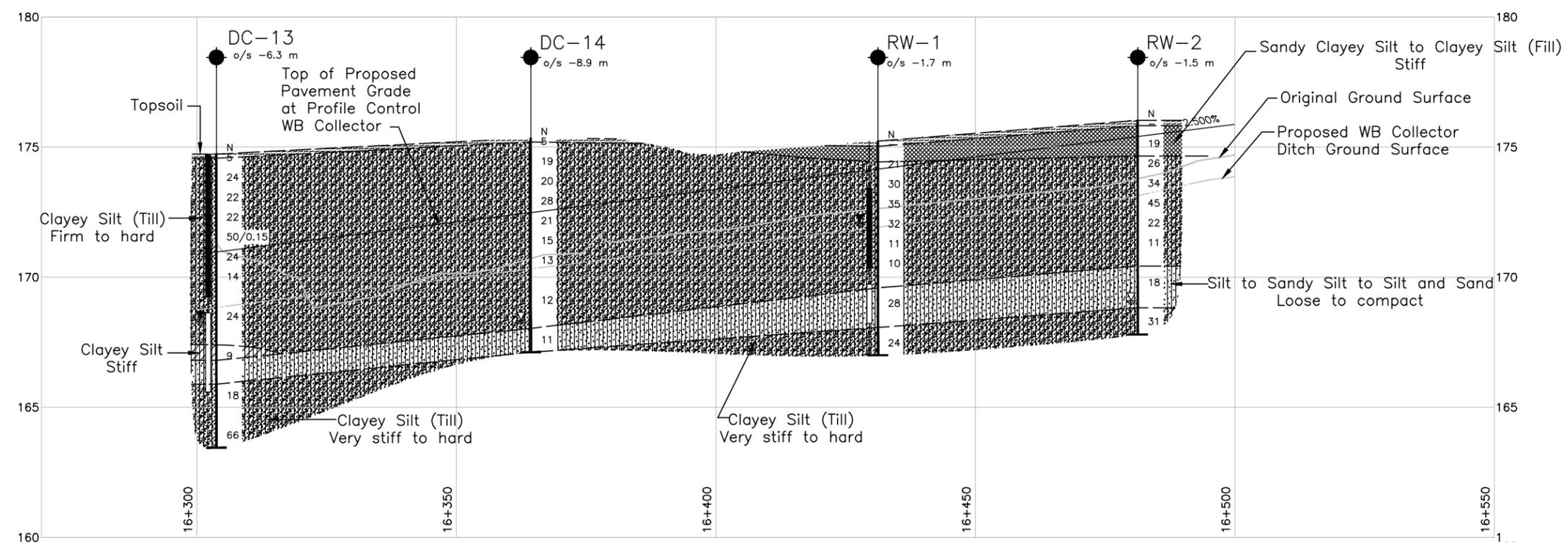


KEY PLAN SCALE 10 0 10 20 m

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 November 05, 2012 (DC-13) and September 15, 2014 (RW-1)
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
DC-13	174.7	4830934.4	287419.4
DC-14	175.4	4830962.3	287473.2
RW-1	175.2	4831002.0	287527.6
RW-2	176.0	4831027.1	287570.9



A-A
RETAINING WALL 4
STA. 16+315 TO 16+480



NOTES
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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-DE-HWY401_FLTCH_CRK - RW Plan.dwg,
X-60213979-C-DE-NB & SLOPE.dwg, received February 25, 2015 and
X-60213979-C-DE-HWY401_MAVIS.dwg, received September 24, 2014.

NO.	DATE	BY	REVISION

Geocres No. 30M12-388

HWY. 401	PROJECT NO. 10-1111-0211	DIST. .
SUBM'D. KJB	CHKD. NK	DATE: July 2015
DRAWN: JFC	CHKD. KJB	APPD. JMAC
		SITE: .
		DWG. 6

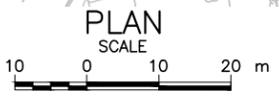
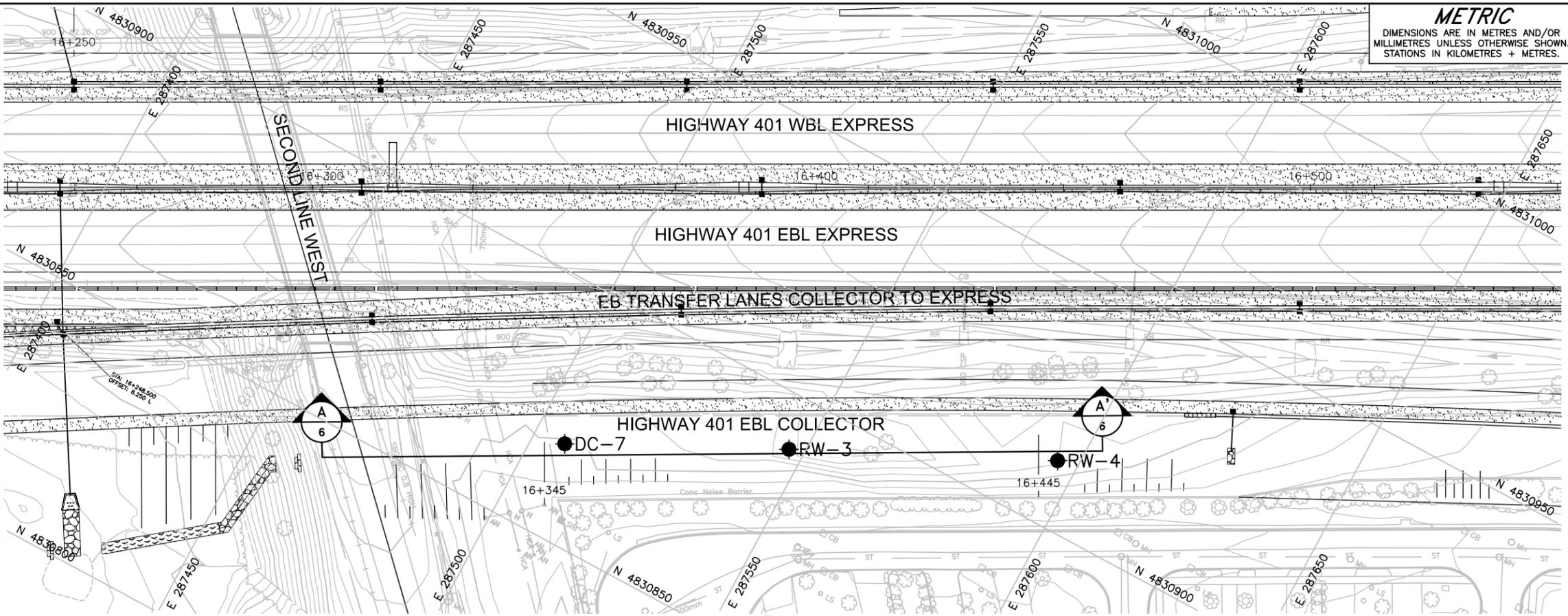
METRIC
 DIMENSIONS ARE IN METRES AND/OR
 MILLIMETRES UNLESS OTHERWISE SHOWN.
 STATIONS IN KILOMETRES + METRES.

CONT No. GWP No. 2150-01-00



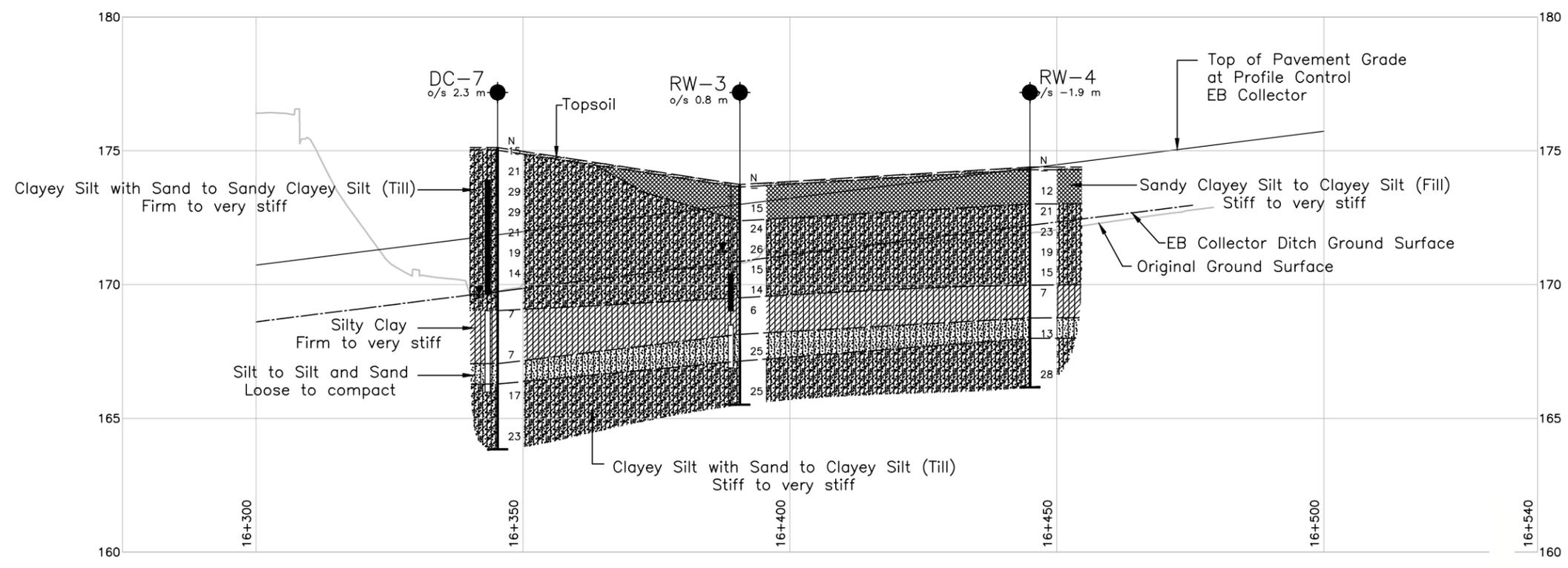
HIGHWAY 401
 RETAINING WALL 5 16+345 TO 16+445
 BOREHOLE LOCATIONS AND
 SOIL STRATA

SHEET



LEGEND

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
DC-7	175.1	4830868.9	287506.4
RW-3	173.7	4830889.5	287546.9
RW-4	174.4	4830913.2	287595.9



RETAINING WALL 5
STA. 16+345 TO 16+445



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-DE-HWY401_FLTCH_CRK - RW Plan.dwg,
 X-60213979-C-DE-NB & SLOPE.dwg, received February 25, 2015 and
 X-60213979-C-DE-HWY401_MAVIS.dwg, received September 24, 2014.

NO.	DATE	BY	REVISION

Geocres No. 30M12-388		PROJECT NO. 10-1111-0211		DIST. .
HWY. 401	CHKD. NK	DATE: July 2015	SITE: .	
SUBM'D. KJB	CHKD. KJB	APPD. JMAC	DWG. 7	



APPENDIX A

Retaining Wall 1, Highway 401 - STA. 15+830 to STA 15+945 Record of Borehole Sheets and Laboratory Test Results

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No DC-9	SHEET 1 OF 1	METRIC
2150-01-00	LOCATION <u>N 4830722.1 ; E 287015.8</u>	ORIGINATED BY <u>SB</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>57 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>BM</u>	
DATUM <u>Geodetic</u>	DATE <u>September 7, 2012</u>	CHECKED BY <u>TVA</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
			NUMBER	TYPE	"N" VALUES			20	40						60
171.1	GROUND SURFACE														
0.9	TOPSOIL														
	CLAYEY SILT, some sand, trace gravel, containing roots to a depth of 0.6 m (TILL) Stiff to very stiff Brown Moist		1	SS	11										
			2	SS	20		170								
			3	SS	28		169								
			4	SS	23		168							1 15 40 44	
			5	SS	17		167								
167.4	CLAYEY SILT, trace sand, trace gravel Soft to very stiff Grey Moist to wet		6	SS	5		167								
			7	SS	2		166								
							165								
165.0	Sandy SILT, trace to some clay Compact Grey Moist to wet		8	SS	28		165							0 22 71 7	
							164								
163.8	CLAYEY SILT, trace sand, trace gravel (TILL) Very stiff Grey Moist		9	SS	24		163								
							162								
161.3	END OF BOREHOLE		10	SS	19										
9.8	NOTES: 1. Borehole open to a depth of 8.4 m below ground surface (Elev. 162.7 m). 2. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 168.8 m) upon completion of drilling.														

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No DC-10 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830738.9 ; E 287051.3 ORIGINATED BY SB

2150-01-00 DIST HWY 401- 403 W Ramp BOREHOLE TYPE 57 mm I.D. Hollow Stem Augers COMPILED BY BM

DATUM Geodetic DATE September 11, 2012 CHECKED BY TVA

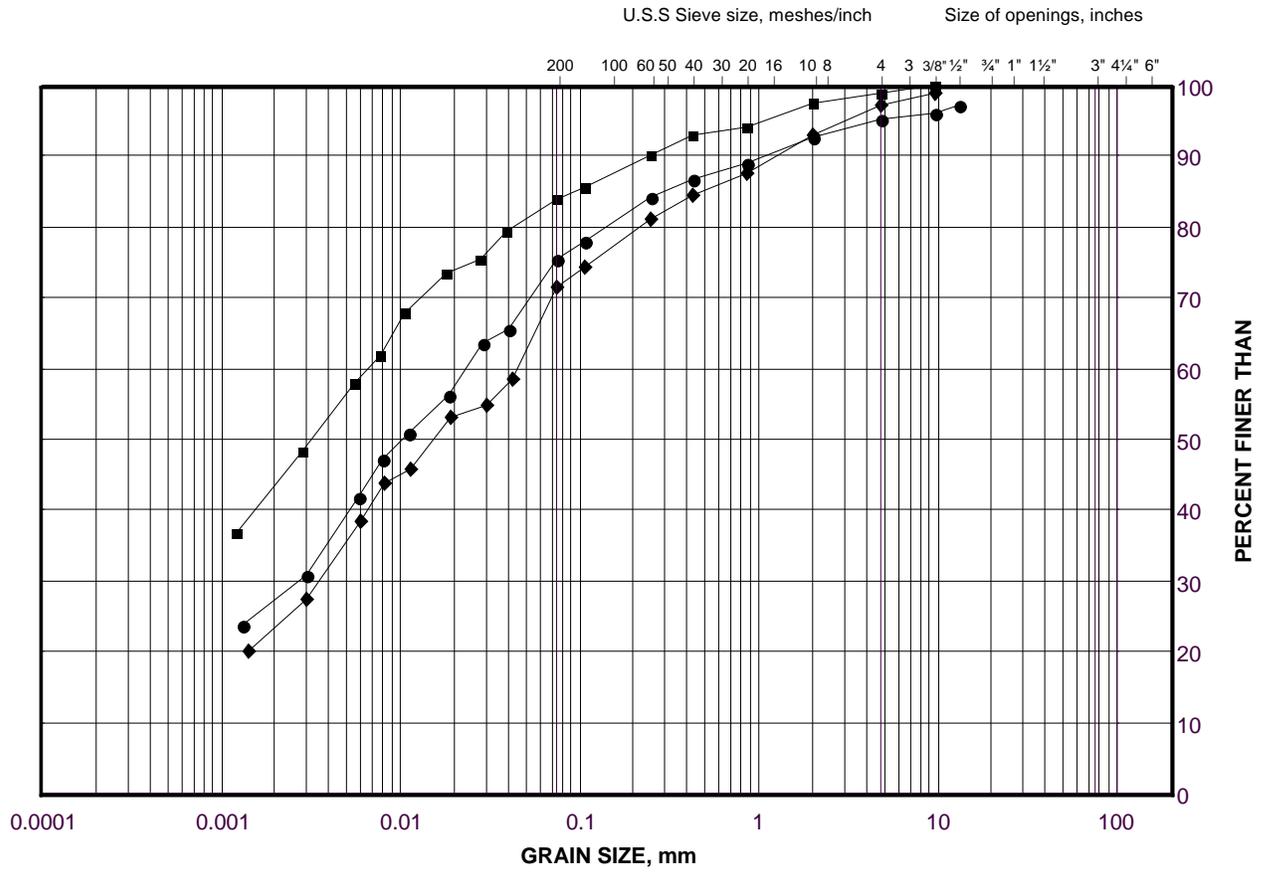
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	10 20 30	GR SA SI CL		
170.5	GROUND SURFACE												
0.0	TOPSOIL												
0.2	CLAYEY SILT, some sand, trace gravel, containing roots to a depth of 1.5 m (TILL) Firm to hard Brown Moist	1	SS	8									
		2	SS	20									
		3	SS	35									4 20 49 27
		4	SS	26									
		5	SS	16									
		6	SS	7									
165.9	CLAYEY SILT, trace sand, trace gravel Firm to stiff Grey Moist to wet	7	SS	7									
4.6		8	SS	11									
163.5	CLAYEY SILT, sandy, trace gravel (TILL) Very stiff to hard Grey Moist	9	SS	32									5 30 48 17
7.0		10	SS	23									
		11	SS	26									6 35 50 9
160.1	SAND and SILT, trace to some clay, trace to some gravel (TILL) Compact Grey Moist	12	SS	16									
10.4													
158.6	CLAYEY SILT, trace sand, trace gravel (TILL) Very stiff Grey Moist												
11.9													
157.7	END OF BOREHOLE NOTE: 1. Piezometer installation consists of 50 mm diameter PVC pipe with a 3.0 m slotted screen.												
12.8													

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION
 Sandy Clayey Silt to Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 1

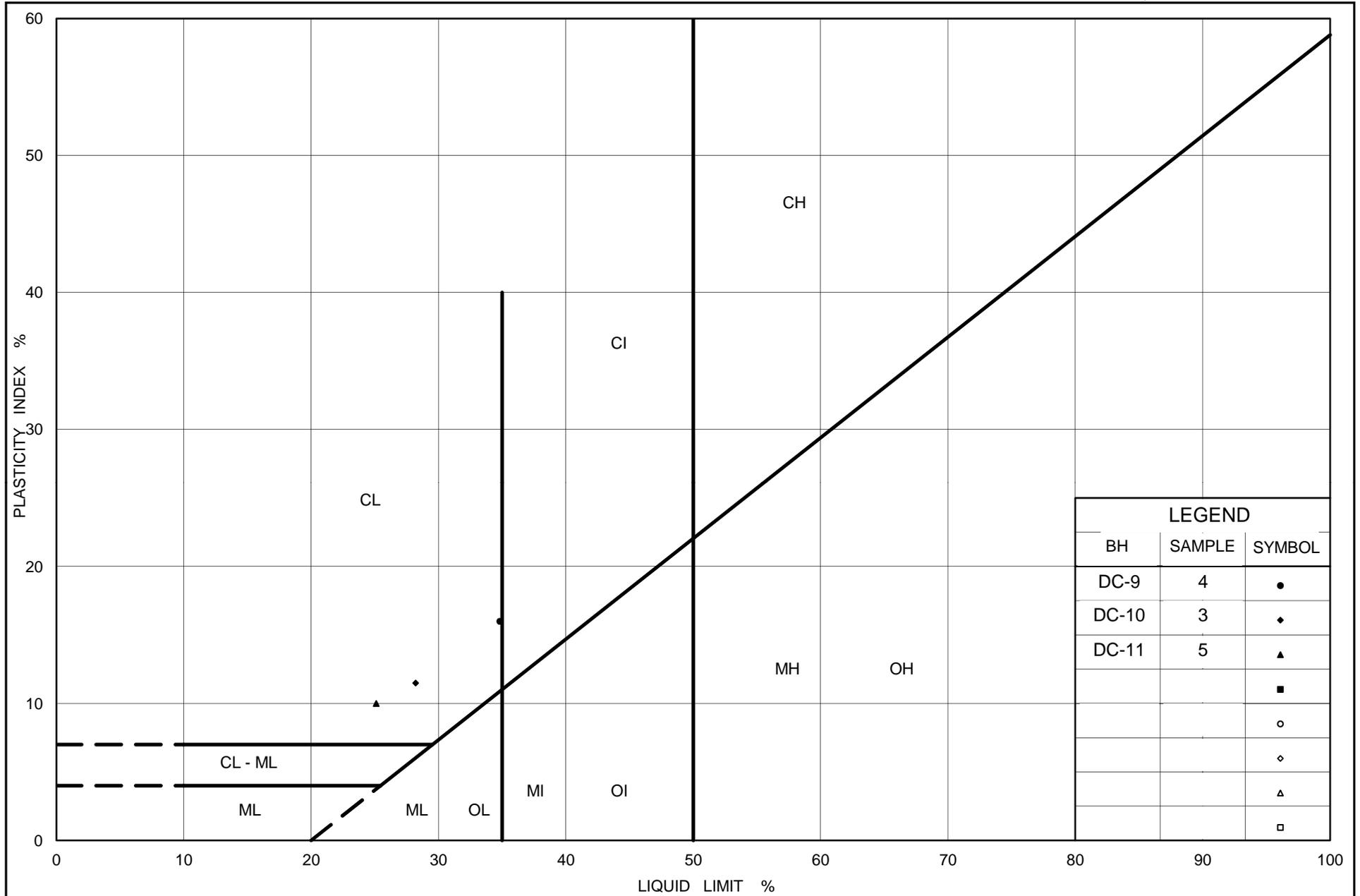
FIGURE A1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	DC-10	3	168.6
■	DC-9	4	168.5
◆	DC-11	5	169.7



Ministry of Transportation

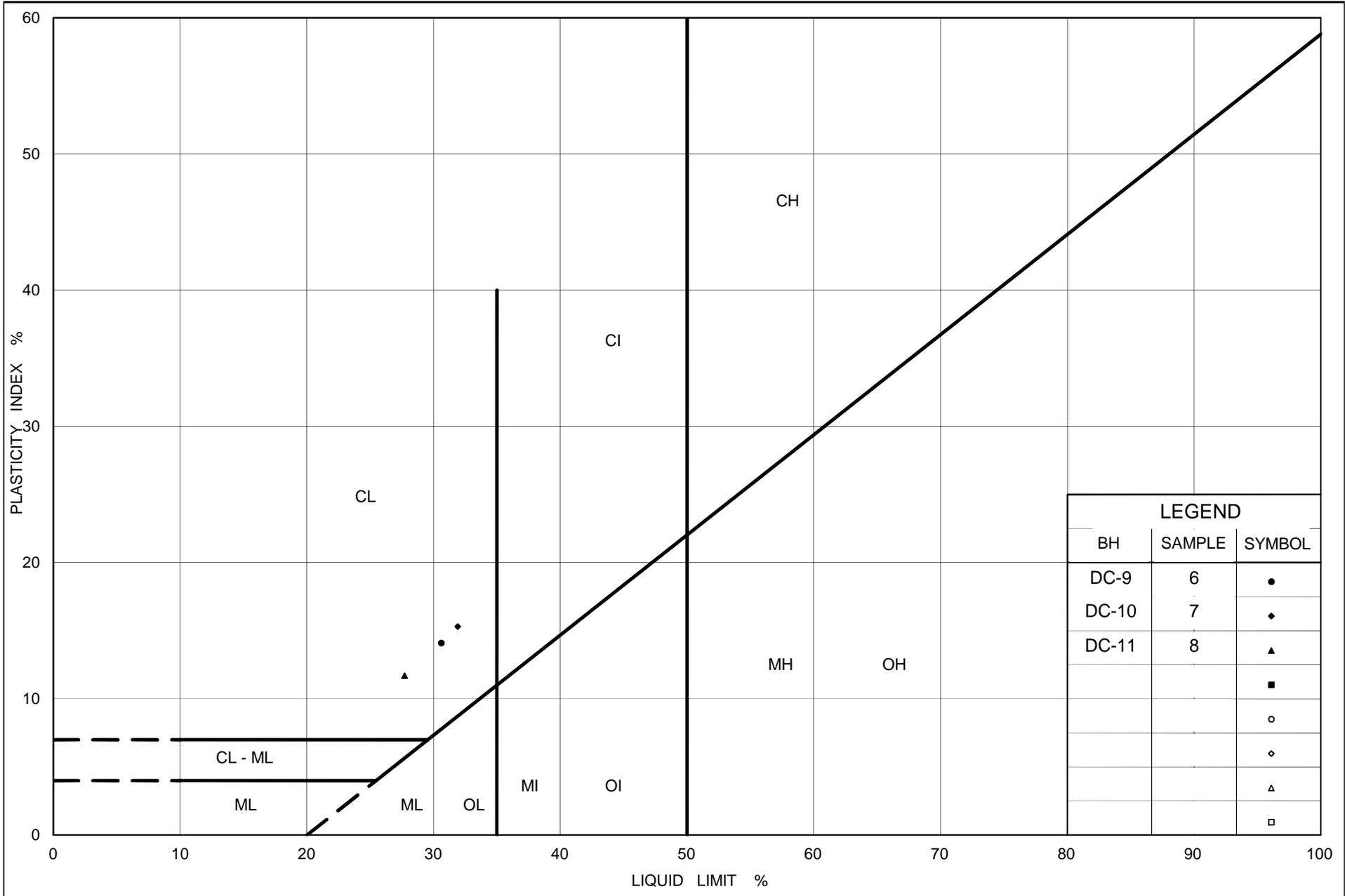
Ontario

PLASTICITY CHART
 Sandy Clayey Silt to Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 1

Figure No. A2

Project No. 10-1111-0211

Checked By: NK

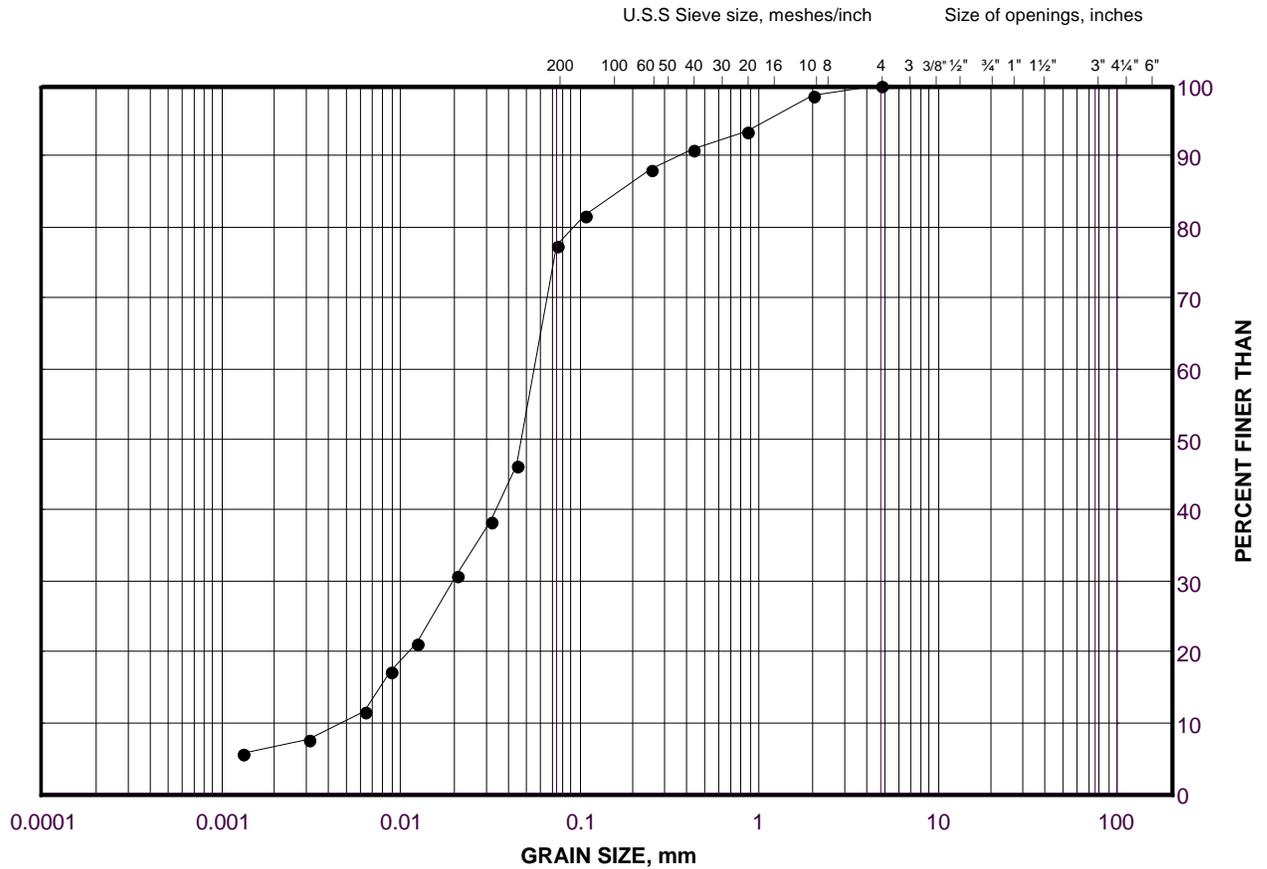


GRAIN SIZE DISTRIBUTION

Sandy Silt (Interlayer)

Retaining Wall 1

FIGURE A4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	DC-9	8	164.7

Project Number: 10-1111-0211

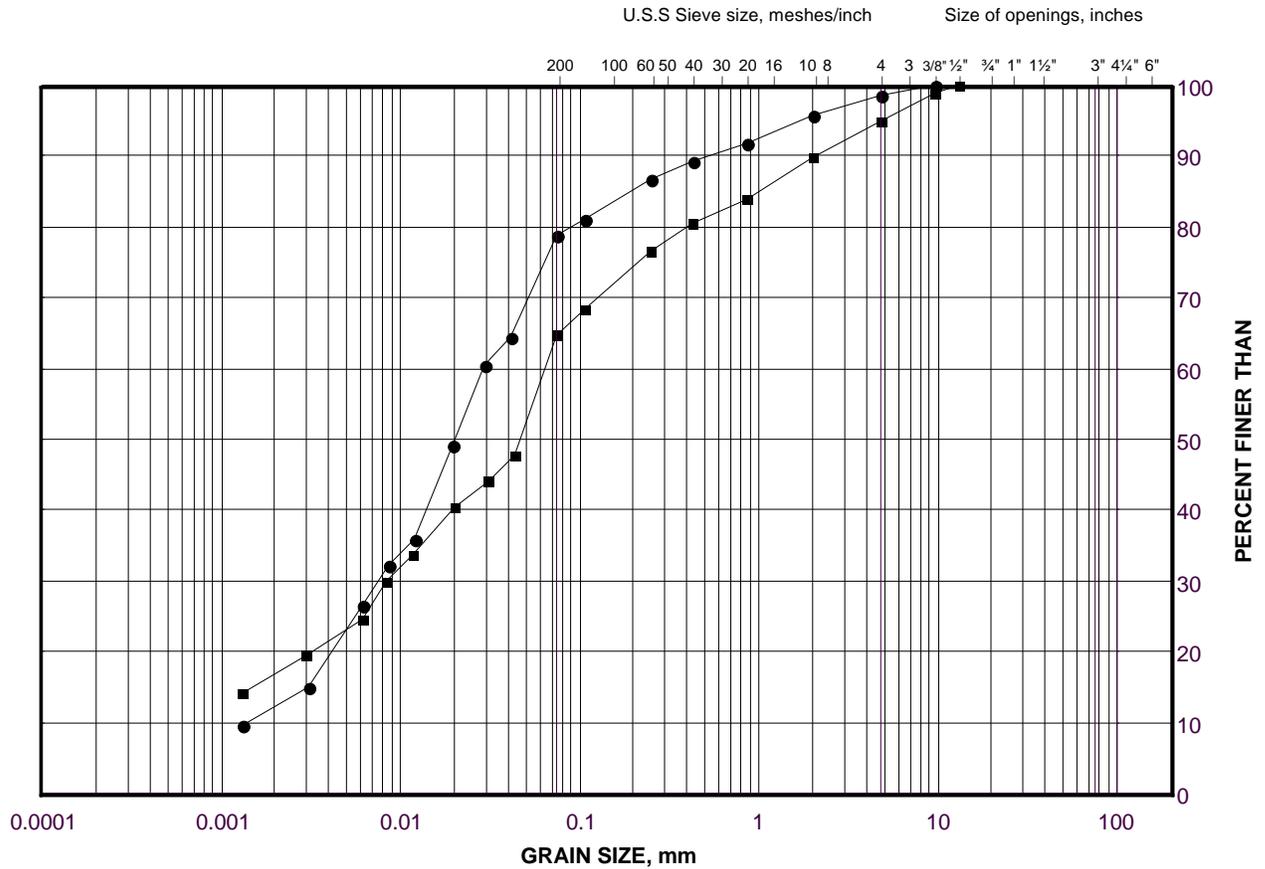
Checked By: NK

Golder Associates

Date: 11-Mar-15

GRAIN SIZE DISTRIBUTION
 Sandy Clayey Silt to Clayey Silt (Till) (Lower Deposit)
 Retaining Wall 1

FIGURE A5



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

LEGEND

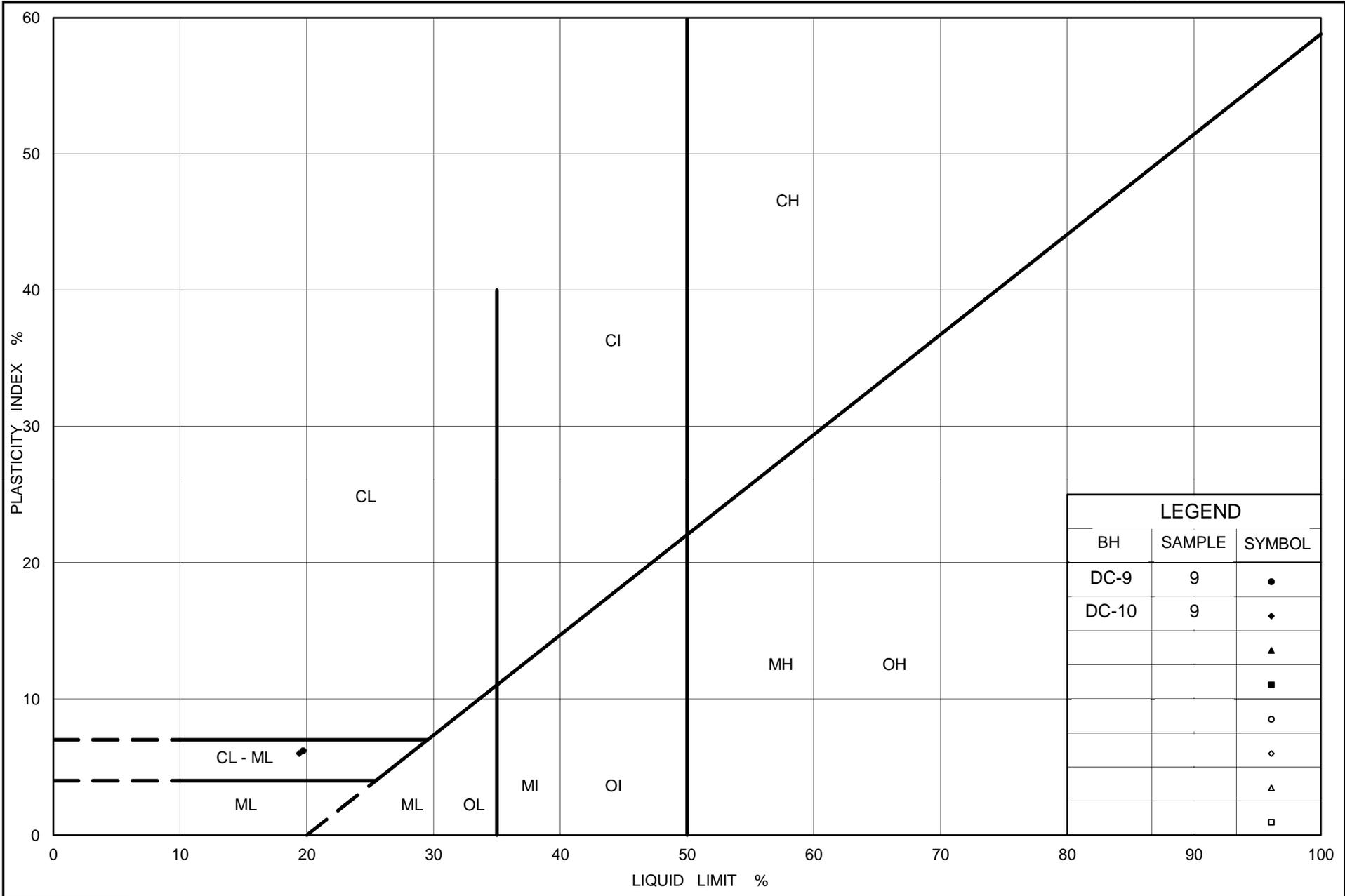
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	DC-11	9	165.2
■	DC-10	9	162.5

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 11-Mar-15

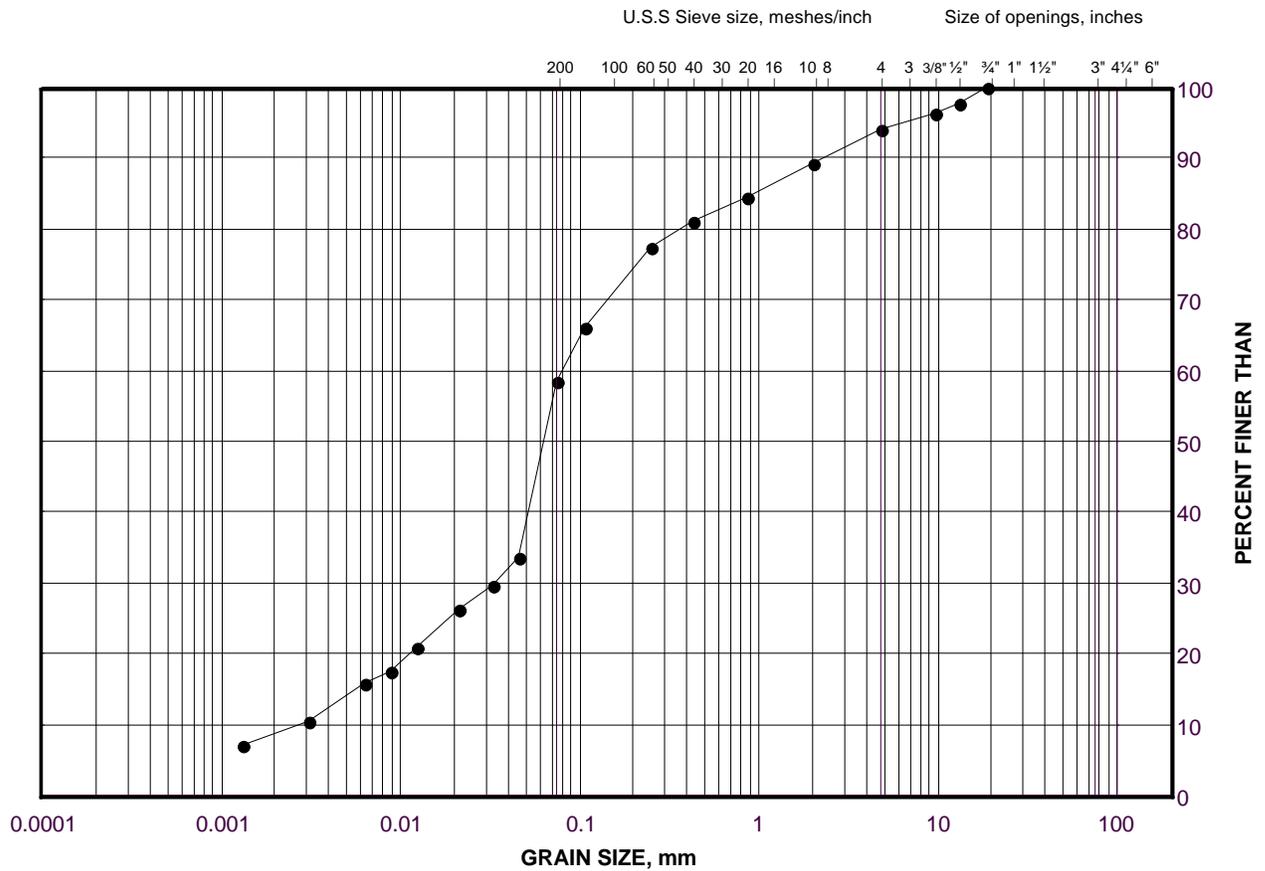


GRAIN SIZE DISTRIBUTION

Silt and Sand (Till) (Interlayer)

Retaining Wall 1

FIGURE A7



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	DC-10	11	159.5

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 11-Mar-15



APPENDIX B

Retaining Wall 2, Highway 401 - STA. 15+985 to STA. 16+142 Record of Borehole Sheets and Laboratory Test Results

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No SC8-3	SHEET 1 OF 1	METRIC
G.W.P. <u>2152-01-00</u>	LOCATION <u>N 4830771.3 ; E 287144.6</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>MP</u>	
DATUM <u>GEODETIC</u>	DATE <u>January 11, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
164.7	GROUND SURFACE							20 40 60 80 100									
0.9	TOPSOIL																
	SILTY CLAY, trace to some sand, trace to some gravel, trace rootlets to 0.6 m Firm to very stiff dark to light brown Moist		1	SS	6												
			2	SS	23								○				
			3	SS	13												
162.5	CLAYEY SILT, trace to some sand, trace to some gravel (TILL) Soft to stiff Grey Moist		4	SS	4								○	—			
			5	SS	3												
			6	SS	3								○				
			7	SS	9									—			3 16 65 16
159.1	Gravelly SILTY SAND to SAND and GRAVEL, trace clay, grinding of augers on inferred cobble/boulder at 6.6 m depth (TILL) Very dense Grey Moist to Wet		8	SS	98/0.29								○				27 48 22 3
			9	SS	92												
156.6	END OF BOREHOLE																
8.1	NOTES: 1. Water level in open borehole measured at a depth of 4.6 m below ground surface (Elev. 160.1 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 08/12/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No SC8-4	SHEET 1 OF 1	METRIC
G.W.P. <u>2152-01-00</u>	LOCATION <u>N 4830812.3 ; E 287208.7</u>	ORIGINATED BY <u>QC</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>MP</u>	
DATUM <u>GEODETIC</u>	DATE <u>January 12, 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 NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
164.5	GROUND SURFACE													
0.9	TOPSOIL													
	SILTY CLAY to CLAYEY SILT, trace to some sand, trace to some gravel, trace organics / rootlets throughout, oxidation staining Firm Brown Moist to Wet		1	SS	6		164							
			2	SS	6		163						46	
			3	SS	6	▽								
162.2	CLAYEY SILT with SAND, trace to some gravel (TILL) Firm to stiff Grey Moist		4	SS	11		162							12 30 48 10
			5	SS	5		161							
160.9	CLAYEY SILT with SAND, trace gravel Soft to firm Grey Moist		6	SS	3		160							4 30 48 18
			7	SS	8		159							
158.9	SAND and GRAVEL to gravelly SAND, trace to some silt, trace clay (TILL) Very dense Grey Moist to wet		8	SS	53		158							
			9	SS	66		157							
			10	SS	93		156							
			11	SS	50/0.13		155							31 46 20 3
153.7	END OF BOREHOLE						154							
10.8	NOTES : 1. Water level in open borehole measured at a depth of 1.8 m below ground surface (Elev. 162.7 m) upon completion of drilling.													

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 08/12/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-2	SHEET 1 OF 1	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830851.3 ; E 287283.0</u>	ORIGINATED BY <u>CS</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing with Tricone, Wash Boring</u>	COMPILED BY <u>CG/TVA</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8, 2012</u>	CHECKED BY <u>KJB</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									GR SA SI CL			
163.8	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Clayey silt, some gravel, some sand, containing organics and rootlets to a depth of 0.8 m (FILL) Firm Brown Moist	1	SS	5													
		2	SS	6													
162.3	CLAYEY SILT with SAND, trace to some gravel Firm to stiff Grey Moist	3	SS	9												8 28 47 17	
1.5																	
		4	SS	8													
		5	SS	5													
		6	SS	45													33 27 36 4
158.6	Sandy SILT and GRAVEL, trace clay (TILL) Dense to very dense Grey Moist	7	SS	56													
5.2																	
156.6	SAND and GRAVEL, some silt, trace clay, containing cobbles (TILL) Very dense Grey Wet	8	SS	73												43 38 15 4	
7.2																	
		9	SS	100/0.2													
153.4	END OF BOREHOLE SPOON AND CASING REFUSAL																
10.4	** Artesian Conditions - see Note 2. NOTES: 1. Unable to advance casing below a depth of 10.4 m below ground surface (Elev. 153.4 m). 2. Water flowing from top of casing at the end of work day on May 8, 2012, when bottom of casing at a depth of 10.4 m below ground surface (Elev. 153.4 m).																

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-4	SHEET 1 OF 1	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830837.9 ; E 287276.8</u>	ORIGINATED BY <u>CS</u>	
DIST <u> </u> HWY <u>401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>CG/TVA</u>	
DATUM <u>Geodetic</u>	DATE <u>May 9, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
								20	40	60	80	100							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)				GR SA SI CL		
164.4	GROUND SURFACE																		
0.0	TOPSOIL																		
0.2	Clayey silt, some sand, containing rootlets (FILL) Firm Brown Moist		1	SS	5														
			2	SS	5														
162.9	CLAYEY SILT, trace to some gravel, trace to some sand, containing rootlets to a depth of 2.2 m Very soft to stiff Brown Moist to wet					▽													
1.5			3	SS	11														
			4	SS	3														
			5	SS	WH														
			6	SS	100/0.3														
159.1	Auger grinding at a depth of 5.2 m																		
5.3	SAND and SILT, some gravel, trace to some clay (TILL) Very dense Grey Wet																		
158.6			6	SS	100/0.3													20 43 30 7	
5.8	END OF BOREHOLE																		

NOTES:

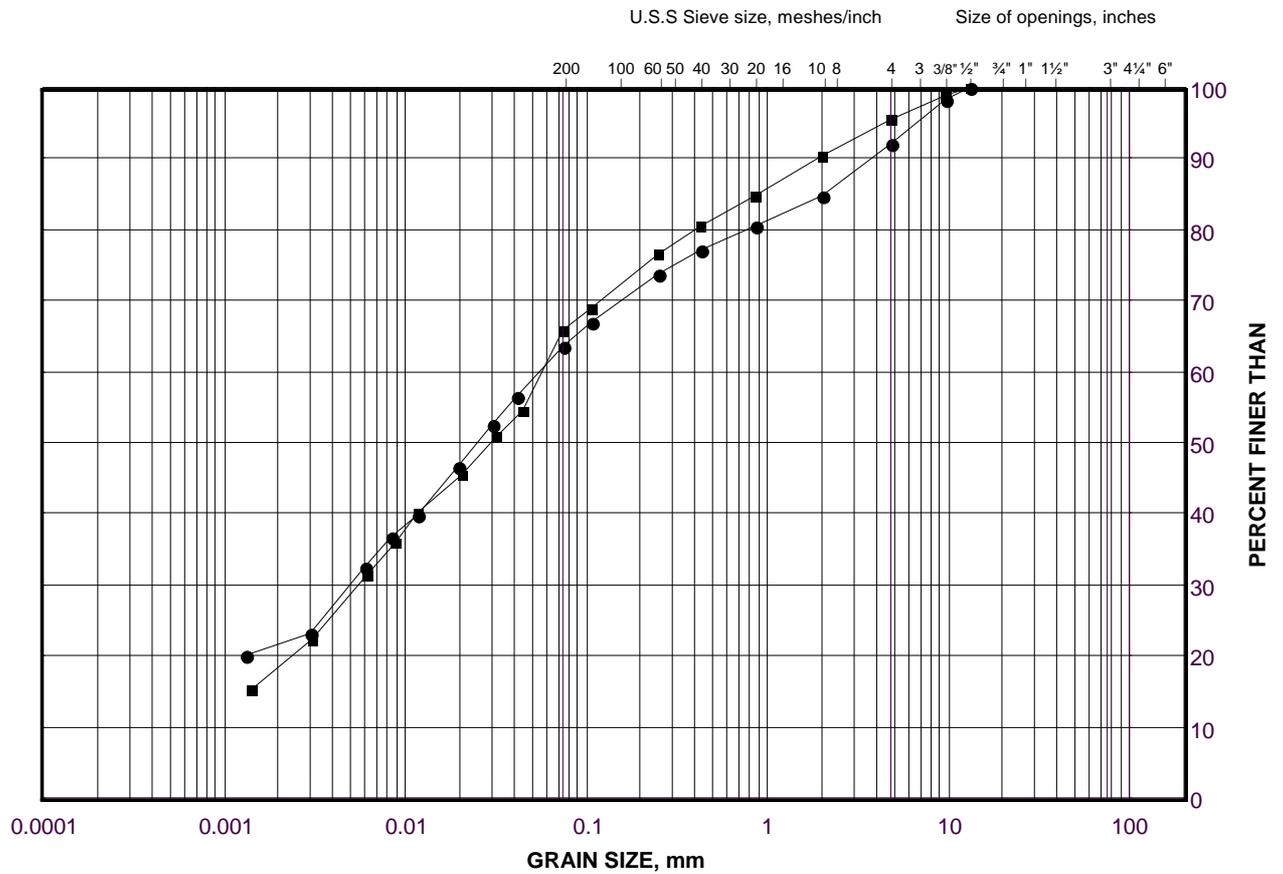
1. Water level inside augers at a depth of 0.3 m below ground surface (Elev. 164.1 m) when advanced augers to a depth of 4.6 m below ground surface (Elev. 159.8 m).
2. Water level inside augers at a depth of 2.2 m below ground surface (Elev. 162.2 m) upon completion of sampling.
3. Water level in open borehole at a depth of 2.0 m below ground surface (Elev. 162.4 m), measured one hour upon completion of drilling.

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION
 Clayey Silt with Sand to Clayey Silt
 Retaining Wall 2

FIGURE B1



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

LEGEND

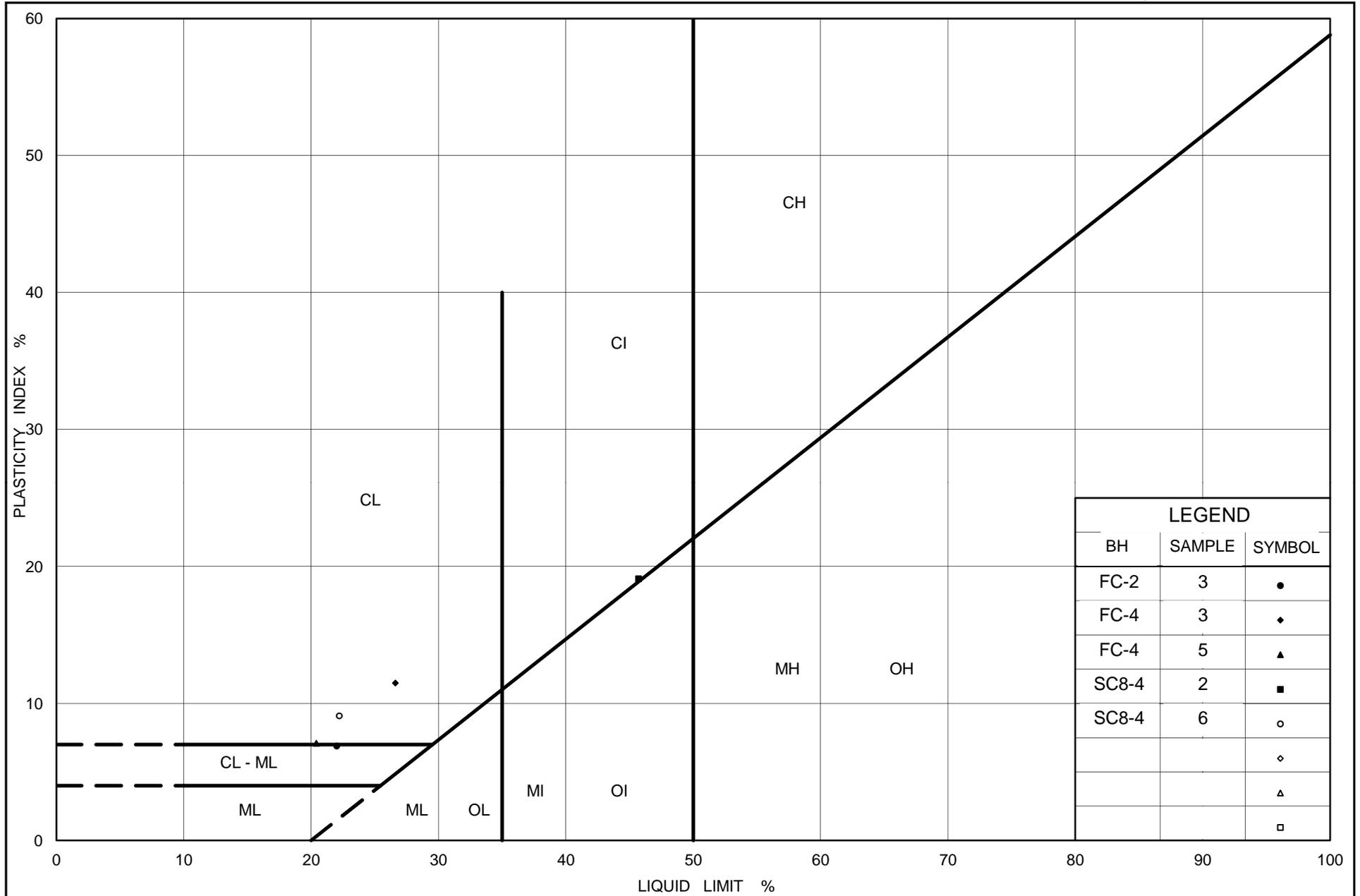
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	FC-2	3	162.0
■	SC8-4	6	160.4

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 12-Jun-15



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PLASTICITY CHART
 Clayey Silt to Silty Clay
 Retaining Wall 2

Figure No. B2

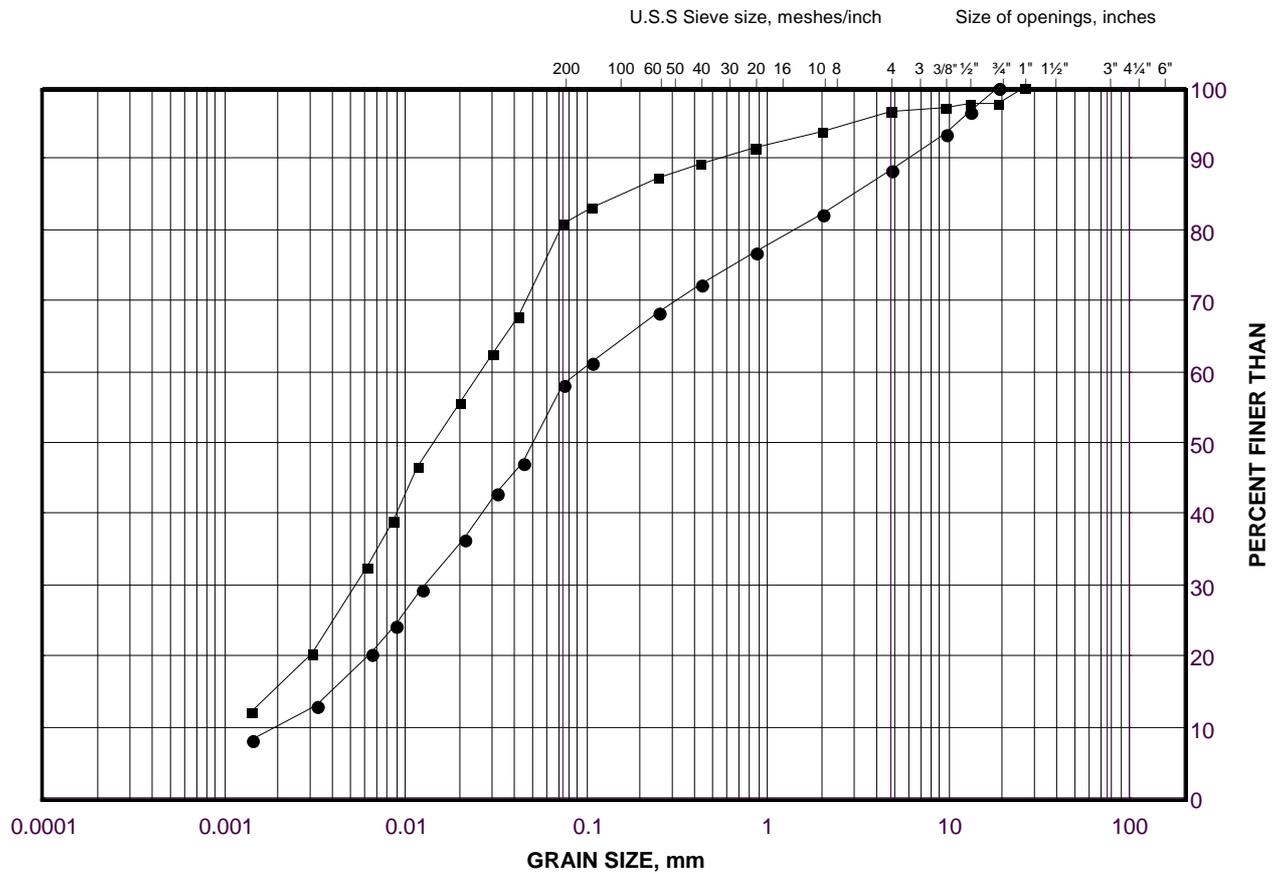
Project No. 10-1111-0211

Checked By: NK

GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)
Retaining Wall 2

FIGURE B3



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

LEGEND

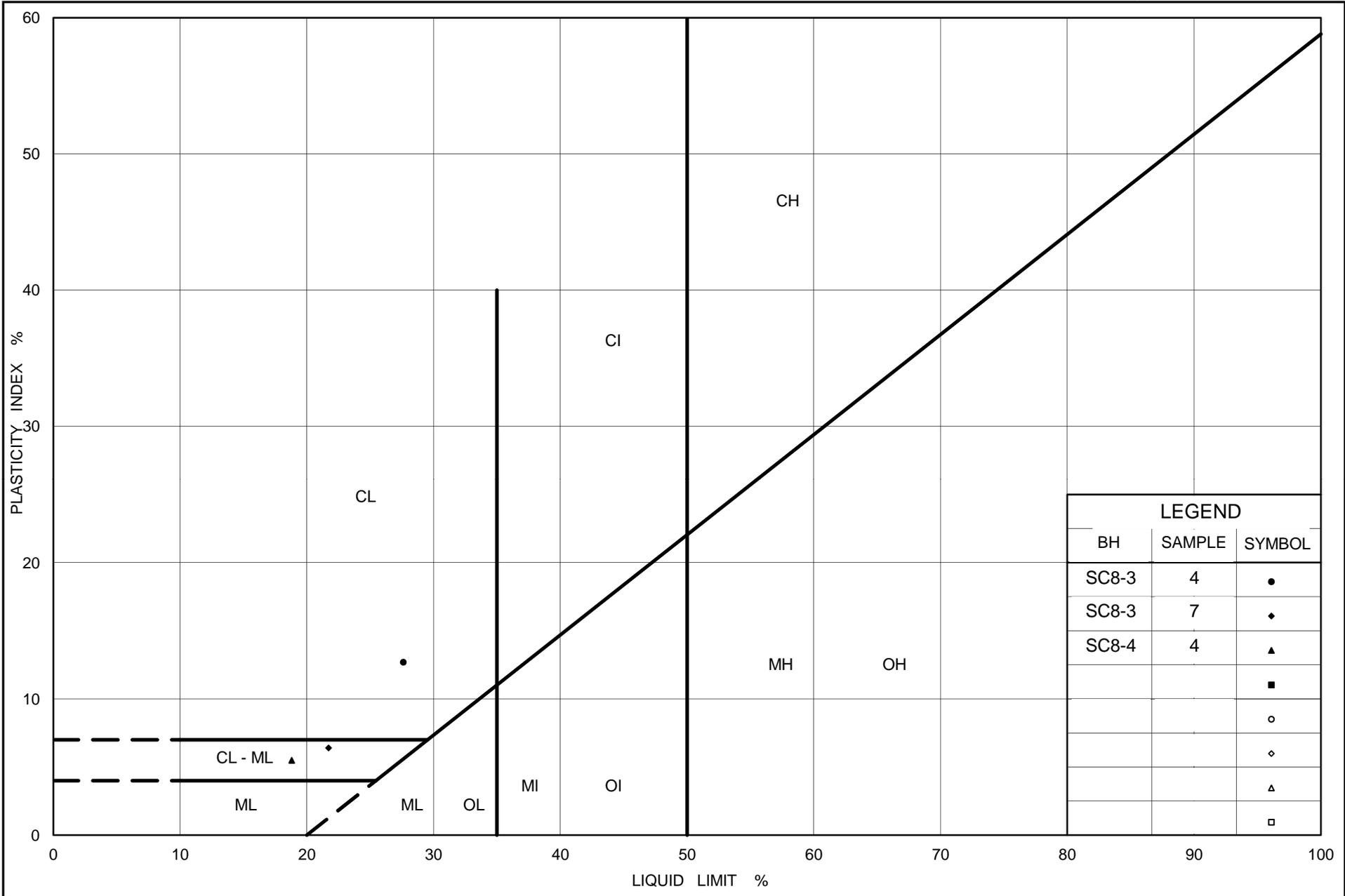
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC8-4	4	161.9
■	SC8-3	7	159.8

Project Number: 10-1111-0211

Checked By: NK

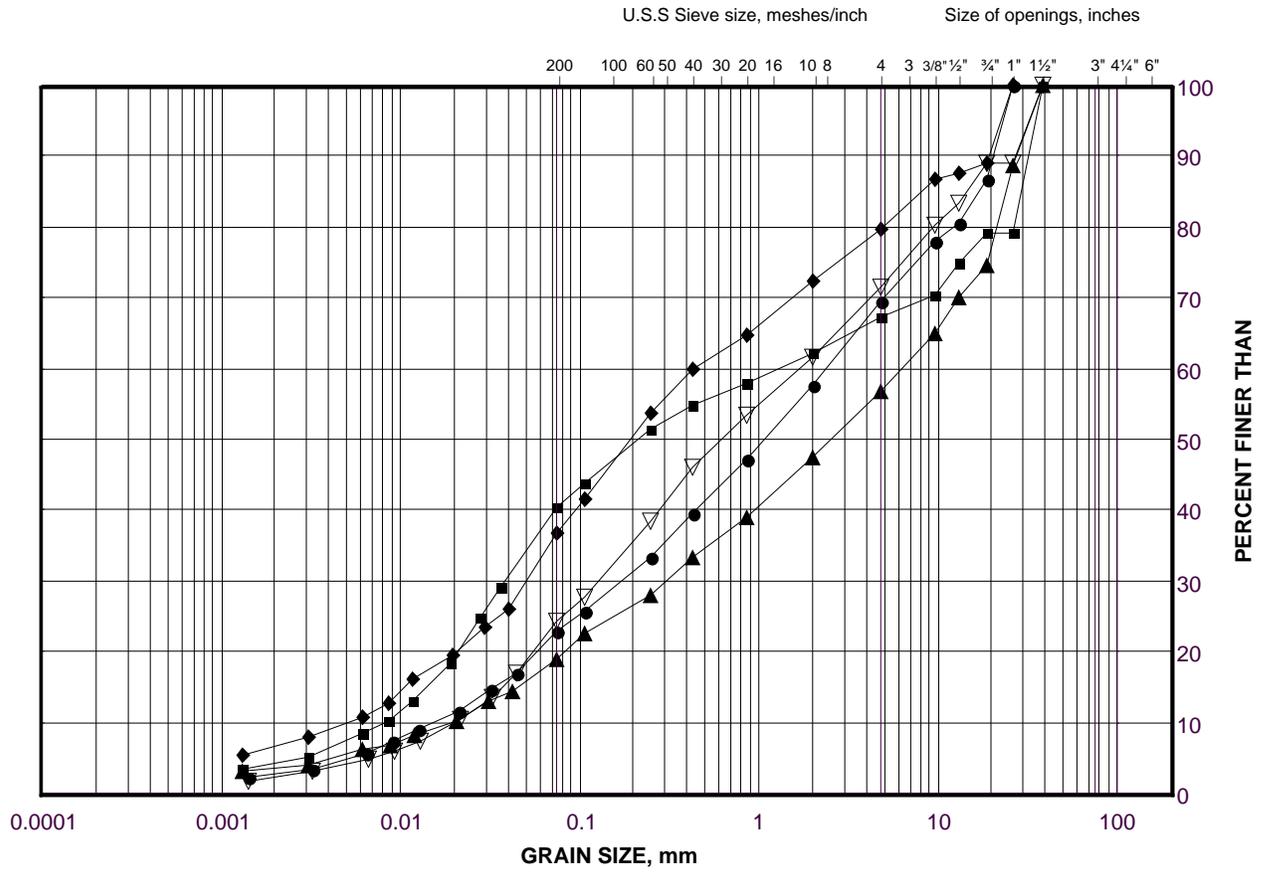
Golder Associates

Date: 12-Jun-15



GRAIN SIZE DISTRIBUTION
Gravelly Silty Sand to Sand and Gravel (Till)
Retaining Wall 2

FIGURE B5



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SC8-4	10	155.1
■	FC-2	6	158.2
◆	FC-4	6	158.8
▲	FC-2	8	155.9
▽	SC8-3	8	158.3

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 26-May-15



APPENDIX C

Retaining Wall 3, Highway 401 – STA. 16+179 to STA. 16+250 Record of Borehole Sheets and Laboratory Test Results

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-1	SHEET 1 OF 2	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830867.9 ; E 287311.4</u>	ORIGINATED BY <u>CS</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, HW Casing and HQ Coring</u>	COMPILED BY <u>CG/TVA</u>	
DATUM <u>Geodetic</u>	DATE <u>May 1 and 3, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
163.7	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Clayey silt, some gravel, some sand, containing rootlets (FILL) Soft Brown and grey Moist		1	SS	3												
			2	SS	3												
162.2	CLAYEY SILT with SAND, trace to some gravel Soft to stiff Brown Moist		3A	SS	5												
			3B														
1.5			4	SS	13												0 30 53 17
	sandy grey wet		5	SS	3												
			6	SS	8												16 24 40 20
159.2	SAND and SILT, some gravel, trace to some clay (TILL) Very dense Grey Wet		7	SS	52												16 33 45 6
4.5			8	SS	68												
156.5	Silty SAND and GRAVEL, trace to some clay (TILL) Very dense Grey Wet		9	SS	86/0.25												
7.2			10	SS	50/0.1												
			11	SS	73/0.15												
			12	SS	76/0.2												29 34 29 8
150.9	SAND and GRAVEL, trace silt, containing cobbles and shale fragments (TILL) Very dense Grey Wet		13	SS	72/0.15												
12.8			1	RC	REC 45%												
			2	RC	REC 30%												
			3	RC	REC 8%												

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

Continued Next Page

 + ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-1	SHEET 2 OF 2	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830867.9 ; E 287311.4</u>	ORIGINATED BY <u>CS</u>	
DIST <u> </u> HWY <u>401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, HW Casing and HQ Coring</u>	COMPILED BY <u>CG/TVA</u>	
DATUM <u>Geodetic</u>	DATE <u>May 1 and 3, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60
148.2	END OF BOREHOLE						148													
147.9	END OF DCPT Refusal to Further Penetration (163 Blows/0.3 m)																			
15.9	END OF DCPT Refusal to Further Penetration (163 Blows/0.3 m) ** Artesian Conditions - see Note 3. NOTES: 1. Auger refusal at a depth of 12.9 m, cored through overburden soil and cobbles using HQ size core barrel to a depth of 15.5 m. Advanced Dynamic Cone Penetration Test (DCPT) from depths of 15.5 m to 15.9 m. 2. Water level inside augers at a depth of 1.8 m below ground surface (Elev. 161.9 m), measured at the end of work day on May 1, 2012, when augers advanced to a depth of 12.8 m below ground surface (Elev. 150.9 m). 3. Water level inside casing at 1.0 m above ground surface (Elev. 164.7 m), measured at start of work day on May 2, 2012, when bottom of casing at a depth of 13.0 m below ground surface (Elev. 150.7 m).																			

DRAFT

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-3	SHEET 1 OF 1	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830871.4 ; E 287325.3</u>	ORIGINATED BY <u>CS</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>	COMPILED BY <u>CG/TVA</u>	
DATUM <u>Geodetic</u>	DATE <u>May 7, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
165.9 0.0	GROUND SURFACE Clayey silt, some sand, trace gravel, containing rootlets (FILL) Firm Brown Moist		1	SS	6													
165.0 0.9	CLAYEY SILT, some sand, some gravel Stiff to very stiff Brown to grey Moist		2	SS	16													
			3	SS	22													12 20 42 26
			4	SS	14													
			5	SS	8													
162.2 3.7	SILT, trace to some sand, trace to some clay, trace gravel Loose Grey Wet		6	SS	4													
161.4 4.5	CLAYEY SILT, some gravel, some sand Firm Grey Moist		7	SS	6													
160.7 5.2	END OF BOREHOLE																	

NOTE:
1. Open borehole dry upon completion of drilling.

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No FC-13 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830881.8 ; E 287336.5 ORIGINATED BY SB

DIST 2150-01-00 HWY 401- 403 W Ramp BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers, NW Casing with Tricone, Wash Boring COMPILED BY BMTVA

DATUM Geodetic DATE September 4, 2012 CHECKED BY KJB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL	
167.1	GROUND SURFACE																						
0.0	CLAYEY SILT with SAND, trace to some gravel, containing rootlets to a depth of 0.6 m Stiff to very stiff Brown to grey Moist	[Strat Plot Hatched]	1	SS	11																		
			2	SS	15																		
			3	SS	11																		
			4	SS	19																		
			5	SS	12																		
			6	SS	10																		
			7	SS	6																		
			8A																				
			8B	SS	4																		
160.5	SAND and SILT, trace to some clay, trace gravel (TILL) Dense Grey Moist to wet	[Strat Plot Dotted]																					
6.6			9	SS	35																		
158.4	Silty SAND, some gravel, trace clay (TILL) Very dense Wet	[Strat Plot Dotted]																					
8.7			10	SS	50/0.03																		
156.3	END OF BOREHOLE BROKEN CASING		11	SS	60/0.15																		
10.8	NOTE: 1. Unable to advance borehole beyond a depth of 10.8 m as part of the casing broke while penetrating through the very dense overburden. Backfilled borehole, moved drilling 1.5 m west and advanced Borehole FC-13A, and continued sampling below 10.8 m depth.																						

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-13A	SHEET 1 OF 2	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830881.8 ; E 287335.0</u>	ORIGINATED BY <u>SB</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing with Tricone, Wash Boring</u>	COMPILED BY <u>BMTVA</u>	
DATUM <u>Geodetic</u>	DATE <u>September 4 to 6, 2012</u>	CHECKED BY <u>KJB</u>	

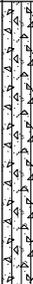
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
						20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	○	○	○				
167.1	GROUND SURFACE					167											
0.0	Refer to Record of Borehole FC-13 for subsurface conditions within these elevations.					166											
						165											
						164											
						163											
						162											
						161											
						160											
						159											
						158											
						157											
156.3	10.8					156											
	Silty SAND, some gravel, trace clay (TILL) Very dense Wet						155										
	Loose, containing cobbles		12	SS	9*		154										
153.4	13.7					153											
	Gravelly SAND, some silt, trace clay (TILL) Very dense Wet	13	SS	50/0.08											25 50 20 5		

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

Continued Next Page

 +³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No FC-13A	SHEET 2 OF 2	METRIC
<u>2150-01-00</u>	LOCATION <u>N 4830881.8 ; E 287335.0</u>	ORIGINATED BY <u>SB</u>	
DIST <u>HWY 401- 403 W Ramp</u>	BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers, NW Casing with Tricone, Wash Boring</u>	COMPILED BY <u>BMTVA</u>	
DATUM <u>Geodetic</u>	DATE <u>September 4 to 6, 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 _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)																
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)															
								20	40	60	80	100						GR SA SI CL															
149.3	Gravelly SAND, some silt, trace clay (TILL) Very dense Wet		14	SS	50/0.08		152																										
								151																									
					15	SS	65/0.03		150																								
17.8	END OF BOREHOLE																																
	<p>* SPT "N" value may have been influenced by difficulties advancing augers / wash boring at this depth.</p> <p>** Artesian Conditions - see Note 4.</p> <p>NOTES:</p> <p>1. Borehole FC-13A augered from ground surface to a depth of 7.6 m; then switched to 'NW' casing method. Lost casing shoe at depth of 11.9 m while penetrating through the very dense overburden, then switched back to auger with difficulties advancing auger to 12.2 m depth, then completed borehole using NW Casing.</p> <p>2. Water level inside augers at a depth of 2.7 m below ground surface (Elevation 164.4 m), measured at end of work day (at 4:16 pm) on Sept. 05, 2012, when augers advanced to a depth of 12.2 m below ground surface (Elev. 154.9 m).</p> <p>3. Water level inside augers at a depth of 2.1 m below ground surface (Elevation 165.0 m), measured at start of work day (at 7:00 am) on Sept. 06, 2012, when augers advanced to a depth of 12.8 m below ground surface (Elev. 154.3 m).</p> <p>4. Water flowing from top of casing when advanced to a depth of 17.8 m (Elev. 149.3 m). Stacked up casing to about 5.0 m above ground surface to monitor the hydrostatic head upon completion of drilling operations on September 6, 2012. The recorded water level readings are:</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Time</th> <th>Depth (m)</th> <th>W.L. to W.L. Elev(m)</th> </tr> </thead> <tbody> <tr> <td>12:30 pm</td> <td>-0.6</td> <td>167.7</td> </tr> <tr> <td>12:36 pm</td> <td>-2.1</td> <td>169.2</td> </tr> <tr> <td>12:41 pm</td> <td>-3.5</td> <td>170.6</td> </tr> <tr> <td>1:30 pm</td> <td>-4.8</td> <td>171.9</td> </tr> </tbody> </table>																		Time	Depth (m)	W.L. to W.L. Elev(m)	12:30 pm	-0.6	167.7	12:36 pm	-2.1	169.2	12:41 pm	-3.5	170.6	1:30 pm	-4.8	171.9
Time	Depth (m)	W.L. to W.L. Elev(m)																															
12:30 pm	-0.6	167.7																															
12:36 pm	-2.1	169.2																															
12:41 pm	-3.5	170.6																															
1:30 pm	-4.8	171.9																															

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No DC-12 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830923.2 ; E 287393.6 ORIGINATED BY SB

2150-01-00 DIST HWY 401- 403 W Ramp BOREHOLE TYPE 57 mm I.D. Hollow Stem Augers COMPILED BY BM

DATUM Geodetic DATE September 12, 2012 CHECKED BY TVA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL	
176.3	GROUND SURFACE																						
0.0	ASPHALT																						
0.2	Silty sand, trace clay, trace gravel (FILL)		1	SS	12																		
175.5	Compact Brown Moist		2	SS	6																		
0.8	Clayey silt, sandy, trace gravel (FILL)		3	SS	5																		
	Firm to stiff Grey Moist		4	SS	10																		2 24 47 27
			5	SS	6																		
			6	SS	6																		
			7	SS	7																		
170.5	CLAYEY SILT, sandy, trace gravel (TILL)		8	SS	25																		4 23 46 27
5.8	Very stiff to hard Brown Moist		9	SS	32																		
			10	SS	10																		
167.5	CLAYEY SILT, trace sand, trace gravel		11	SS	23																		
8.8	Stiff Grey Moist		12	SS	34																		
165.9	Silty SAND, trace clay, trace gravel (TILL)																						
10.4	Compact Grey Moist																						5 22 61 12
164.4	CLAYEY SILT, trace sand, trace gravel (TILL)																						
11.9	Hard Grey Moist																						
163.5	END OF BOREHOLE																						
12.8	NOTES:																						
	1. Borehole open to a depth of 10.0 m below ground surface (Elev. 166.3 m).																						
	2. Open borehole dry upon completion of drilling.																						

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

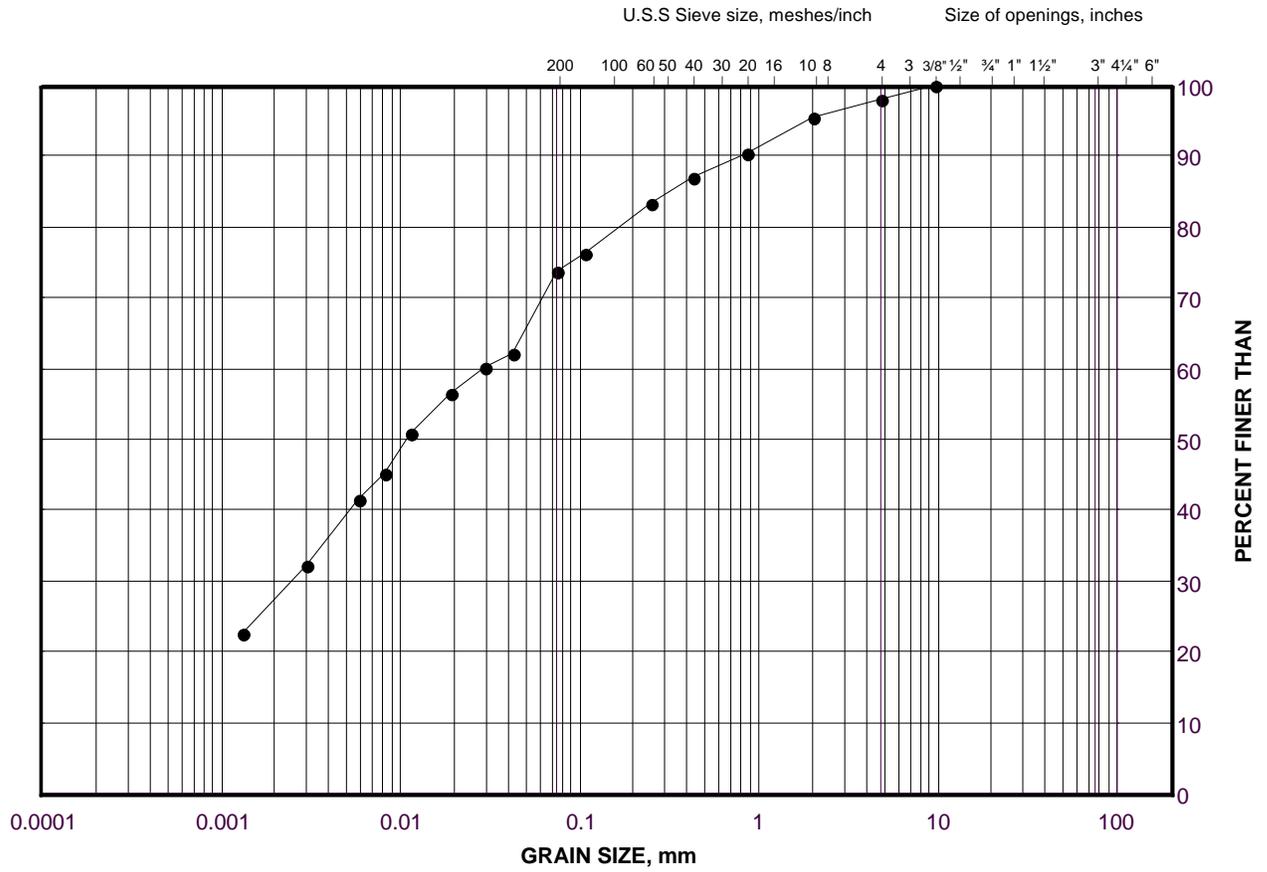
+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Clayey Silt (Fill)

Retaining Wall 3

FIGURE C1



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

LEGEND

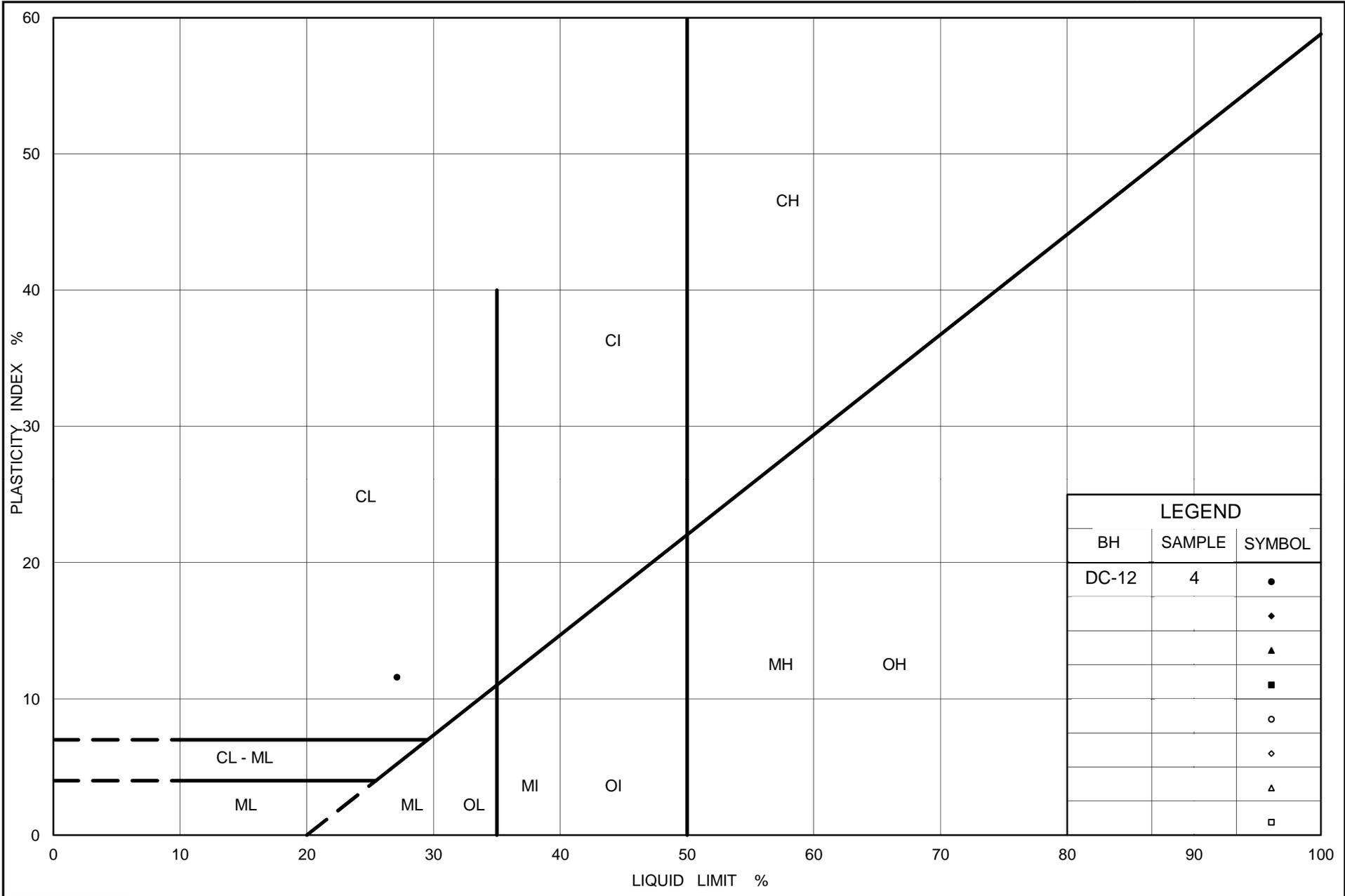
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	DC-12	4	173.7

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

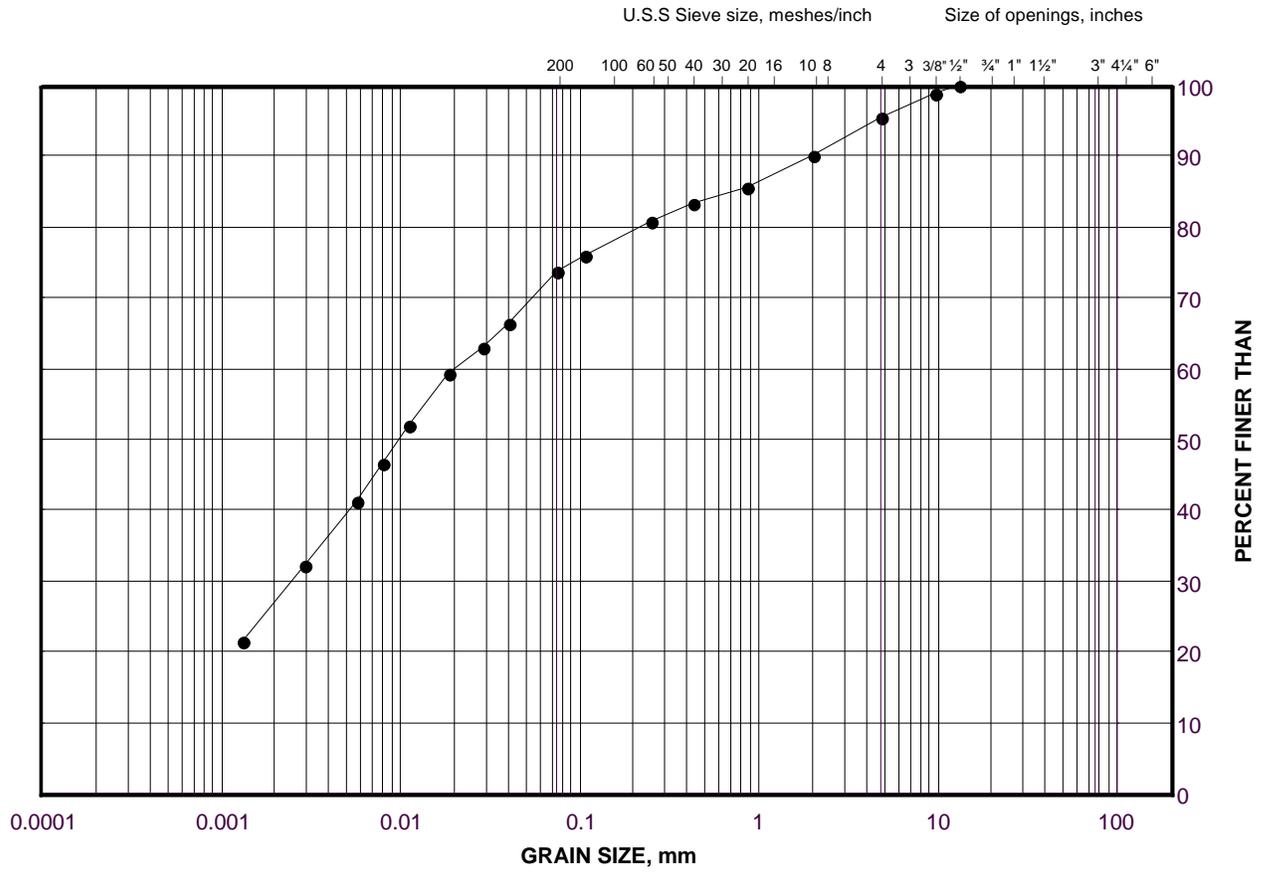
Date: 11-Mar-15



LEGEND		
BH	SAMPLE	SYMBOL
DC-12	4	●
		◆
		▲
		■
		○
		◇
		△
		□

GRAIN SIZE DISTRIBUTION
 Sandy Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 3

FIGURE C3



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

LEGEND

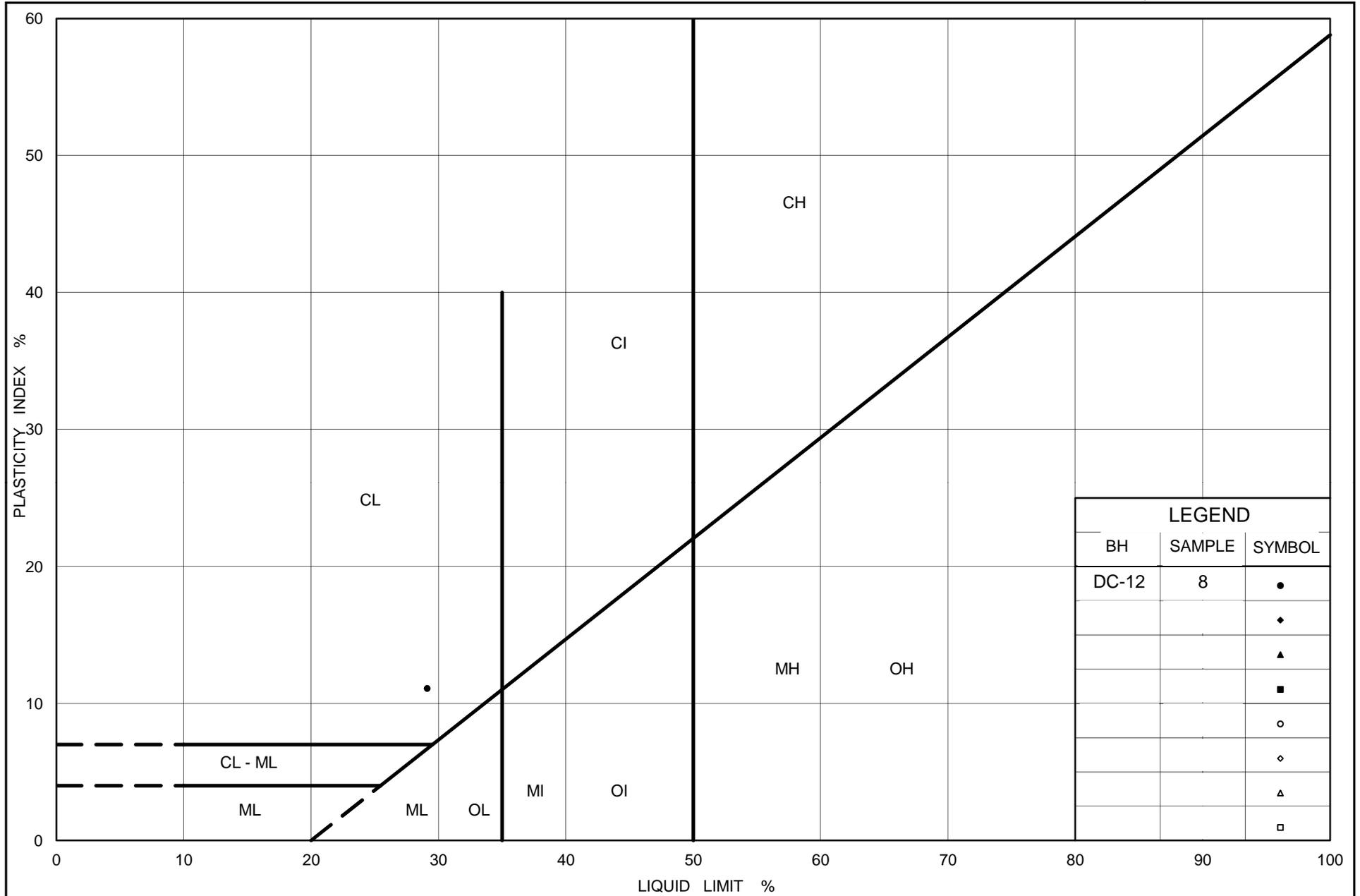
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	DC-12	8	169.9

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 11-Mar-15



LEGEND		
BH	SAMPLE	SYMBOL
DC-12	8	●
		◆
		▲
		■
		○
		◇
		△
		□



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PLASTICITY CHART
 Sandy Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 3

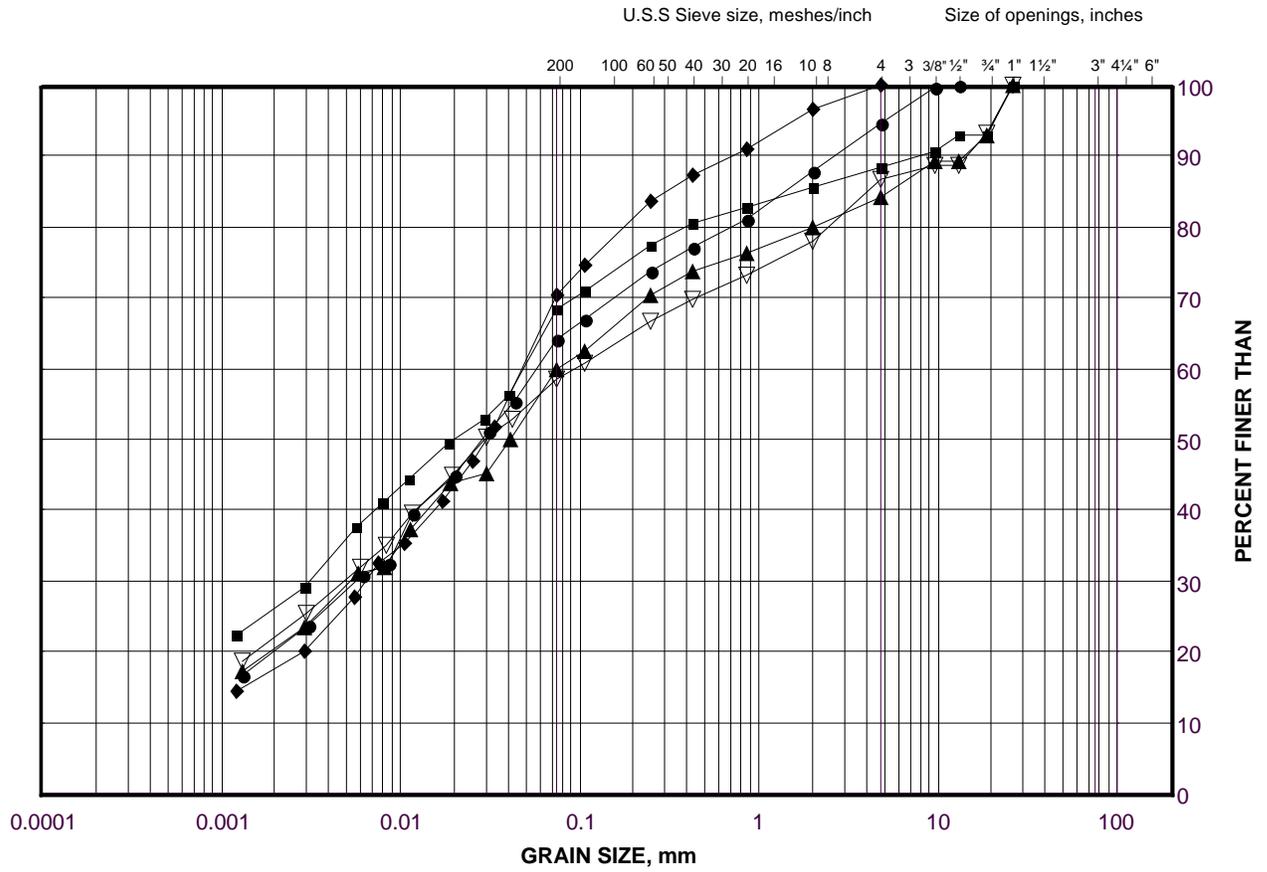
Figure No. C4

Project No. 10-1111-0211

Checked By: NK

GRAIN SIZE DISTRIBUTION
 Clayey Silt with Sand to Clayey Silt
 Retaining Wall 3

FIGURE C5



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

LEGEND

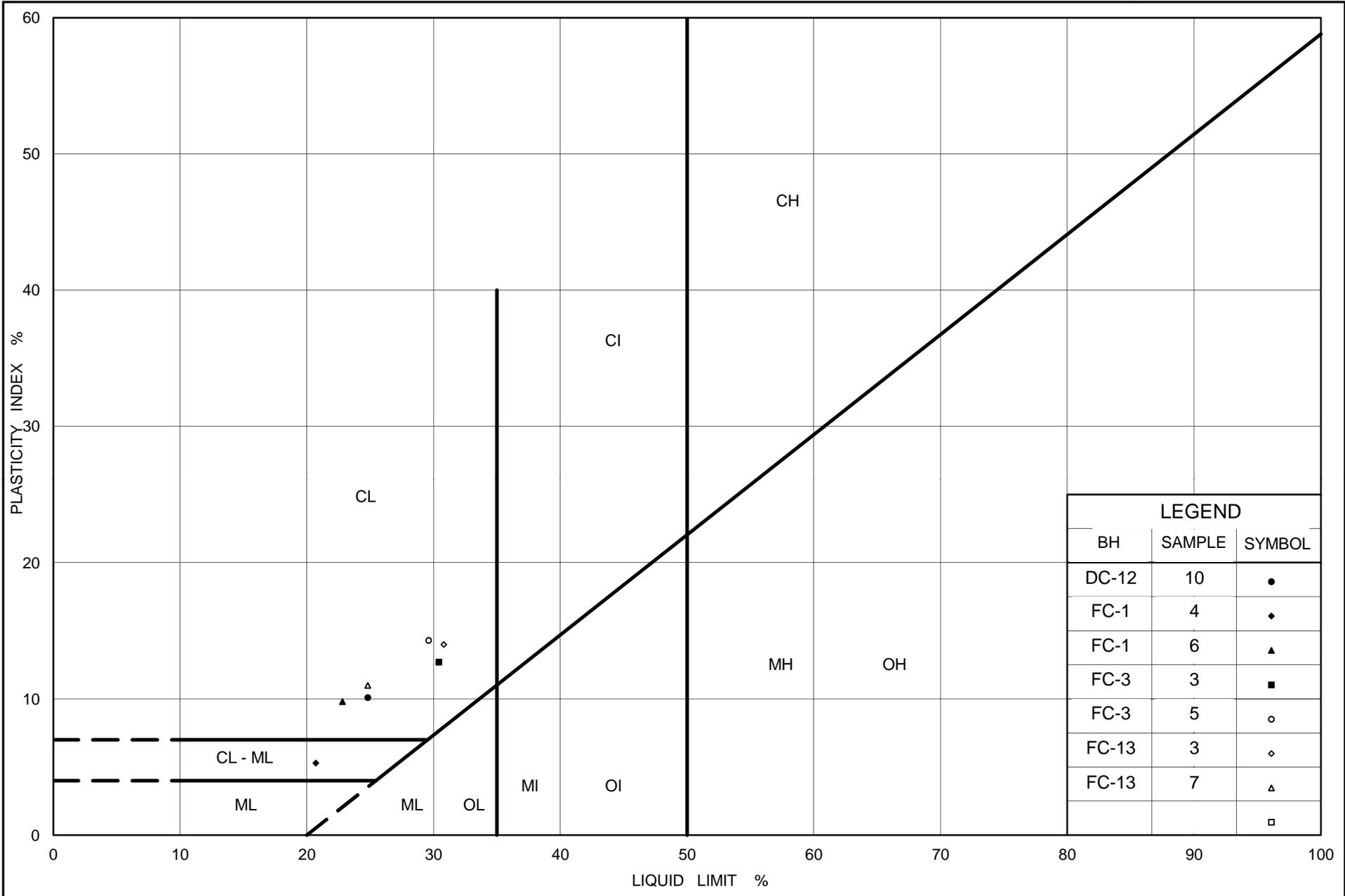
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	FC-13	3	165.3
■	FC-3	3	164.1
◆	FC-1	4	161.1
▲	FC-1	6	159.6
▽	FC-13	7	162.2

Project Number: 10-1111-0211

Checked By: NK

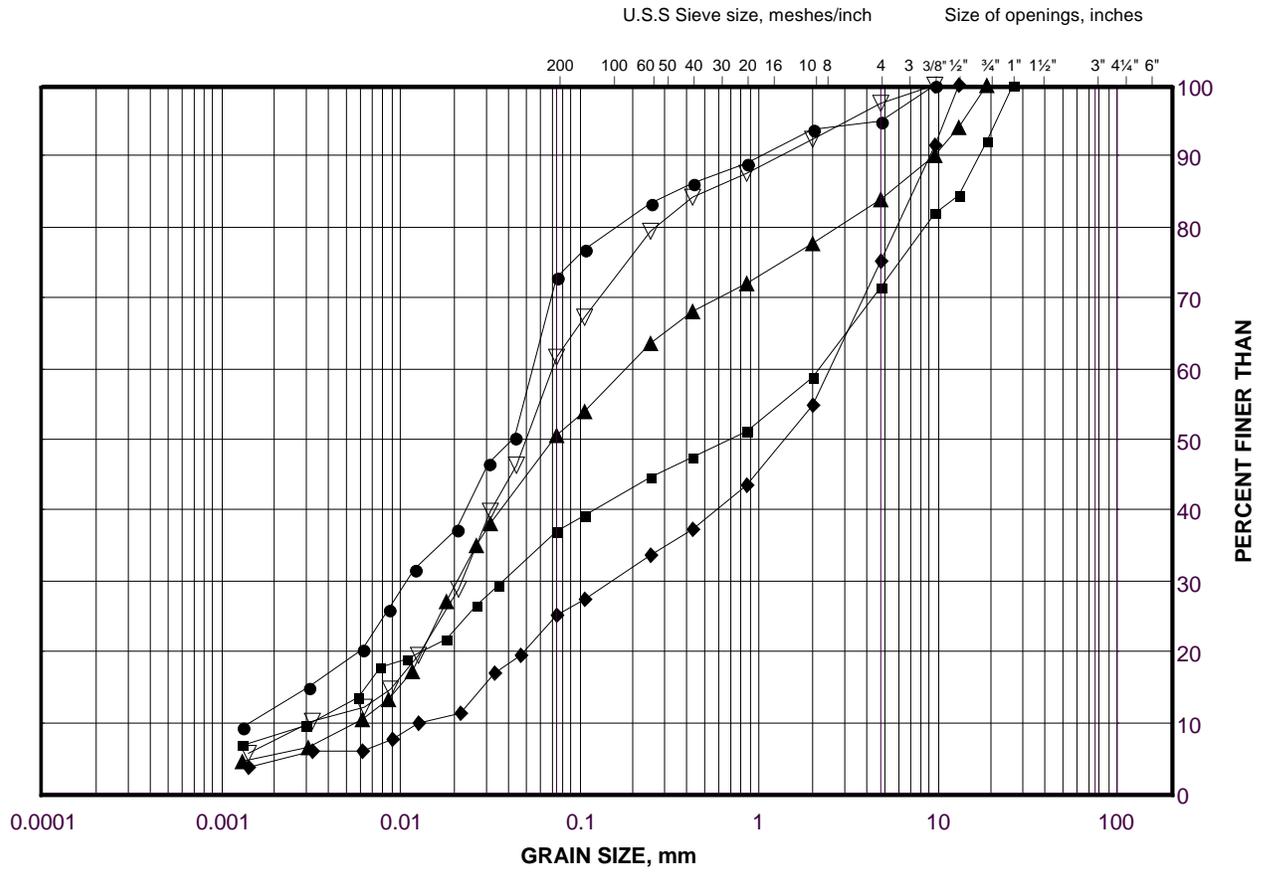
Golder Associates

Date: 24-Mar-15



GRAIN SIZE DISTRIBUTION
 Sandy Silt to Silt and Sand to Gravelly Sand (Till)
 Retaining Wall 3

FIGURE C7



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	DC-12	11	165.4
■	FC-1	12	151.9
◆	FC-13A	13	153.3
▲	FC-1	7	158.8
▽	FC-13	9	159.2

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 24-Mar-15



APPENDIX D

Retaining Wall 4, Highway 401 – STA. 16+315 to STA. 16+480 Record of Borehole Sheets and Laboratory Test Results

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No RW-1	SHEET 1 OF 1	METRIC
G.W.P. <u>2152-01-00</u>	LOCATION <u>N 4831002.0 ; E 287527.6</u>	ORIGINATED BY <u>AV</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Solid Stem Augers</u>	COMPILED BY <u>MP/AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>July 7, 2014</u>	CHECKED BY <u>NK</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL												
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																					
								20	40	60	80	100																	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)																
								20	40	60	80	100	10	20	30														
175.2	GROUND SURFACE																												
0.0	TOPSOIL																												
0.2	Clayey silt, sandy, trace gravel, trace rootlets (FILL) Brown Moist		1	AS	-		175																						
174.4	Sandy CLAYEY SILT, trace to some gravel, trace rootlets to a depth of 1.1 m (TILL) Stiff to hard Brown Moist ----- Auger grinding ----- Becoming grey		2	SS	21		174						○																
0.8			3	SS	30		173						○	┌───┐			5 28 45 22												
				4	SS	35		172						○															
				5A	SS	32		171						○															
				5B	SS	32		170						○	┌───┐														
			6	SS	11		171																						
			7	SS	10		170																						
169.6	SILT and SAND, trace to some clay Compact Grey Wet		8	SS	28		169							○			0 34 60 6												
168.0	CLAYEY SILT with SAND, some gravel (TILL) Very stiff Moist		9	SS	24		168																						
167.0	END OF BOREHOLE						167																						
	NOTES: 1. Borehole open to a depth of 7.0 m below ground surface (Elev. 168.2 m). 2. Water level at a depth of 5.0 m below ground surface (Elev. 170.2 m) upon completion of drilling. 3. Water level readings in piezometer: <table style="margin-left: 20px; border-collapse: collapse;"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>08/08/14</td> <td>3.1</td> <td>172.1</td> </tr> <tr> <td>08/27/14</td> <td>3.1</td> <td>172.1</td> </tr> <tr> <td>09/15/14</td> <td>3.1</td> <td>172.1</td> </tr> </table>																	Date	Depth (m)	Elev. (m)	08/08/14	3.1	172.1	08/27/14	3.1	172.1	09/15/14	3.1	172.1
Date	Depth (m)	Elev. (m)																											
08/08/14	3.1	172.1																											
08/27/14	3.1	172.1																											
09/15/14	3.1	172.1																											

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 08/12/15 PR

RECORD OF BOREHOLE No RW-2 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 G.W.P. 2152-01-00 LOCATION N 4831027.1 ; E 287570.9 ORIGINATED BY AV

DIST Central HWY 401 BOREHOLE TYPE 150 mm O.D. Solid Stem Augers COMPILED BY MP/AJS

DATUM GEODETIC DATE July 7, 2014 CHECKED BY NK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)								
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL			
176.0	GROUND SURFACE																								
0.0	TOPSOIL																								
0.2	Sandy clayey silt, sandy, trace gravel, trace organics and rootlets (FILL) Very stiff Brown Moist		1	AS	-																				
174.6			2	SS	19																			4 27 45 24	
1.4	Sandy CLAYEY SILT, trace to some gravel (TILL) Stiff to hard Brown Moist ----- Becoming grey Auger grinding at 4.6 m depth		3	SS	26																				
			4	SS	34																				
			5	SS	45																				
			6	SS	22																				
			7	SS	11																				
170.4	SILT, some sand, dilutant Compact Grey Wet																								
5.6			8	SS	18																				
168.8	CLAYEY SILT, sandy, some gravel (TILL) Hard Grey Moist																								
7.2			9	SS	31																				
167.8	END OF BOREHOLE																								
8.2			NOTES: 1. Borehole open to a depth of 7.0 m below ground surface (Elev. 169.0 m). 2. Water level at a depth of 6.9 m below ground surface (Elev. 169.1 m) upon completion of drilling.																						

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 08/12/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No DC-13 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830934.4 ; E 287419.4 ORIGINATED BY SB

2150-01-00 DIST HWY 401- 403 W Ramp BOREHOLE TYPE 57 mm I.D. Hollow Stem Augers COMPILED BY BM

DATUM Geodetic DATE September 13, 2012 CHECKED BY TVA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L			GR	SA
174.7	GROUND SURFACE																	
0.0	TOPSOIL																	
0.2	CLAYEY SILT, some sand, some gravel to gravelly, containing roots to a depth of 0.6 m (TILL) Firm to hard Brown Moist	1	SS	5														
		2	SS	24														
		3	SS	22														
		4	SS	22														
		5	SS	50/0.15														
		6	SS	24														
		7	SS	14														
		8	SS	24														
167.4	CLAYEY SILT, trace sand Stiff Grey Wet	9A	SS	9														
166.8		9B																
166.8	SILT, trace to some clay, trace sand Loose Grey Wet																	
165.9																		
165.9	CLAYEY SILT, trace sand, trace gravel (TILL) Very stiff to hard Grey Moist to wet	10	SS	18														
163.4	END OF BOREHOLE	11	SS	66														
11.3																		

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No DC-14 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830962.3 ; E 287473.2 ORIGINATED BY SB

2150-01-00 DIST HWY 401- 403 W Ramp BOREHOLE TYPE 57 mm I.D. Hollow Stem Augers COMPILED BY BM

DATUM Geodetic DATE September 12, 2012 CHECKED BY TVA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40	60	80	100	10
175.4	GROUND SURFACE																					
0.0	TOPSOIL																					
0.2	CLAYEY SILT, some sand, trace to some gravel, containing roots to a depth of 0.6 m (TILL) Firm to very stiff Brown Moist	1	SS	5																		
		2	SS	19																		
		3	SS	20																		
		4	SS	28																		
		5	SS	21																		
		6	SS	15																		
		7	SS	13																		
		8	SS	12																		
168.1	Sandy SILT, trace to some clay, trace gravel Compact Grey Wet	9	SS	11																		
167.2	END OF BOREHOLE																					
8.2	NOTES: 1. Borehole open to a depth of 7.3 m below ground surface (Elev. 168.1 m). 2. Water level inside augers at a depth of 7.0 m below ground surface (Elev. 168.4 m) upon completion of drilling.																					

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

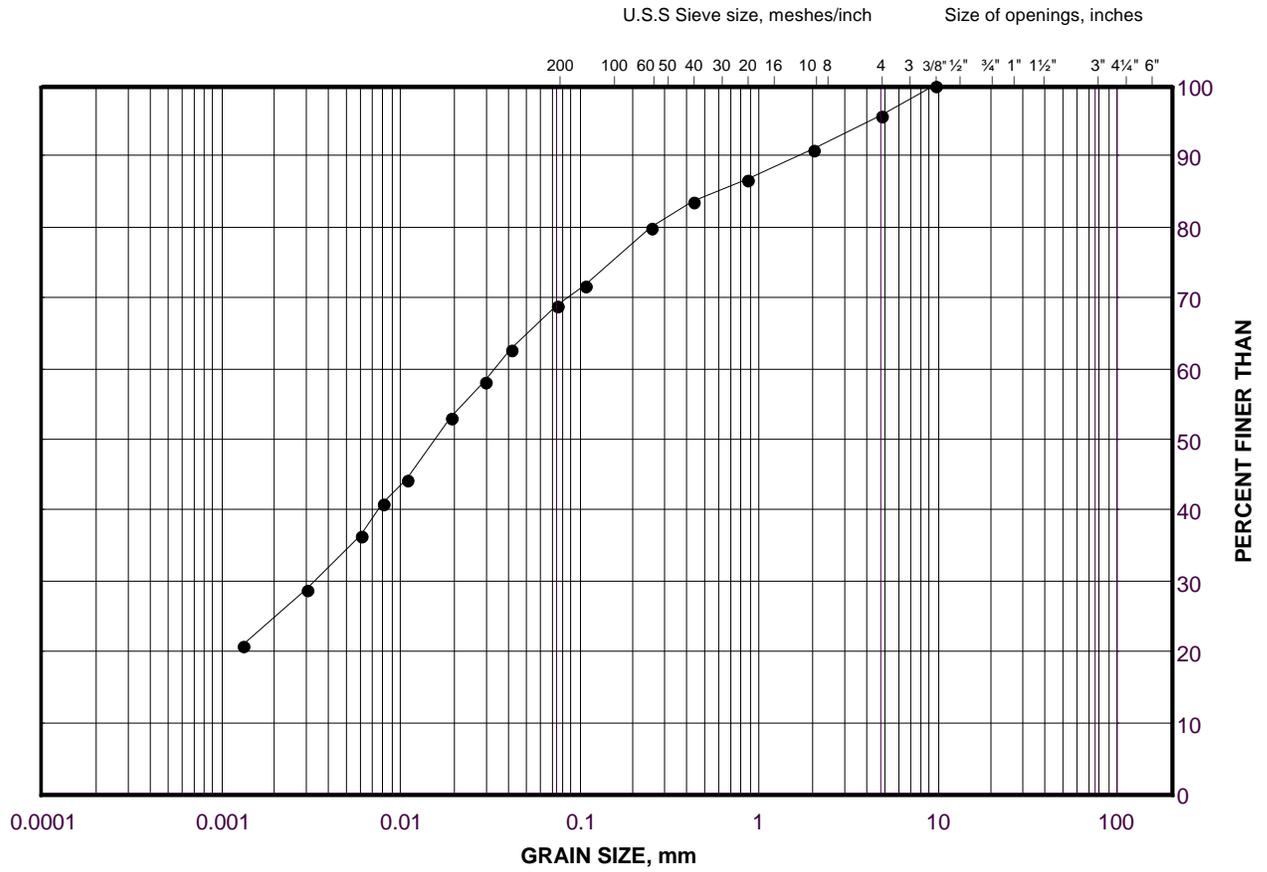
+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

Retaining Wall 4

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)
•	RW-2	2	175.0

Project Number: 10-1111-0211

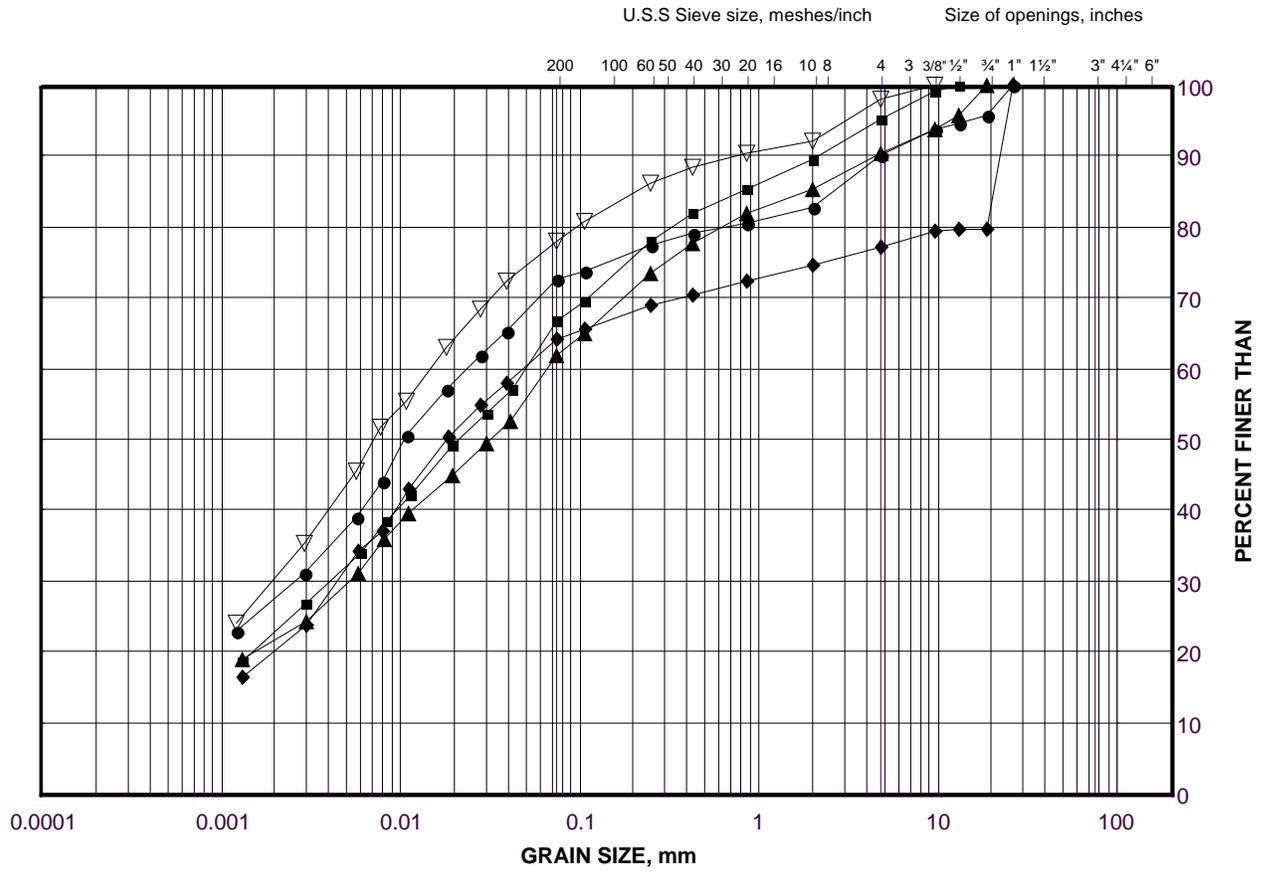
Checked By: NK

Golder Associates

Date: 11-Mar-15

GRAIN SIZE DISTRIBUTION
 Sandy Clayey Silt to Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 4

FIGURE D2



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

LEGEND

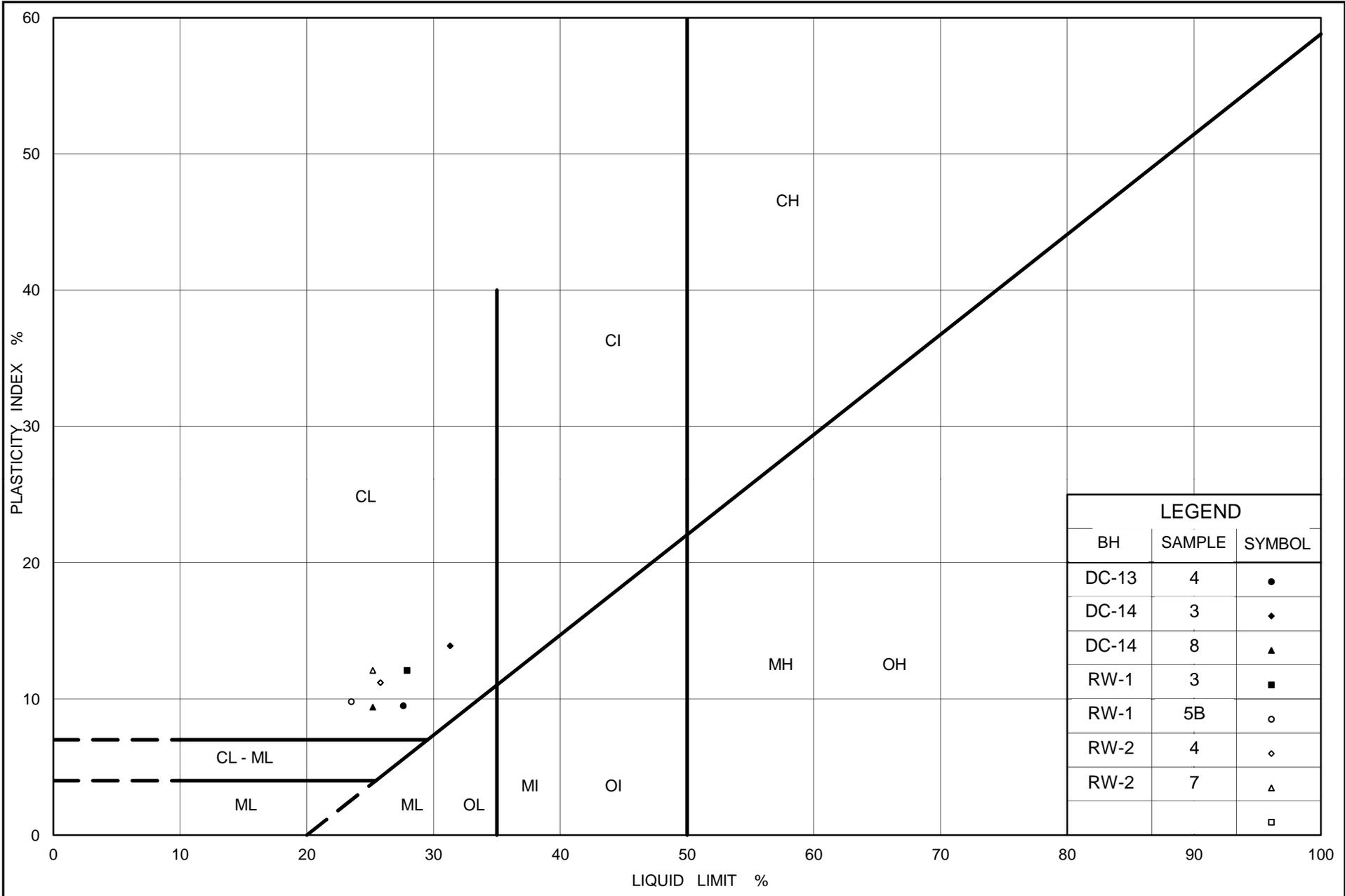
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	DC-14	3	173.7
■	RW-1	3	173.4
◆	DC-13	4	172.1
▲	RW-2	4	173.4
▽	DC-14	8	168.9

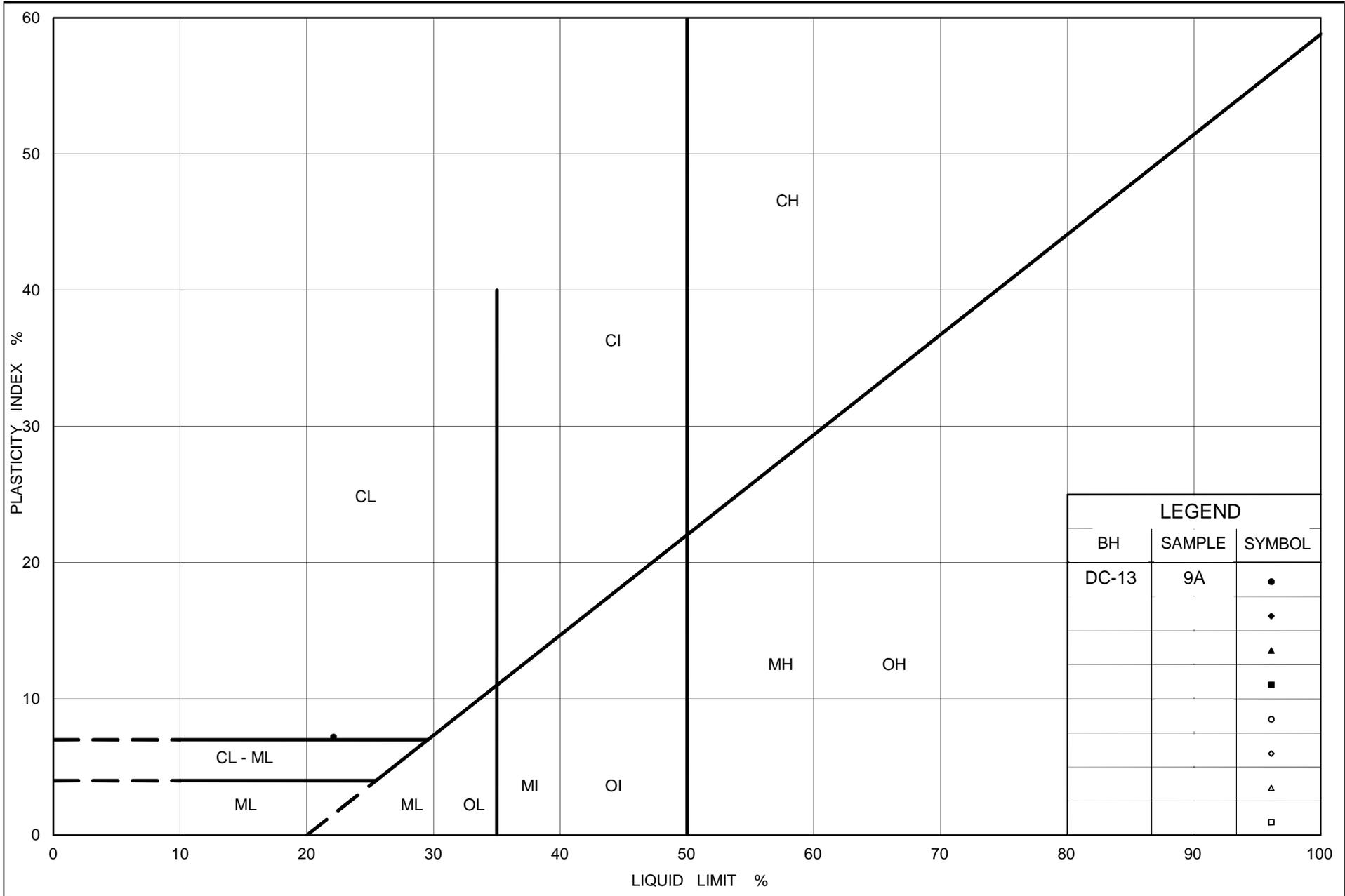
Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 24-Mar-15



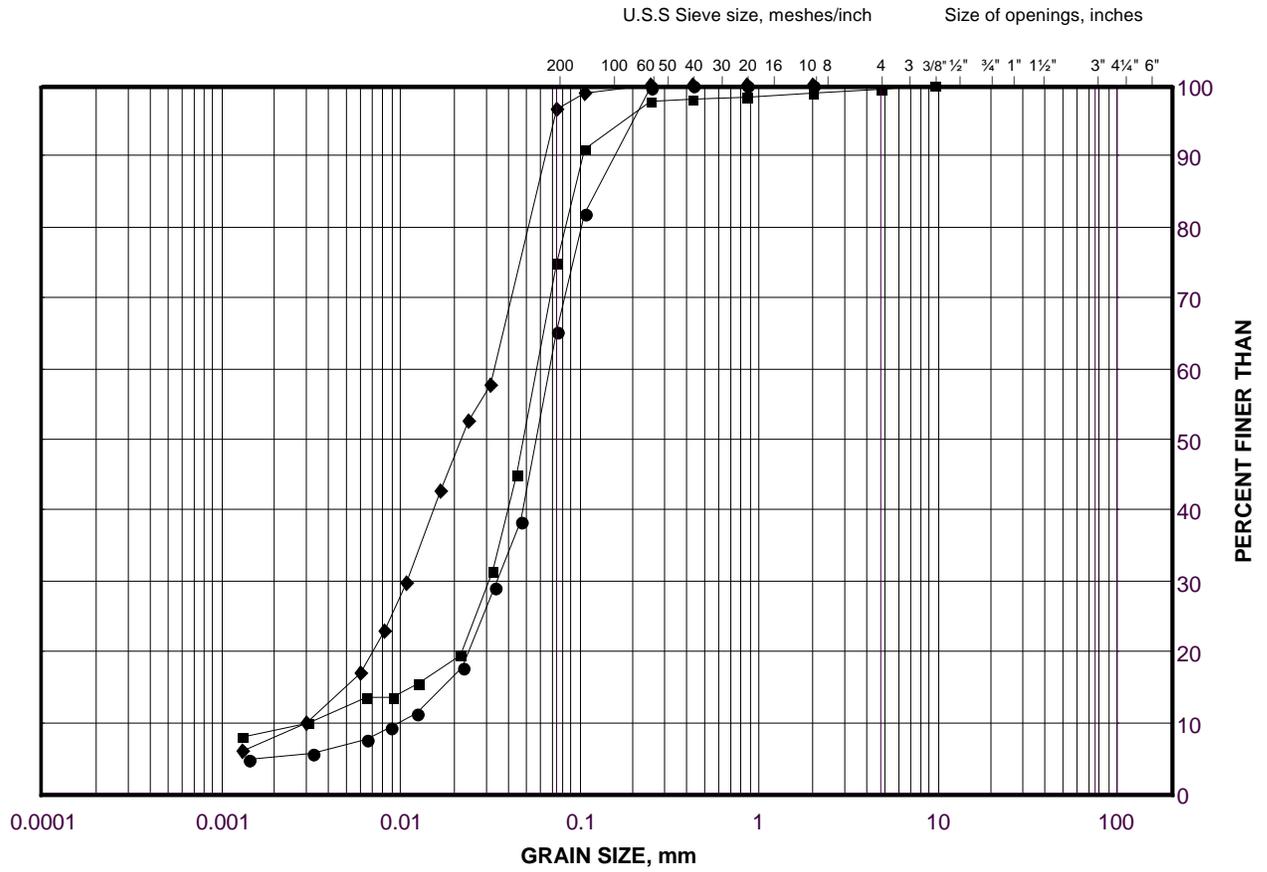


LEGEND		
BH	SAMPLE	SYMBOL
DC-13	9A	●
		◆
		▲
		■
		○
		◇
		△
		□

GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt to Silt and Sand
Retaining Wall 4

FIGURE D5



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

LEGEND

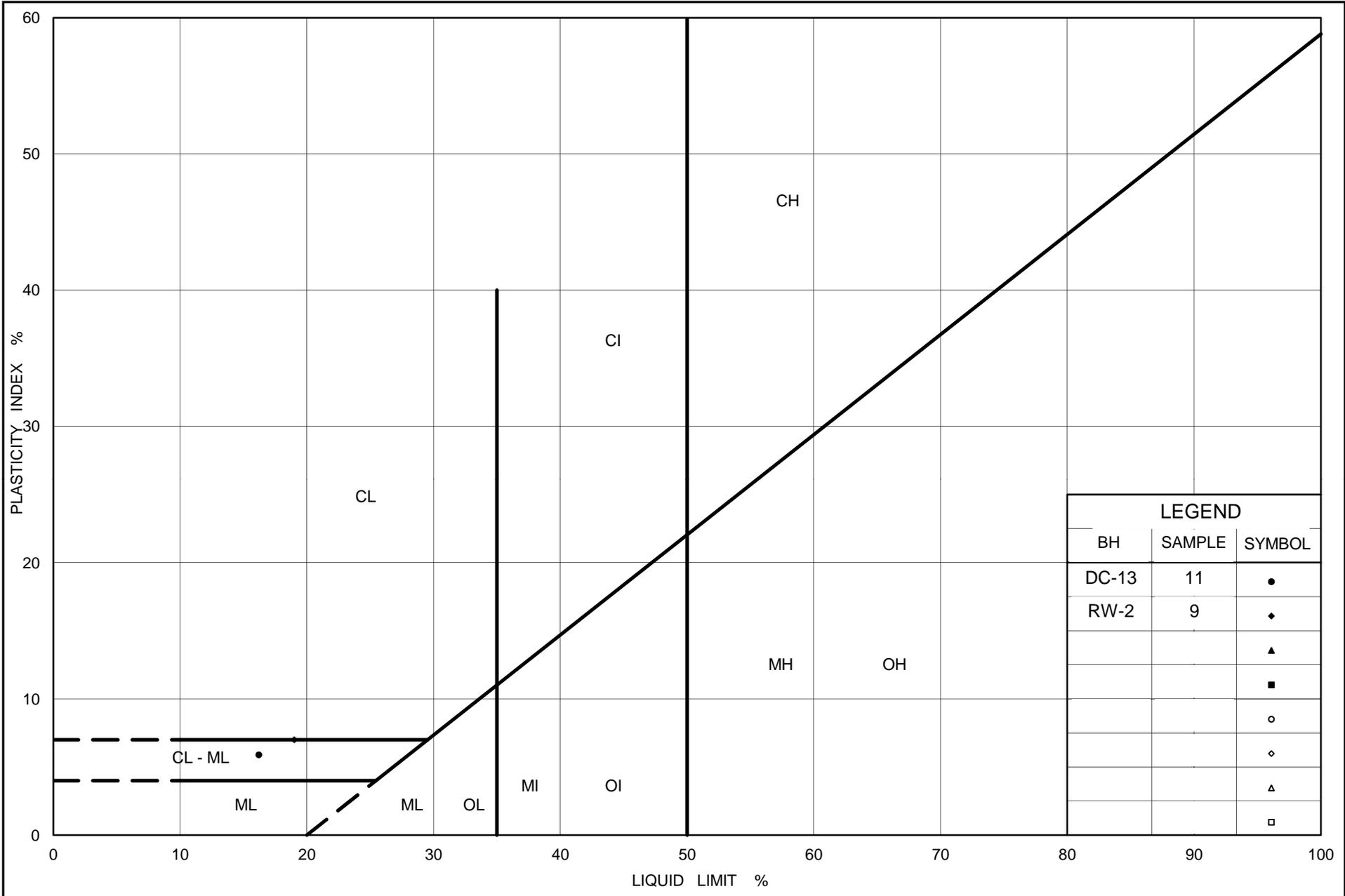
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RW-1	8	168.8
■	DC-14	9	167.5
◆	DC-13	9B	166.7

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 24-Mar-15





APPENDIX E

Retaining Wall 5, Highway 401 – STA. 16+345 to STA. 16+445 Record of Borehole Sheets and Laboratory Test Results

PROJECT <u>10-1111-0211</u>	RECORD OF BOREHOLE No RW-3	SHEET 1 OF 1	METRIC
G.W.P. <u>2152-01-00</u>	LOCATION <u>N 4830889.5 ; E 287546.9</u>	ORIGINATED BY <u>AV</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>150 mm O.D. Solid Stem Augers</u>	COMPILED BY <u>MP/AJS</u>	
DATUM <u>GEODETIC</u>	DATE <u>July 8, 2014</u>	CHECKED BY <u>NK</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL												
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																					
								20	40	60	80	100																	
173.7	GROUND SURFACE																												
0.0	TOPSOIL Sandy clayey silt, trace gravel (FILL) Stiff Brown Moist		1	AS	-								o																
172.3			2	SS	15								o																
1.4	CLAYEY SILT with SAND, trace to some gravel (TILL) Firm to very stiff Brown Moist		3	SS	24																								
			4	SS	26																								
	Auger grinding Becoming grey		5	SS	15																								
			6	SS	14																								
169.2	CLAYEY SILT Firm Brown Moist		7	SS	6																								
4.5																													
168.1	SILT and SAND Compact Grey Wet		8A	SS	25																								
5.6			8B																										
167.1	CLAYEY SILT with SAND, trace to some gravel (TILL) Very stiff Grey Moist																												
6.6																													
165.5	END OF BOREHOLE		9	SS	25																								
8.2																													
	NOTES: 1. Water level at a depth of 4.70 m below ground surface (Elev. 169.0 m) upon completion of drilling. 2. Water level readings in piezometer: <table style="margin-left: 40px; border-collapse: collapse;"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>08/08/14</td> <td>2.5</td> <td>171.2</td> </tr> <tr> <td>08/27/14</td> <td>2.5</td> <td>171.2</td> </tr> <tr> <td>09/15/14</td> <td>2.5</td> <td>171.2</td> </tr> </table>																	Date	Depth (m)	Elev. (m)	08/08/14	2.5	171.2	08/27/14	2.5	171.2	09/15/14	2.5	171.2
Date	Depth (m)	Elev. (m)																											
08/08/14	2.5	171.2																											
08/27/14	2.5	171.2																											
09/15/14	2.5	171.2																											

GTA-MTO 001 T:\PROJECTS\2010\10-1111-0211 (AECOM, MISSISSAUGA)\LOG\101110211.GPJ GAL-GTA.GDT 08/12/15 PR

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-4 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 G.W.P. 2152-01-00 LOCATION N 4830913.2 ; E 287595.9 ORIGINATED BY AV

DIST Central HWY 401 BOREHOLE TYPE 150 mm O.D. Solid Stem Augers COMPILED BY MP/AJS

DATUM GEODETIC DATE July 5, 2014 CHECKED BY NK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
174.4	GROUND SURFACE																
0.0	TOPSOIL																
	Sandy clayey silt, trace gravel, trace rootlets, with sand lenses (FILL) Stiff Brown Moist		1	AS	-												
			2	SS	12								○				2 25 48 25
173.0																	
1.4	Sandy CLAYEY SILT, some gravel (TILL) Firm to very stiff Brown Moist		3	SS	21												
			4	SS	23								○				
	----- Becoming grey		5	SS	19												
			6	SS	15												
169.9																	
4.5	CLAYEY SILT Firm Brown Moist		7	SS	7								○	—			
168.8																	
5.6	SILT, some sand, trace to some gravel, trace to some clay Compact Grey Wet		8A	SS	13								○				10 18 64 8
168.0			8B	SS	13								○	—			
6.4	Sandy CLAYEY SILT, some gravel (TILL) Stiff to very stiff Grey Wet																
			9	SS	28												
166.2																	
8.2	END OF BOREHOLE																
	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 08/12/15 PR

RECORD OF BOREHOLE No DC-7 SHEET 1 OF 1 **METRIC**

PROJECT 10-1111-0211 LOCATION N 4830868.9 ; E 287506.4 ORIGINATED BY SB

2150-01-00 DIST HWY 401- 403 W Ramp BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers COMPILED BY BM

DATUM Geodetic DATE August 30, 2012 CHECKED BY TVA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W _p	W	W _L	GR	SA
175.1	GROUND SURFACE																	
8.0	TOPSOIL																	
	CLAYEY SILT, sandy, trace gravel (TILL) Stiff to very stiff Brown Moist	1	SS	15														
		2	SS	21														
		3	SS	29														
		4	SS	29													5 23 46 26	
		5	SS	21														
		6	SS	19														
		7	SS	14														
169.0																		
6.1	SILTY CLAY, trace sand, trace gravel Firm to very stiff Grey Moist	8	SS	7														
		9A	SS	7														
167.0		9B	SS	7														
8.1	SILT, trace to some sand, trace to some clay Loose Grey Wet																0 6 86 8	
166.3																		
8.8	CLAYEY SILT, trace sand, trace gravel (TILL) Very stiff Grey Moist	10	SS	17														
		11	SS	23														
163.8																		
11.3	END OF BOREHOLE																	
	NOTE: 1. Piezometer installation consists of 50 mm diameter PVC pipe with a 3.0 m slotted screen. Water Level Readings Date Depth (m) Elev. (m) 08/30/12 Dry - 10/09/12 5.6 169.5 11/05/12 5.5 169.6																	

GTA-MTO 001 1011110211.GPJ GAL-GTA.GDT 2/17/15 PR

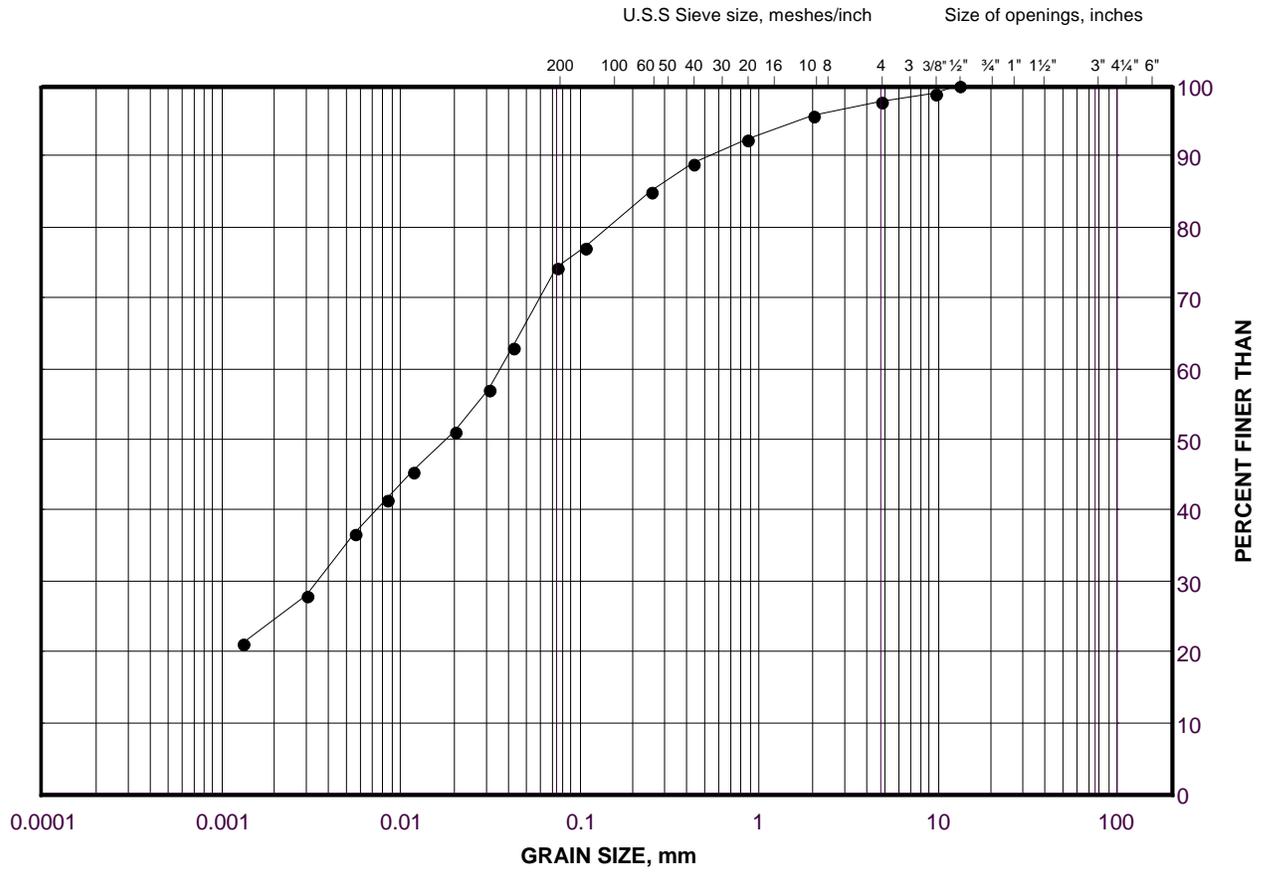
+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt (Fill)

Retaining Wall 5

FIGURE E1



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

LEGEND

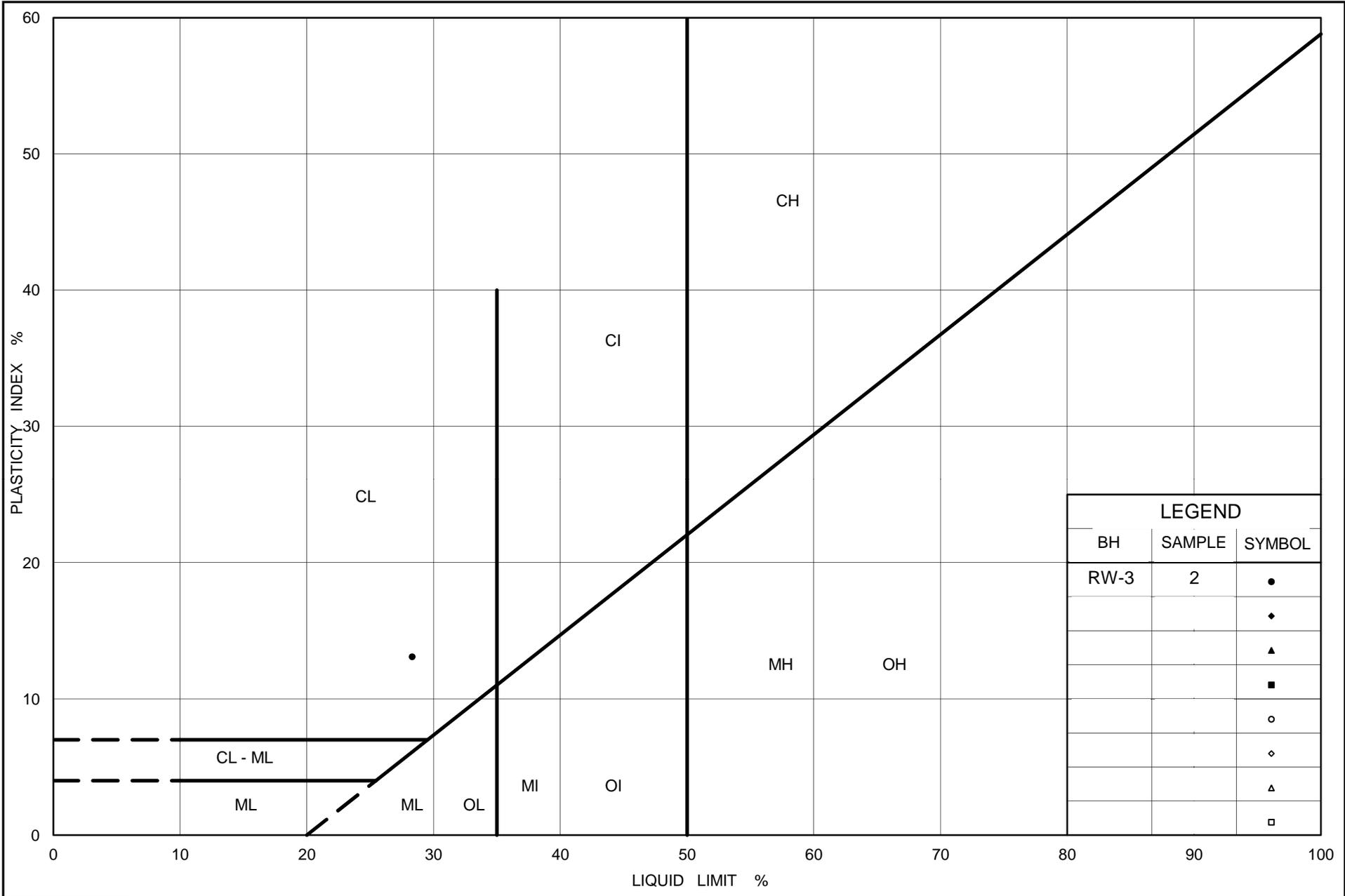
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	RW-4	2	173.3

Project Number: 10-1111-0211

Checked By: NK

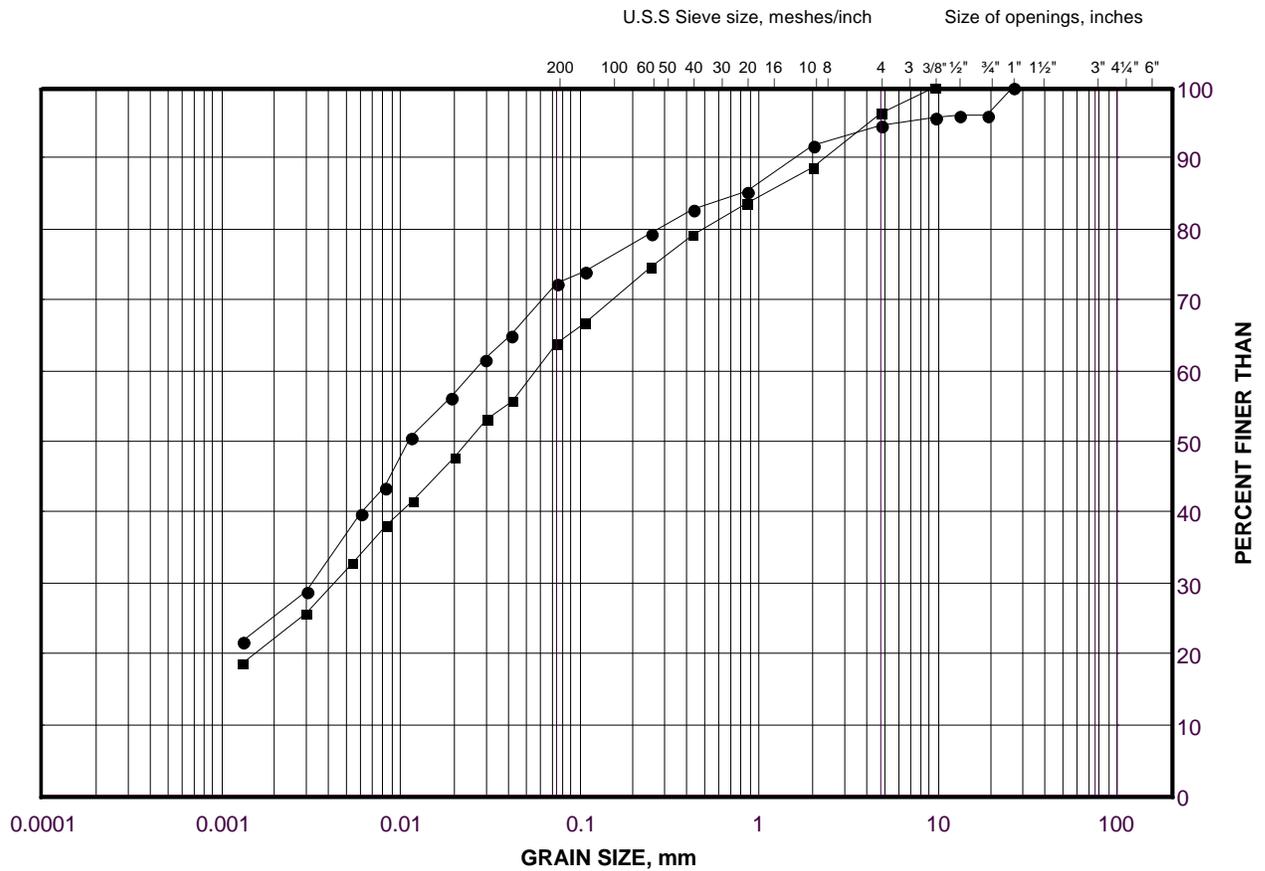
Golder Associates

Date: 11-Mar-15



GRAIN SIZE DISTRIBUTION
 Sandy Clayey Silt (Till) (Upper Deposit)
 Retaining Wall 5

FIGURE E3



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

LEGEND

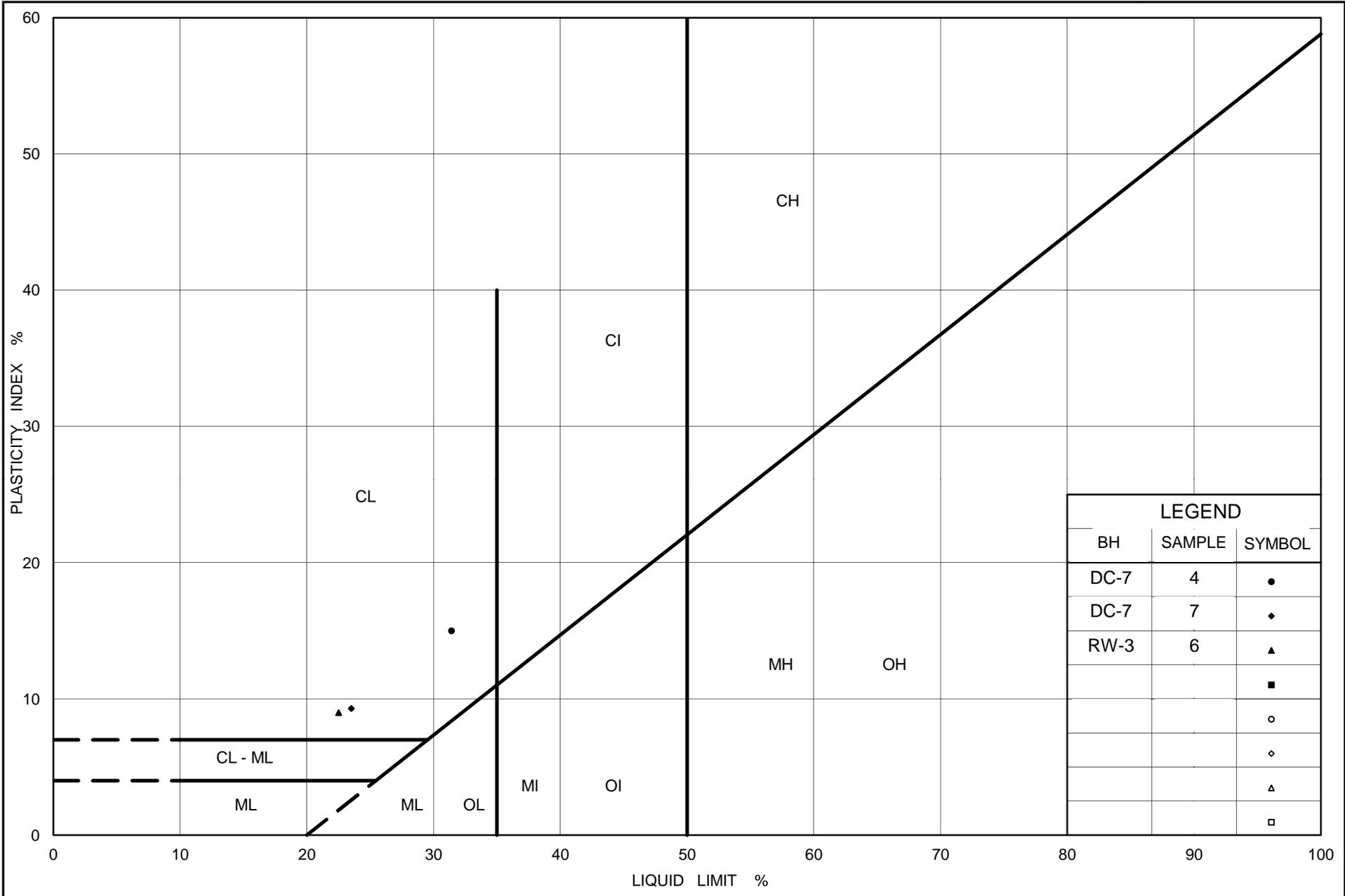
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	DC-7	4	172.5
■	RW-3	4	171.1

Project Number: 10-1111-0211

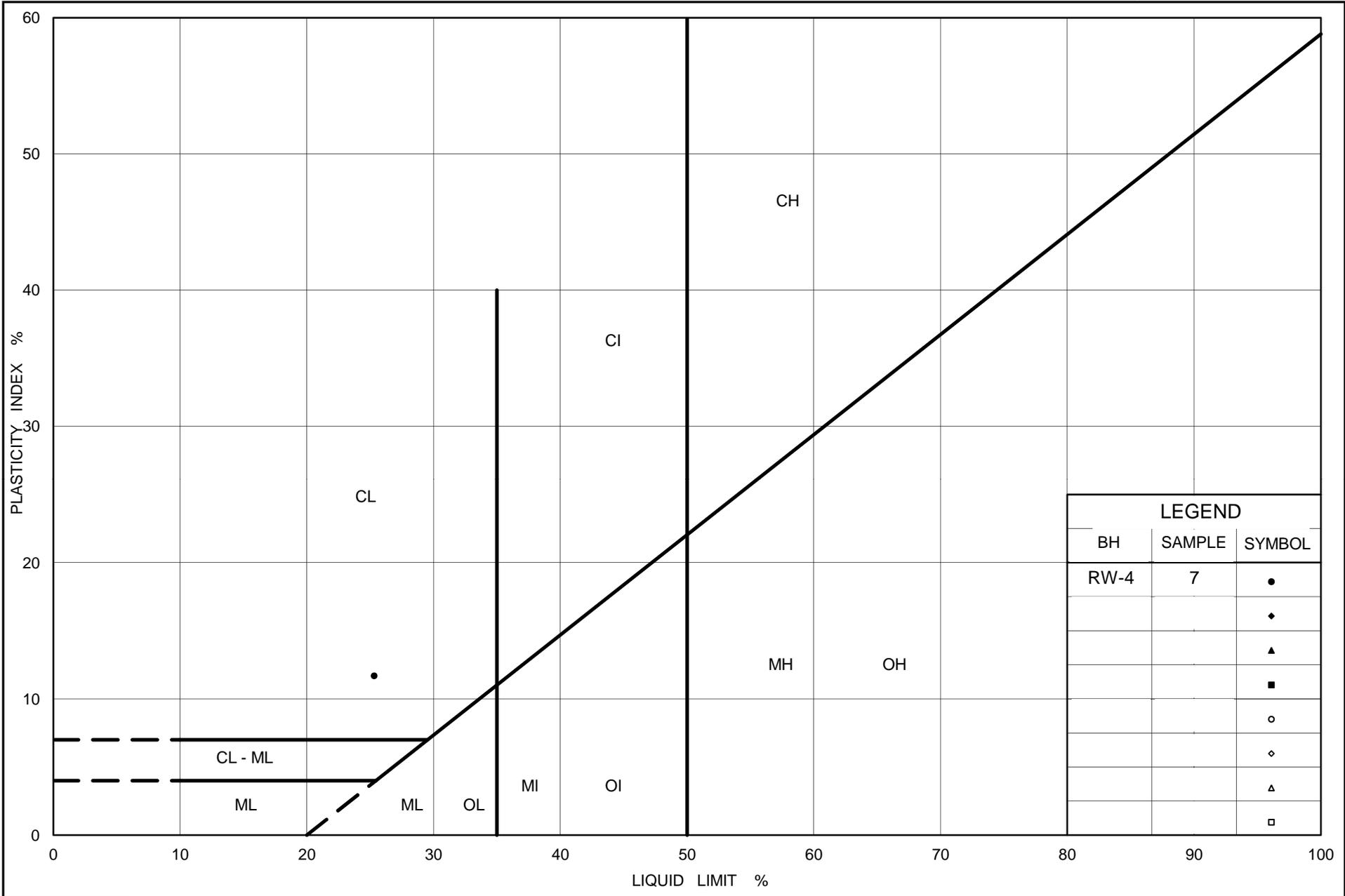
Checked By: NK

Golder Associates

Date: 11-Mar-15



LEGEND		
BH	SAMPLE	SYMBOL
DC-7	4	●
DC-7	7	◆
RW-3	6	▲
		■
		○
		◇
		△
		□

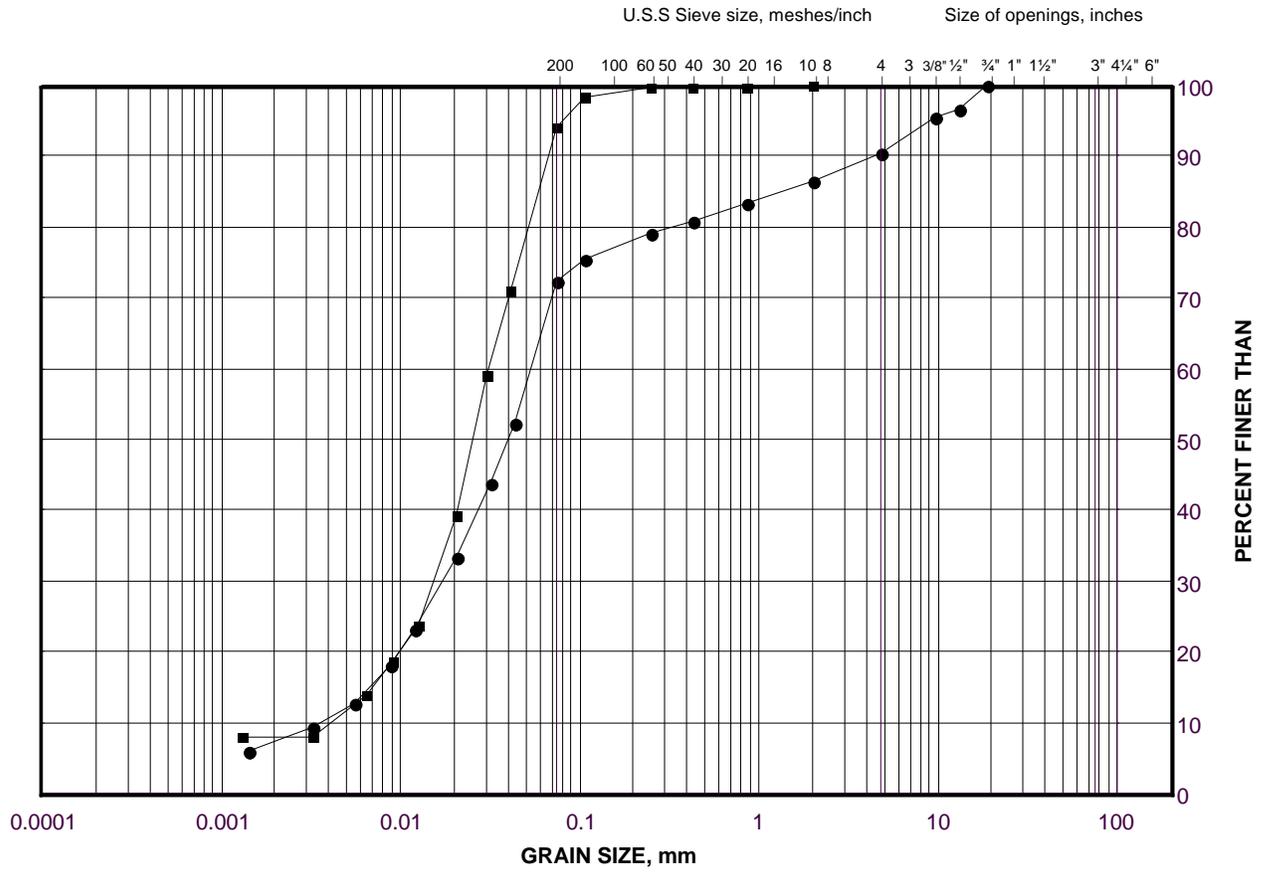


LEGEND		
BH	SAMPLE	SYMBOL
RW-4	7	●
		◆
		▲
		■
		○
		◇
		△
		□

GRAIN SIZE DISTRIBUTION

Silt
Retaining Wall 5

FIGURE E6



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RW-4	8A	168.2
■	DC-7	9B	167.0

Project Number: 10-1111-0211

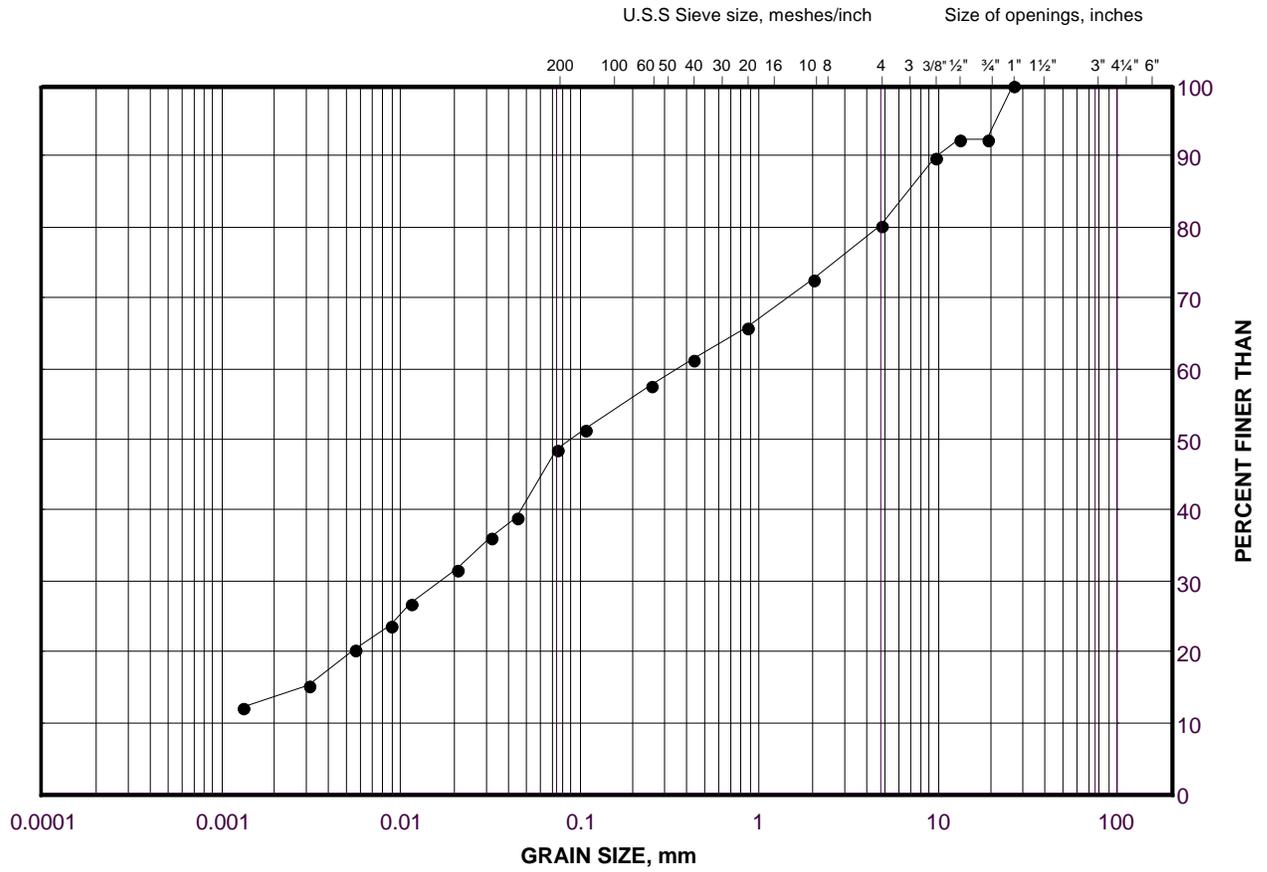
Checked By: NK

Golder Associates

Date: 11-Mar-15

GRAIN SIZE DISTRIBUTION
 Clayey Silt with Sand (Till) (Lower Deposit)
 Retaining Wall 5

FIGURE E7



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

LEGEND

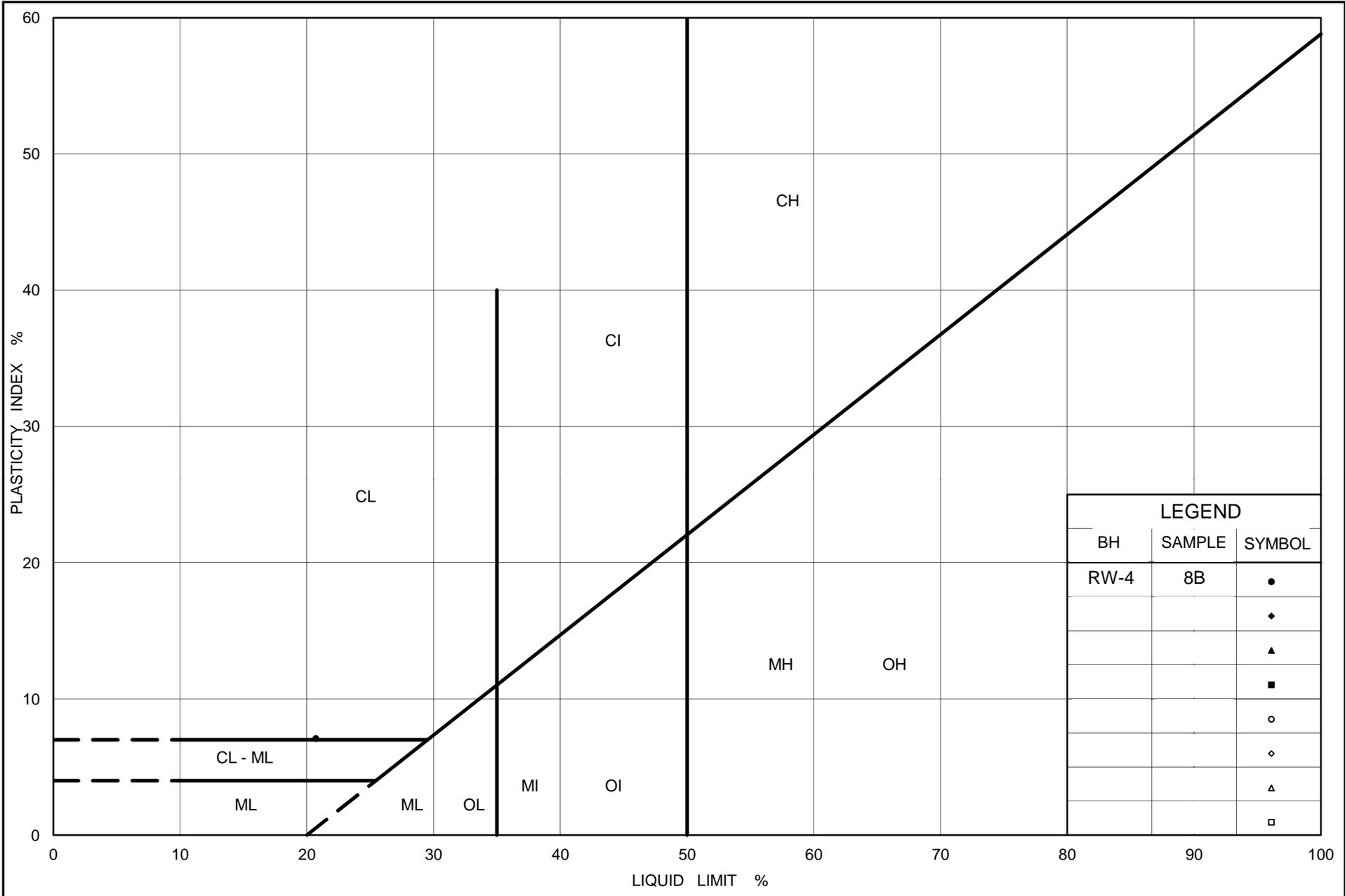
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RW-3	9	165.8

Project Number: 10-1111-0211

Checked By: NK

Golder Associates

Date: 11-Mar-15



LEGEND		
BH	SAMPLE	SYMBOL
RW-4	8B	●
		◆
		▲
		■
		○
		◇
		△
		□

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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