

Foundation Investigation Report

Essa Road Overpass (Site No. 30X-0178/B1&2)

Highway 400 / Essa Road Interchange Reconstruction, Barrie, Ontario

MTO G.W.P. 2337-16-00

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Certificate of Analysis Report # R5762201

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the reconstruction of the Highway 400/ Essa Road Interchange in Barrie, Ontario.

This report presents the results of the foundation investigation carried out at the proposed Essa Road Overpass (MTO Structure Site No. 30X-0178/B1&2) replacement, including associated approach embankments.

The purpose of this investigation is to establish the subsurface soil conditions at the proposed Essa Road Overpass replacement and associated approach embankments, by borehole drilling and laboratory testing of selected soil samples. The results of foundation investigations for other works associated with the interchange reconstruction are presented in separate reports.

2.0 SITE DESCRIPTION

Highway 400 through this area is oriented in a northwest-to-southeast direction, while Essa Road is oriented in a northeast-southwest direction; for the purposes of this report and the contract, Highway 400 is taken as oriented north-south, and Essa Road as east-west.

The existing Essa Road Overpass is a single span bridge, located about 3 km north of the Maplevue Drive interchange and 2.5 km south of the Dunlop Street interchange, as shown on the Key Plan on Drawing 1. Highway 400 currently consists of a total of six lanes (three lanes each in the northbound and southbound direction) while Essa Road has a total of four lanes (two lanes each in the westbound and eastbound directions), with additional turning lanes at various intersections and on-ramp locations.

At the interchange, the highway grade ranges from about Elevation 242 m to 263 m, sloping downward to the north, and the Essa Road grade ranges from about Elevation 243 m to 252 m, sloping downward to the east. An MTO-owned carpool parking lot is located at the northeast quadrant of the interchange.

In general, the area surrounding the proposed bridge consists of commercial, retail, and industrial developments as well as residential properties beyond the immediate service roads parallel to Highway 400.

3.0 INVESTIGATION PROCEDURES

3.1 1970 Subsurface Investigation (GEOCRE No. 31D-169)

In October 1970, the Department of Highways, Ontario (DHO) carried out a subsurface investigation at the site to determine the subsurface conditions for widening of the then-existing Essa Road Overpass. The investigation consisted of advancing two boreholes (designated as Boreholes 1 and 2) at the site; Borehole 1 was advanced at the east side of the existing south abutment and Borehole 2 was advanced at the west side of the existing north abutment, as shown on Drawing 1. The results of the investigation are presented in DHO's report titled "*Preliminary Foundation Investigation and Design Report, Essa Road (Simcoe Road 30) Overpass, Structure Site 30-178, Highway Widening from 1 km South of Highway 89 to Highway 11, GWP 30-95-00*", dated December 3, 1970 (GEOCRE No. 31D-169).

The borehole locations provided on the borehole records in Appendix A and shown on Drawing 1 were surveyed by personnel from the Central Region Engineering Surveys Section. The locations are positioned relative to MTM NAD83 (Zone 10) northing and easting coordinates and the ground surface elevation referenced to Geodetic datum. The borehole locations, ground surface elevations, and borehole depths are summarized below.

Borehole Number	MTM NAD83 Northing (m) (Latitude, °)	MTM NAD83 Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
1	4,913,607 (44.362307)	289,072 (-79.697322)	245.8	12.3

Borehole Number	MTM NAD83 Northing (m) (Latitude, °)	MTM NAD83 Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
2	4,913,566 (44.361938)	289,058 (-79.697497)	247.2	19.8

3.2 2016 Subsurface Investigation (GEOCRES No. 31D-684)

In December 2016, Golder carried out a subsurface investigation at the site as part of the preliminary foundation engineering services for the replacement of the existing Essa Road Overpass. The investigation consisted of advancing two boreholes (designated as Boreholes ES1--and ES1-2), one on the east side of the proposed south abutment and one on the west side of the proposed north abutment, as shown on Drawing 1. In addition, a Dynamic Cone Penetration Test (DCPT) was advanced from the bottom of Borehole ES1-2 to assess refusal conditions, and a standpipe piezometer was installed in Borehole ES1-1. The results of the investigation are presented in Golder's report titled *"Preliminary Foundation Investigation and Design Report, Essa Road (Simcoe Road 30) Overpass, Site No. 30-178, Highway 400 Widening from 1 km south of Highway 89 to Junction of Highway 11, Ministry of Transportation, Ontario"*, dated December 11, 2017 (GEOCRES No. 31D-684).

The borehole locations provided on the borehole records in Appendix B and shown on Drawing 1 were measured relative to existing on-site features and plotted within the Digital Terrain Model for the site, and the ground surface elevations were interpolated from topographic data. The locations are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations, and borehole depths are summarized below.

Borehole Number	MTM NAD83 Northing (m) (Latitude, °)	MTM NAD83 Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole / DCPT Depth (m)
ES1-1	4,913,616.6 (44.362386)	289,109.0 (-79.696855)	246.5	30.9
ES1-2	4,913,561.8 (44.361891)	289,025.5 (-79.697901)	245.6	20.3 / 22.6

3.3 Current Subsurface Investigation

The field work for the current subsurface investigation was carried out between May 8 and June 12, 2019 during which time a total of twelve boreholes (designated as Borehole ERO-1 to ERO-12) were advanced for the proposed overpass and approach embankments, and one borehole (designated as Borehole PLT-1) was advanced at the proposed pile load testing location, as shown on Drawing 1.

The investigation was carried out using a track-mounted Fordia GT8, Diedrich D90, and Diedrich D120 drill rigs, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario and a track-mounted CME-55 drill rig, supplied and operated by Geo-Environmental Drilling Inc., of Acton, Ontario. The boreholes were generally advanced through the overburden using 210 mm outside diameter hollow-stem augers and mud rotary drilling techniques. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586)¹. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested

¹ ASTM D1586-08a – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of the soil.

to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions.

The groundwater conditions were noted in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in five boreholes (Boreholes ERO-1, ERO-5, ERO-8, ERO-10, and PLT-1) to allow for monitoring of the groundwater level. The remaining boreholes were backfilled with bentonite and the ground surface was restored to near original condition as practicable. Where boreholes were advanced through road surface, cold patch asphalt was used to match the existing pavement structure at surface.

The field work was observed by members of Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Mississauga laboratory where the samples underwent further visual examination. Geotechnical laboratory testing (water content, grain size distribution, and Atterberg limits) was carried out on select soil samples, in accordance with MTO and / or ASTM Standards, as appropriate. In addition, four soil samples were submitted to Bureau Veritas Laboratories of Mississauga, Ontario for analysis of select parameters to assess for the potential corrosion to buried steel and deterioration of concrete.

The borehole locations provided on Drawing 1 and on the borehole records in Appendix C were surveyed by Golder using a hand-held Trimble GPS unit with a horizontal and vertical accuracy of 0.1 m. The locations are positioned relative to MTM NAD 83 northing and easting (Zone 10 CSRS CBNv6-2010.0) coordinates and the ground surface elevations are referenced to a Geodetic datum (CGVD28). The borehole locations, including geographic coordinates, ground surface elevations, and borehole depths are summarized below.

Location	Borehole ID	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
North Approach	ERO-1	4,913,680.6 (44.362969)	289,031.6 (-79.697832)	244.5	9.8
	ERO-2	4,913,564.6 (44.361924)	289,008.6 (-79.698116)	245.0	11.3
North Abutment	ERO-3	4,913,662.5 (44.362806)	289,047.6 (-79.69763)	244.8	39.9
	ERO-4	4,913,593.9 (44.362188)	289,041.8 (-79.697701)	252.1	17.4
	ERO-5	4,913,558.1 (44.361866)	289,034.1 (-79.697796)	246.5	40.1
Pier	ERO-6	4,913,636.2 (44.36257)	289,067.9 (-79.697375)	245.5	40.1
	ERO-7	4,913,536.4 (44.361672)	289,061.3 (-79.697454)	248.2	41.5
South Abutment	ERO-8	4,913,606.9 (44.362307)	289,091.2 (-79.697081)	246.7	41.3
	ERO-9	4,913,583.6 (44.362097)	289,084.8 (-79.697161)	252.2	14.6
	ERO-10	4,913,484 (44.361201)	289,105.4 (-79.696900)	251.5	47.5
South Approach	ERO-11	4,913,600.3 (44.362247)	289,102.2 (-79.696943)	247.0	9.8
	ERO-12	4,913,524.4 (44.361565)	289,097.3 (-79.697002)	254.8	17.2
Pile Load Test	PLT-1	4,913,544.7 (44.361745)	289,011.1 (-79.698085)	246.2	35.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)², the section of Highway 400 through Barrie, Ontario, traverses across the following physiographic regions: the Peterborough Drumlin Field; the Simcoe Lowlands; and the Simcoe Uplands. Specifically, the Highway 400 / Essa Road Interchange is located at the boundary between the Simcoe Lowlands and the Peterborough Drumlin Field.

The surficial soils in the Peterborough Drumlin Field consist primarily of rolling sandy till deposits and sand to sand and gravel deposits. Deposits of silt, clay or peat may also be found in the low-lying areas between drumlins and eskers. Near Lake Simcoe the drumlins or drumlin uplands rise from sand plains and have been subjected to wave action.

The Simcoe Lowlands are generally characterized by deep deposits of deltaic or lacustrine silts, sands and clays associated with glacial Lake Algonquin. The region is bordered by shorecliffs, beaches and bouldery terraces.

4.2 Subsurface Conditions

The subsurface soil and groundwater conditions as encountered in the boreholes advanced as part of the previous and current subsurface investigations are presented on the borehole records in Appendices A to C. In addition, *Method of Soil Classification, Abbreviations and Terms Used on Records of Boreholes and Test Pits* and *List of Symbols* sheets are provided in Appendices B and C to assist in the interpretation of the borehole records prepared by Golder. The geotechnical laboratory test results from the 2016 and 2019 investigations are presented in Appendix D. The analytical laboratory test results are presented in Appendix E.

The results of the in-situ field tests (i.e., SPT “N”-values) as presented on the borehole records and in Section 4.2 are uncorrected. The boundaries between the strata on the borehole records have been inferred from drilling observations and non-continuous sampling. Therefore, these boundaries represent transitions between soil types rather than exact planes of geological change. The interpreted stratigraphic profiles along various sections of the proposed Essa Road Overpass as shown on Drawings 1 to 3 are simplifications of the subsurface conditions. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface conditions at the Essa Road Overpass consist of fill and surficial deposits underlain by a non-cohesive deposit consisting of loose to very dense silty sand to sand that extends to depths from 31 m to 37 m below ground surface. This extensive silty sand to sand deposit contains interlayers of cohesive soils, silt to sandy silt, and sand and gravel to sandy gravels. These predominantly non-cohesive soils are underlain by a hard silty clay to clay deposit extending to depths of 36 m to 43 m below ground surface. The silty clay to clay deposit is in turn underlain by a deposit of very dense sand to silty sand to sandy silt, which was encountered in the deepest boreholes advanced as a part of this subsurface exploration.

More detailed description of the soil deposits at the site is provided in the following sub-sections. Some soil descriptions from the previous investigations may have been modified/reclassified based on the geotechnical laboratory test results consistent with the current MTO standards for soil classification.

² Chapman, L.J. and Putnam, D.F., 1984, *The Physiography of Southern Ontario*, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

4.2.1 Topsoil

An approximately 50 mm to 200 mm thick layer of topsoil was encountered at ground surface in Boreholes ES1-1, ES1-2, ERO-1 to ERO-3, ERO-5, ERO-8, ERO-10, ERO-11, and PLT-1.

4.2.2 Asphalt

Boreholes ERO-4, ERO-9, and ERO-12 were advanced through the Highway 400 surface and encountered an approximately 100 mm to 280 mm thick layer of asphalt at ground surface. Boreholes ERO-6 and ERO-7 were advanced through the Essa Road surface and encountered an approximately 100 mm and 200 mm thick layer of asphalt at ground surface, respectively.

4.2.3 Silty Sand (SM) to Sand (SP-SM) to Sand (SP-SM/GP-GM) and Gravel to Sand (SW) and Gravel (FILL)

A 0.4 m to 7.0 m thick layer of non-cohesive fill was encountered underlying the topsoil in Boreholes ES1-1, ES1-2, ERO-1, ERO-3, ERO-5, ERO-8, ERO-10, and ERO-11, and below the asphalt in Boreholes ERO-4, ERO-6, ERO-7, ERO-9, and ERO-12. The non-cohesive fill extends to a depth below ground surface of 0.6 m to 7.2 m (Elevations 249.4 m to 243.1 m). This fill consists of silty sand, trace to some gravel to sand, some fines, to sand and gravel. Trace organics were noted within the fill in Borehole ES1-1, while trace to some rootlets were noted in Boreholes ERO-5 and ERO-10. Clayey silt pockets were noted within the silty sand fill recovered from Borehole ERO-8.

The SPT “N”-values measured within the silty sand to sand and gravel fill range from 0 blows (weight of hammer) to 58 blows per 0.3 m of penetration, indicating a variable, very loose to very dense state of compactness.

Grain size distribution testing was carried out on four samples of the fill and the results are presented on Figure D-1 in Appendix D. The water content measured on samples of the silty sand to sand and gravel fill ranges from about 2% to 23%.

4.2.4 Silty Sand (SM) to Sand (SP-SM) to Sand (SW)

An 8.4 m to more than 39.2 m thick deposit of silty sand to sand with interlayers of varying composition was encountered underlying the fill or topsoil in all boreholes, at depths ranging between 0.2 m and 7.2 m below ground surface (Elevations 249.4 m to 243.1 m). This deposit extends to depths of at least 9.7 m to 39.9 m below ground surface (Elevations 237.6 to 204.9 m). Interlayers of sandy clayey silt to silty clay with sand, silt to sandy silt, and sand and gravel to silty gravel and sand to sandy gravel were encountered within this deposit and are described in more detail in Sections 4.2.5, 4.2.6, and 4.2.7. Boreholes ERO-1, ERO-2, ERO-3, ERO-4, ERO-9, ERO-11, ERO-12, PLT-1, ES1-1, and ES1-2 were terminated within this deposit.

The SPT “N”-values measured within the silty sand to sand deposit range from 7 blows to 151 blows per 0.3 m of penetration, with values as high as 112 blows for 0.25 m of penetration to 100 blows for 0.13 m of penetration, indicating a variable, loose to compact state of compactness.

The results of grain size distribution testing carried out on samples of the silty sand to sand are shown on Figures D-2A to D-2I in Appendix D. Atterberg limits testing was carried out on samples of the silty sand deposit and the results are presented on Figure D-3 in Appendix D. Three Atterberg limits tests indicated the material is non-plastic, while Atterberg limits tests carried out on other samples measured liquid limits of 10% to 12%, plastic limits of 11% to 13%, and plasticity indices of 1% to 2%, indicating the fines are non-plastic to slightly plastic. The natural water content measured on samples of the silty sand to sand ranges from about 2% to 27%.

4.2.5 Sandy Clayey Silt-Silt (CL-ML) to Sandy Clayey Silt (CL) to Silty Clay (CL/SC) and Sand – Interlayers

Interlayers of sandy clayey silt-silt to sandy clayey silt to silty clay with sand, between 0.7 m and 4.6 m thick, were encountered within the extensive silty sand to sand deposit in several of the boreholes (Boreholes ERO-2, ERO-4, ERO-5, ERO-10, PLT-1, ES1-1, and ES1-2). These cohesive interlayers were generally encountered within the upper portion of the extensive silty sand to sand deposit, with the interlayer surface at depths ranging between 0.2 m and 7.2 m below ground surface (Elevations 249.4 m to 240.0 m).

The SPT “N”-values measured within the silt to sandy silt interlayers range from 5 blows to 44 blows per 0.3 m of penetration, indicating a firm to hard consistency.

The results of grain size distribution testing carried out on samples of the silty clay to clayey silt-silt and sand are shown on Figure D-4 in Appendix D. Atterberg limits testing was carried out on samples of the cohesive interlayers and the results are presented on Figure D-5 in Appendix D. The Atterberg limits tests measured liquid limits of 11% to 17%, plastic limits of 16% to 37%, and plasticity indices of 4% to 20%, indicating the material is clayey silt of low plasticity to silty clay of intermediate plasticity. The natural water content measured on samples from these interlayers ranges from about 10% to 35%.

4.2.6 Silt (ML) to Sandy Silt (ML) – Interlayers

Interlayers of silt to sandy silt, between 0.6 m and 10.9 m thick, were encountered within the extensive silty sand to sand deposit in several boreholes (Boreholes ERO-1, ERO-3, ERO-7, ERO-8, ERO-10, and ES1-1). The surface of these interlayers was encountered throughout the deposit, at depths ranging between 1.2 m and 29.9 m below ground surface (Elevations 245.3 m to 218.3 m).

The SPT “N”-values measured within the silt to sandy silt interlayers range from 2 blows to 121 blows per 0.3 m of penetration, with values as high as 194 blows for 0.28 m of penetration to 100 blows for 0.05 m of penetration, indicating a very loose to very dense state of compactness.

The results of grain size distribution testing carried out on samples of silt to sandy silt are shown on Figure D-6A in Appendix D. Atterberg limits testing was carried out on samples of the silt to sandy silt interlayers and the results are presented on Figure D-7 in Appendix D. One of the Atterberg limits tests indicated the material is non-plastic, while Atterberg limits tests carried out on other samples measured liquid limits of 14% to 23%, plastic limits of 13% to 20%, and plasticity indices of 2% to 4%, indicating the material is silt of slight plasticity. The natural water content measured on samples from these interlayers ranges from about 12% to 26%.

4.2.7 Sand (SP-SM) and Gravel to Silty Gravel (GM) and Sand to Sandy Gravel (GW-GM) – Interlayers

Interlayers of sand and gravel, to silty gravel and sand, to sandy gravel, between 1.5 m and 6.1 m thick, were encountered throughout the extensive silty sand to sand deposit in several of the boreholes (Boreholes ERO-3, ERO-6, ERO-7, ERO-8, and ES1-1). The surface of these interlayers was encountered at depths ranging between 17.8 m and 34.5 m below ground surface (Elevations 227.8 m to 210.3 m).

The SPT “N”-values measured within the sand and gravel to silty gravel and sand to sandy gravel interlayers range from 31 blows to 89 blows per 0.3 m of penetration and 100 blows for 0.13 m of penetration, indicating a dense to very dense state of compactness.

The results of grain size distribution testing carried out on samples of sand and gravel deposit are shown on Figure D-8 in Appendix D. The natural water content measured on samples from these interlayers range from about 8% to 17%.

4.2.8 Silty Clay (CI) to Clay (CH)

A 1.5 m to 8.2 m thick layer of silty clay to clay was encountered underlying the extensive silty sand to sand deposit in Boreholes ERO-5, ERO-7, ERO-8, and ERO-10. The silty clay to clay deposit was encountered at depths ranging between 34.4 m and 34.7 m below ground surface (Elevations 216.8 m to 212.1 m) and extended to depths of 36.0 m and 42.9 m below ground surface (Elevations 210.7 m to 208.6 m).

The SPT “N”-values measured within this deposit range from 37 blows to 71 blows per 0.3 m of penetration and 122 blows for 0.23 m of penetration, suggesting a hard consistency.

The results of grain size distribution testing carried out on samples of silty clay to clay are shown on Figure D-9 in Appendix D. Atterberg limits testing was carried out on samples of the cohesive interlayers and the results are presented on Figure D-10 in Appendix D. The Atterberg limits tests measured liquid limits of 38% to 51%, plastic limits of 18% to 21%, and plasticity indices of 19% to 30%, indicating the material is silty clay of intermediate to clay of high plasticity. The natural water content measured on samples from these interlayers ranges from about 23% to 28%.

4.2.9 Silt (ML) and Sand

A silt and sand deposit was encountered underlying the silty clay to clay deposit in Boreholes ERO-5, ERO-7, ERO-8, and ERO-10, and underlying the silty sand to sand deposit in Borehole ERO-6. This lower non-cohesive deposit was encountered at depths of 36.0 m to 42.9 m below ground surface (Elevations 210.7 m to 208.0 m). The deposit is at least 2.3 m to 5.3 m thick; all of the above-noted boreholes were terminated within this deposit.

The SPT “N”-values measured within the silt and sand deposit range from 95 blows to 147 blows per 0.3 m of penetration, with values as high as 171 blows for 0.28 m of penetration to 100 blows for 0.10 m of penetration, indicating a very dense state of compactness.

The results of grain size distribution testing carried out on samples of the silt and sand deposit are shown on Figure D-11 in Appendix D. The natural water content measured on samples from these interlayers ranges from about 20% to 23%.

4.3 Groundwater Conditions

Details of the water levels observed in the boreholes upon completion of drilling are summarized on the borehole records. A standpipe piezometer was installed in a borehole as part of the 2016 investigation and in five boreholes as part of the current investigation to allow for monitoring the groundwater level at the site, as shown on the borehole records. The groundwater levels measured within the standpipe piezometers are summarized below. It should be noted that the groundwater level is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

Borehole	Screened Stratigraphy	Screened Depth (m) (Elevation) (m)	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date of Measurement
ES1-1	Sand to silt	6.1 – 9.1 (240.4 – 237.4)	246.5	5.5	241.0	01-Aug-2019
				5.1	241.4	02-Apr-2020
ERO-1	Silty sand to silt	4.6 – 6.1 (239.9 – 238.4)	244.5	5.7	238.7	24-Jun-2019
				5.8	238.6	01-Aug-2019
				5.8	238.7	02-Apr-2020
ERO-5	Silty sand	18.3 – 21.3 (228.2 – 225.2)	246.5	5.0	241.5	24-Jun-2019
				5.2	241.3	01-Aug-2019
				4.8	241.7	02-Apr-2020
ERO-8	Sandy silt to silty sand	15.9 – 18.9 (230.8 – 227.8)	246.7	2.8	243.9	24-Jun-2019
				4.7	242.0	01-Aug-2019
				4.3	242.4	02-Apr-2020
ERO-10	Sand	9.2 – 10.8 (242.3 – 240.8)	251.5	7.3	244.2	24-Jun-2019
				8.6	242.8	01-Aug-2019
				8.2	243.3	02-Apr-2020

4.4 Analytical Testing

Four soil samples were collected and submitted for analyses of parameters used to assess corrosion potential and sulphate attack. A summary of the results of the analyses is presented below and the detailed test results and Certificates of Analysis are presented in Appendix E.

Borehole	Sample	Sample Depth / Elevation (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (umho/cm)	Resistivity (ohm-cm)
ERO-4	4	7.9 / 244.2	Sand	2,000	<20	8.0	3,330	300
ERO-6	5	3.3 / 242.2	Silty sand	820	<20	8.2	1,830	550
ERO-7	4	3.3 / 244.9	Silty Sand	2,100	<20	7.8	3,730	270
ERO-8	4	2.5 / 244.2	Sandy silt of slight plasticity	46	<20	7.9	239	4,200

5.0 CLOSURE

This Foundation Investigation Report was prepared by Ms. Alysha Kobylinski, P.Eng. and Ms. Anastasia Poliacik, P.Eng., and was reviewed by Mr. Christopher Ng, P.Eng., a senior geotechnical engineer, and Associate of Golder. Ms. Lisa Coyne, P.Eng., a Principal and Designated MTO Foundations Contact with Golder, conducted an independent technical and quality control review of this report.

Signature Page

Golder Associates Ltd.



Alysha Kobylinski, P.Eng.
Geotechnical Engineer



Christopher Ng, P.Eng.
Associate, Senior Geotechnical Engineer

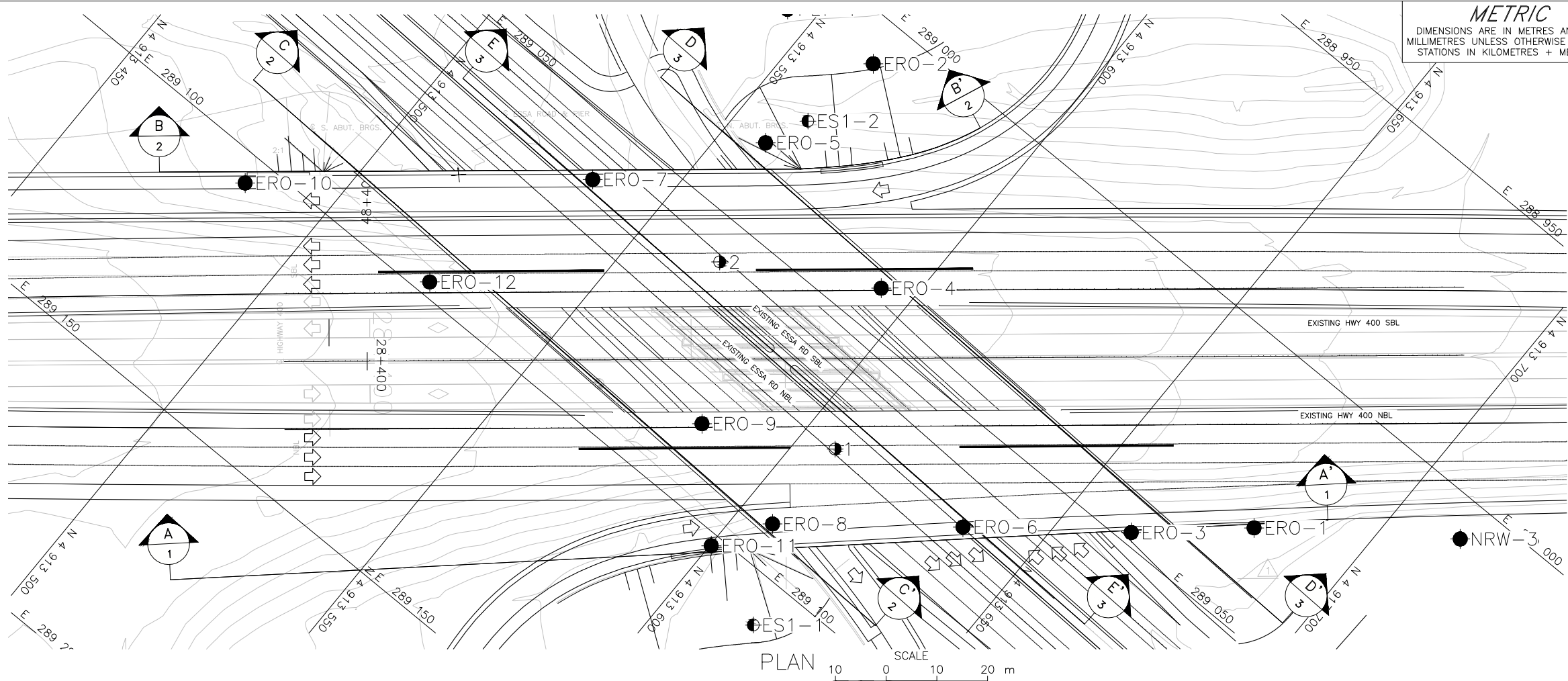


Lisa Coyne, P.Eng.
Principal, MTO Designated Foundations Contact

ACK/AMP/CN/LCC/ljv

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[https://golderassociates.sharepoint.com/sites/29588g/technical work/6. deliverables/1. ero/6. final fir/18105050 fir rev0 2021'07'19 hwy 400 essa road ero.docx](https://golderassociates.sharepoint.com/sites/29588g/technical%20work/6.%20deliverables/1.%20ero/6.%20final%20fir/18105050%20fir%20rev0%202021%2007%2019%20hwy%20400%20essa%20road%20ero.docx)



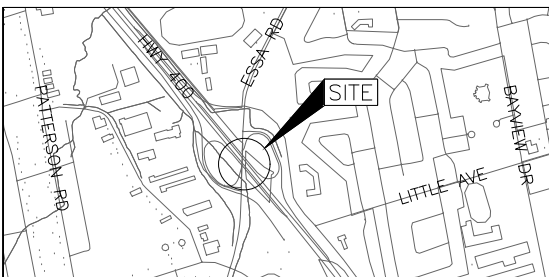
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2337-16-00



HWY 400 / ESSA ROAD INTERCHANGE
RECONSTRUCTION
ESSA ROAD OVERPASS REPLACEMENT
BOREHOLE LOCATION AND SOIL STRATA

SHEET



KEY PLAN

SCALE

2 0 2 4 km

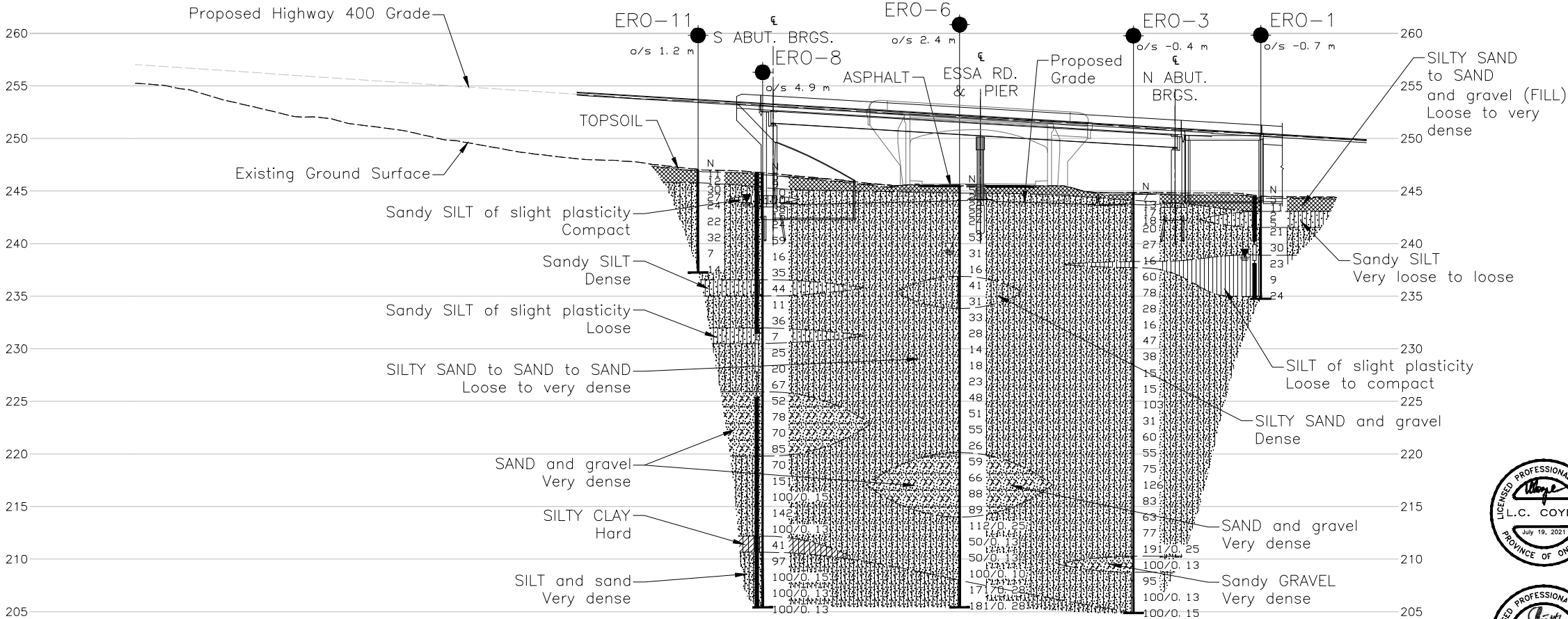
LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (Geocres No. 31D-684)
- Borehole - Previous Investigation (Geocres No. 31D-169)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL in piezometer
- ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION (m)	NORTHING	EASTING
ERO-1	244.5	4913680.6	289031.6
ERO-2	245.0	4913564.6	289008.6
ERO-3	244.8	4913662.5	289047.6
ERO-4	252.1	4913593.9	289041.8
ERO-5	246.5	4913558.1	289034.1
ERO-6	245.5	4913636.2	289067.9
ERO-7	248.2	4913536.4	289061.3
ERO-8	246.7	4913606.9	289091.2
ERO-9	252.2	4913583.6	289084.8
ERO-10	251.5	4913484.0	289105.4
ERO-11	247.0	4913600.3	289102.2
ERO-12	254.8	4913524.4	289097.3
PLT-1	246.2	4913544.7	289011.1
ES1-1	246.5	4913616.6	289109.0
ES1-2	245.6	4913561.8	289025.5
1	245.8	4913607.0	289072.0
2	247.2	4913566.0	289058.0

REFERENCES

General arrangement plan and profile provided in digital format by STANTEC, drawing file no. 165001100-30-178-01.dwg, received January 15, 2021.
Existing ground contours provided in digital format by AECOM, drawing file no. 165001100-30-178-p1, received Feb. 11, 2020.

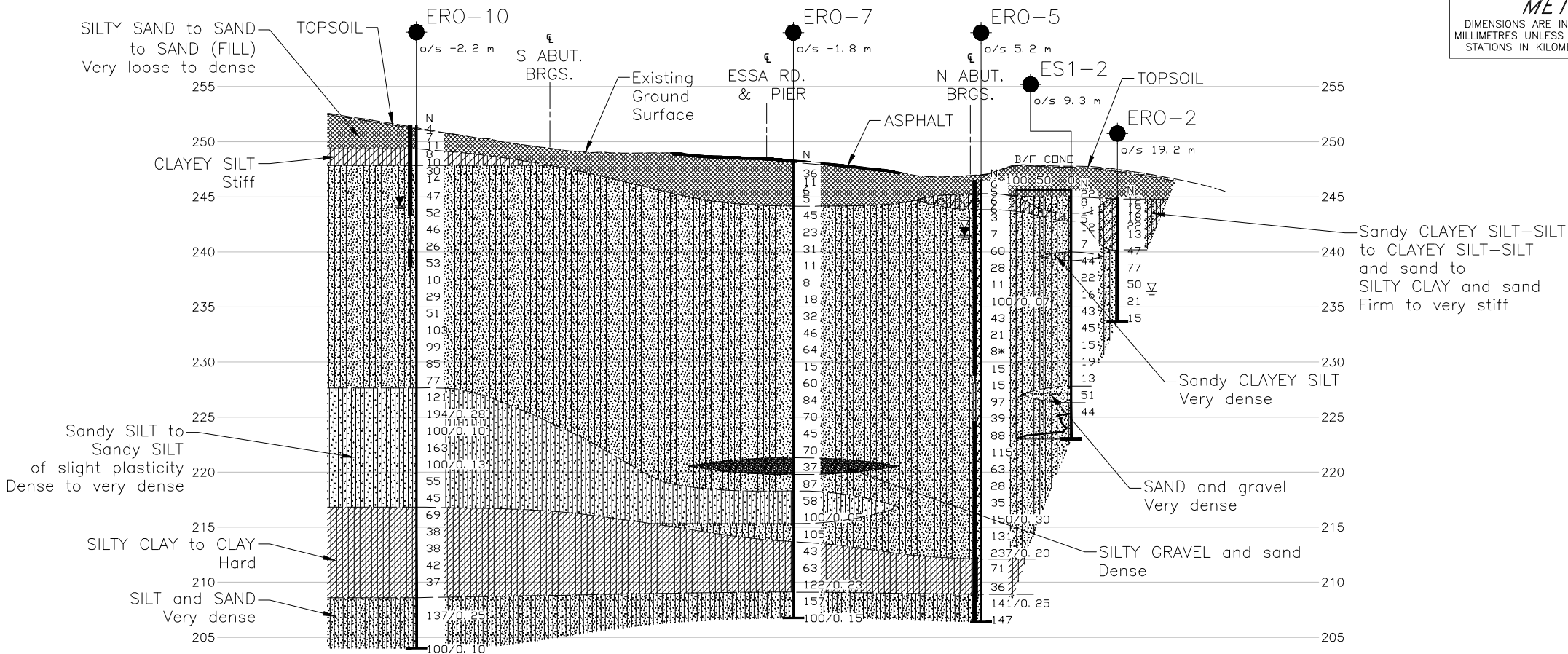


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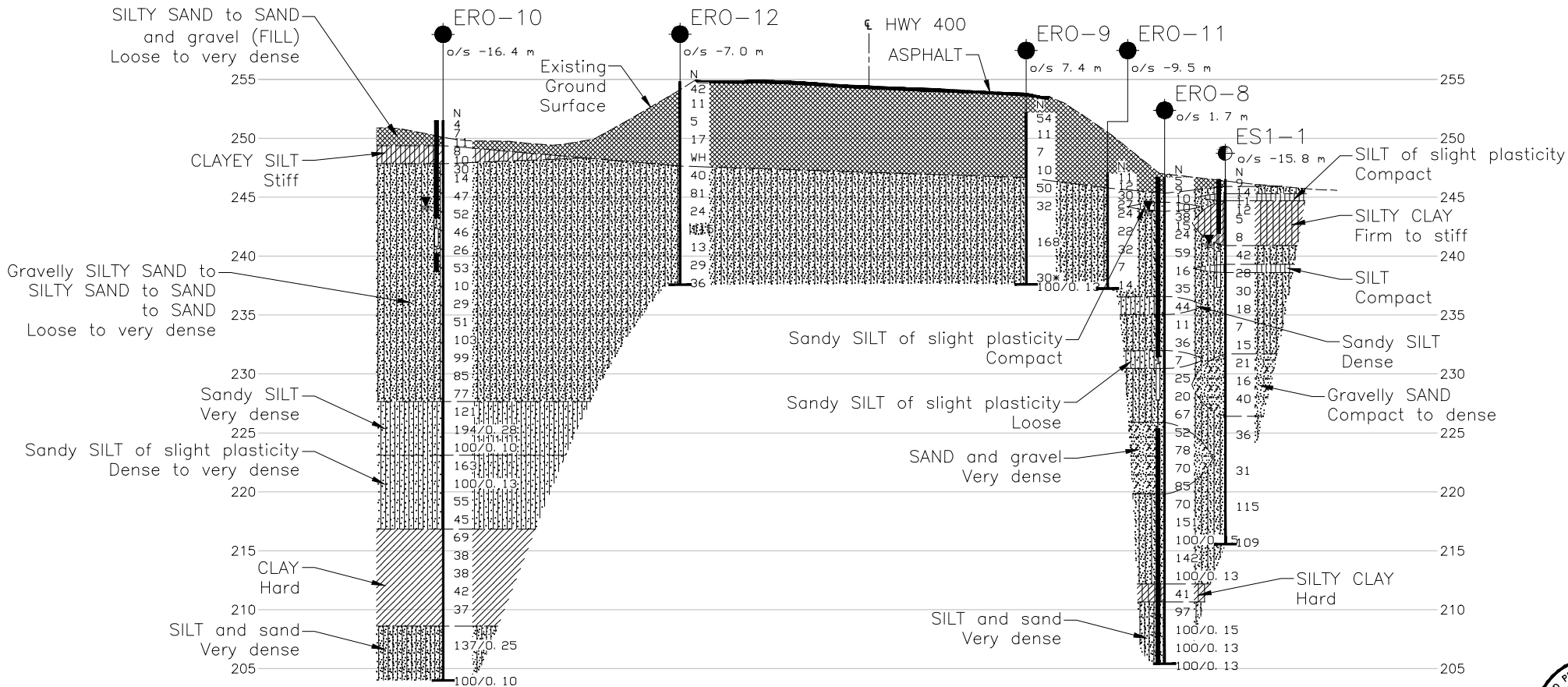
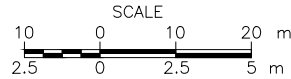
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

BRIDGE PROFILE A-A'

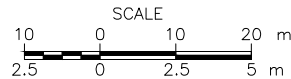
SCALE
10 0 10 20 m
2.5 0 2.5 5 m



BRIDGE PROFILE B-B'



SOUTH ABUTMENT CROSS-SECTION C-C'



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.

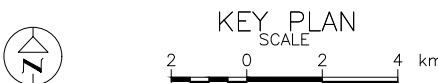
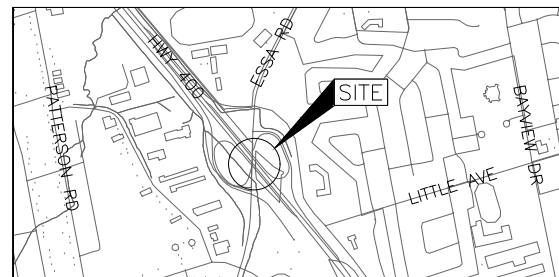
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METRIC
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STATIONS IN KILOMETRES + METRES.

CONT No. 2337-16-00
WP No. 2337-16-00

HWY 400 / ESSA ROAD INTERCHANGE
RECONSTRUCTION
ESSA ROAD OVERPASS REPLACEMENT
SOIL STRATA

SHEET



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (Geocres No. 31D-684)
- Borehole - Previous Investigation (Geocres No. 31D-169)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION (m)	NORTHING	EASTING
ERO-1	244.5	4913680.6	289031.6
ERO-2	245.0	4913564.6	289008.6
ERO-3	244.8	4913662.5	289047.6
ERO-4	252.1	4913593.9	289041.8
ERO-5	246.5	4913558.1	289034.1
ERO-6	245.5	4913636.2	289067.9
ERO-7	248.2	4913536.4	289061.3
ERO-8	246.7	4913606.9	289091.2
ERO-9	252.2	4913583.6	289084.8
ERO-10	251.5	4913484.0	289105.4
ERO-11	247.0	4913600.3	289102.2
ERO-12	254.8	4913524.4	289097.3
PLT-1	246.2	4913544.7	289011.1
ES1-1	246.5	4913616.6	289109.0
ES1-2	245.6	4913561.8	289025.5
1	245.8	4913607.0	289072.0
2	247.2	4913566.0	289058.0

REFERENCES

General arrangement plan and profile provided in digital format by STANTEC, drawing file no. 165001100-30-178-01.dwg, received January 15, 2021.
Existing ground contours provided in digital format by AECOM, drawing file no. 165001100-30-178-p1, dated Feb. 2020, received Feb. 11, 2020.



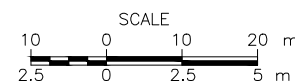
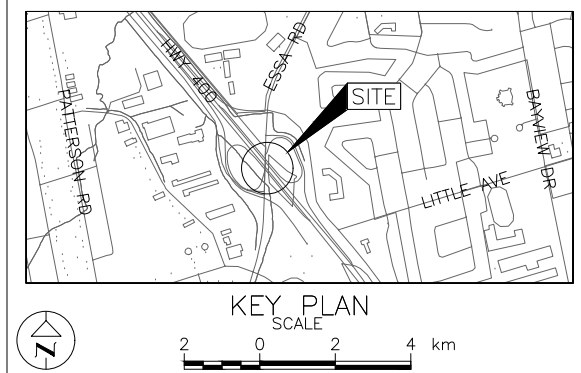
NO.	DATE	BY	REVISION
1	07/19/2021	JM	Initial design
2	07/19/2021	CN	Revised design

Geocres No. 31D-767

HWY. 400	PROJECT NO. 18105050	DIST. CENTRAL
SUBM'D. AMP	CHKD. AMP	DATE: 07/19/2021
DRAWN: JM	CHKD. CN	APPD. LCC
		DWG. 2









HWY 400 / ESSA ROAD INTERCHANGE
RECONSTRUCTION
ESSA ROAD OVERPASS REPLACEMENT
SOIL STRATA



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.

LEGEND	
	Borehole — Current Investigation
	Borehole — Previous Investigation (Geocres No. 31D—684)
	Seal
	Piezometer
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
	WL in piezometer
	WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION (m)	NORTHING	EASTING
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ERO-8	246.7	4913606.9	289091.2
ERO-9	252.2	4913583.6	289084.8
ERO-10	251.5	4913484.0	289105.4
ERO-11	247.0	4913600.3	289102.2
ERO-12	254.8	4913524.4	289097.3
PLT-1	246.2	4913544.7	289011.1
ES1-1	246.5	4913616.6	289109.0
ES1-2	245.6	4913561.8	289025.5
1	245.8	4913607.0	289072.0
2	247.2	4913566.0	289058.0

General arrangement plan and profile provided in digital format by STANTEC, drawing file no. 165001100-30-178-01.dwg, received January 15, 2021.

Existing ground contours provided in digital format by AECOM, drawing file no. 165001100-30-178-p1, dated Feb. 2020, received Feb. 11, 2020.

NO.		DATE		REVISION	
Geocres No. 31D-767					
HWY. 400			PROJECT NO. 18105050		DIST. CENTRA
SUBM'D. AMP		CHKD. AMP		DATE: 07/19/2021	SITE:
DRAWN: JM		CHKD. CN		APPD. LCC	DWG. 3

APPENDIX A

**Borehole Records –
1970 Investigation
(GEOCRES No. 31D-169)**

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-11091

LOCATION

Sta. 706 + 73 69' Rt. Hwy. 400

ORIGINATED BY

VK

W.P. 105-90-09

BORING DATE

Oct. 14, 1970

COMPILED BY

VK

DATUM Geodetic

BOREHOLE TYPE

Cont. flight auger

CHECKED BY

VK

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WATER CONTENT % 10 20 30				
806.5	Ground Level															
0.0	Firm to medium sand, trace of silt. Loose to Very Dense Brown		1	SS	6										244.9	
			2	SS	16										0 87 (13)	
			3	SS	21										0 94 (6)	
			4	SS	42										WL in open BH Oct. 14/70	
789.0	240.5 m (5.3 m)		5	SS	65											
7.5	Het. mix. of silt, sand and gravel, trace of clay. Glacial Till Compact to Very Dense Grey		6	SS	19										2 65 23 10	
			7	SS	19											
			8	SS	79											
			9	SS	22											
766.0	233.5 m (12.3 m)		10	SS	34										7 59 29 5	
40.5	End of Borehole															

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 70-11091

LOCATION

Sta. 706 + 03 69' Lt. Hwy. 400

ORIGINATED BY

VK

W.P. 105-80-09

BORING DATE

Oct. 15/70

COMPILED BY

SAA

DATUM Geodetic

BOREHOLE TYPE

Cont. flight auger

CHECKED BY

VK

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ P.C. %	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		SHEAR STRENGTH P.S.F.				WATER CONTENT % 0 20 30
							20 40 60 80 100	UNCONFINED ● QUICK TRIAXIAL	FIELD VANE + LAB. VANE x				
811.0	247.2 m (0.0 m) Ground Level												
0.0	Fine to medium sand with silt.					810							
245.4m	Compact to Dense Brown		1	SS	27							2 78 (20)	
805.0	Clayey silt with trace of sand and gravel.		2	SS	27								
6.0 (1.8 m)	Very Stiff Brown-Grey		3	SS	27								
799.0	240.5 m (3.7 m)		4	SS	12								
12.0			5	SS	27								
			6	SS	20								
			7	SS	20								
783.0	238.7 m (8.5 m)		8	SS	16								
28.0			9	SS	51								
	Het. mix. of silt, sand and gravel, trace of clay. Compact to Very Dense Grey		10	SS	14								

20

13-5 % STRAIN AT FAILURE

10

APPENDIX B

**Borehole Records -
2016 Investigation
(GEOCRES No. 31D-684)**



LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_c	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_{α}	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
C_u, S_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
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

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 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.

PROJECT 14-1111-0002		RECORD OF BOREHOLE No ES1-1		SHEET 1 OF 3	METRIC
G.W.P. 06-20016		LOCATION N 4913616.6; E 289109.0 MTM NAD ZONE 10 (LAT. 44.362386; LONG. -79.696855)		ORIGINATED BY ML	
DIST Central HWY 400		BOREHOLE TYPE Track - Mounted D-53, 108 mm I.D., 194 mm O.D. Hollow Stem Augers		COMPILED BY SMD	
DATUM Geodetic		DATE December 6 and 7, 2016		CHECKED BY MCK	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
246.5	GROUND SURFACE													
0.0	TOPSOIL													
245.9	Silty sand, trace organics (FILL)		1	SS	9									
0.6	Loose Brown Moist													
245.3	Silty SAND		2	SS	14									
1.2	Compact Brown Moist													
244.7	SILT, some clay, some sand, trace gravel		3A	SS	11									
1.8	Compact Brown Wet		3B											
	SILTY CLAY, trace to some sand, trace gravel		4	SS	12									
	Firm to stiff Brown Moist to wet		5	SS	5									1 5 48 46
			6	SS	8									
240.9	SAND, some gravel													
5.6	Brown Dense Wet		7	SS	42									
239.3	SILT, trace to some sand, trace clay													
7.2	Compact Brown Moist		8A	SS	28									0 5 91 4
238.6	Silty SAND		8B											
7.9	Compact to dense Brown Moist													
			9	SS	30									
236.3	SILT and SAND, trace to some clay, trace to some gravel													
10.2	Loose to compact Brown Wet		10	SS	18									4 39 54 3
			11	SS	7									11 51 31 7
			12	SS	15									
231.7														
14.8														


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

GTA-MTO 001 S:\CLIENTS\TOHWY_400_BARRIER\1411110002_LAT_LONG.GPJ GAL-GTA.GDT 30/11/17



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

PROJECT		RECORD OF BOREHOLE				No ES1-1		SHEET 3 OF 3		METRIC						
G.W.P. 06-20016		LOCATION				N 4913616.6; E 289109.0 MTM NAD ZONE 10 (LAT. 44.362386; LONG. -79.696855)				ORIGINATED BY ML						
DIST Central HWY 400		BOREHOLE TYPE				Track - Mounted D-53, 108 mm I.D., 194 mm O.D. Hollow Stem Augers				COMPILED BY SMD						
DATUM Geodetic		DATE				December 6 and 7, 2016				CHECKED BY MCK						
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								
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100					
215.6	SAND, some gravel, trace to some silt, trace clay Dense to very dense Brown Wet		19	SS	109	216										
30.9	END OF BOREHOLE															
	NOTE: 1. Water level measured in piezometer: Date Depth(m) Elev(m) 15/03/17 5.5 241.0															

PROJECT <u>14-1111-0002</u>		RECORD OF BOREHOLE No ES1-2		SHEET 1 OF 2		METRIC	
G.W.P. <u>06-20016</u>		LOCATION <u>N 4913561.8; E 289025.5 MTM NAD ZONE 10 (LAT. 44.361891; LONG. -79.697901)</u>		ORIGINATED BY <u>ML</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>Diedrich D-53, 108 mm I.D., 194 mm O.D. Hollow Stem Augers</u>		COMPILED BY <u>SMD</u>			
DATUM <u>Geodetic</u>		DATE <u>December 9, 2016</u>		CHECKED BY <u>MCK</u>			

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Continued Next Page

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

PROJECT 14-1111-0002			RECORD OF BOREHOLE No ES1-2			SHEET 2 OF 2			METRIC								
G.W.P. 06-20016			LOCATION N 4913561.8; E 289025.5 MTM NAD ZONE 10 (LAT. 44.361891; LONG. -79.697901)			ORIGINATED BY ML											
DIST Central HWY 400			BOREHOLE TYPE Diedrich D-53, 108 mm I.D., 194 mm O.D. Hollow Stem Augers			COMPILED BY SMD											
DATUM Geodetic			DATE December 9, 2016			CHECKED BY MCK											
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									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
	Silty SAND, some gravel, trace to some clay Compact Brown Wet		13	SS	19												
			14	SS	13												
227.8																	
17.8	SAND and GRAVEL, trace clay Very dense Brown Wet		15	SS	51												
226.3																	
19.3	Silty SAND, some gravel Dense Brown Wet		16	SS	44												
225.3																	
20.3	END OF BOREHOLE																
223.0																	
22.6	END OF DCPT (100/0.20 m)																
	NOTE: 1. Water level not recorded upon completion of drilling.																

APPENDIX C

**Borehole Records -
Current Investigation (2019)**

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (<i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An 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 (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); 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

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, 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
GS	specific gravity
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 (FV)	field vane (LV-laboratory vane test)
Y	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

- Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
- SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)

σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index $= (w_L - w_P)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_P) / I_P$
I_c	consistency index $= (w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or 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 $\gamma = \rho \cdot g$ (i.e., mass density multiplied by
acceleration due to gravity)

Notes: 1
2

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

Fresh (W1): no visible sign of rock material weathering.

Slightly Weathered (W2): discoloration indicates weathering of rock mass material on discontinuity surfaces. **Less than 5%** of rock mass is altered or weathered.

Moderately Weathered (W3): less than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Highly Weathered (W4): more than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Completely Weathered (W5): 100% of the rock mass is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.

Residual Soil (W6): all rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

AXJ Axial Joint	KV Karstic Void
BD Bedding	K Slickensided
BC Broken Core	LC Lost Core
CC Continuous Core	MB Mechanical Break
CL Closed	PL Planar
CO Contact	PO Polished
CU Curved	RO Rough
CT Coated	SA Slightly Altered
FLT Fault	SH Shear
FOL Foliation	SM Smooth
FR Fracture	SR Slightly Rough
GO Gouge	SY Stylolite
IN Infilled	UN Undulating
IR Irregular	VN Vein
JN Joint	VR Very Rough

ISRM Intact Rock Material Strength Classification

Grade	Description	Approx. Range of Uniaxial Compressive Strength (MPa)
R0	Extremely weak rock	0.25 – 1.0
R1	Very weak rock	1.0 – 5.0
R2	Weak rock	5.0 – 25
R3	Medium strong rock	25 – 50
R4	Strong rock	50 -100
R5	Very strong rock	100 -250
R6	Extremely strong rock	>250

PROJECT 18105050		RECORD OF BOREHOLE No ERO-1		SHEET 1 OF 1		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913680.6; E 289031.6 MTM NAD 83 ZONE 10 (LAT. 44.362969; LONG. -79.697832)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers		COMPILED BY ML			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 16, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)													
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL										
								20	40	60	80	100	W _p	W	W _L															
244.5	GROUND SURFACE																													
0.0	TOPSOIL (150 mm)																													
0.2	SILTY SAND (SM), trace gravel (FILL) Loose to compact Brown Moist		1	SS	5																									
			2	SS	11																									
243.1																														
1.5	Sandy SILT (ML) Very loose to loose Brown Moist		3	SS	2																									
			4	SS	5																									
241.5																														
3.0	SILTY SAND (SM) Compact Grey Moist		5	SS	21																									
			6	SS	30																									
238.9																														
5.6	SILT (ML) of slight plasticity, trace to some sand Loose to compact Grey Wet		7	SS	23																									
			8	SS	9																									
235.0	SILTY SAND (SM), some fines Compact Grey Moist		9A 9B	SS	24																									
9.8	END OF BOREHOLE																													
NOTES: 1. Borehole open and dry inside augers upon completion of drilling. 2. Water level measured in piezometer as follows: <table><tr><td>Date</td><td>Depth (m)</td><td>Elev. (m)</td></tr><tr><td>24-Jun-19</td><td>5.8</td><td>238.7</td></tr><tr><td>01-Aug-19</td><td>5.8</td><td>238.7</td></tr><tr><td>02-Apr-20</td><td>5.8</td><td>238.7</td></tr></table>																			Date	Depth (m)	Elev. (m)	24-Jun-19	5.8	238.7	01-Aug-19	5.8	238.7	02-Apr-20	5.8	238.7
Date	Depth (m)	Elev. (m)																												
24-Jun-19	5.8	238.7																												
01-Aug-19	5.8	238.7																												
02-Apr-20	5.8	238.7																												

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-2		SHEET 1 OF 1		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913564.6; E 289008.6 MTM NAD 83 ZONE 10 (LAT. 44.361924; LONG. -79.698116)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers		COMPILED BY ML			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 8, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p	w	w _L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED												
245.0	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL (200 mm)																			
0.2	Sandy CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT-SILT (CL-ML/SC) and sand, trace gravel Stiff to very stiff Brown Moist		1	SS	12		244													
			2	SS	19															
			3	SS	18		243													
			4	SS	22															
			5	SS	13		242													
							241													
240.2			6A																	
4.8	SAND (SP-SM), trace to some gravel, trace to some fines Dense to very dense Grey to brown Wet		6B	SS	47		240													
							239													
			7	SS	77															
							238													
237.8																				
7.2	SILTY SAND (SM), some gravel Compact to dense Grey Wet		8	SS	50		237													
							236													
			9	SS	21															
							235													
234.8																				
10.2	SILTY SAND (SM) of slight plasticity Compact Grey Wet		10	SS	15		234													
233.7																				
11.3	END OF BOREHOLE																			
	NOTES: 1. Water level measured inside augers at a depth of 8.6 m below ground surface (Elev. 236.4 m) upon completion of drilling. 2. Borehole caved to a depth of 5.5 m below ground surface (Elev. 239.5 m) upon removal of augers.																			

PROJECT 18105050		RECORD OF BOREHOLE No ERO-3		SHEET 1 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913662.5; E 289047.6 MTM NAD 83 ZONE 10 (LAT. 44.362806; LONG. -79.697630)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ML			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 17, 21 and 22, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)								
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L						
244.8	GROUND SURFACE																	
0.0	TOPSOIL (130 mm)																	
0.1	SILTY SAND (SM) (FILL)		1	SS	7													
244.1	Loose Brown Moist																	
0.7	SILTY SAND (SM)		2	SS	13													
	Compact Brown Moist		3	SS	17													
			4	SS	18													
			5	SS	20													
			6	SS	27													
			7A	SS	16													
238.3	SILT (ML) of slight plasticity, trace sand		7B	SS	16													
6.5	Compact Grey Moist																	
237.7	SAND (SP-SM), trace gravel, trace fines		8	SS	60													
7.1	Compact to very dense Grey Wet																	
			9	SS	78													
			10	SS	28													
233.1	SILTY SAND (SM), trace to some gravel		11	SS	16													
11.7	Compact to very dense Brown Wet																	
	- Tricone grinding at a depth of 13.7 m (Elev. 231.1 m)		12	SS	47													
	- Tricone grinding at a depth of 14.5 m (Elev. 230.3 m)																	

Continued Next Page

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

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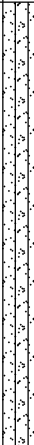



PROJECT 18105050		RECORD OF BOREHOLE No ERO-3		SHEET 2 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913662.5; E 289047.6 MTM NAD 83 ZONE 10 (LAT. 44.362806; LONG. -79.697630)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ML			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 17, 21 and 22, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	20	40	60	80	100	W _p	W		W _L				
	--- CONTINUED FROM PREVIOUS PAGE ---																				
	SILTY SAND (SM), trace to some gravel Compact to very dense Brown Wet		13	SS	38									○				5	81	14	0
			14	SS	15																
			15	SS	15									○							
			16	SS	103																
	- Tricone grinding at a depth of 20.7 m (Elev. 224.1 m)																				
	- Tricone grinding at a depth of 21.6 m (Elev. 223.2 m)		17	SS	31									○				4	58	34	4
			18	SS	60																
	- Tricone grinding at a depth of 24.1 m (Elev. 220.7 m)																				
			19	SS	55									○							
			20	SS	75																
			21	SS	126									○				3	82	14	1
	- Tricone grinding at a depth of 28.0 m (Elev. 216.8 m)																				
			22	SS	83																
	- Tricone grinding at a depth of 29.6 m (Elev. 215.2 m)																				

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

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-3				SHEET 3 OF 3		METRIC										
G.W.P. 2337-16-00		LOCATION N 4913662.5; E 289047.6 MTM NAD 83 ZONE 10 (LAT. 44.362806; LONG. -79.697630)				ORIGINATED BY SK												
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary				COMPILED BY ML												
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 17, 21 and 22, 2019				CHECKED BY AMP												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					10 20 30 W _p W W _L					
--- CONTINUED FROM PREVIOUS PAGE ---																		
210.3	SILTY SAND (SM), trace to some gravel Compact to very dense Brown Wet - Tricone grinding at a depth of 33.2 m (Elev. 211.6 m)		23	SS	63													
34.5	Sandy GRAVEL (GP-GM), some fines, some rock fragments Very dense Brown Wet - Tricone grinding at a depth of 35.1 m (Elev. 209.7 m)		24	SS	77													
208.8	SILTY SAND (SM) Very dense Brown Moist to wet		25	SS	191/0.25													
36.0																		
204.9	END OF BOREHOLE NOTES: 1. Borehole was dry inside augers to a depth of 6.1 m below ground surface (Elev. 238.7 m) prior to Tricone (Mud Rotary) drilling. 2. Mud Rotary drilling carried out below a depth of 6.1 m below ground surface (Elev. 238.7 m).		26	SS	100/0.13													
39.9																		
205			27	SS	95													
			28	SS	100/0.13													
			29	SS	100/0.13													

PROJECT		18105050		RECORD OF BOREHOLE No ERO-4				SHEET 1 OF 2		METRIC				
G.W.P.		2337-16-00		LOCATION				N 4913593.9; E 289041.8 MTM NAD 83 ZONE 10 (LAT. 44.362188; LONG. -79.697701)		ORIGINATED BY		CC		
DIST		Central HWY 400		BOREHOLE TYPE				Power Auger; 210 mm O.D. Hollow Stem Augers		COMPILED BY		ML		
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE				May 15, 2019		CHECKED BY		AMP		
SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20 40 60 80 100			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W			LIQUID LIMIT W _L
252.1	GROUND SURFACE													
0.0	ASPHALT (280 mm)						252							
251.8														
0.3	SAND (SP-SM), trace fines, trace gravel (FILL) Loose to dense Brown Moist		1	SS	46		251							
			2	SS	11		250							
			3	SS	6		249							
							248							
			4	SS	4		247							
			5	SS	5		246							
	- Augers grinding at a depth of 7.0 m (Elev. 245.1 m)						245							
244.9														
7.2	Sandy CLAYEY SILT-SILT (CL-ML), trace gravel Very stiff Brown Moist		6	SS	17		244							
							243							
242.7														
9.5	SILTY SAND (SM) Dense Grey Moist		7	SS	48		242							
							241							
							240							
239.6														
12.5	SILTY SAND (SM) of slight plasticity, trace to some gravel Loose to dense Grey Wet		8	SS	5		239							
							238							

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

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PROJECT		18105050		RECORD OF BOREHOLE No ERO-4				SHEET 2 OF 2		METRIC							
G.W.P.		2337-16-00		LOCATION		N 4913593.9; E 289041.8 MTM NAD 83 ZONE 10 (LAT. 44.362188; LONG. -79.697701)				ORIGINATED BY							
DIST		Central HWY 400		BOREHOLE TYPE		Power Auger; 210 mm O.D. Hollow Stem Augers				COMPILED BY							
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		May 15, 2019				CHECKED BY							
AMP																	
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									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
	SILTY SAND (SM) of slight plasticity, trace to some gravel Loose to dense Grey Wet						237										
							236										
234.7	- Rock fragments at a depth of 17.3 m (Elev. 234.8 m)		9	SS	31		235										
17.4	END OF BOREHOLE																
	NOTES: 1. Borehole dry to a depth of 16.5 m below ground surface (Elev. 235.6 m) prior to Wash Boring. 2. Mud Rotary drilling carried out below a depth of 16.5 m below ground surface (Elev. 235.6 m).																

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

PROJECT 18105050		RECORD OF BOREHOLE No ERO-5		SHEET 2 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913558.1; E 289034.1 MTM NAD 83 ZONE 10 (LAT. 44.361866; LONG. -79.697796)		ORIGINATED BY DH			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 144 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ML			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 21 and 23, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED											
	--- CONTINUED FROM PREVIOUS PAGE ---																			
	SILTY SAND (SM), trace to some gravel Loose to very dense Grey to brown Wet		13	SS	8															
			14	SS	15															
			15	SS	15															
			16	SS	97															
			17A 17B	SS	39															
			18	SS	88															
			19	SS	115															
221.0																				
25.5	SAND (SP-SM), trace silt, trace gravel Very dense Grey Wet - 0.6 m of sand heave in casing at a depth of 25.9 m (Elev. 220.1 m)		20	SS	63															
219.5																				
27.0	SILTY SAND (SM), trace gravel Compact Grey Moist		21	SS	28															
217.8																				
28.7	SAND (SP-SM), trace gravel, trace fines Dense to very dense Brown Wet - Spoon bouncing at a depth of 29.5 m (Elev. 217.0 m)		22	SS	35															

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PROJECT		18105050		RECORD OF BOREHOLE No ERO-5		SHEET 3 OF 3		METRIC									
G.W.P.		2337-16-00		LOCATION		N 4913558.1; E 289034.1 MTM NAD 83 ZONE 10 (LAT. 44.361866; LONG. -79.697796)		ORIGINATED BY									
DIST		Central HWY 400		BOREHOLE TYPE		Power Auger; 144 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY									
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		May 21 and 23, 2019		CHECKED BY									
AMP																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	10 20 30	γ	GR SA SI CL			
--- CONTINUED FROM PREVIOUS PAGE ---																	
215.1	SAND (SP-SM), trace gravel, trace fines Dense to very dense Brown Wet		23	SS	150/0.30		216										
31.4	SILTY SAND (SM), trace gravel Very dense Grey Moist		24	SS	131		215							8	56 31 5		
							214										
							213										
212.1	- Increased resistance in tricone and casing advancement from a depth of 33.5 m to 34.9 m (between Elev. 213.0 m and Elev. 211.6 m)		25	SS	237/0.20		212										
34.4	SILTY CLAY (CI), trace sand, varved Hard Grey and light grey Moist - Tricone grinding at a depth of 34.9 m (Elev. 211.6 m)		26	SS	71		211							0	2 48 50		
							210										
							209										
208.9	SILT (ML/SM) and sand Very dense Grey Wet		28	SS	141/0.25		208										
37.6							207										
206.4			29	SS	147									0	38 62 0		
40.1	END OF BOREHOLE																
NOTES: 1. Water level measured inside augers at a depth of 4.4 m below ground surface (Elev. 242.1 m) prior to Tricone (Mud Rotary) drilling. 2. Mud Rotary drilling carried out below a depth of 5.2 m below ground surface (Elev. 241.3 m). 3. Water level measured in piezometer as follows: Date Depth (m) Elev. (m) 24-Jun-19 5.0 241.5 01-Aug-19 5.2 241.3 02-Apr-20 4.8 241.7																	

PROJECT 18105050		RECORD OF BOREHOLE No ERO-6		SHEET 2 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913636.2; E 289067.9 MTM NAD 83 ZONE 10 (LAT. 44.362570; LONG. -79.697375)		ORIGINATED BY JMP			
DIST Central HWY 400		BOREHOLE TYPE Power Augers; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 4 to 6, 9 and 10, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
													20	40	60					
	---	CONTINUED FROM PREVIOUS PAGE ---																		
		SILTY SAND (SM) of slight plasticity, trace to some gravel Compact Grey Moist		13	SS	14														
				14	SS	18														
227.8																				
17.8		SILTY SAND (SM), trace to some gravel Compact to very dense Grey Moist to wet		15	SS	23														
				16	SS	48														
				17	SS	51														

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

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

PROJECT 18105050		RECORD OF BOREHOLE No ERO-7		SHEET 1 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913536.4; E 289061.3 MTM NAD 83 ZONE 10 (LAT. 44.361672; LONG. -79.697454)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 2 to 4, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
248.2	GROUND SURFACE																			
0.0	ASPHALT (200 mm)																			
0.2	SAND (SW), some fines, some gravel (FILL) Dense Brown Moist		1	SS	36															
246.8																				
1.4	SILTY SAND (SM), trace to some gravel (FILL) Loose to compact Brown Moist		2	SS	11															
			3	SS	6															
			4	SS	5															
244.2																				
4.0	SAND (SP-SM), some gravel, trace fines Dense Brown Wet		5	SS	45															
242.6																				
5.6	SILTY SAND (SM), some gravel Compact to dense Grey Wet		6	SS	23															
			7	SS	31															
			8	SS	11															
238.1																				
10.1	SILTY SAND (SM) of slight plasticity, some gravel to gravelly Loose to dense Grey Wet		9	SS	8															
			10	SS	18															
			11	SS	32															
233.5																				
14.7																				

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-7		SHEET 2 OF 3		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913536.4; E 289061.3 MTM NAD 83 ZONE 10 (LAT. 44.361672; LONG. -79.697454)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 2 to 4, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80	100		W _P	W	W _L				
--- CONTINUED FROM PREVIOUS PAGE ---																				
232.3 15.9	SAND (SW), trace fines Dense Brown Wet		12	SS	46		233													
					232															
					231															
					230															
					229															
					228															
					227															
					226															
					225															
					224															
					223															
					222															
					221															
					220															
					219															
227.4 20.8	SAND (SP-SM), trace to some fines, trace to some gravel Dense to very dense Grey Wet - Tricone grinding from depths of 22.3 m to 22.6 m (between Elev. 225.9 m and Elev. 225.6 m)		16	SS	84		227													
						226														
						225														
						224														
						223														
222.8 25.4	SILTY SAND (SM), trace gravel Very dense Grey Wet		19	SS	70	222														
221.3 26.9	SILTY GRAVEL (GM/SM) and sand Dense Grey Wet		20	SS	37	221														
219.8 28.4	SAND (SP-SM), some fines Very dense Grey Wet		21	SS	87	220														
218.3																				

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

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-7		SHEET 3 OF 3		METRIC															
G.W.P. 2337-16-00		LOCATION N 4913536.4; E 289061.3 MTM NAD 83 ZONE 10 (LAT. 44.361672; LONG. -79.697454)		ORIGINATED BY SK																	
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK																	
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 2 to 4, 2019		CHECKED BY AMP																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30	kN/m ³							
--- CONTINUED FROM PREVIOUS PAGE ---																					
29.9	Sandy SILT (ML) of slight plasticity, trace gravel Very dense Grey Wet		22	SS	58		218														
							217														
			23	SS	100/0.05		216						14				7 33 56 4				
215.3 32.9	SILTY SAND (SM) Very dense Grey Wet - 130 mm thick layer of clayey silt at a depth of 33.7 m (Elev. 214.5 m)		24A 24B 24C	SS	105		215														
							214														
213.7 34.5	SILTY CLAY (CI), trace sand, trace gravel Hard Grey Moist		25	SS	43		213														
							212														
			26	SS	63		211														
							210														
			27	SS	122/0.23		209														
209.1 39.1	SILT (ML/SM) and sand Very dense Grey Moist		28	SS	157		208														
							207														
206.8 41.5	END OF BOREHOLE NOTES: 1. Borehole dry inside augers to a depth of 3.0 m below ground surface (Elev. 248.2 m) prior to Mud Rotary drilling. 2. Mud Rotary drilling carried out below a depth of 3.0 m below ground surface (Elev. 248.2 m).		29	SS	100/0.15																

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-8		SHEET 1 OF 4		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913606.9; E 289091.2 MTM NAD 83 ZONE 10 (LAT. 44.362307; LONG. -79.697081)		ORIGINATED BY SK			
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 28 to 30, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
246.7	GROUND SURFACE													
0.0	TOPSOIL (130 mm)		1	SS	5									
0.1	SILTY SAND (SM), containing clayey silt pockets (FILL) Loose Brown Moist		2A 2B	SS	9									
245.3	SILTY SAND (SM) Compact Brown Wet		3	SS	10									
244.6	Sandy SILT (ML) of slight plasticity, trace gravel Compact Brown Moist		4	SS	10									
243.8	SILTY SAND (SM), some gravel to gravelly Compact to very dense Brown to grey Wet		5	SS	38									
2.9	- 0.4 m thick Sandy Silt layer at a depth of 4.3 m (Elev. 242.4 m) - Grey below a depth of 4.4 m (Elev. 242.3 m)		6	SS	15									
			7	SS	24									
			8	SS	59									
			9	SS	16									
			10	SS	35									
236.6	Sandy SILT (ML), trace gravel Dense Grey Moist		11	SS	44									
235.0	SILTY SAND (SM) of slight plasticity, trace gravel Compact Grey Wet		12	SS	11									
233.5	SILTY SAND (SM), some gravel Dense Grey Wet		13	SS	36									
232.0														
14.7														

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

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PROJECT		18105050		RECORD OF BOREHOLE No ERO-8		SHEET 2 OF 4		METRIC					
G.W.P.		2337-16-00		LOCATION		N 4913606.9; E 289091.2 MTM NAD 83 ZONE 10 (LAT. 44.362307; LONG. -79.697081)		ORIGINATED BY SK					
DIST		Central HWY 400		BOREHOLE TYPE		Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK					
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		May 28 to 30, 2019		CHECKED BY AMP					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)		
--- CONTINUED FROM PREVIOUS PAGE ---													
230.5	Sandy SILT of slight plasticity (ML) Loose Grey Wet		14	SS	7		231						
16.2	SILTY SAND (SM), some gravel to gravelly Compact to very dense Grey Wet - Tricone grinding at a depth of 17.1 m		15	SS	25		230						
							229						
	- Tricone grinding from depths of 18.6 m to 18.9 m (between Elev. 228.1 m and Elev. 227.8 m) - Rock fragments at 18.6 m depth (Elev. 228.1 m)		16	SS	20		228						27 48 23 2
							227						
			17	SS	67		226						
225.9	SAND (SP-SM) and gravel, some fines Very dense Grey Wet - Tricone grinding at a depth of 21.6 m (Elev. 225.1 m)		18	SS	52		225						
20.8							224						
			19	SS	78		223						
	- Tricone grinding from depths of 24.4 m to 25.3 m (between Elev. 222.3 m and Elev. 221.4 m)		20	SS	70		222						38 51 5 6
							221						
			21	SS	85		220						
219.8	SILTY SAND (SM), trace gravel Very dense Grey Wet		22	SS	70		219						
26.9							218						
			23	SS	151		217						

Continued Next Page

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

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PROJECT 18105050		RECORD OF BOREHOLE No ERO-8		SHEET 3 OF 4		METRIC										
G.W.P. 2337-16-00		LOCATION N 4913606.9; E 289091.2 MTM NAD 83 ZONE 10 (LAT. 44.362307; LONG. -79.697081)		ORIGINATED BY SK												
DIST Central HWY 400		BOREHOLE TYPE Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK												
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 28 to 30, 2019		CHECKED BY AMP												
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20	40	60	80	100	W _p			W
--- CONTINUED FROM PREVIOUS PAGE ---																
213.7	SILTY SAND (SM), trace gravel Very dense Grey Wet		24	SS	100/0.13											7 57 33 3
212.2	SAND (SP-SM), some fines Very dense Grey Wet		25	SS	142											
210.7	SAND (SP-SM), some fines Very dense Grey Wet		26	SS	100/0.13											
210.7	SAND (SP-SM), some fines Very dense Grey Wet		27	SS	41											0 3 32 65
205.4	SILT (ML/SM) and sand Very dense Gray Wet		28	SS	97											
205.4	SILT (ML/SM) and sand Very dense Gray Wet		29	SS	100/0.13											
205.4	SILT (ML/SM) and sand Very dense Gray Wet		30	SS	100/0.13											
205.4	SILT (ML/SM) and sand Very dense Gray Wet		31	SS	100/0.13											
END OF BOREHOLE																
NOTES:																
1. Water level measured inside augers at a depth of 6.1 m below ground surface (Elev. 240.6 m), prior to Mud Rotary drilling.																
2. Mud Rotary drilling carried out below a depth of 8.1 m below ground surface (Elev. 238.6 m).																

Continued Next Page

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

PROJECT <u>18105050</u>	RECORD OF BOREHOLE No ERO-8	SHEET 4 OF 4	METRIC
G.W.P. <u>2337-16-00</u>	LOCATION <u>N 4913606.9; E 289091.2 MTM NAD 83 ZONE 10 (LAT. 44.362307; LONG. -79.697081)</u>	ORIGINATED BY <u>SK</u>	
DIST <u>Central</u> HWY <u>400</u>	BOREHOLE TYPE <u>Power Auger; 210 mm O.D. Hollow Stem Augers; Mud Rotary</u>	COMPILED BY <u>ACK</u>	
DATUM <u>CGVD28 / HT2 0 (Geodetic)</u>	DATE <u>May 28 to 30, 2019</u>	CHECKED BY <u>AMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100									
	3. Water level measured in piezometer as follows: Date Depth (m) Elev. (m) 24-June-19 2.8 243.8 01-Aug-19 4.7 241.9 02-Apr-20 4.3 242.3																				

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

PROJECT 18105050		RECORD OF BOREHOLE No ERO-9				SHEET 2 OF 2		METRIC								
G.W.P. 2337-16-00		LOCATION N 4913583.6; E 289084.8 MTM NAD 83 ZONE 10 (LAT. 44.362097; LONG. -79.697161)				ORIGINATED BY CC										
DIST Central HWY 400		BOREHOLE TYPE Power Auger; O.D 210 mm Hollow Stem Augers; Wash Boring				COMPILED BY ACK										
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 15, 16, 22 and 23, 2019				CHECKED BY AMP										
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								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	END OF BOREHOLE DUE TO AUGER REFUSAL ON INFERRED COBBLE/BOULDER NOTE: 1. Cannot advance borehole beyond a depth of 13.7 m below ground surface (Elev. 238.5 m) due to heaving sands inside hollow stem augers. Augers removed and borehole was abandoned on May 22, 2019. A new borehole was advanced 1.0 m north of original location on May 22 and 23, 2019, soil sample continued at a depth of 14.5 m (Elev. 237.7 m). 2. Borehole was dry at a depth of 10.2 m below ground surface (Elev. 242.5 m) inside augers prior to Mud Rotary drilling. 3. Mud Rotary drilling was carried out below a depth of 10.7 m below ground surface (Elev. 241.5 m).															

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY 400_ESSA_RD\02_DATA\GINT\HWY_400_ESSA_RD.GPJ GAL-GTA.GDT 7/16/21

PROJECT 18105050		RECORD OF BOREHOLE No ERO-10		SHEET 2 OF 4		METRIC	
G.W.P. 2337-16-00		LOCATION N 4913484.0; E 289105.4 MTM NAD 83 ZONE 10 (LAT. 44.361201; LONG. -79.696900)		ORIGINATED BY JMP			
DIST Central HWY 400		BOREHOLE TYPE Power Augers; 100 mm O.D. Hollow Stem Augers; Mud Rotary		COMPILED BY ACK			
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 12 to 14, 2019		CHECKED BY AMP			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL	
					○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)											
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100									
227.7 23.9	SILTY SAND (SM), trace gravel Compact to very dense Grey Moist		14	SS	29		236														
							235														
							234														
			15	SS	51		233														
							232														
							231														
			16	SS	103		230														
							229														
							228														
							227														
223.1 28.4	Sandy SILT (ML) Very dense Grey Moist to wet		20	SS	121			226													
								225													
			21	SS	194/0.28			224													
								223													
223.1 28.4	Sandy SILT (ML) of slight plasticity Dense to very dense Grey Moist								222												
			22	SS	100/0.10																

Continued Next Page

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

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

PROJECT 18105050		RECORD OF BOREHOLE No ERO-10				SHEET 4 OF 4		METRIC																				
G.W.P. 2337-16-00		LOCATION N 4913484.0; E 289105.4 MTM NAD 83 ZONE 10 (LAT. 44.361201; LONG. -79.696900)				ORIGINATED BY JMP																						
DIST Central HWY 400		BOREHOLE TYPE Power Augers; 100 mm O.D. Hollow Stem Augers; Mud Rotary				COMPILED BY ACK																						
DATUM CGVD28 / HT2 0 (Geodetic)		DATE June 12 to 14, 2019				CHECKED BY AMP																						
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL												
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)															
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>																
204.0	47.5	END OF BOREHOLE				204																						
NOTES: 1. Water level measured inside augers at a depth of 9.1 m below ground surface (Elev. 242.4 m) prior to Mud Rotary drilling. 2. Mud Rotary drilling carried out below a depth of 8.1 m below ground surface (Elev. 243.4 m). 3. Water level measured in piezometer as follows: <table style="margin-left: 20px;"> <tr> <td>Date (m)</td> <td>Depth (m)</td> <td>Elev. (m)</td> </tr> <tr> <td>24-Jun-19</td> <td>7.3</td> <td>244.2</td> </tr> <tr> <td>01-Aug-19</td> <td>8.6</td> <td>242.8</td> </tr> <tr> <td>02-Apr-20</td> <td>8.2</td> <td>243.3</td> </tr> </table>		Date (m)	Depth (m)	Elev. (m)	24-Jun-19	7.3	244.2	01-Aug-19	8.6	242.8	02-Apr-20	8.2	243.3															
Date (m)	Depth (m)	Elev. (m)																										
24-Jun-19	7.3	244.2																										
01-Aug-19	8.6	242.8																										
02-Apr-20	8.2	243.3																										

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PROJECT		18105050		RECORD OF BOREHOLE No ERO-11				SHEET 1 OF 1		METRIC							
G.W.P.		2337-16-00		LOCATION		N 4913600.3; E 289102.2 MTM NAD 83 ZONE 10 (LAT. 44.362247; LONG. -79.696943)				ORIGINATED BY		DH					
DIST		Central HWY 400		BOREHOLE TYPE		Power Auger; 144 mm O.D. Hollow Stem Augers; Wash boring				COMPILED BY		ML					
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		May 24, 2019				CHECKED BY		AMP					
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									
247.0	GROUND SURFACE																
0.0	TOPSOIL (180 mm)																
0.2	SILTY SAND (SM), trace gravel (FILL) Compact Brown Moist		1	SS	11												
245.8			2A	SS	12												
1.2	SILTY SAND (SM), trace to some gravel Compact Grey Moist to wet		3	SS	30												
			4	SS	27												
			5	SS	24												
242.1			6A	SS	22												
4.9	SAND (SP), trace fines Compact Grey Wet		6B	SS	22												
241.4																	
5.6	SILTY SAND (SM), some gravel Dense Grey Wet		7	SS	32												
239.8																	
7.2	SAND (SP-SM), some silt Loose Grey Wet		8	SS	7												
238.3																	
8.7	SILTY SAND (SM) of slight plasticity, trace gravel Compact Grey Wet		9	SS	14												
237.3																	
9.8	END OF BOREHOLE																
NOTES:																	
1. Mud Rotary drilling carried out below a depth of 6.7 m below ground surface (Elev. 240.3 m).																	
2. Borehole caved to a depth of 4.3 m below ground surface (Elev. 242.7 m) upon removal of augers.																	

GTA-MTO 001 S:\CLIENTS\MTOWHY_400_ESSA_RD\02_DATA\GINT\HWY_400_ESSA_RD.GPJ GAL-GTA.GDT 7/16/21

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

PROJECT 18105050		RECORD OF BOREHOLE No ERO-12				SHEET 2 OF 2		METRIC									
G.W.P. 2337-16-00		LOCATION N 4913524.4; E 289097.3 MTM NAD 83 ZONE 10 (LAT. 44.361565; LONG. -79.697002)				ORIGINATED BY SK											
DIST Central HWY 400		BOREHOLE TYPE Power Auger, 210 mm O.D. Hollow Stem Augers				COMPILED BY ML											
DATUM CGVD28 / HT2 0 (Geodetic)		DATE May 15 and 16, 2019				CHECKED BY AMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			UNIT WEIGHT γ kN/m ³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30					
237.6	SAND (SP-SM), trace silt Compact to dense Grey Wet - Flowing sands encountered at a depth of 15.2 m (Elev. 239.6 m)		11	SS	29		239										
238			12	SS	36		238										
17.2	END OF BOREHOLE NOTES: 1. Water level was measured inside augers at a depth of 13.5 m below ground surface (Elev. 241.4 m) upon completion of drilling. 2. Borehole caved to a depth of 6.1 m below ground surface upon removal of augers.																

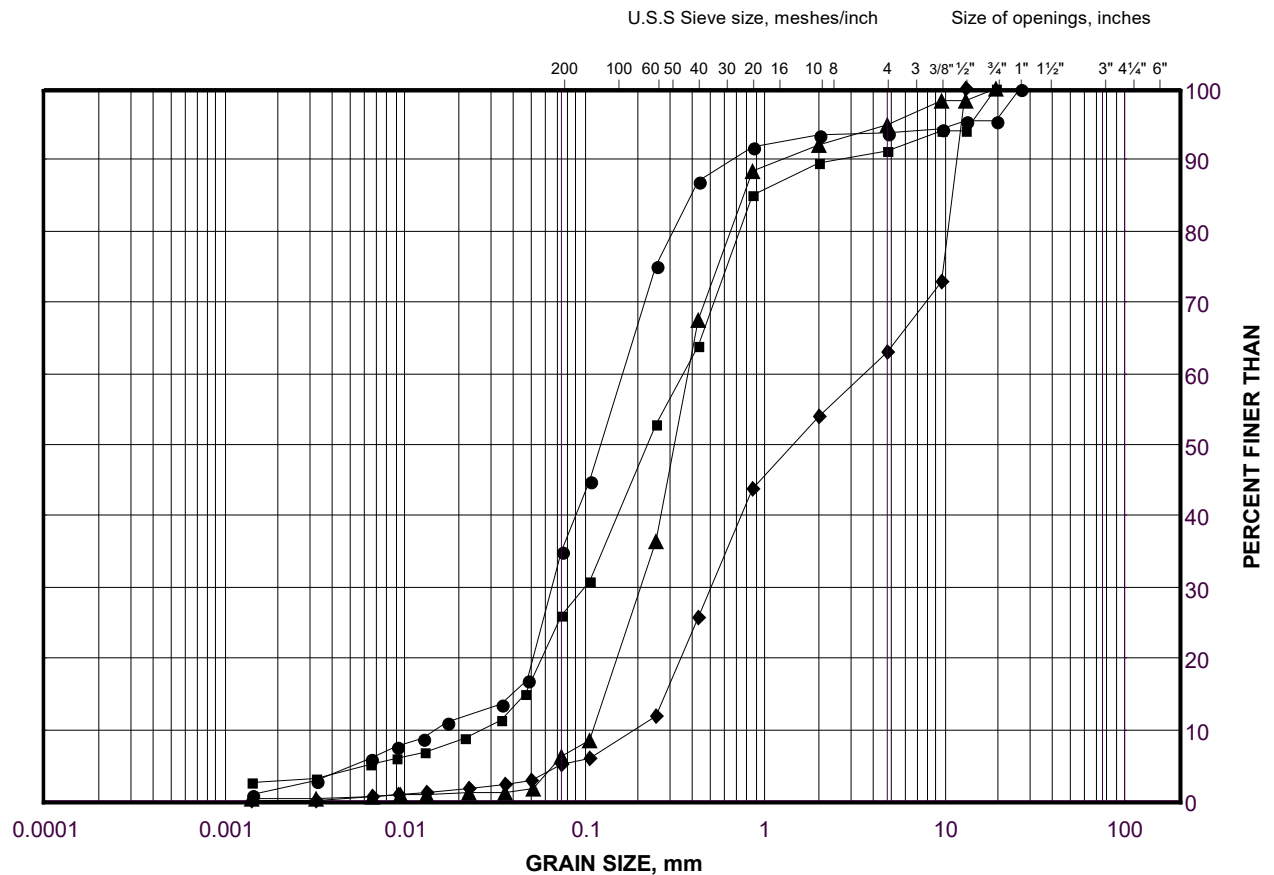
APPENDIX D

**Geotechnical Laboratory
Test Results**

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) to SAND (SP-SM) to
SAND (SP-SM/GP-GM) and gravel (FILL)

FIGURE D-1



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-7	3	245.7
■	ERO-12	3	251.4
◆	ERO-9	3	248.9
▲	ERO-4	4	247.2

Project Number: 18105050-ERO

Checked By: AMP

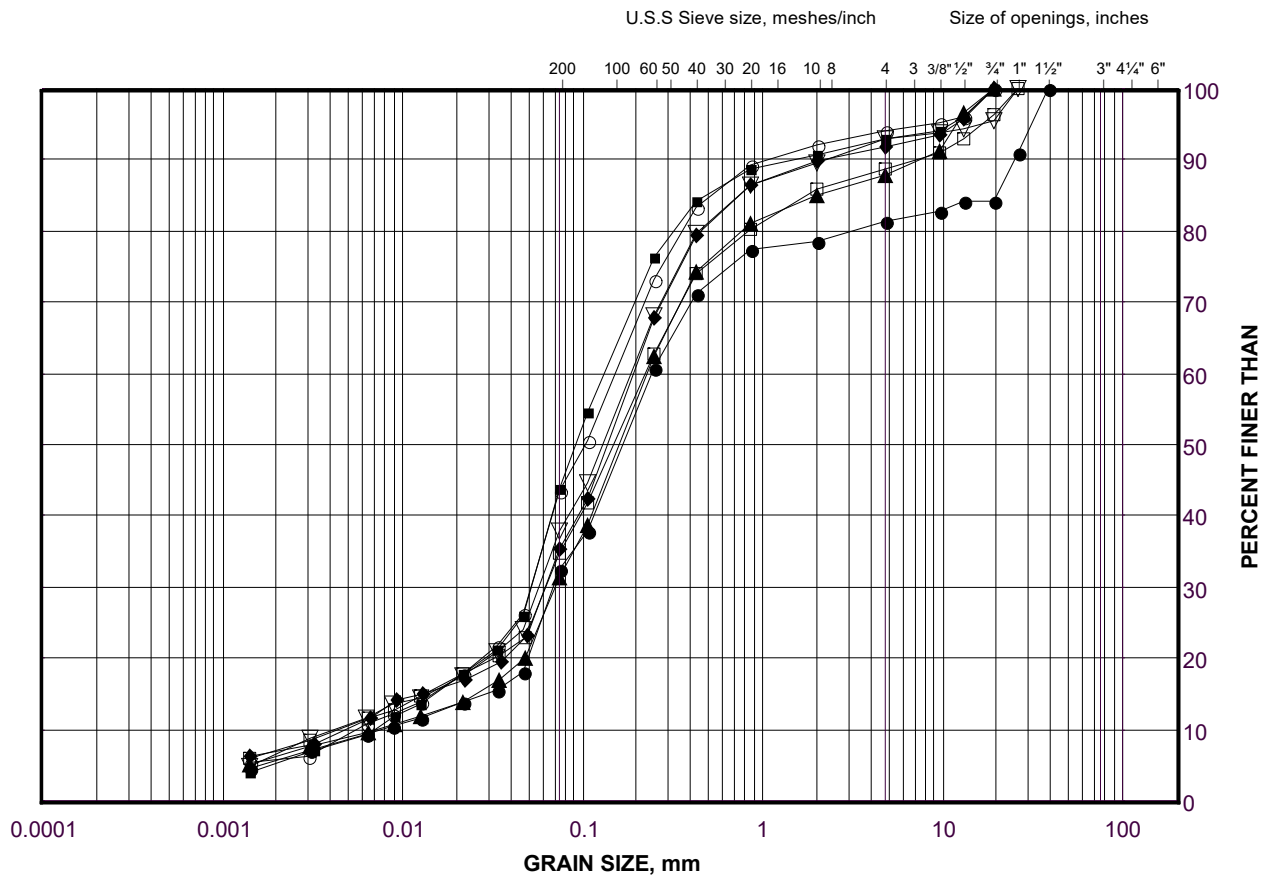
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) to SILTY SAND (SM) of slight plasticity

FIGURE D-2A



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-3	11	232.3
■	PLT-1	5	242.8
◆	ES1-2	6	240.9
▲	PLT-1	8	238.3
▽	PLT-1	9	236.7
○	ERO-11	9	237.6
□	ERO-5	9	237.1

Project Number: 18105050-ERO

Checked By: AMP

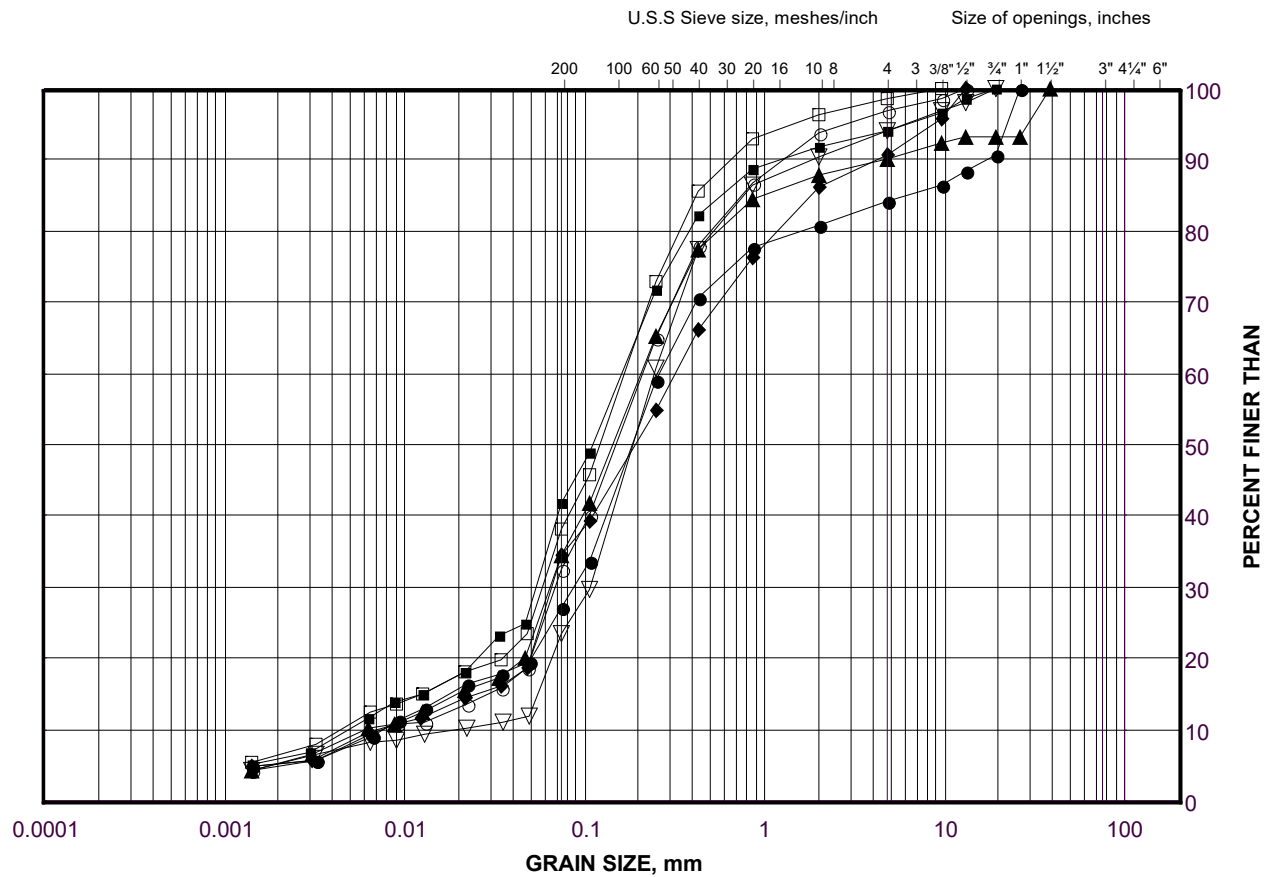
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) of slight plasticity

FIGURE D-2B



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ES1-2	12	231.8
■	ERO-8	12	234.3
◆	ERO-7	14	229.7
▲	ERO-6	14	228.7
▽	ERO-5	15	227.9
○	ERO-5	7	240.1
□	ERO-4	8	238.1

Project Number: 18105050-ERO

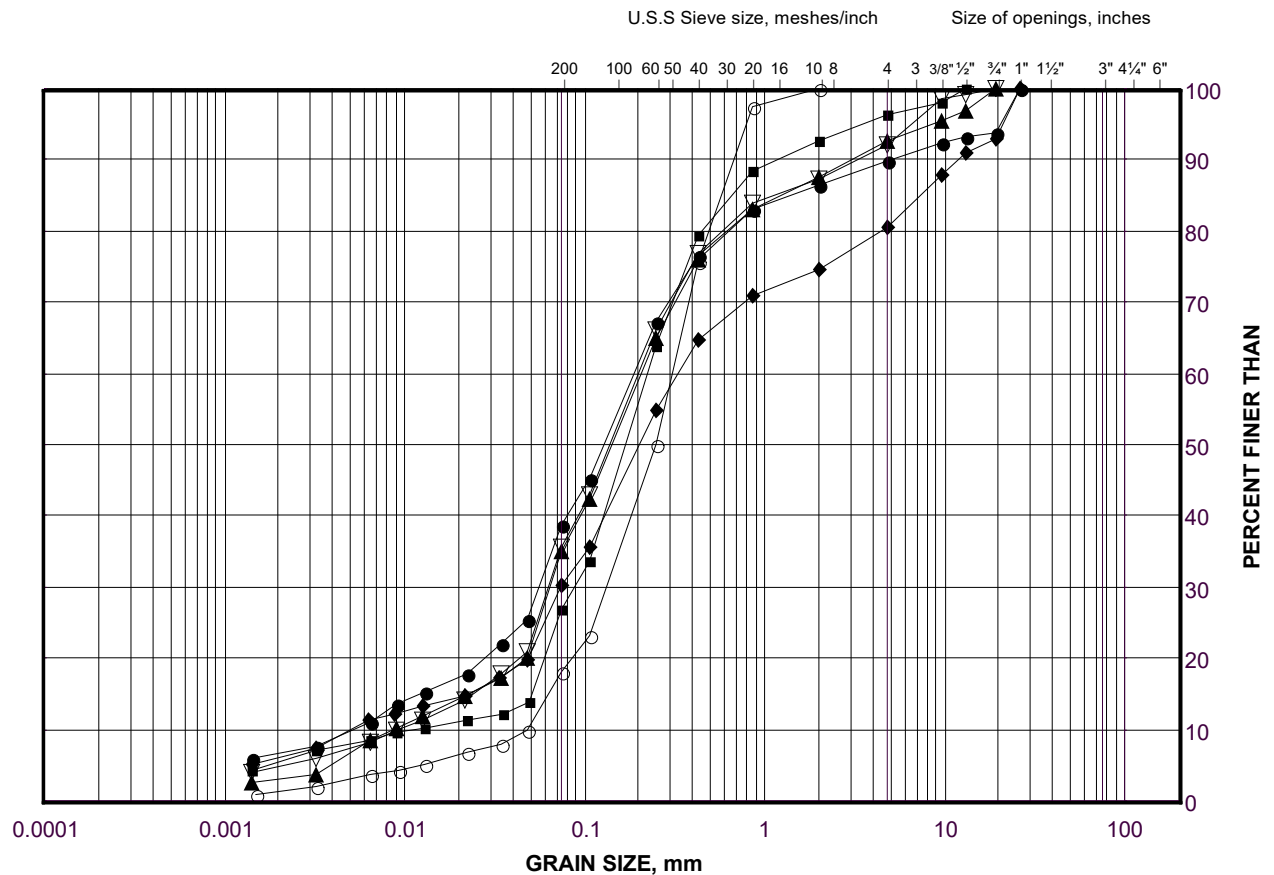
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Golder Associates

Date: 03-Jun-20

SILTY SAND (SM) to SILTY SAND (SM) of slight plasticity

SILTY SAND (SM) to SILTY SAND (SM) of slight plasticity



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ES1-1	11	234.0
■	PLT-1	16	226.1
◆	PLT-1	23	215.6
▲	ERO-8	24	216.1
▽	ERO-5	24	214.3
○	ERO-3	27	207.8

Project Number: 18105050-ERO

Checked By: AMP

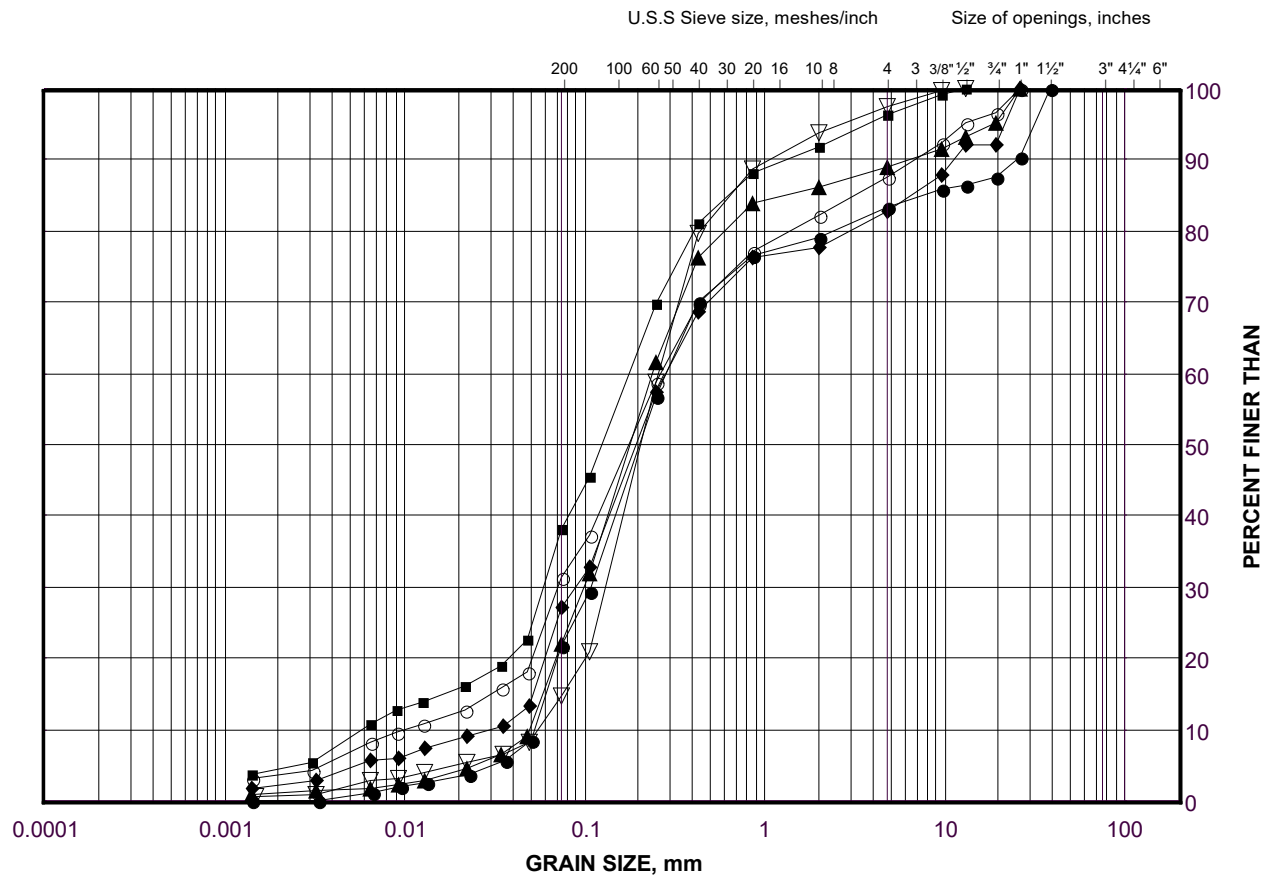
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Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE D-2D



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ES1-2	16	225.6
■	ERO-3	17	223.2
◆	ERO-5	17B	224.8
▲	PLT-1	19	221.5
▽	ERO-3	21	217.1
○	ERO-6	24	213.3

Project Number: 18105050-ERO

Checked By: AMP

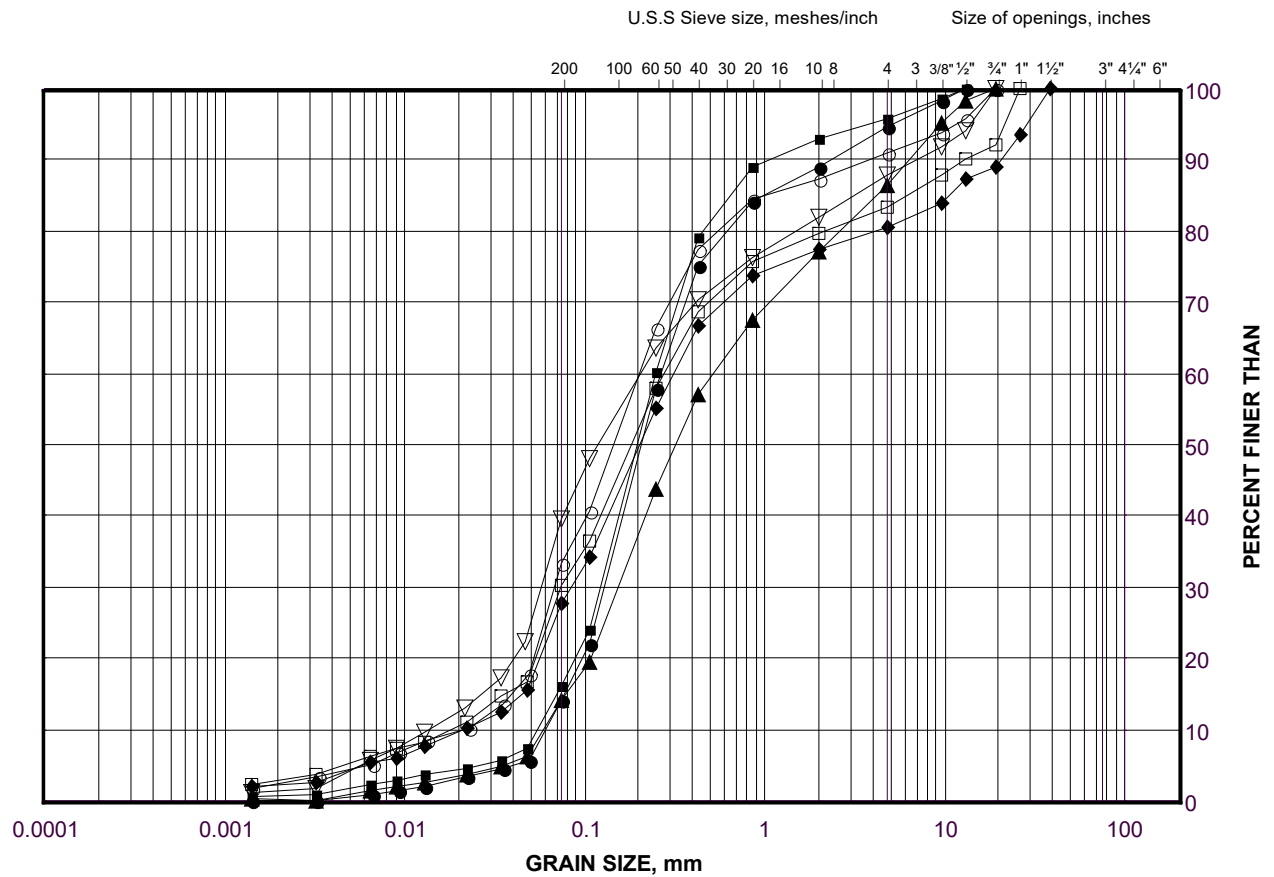
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Date: 28-Aug-20

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE D-2E



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-3	13	229.3
■	ERO-10	15	234.5
◆	ERO-7	6	241.9
▲	ERO-6	6	240.7
▽	ERO-11	7	240.6
○	ES1-2	8	237.8
□	ERO-2	8	237.1

Project Number: 18105050-ERO

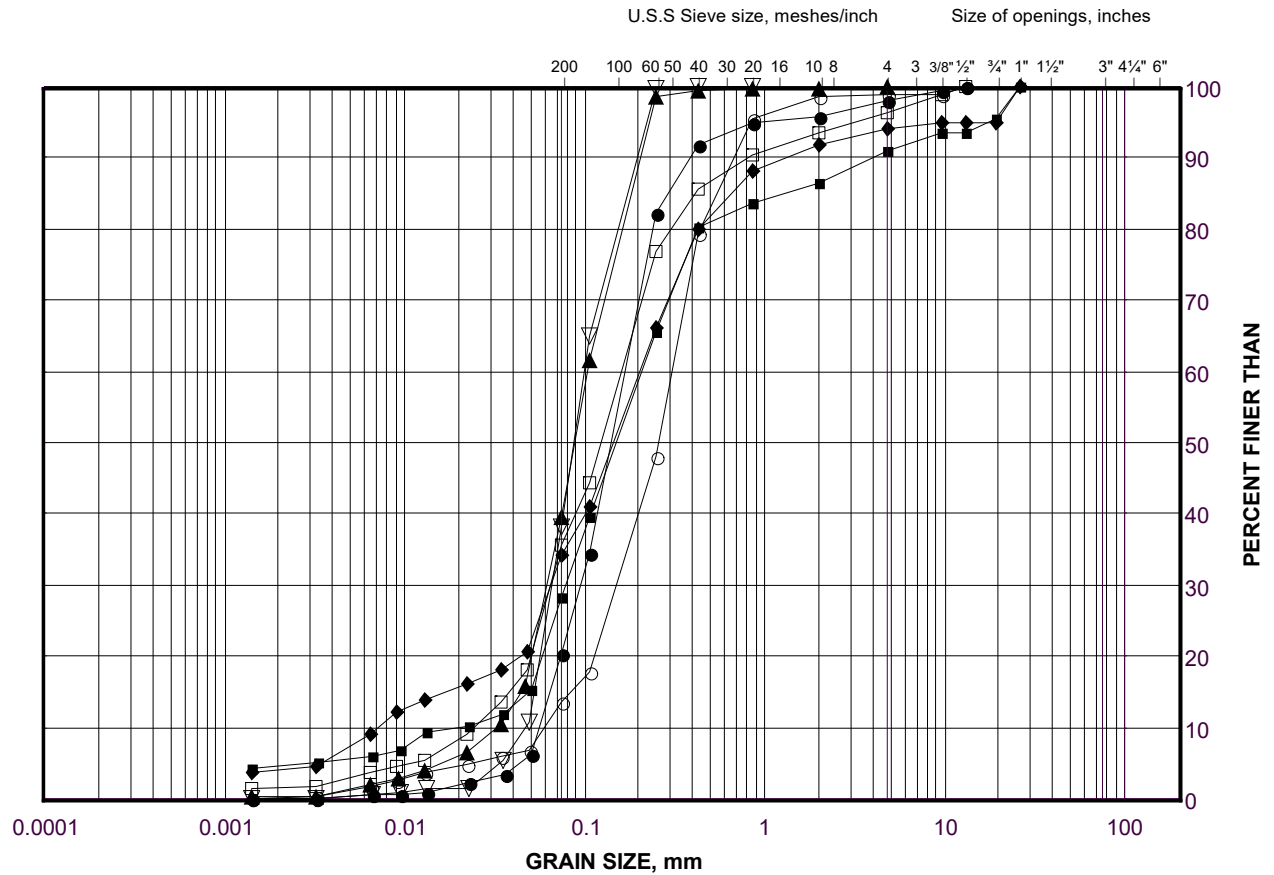
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Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION SILTY SAND (SM)

FIGURE D-2F



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-5	11	234.0
■	ES1-2	3	243.9
◆	ERO-11	5	243.6
▲	ERO-3	5	241.4
▽	ERO-1	5	241.1
○	ERO-10	7	246.7
□	ERO-12	8	243.8

Project Number: 18105050-ERO

Checked By: AMP

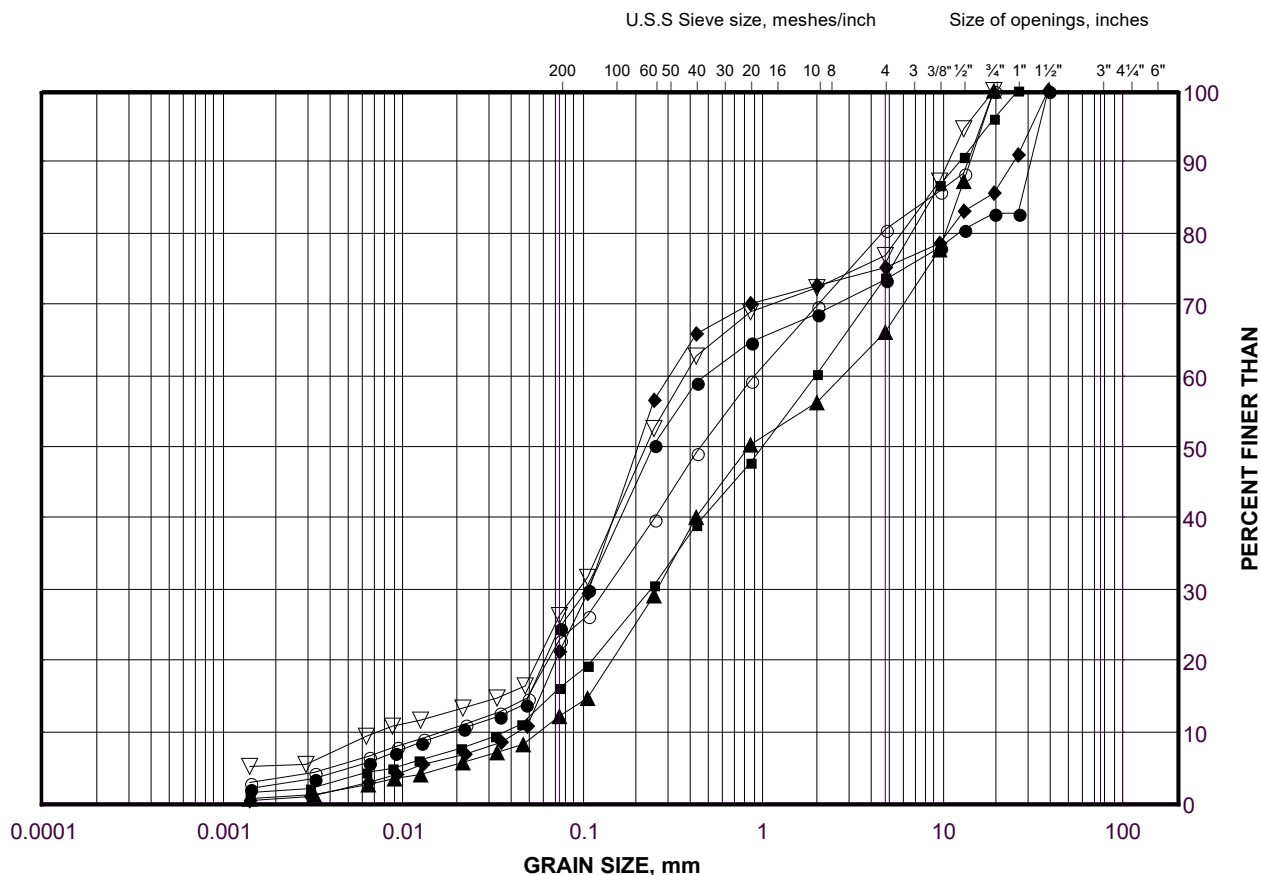
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

Gravelly SILTY SAND (SM) to Gravelly SILTY SAND (SP-SM)

FIGURE D-2G



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-8	16	228.2
■	ERO-9	7	241.3
◆	ERO-8	8	240.4
▲	ERO-9	8	238.3
▽	ERO-7	9	237.3
○	ERO-9	9	237.7

Project Number: 18105050-ERO

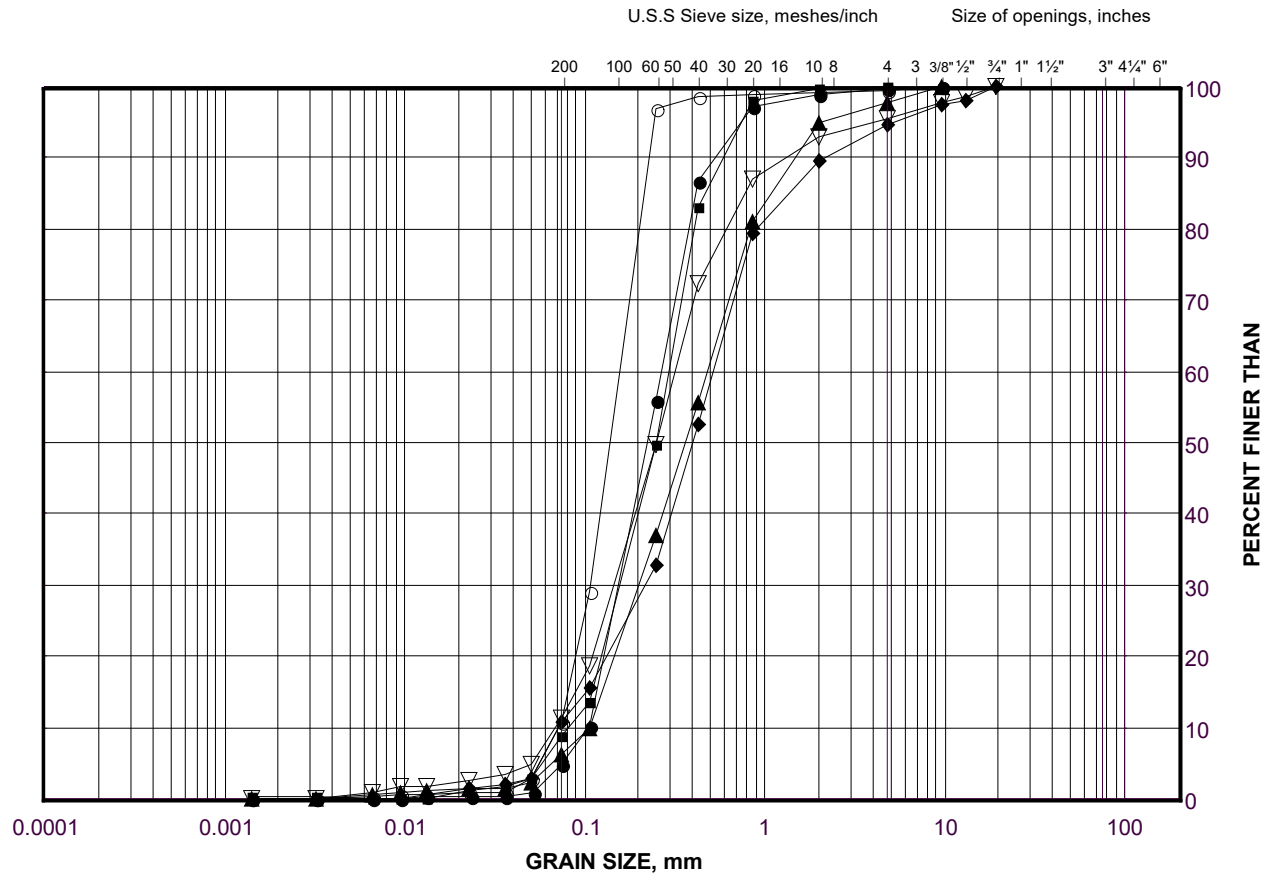
Checked By: AMP

Golder Associates

Date: 28-Aug-20

GRAIN SIZE DISTRIBUTION SAND (SP-SM)

FIGURE D-2H



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-12	10	240.8
■	PLT-1	11	233.7
◆	PLT-1	14	229.1
▲	ERO-5	22	217.2
▽	ERO-12	6	246.9
○	ERO-11	8	239.1

Project Number: 18105050-ERO

Checked By: AMP

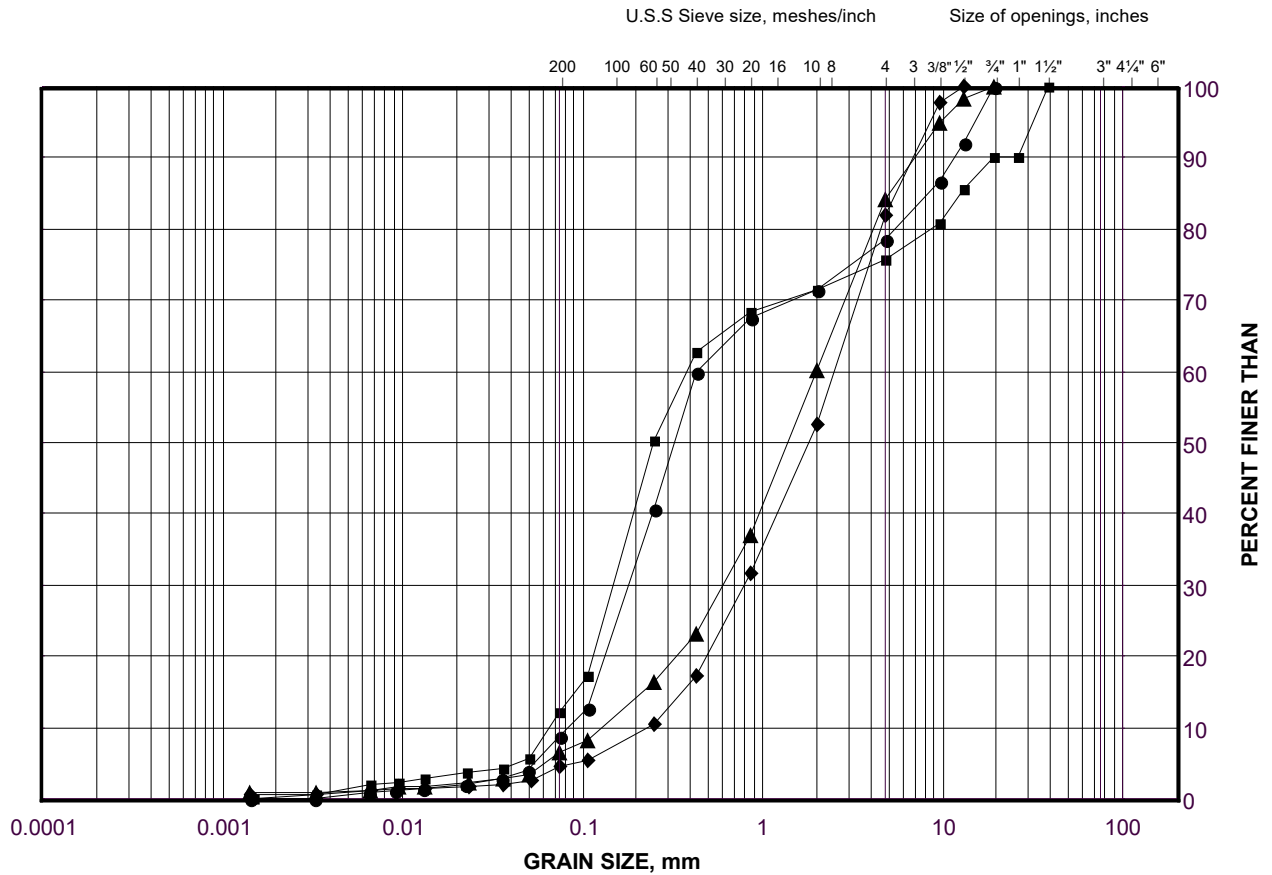
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

SAND (SP-SM) to Gravelly SAND (SP-SM)

FIGURE D-2I



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

LEGEND

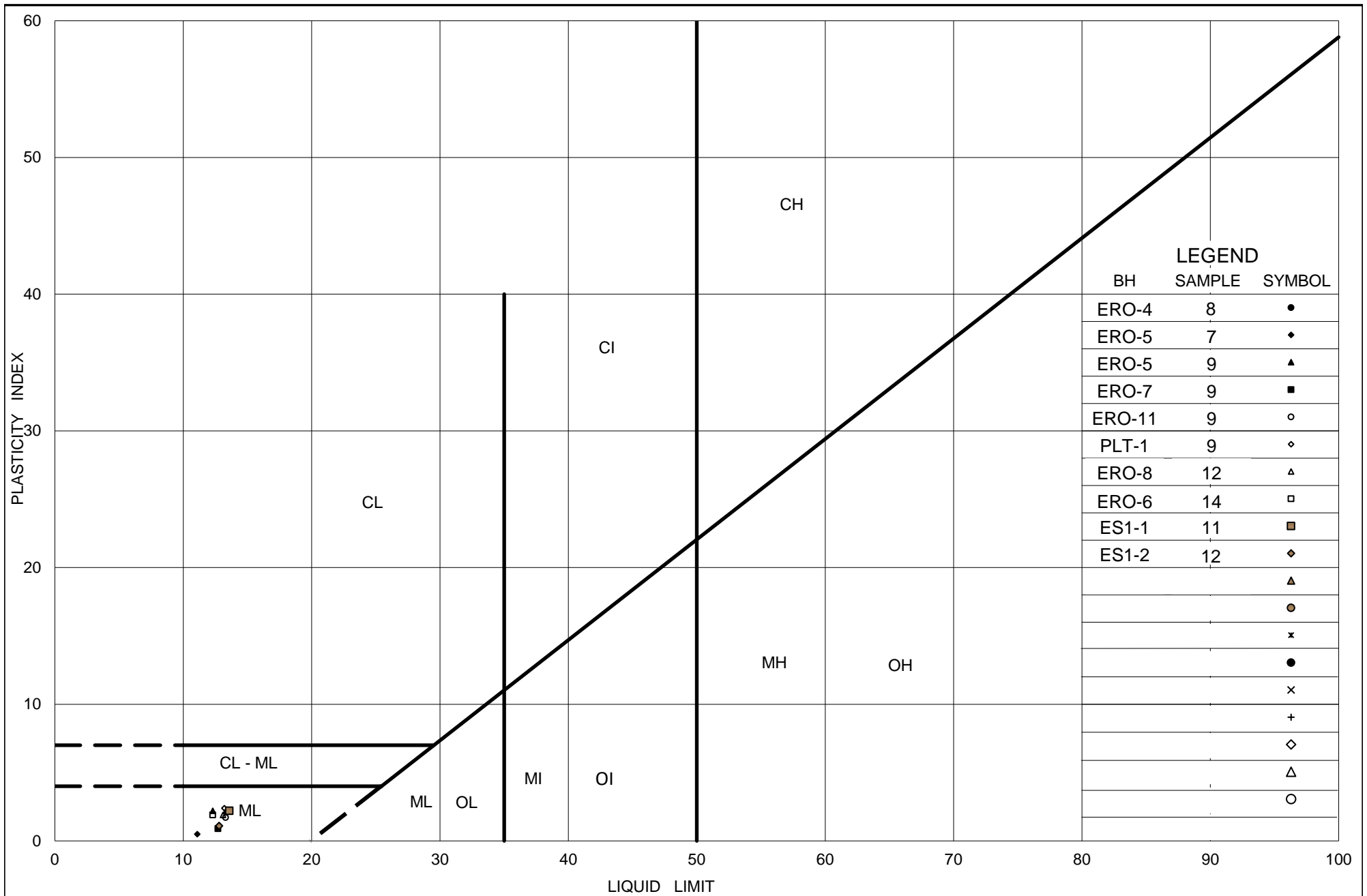
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-10	10	242.1
■	ES1-1	14	229.5
◆	ES1-1	16	224.9
▲	ES1-1	18	217.9

Project Number: 18105050-ERO

Checked By: AMP

Golder Associates

Date: 28-Aug-20



Ministry of Transportation

Ontario

PLASTICITY CHART

SILTY SAND (SM) of slight plasticity

Figure No. D-3

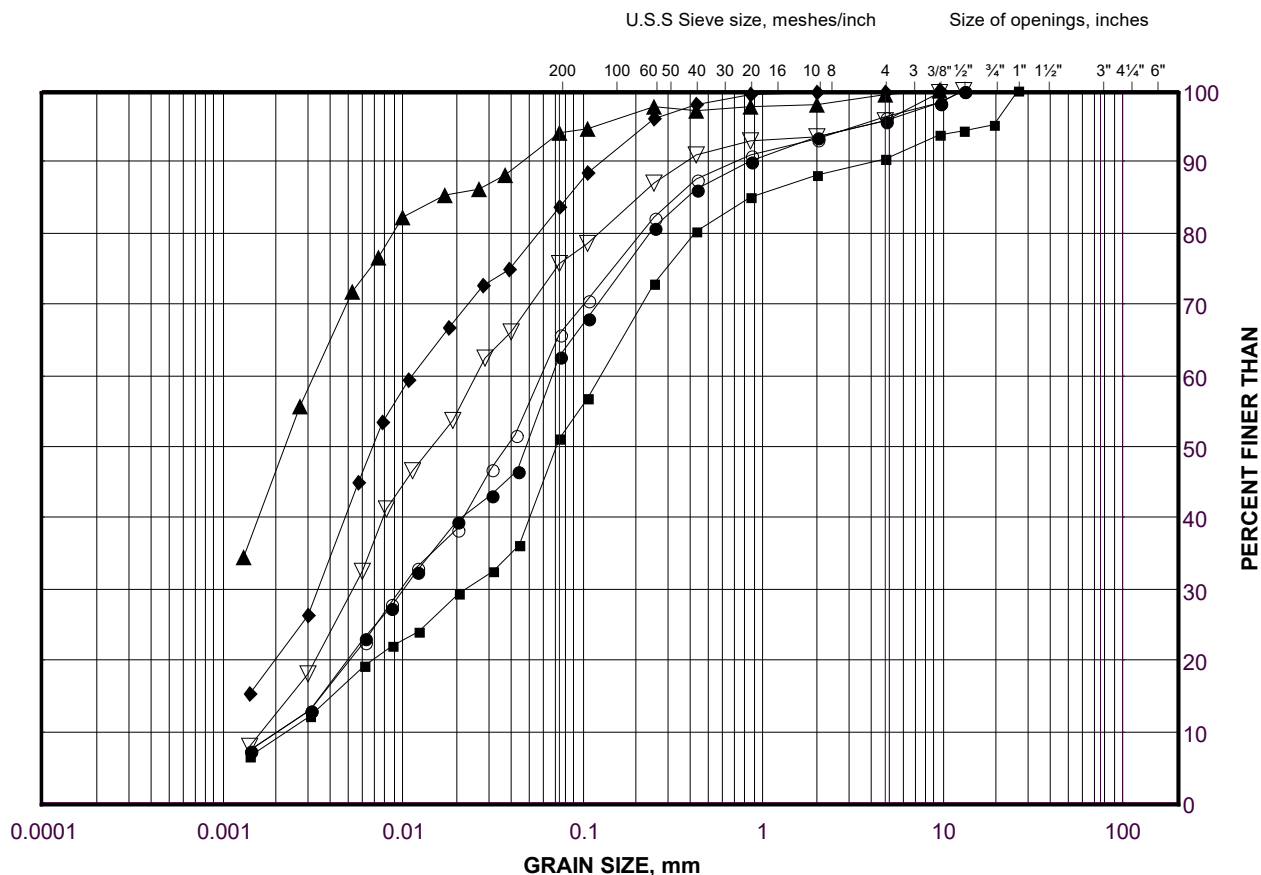
Project No. 18105050-ERO

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI) to CLAYEY SILT (CL) to CLAYEY SILT- SILT (CL-ML) to CLAYEY SILT-SILT (CL-ML/SC-SM) and sand Interlayers

FIGURE D-4



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

LEGEND

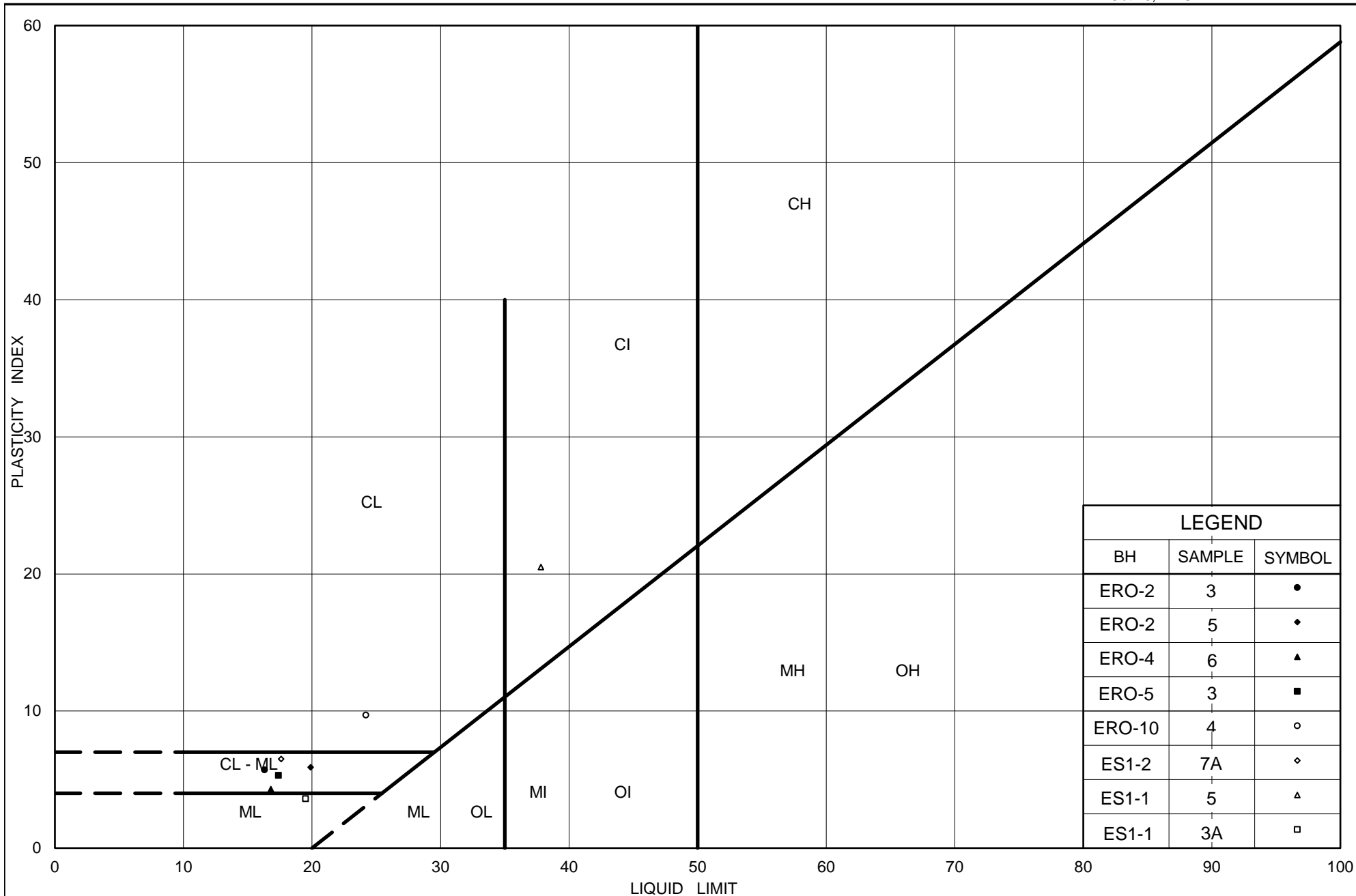
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-5	3	244.7
■	ERO-2	3	243.2
◆	ERO-10	4	249.0
▲	ES1-1	5	243.2
▽	ERO-2	5	241.6
○	ERO-4	6	244.2

Project Number: 18105050-ERO

Checked By: AMP

Golder Associates

Date: 03-Jun-20



Ministry of Transportation

Ontario

PLASTICITY CHART

SILTY CLAY (CI) to CLAYEY SILT (CL) to CLAYEY SILT-SILT (CL-ML) to CLAYEY SILT-SILT (CL-ML/SC-SM) and sand Interlayers

Figure No. D-5

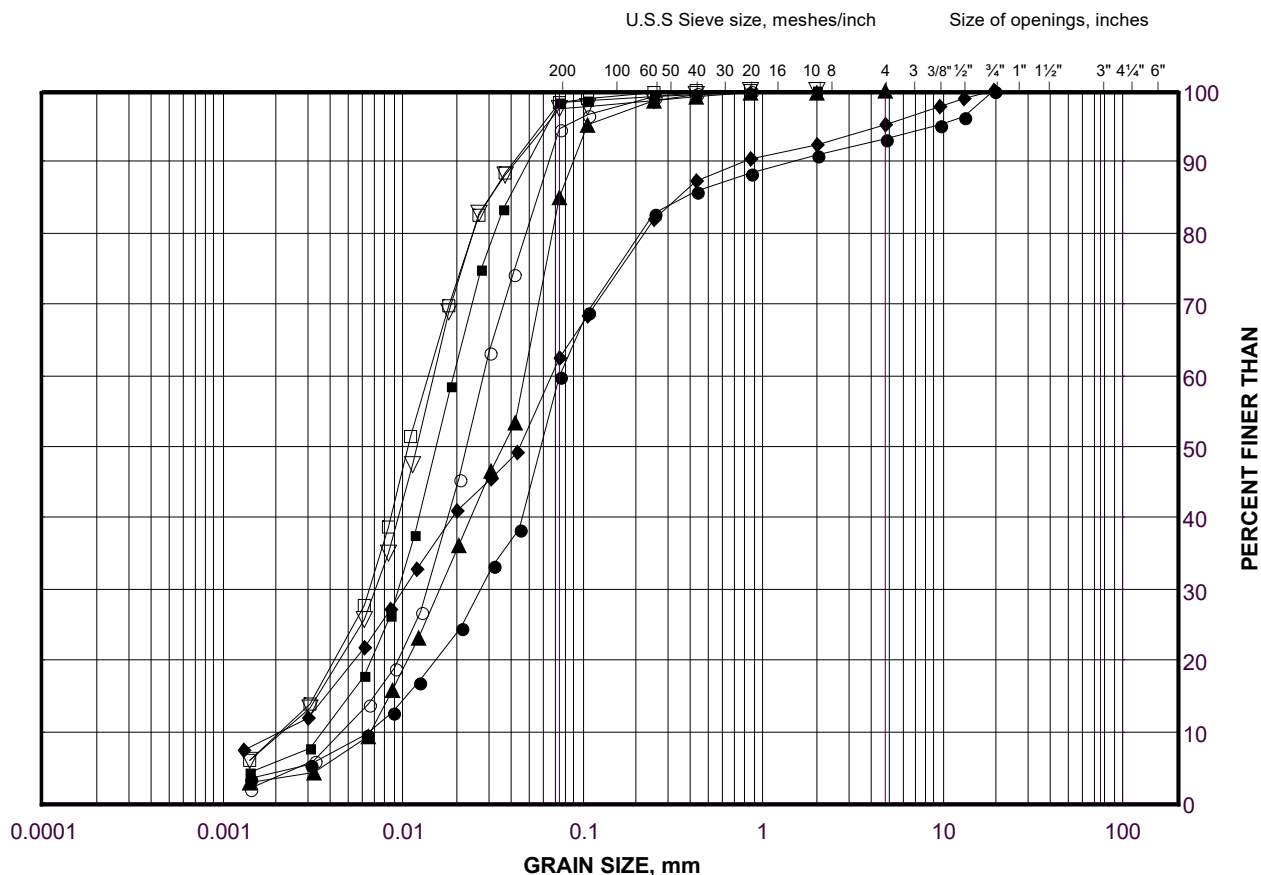
Project No. 18105050-ERO

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILT (ML) of slight plasticity to Sandy SILT (ML) of slight plasticity
Interlayers

FIGURE D-6A



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-7	23	216.1
■	ERO-10	24	220.9
◆	ERO-8	4	244.2
▲	ERO-1	7	238.1
▽	ERO-3	7B	238.2
○	ES1-1	8A	238.9
□	ERO-1	9A	235.2

Project Number: 18105050-ERO

Checked By: AMP

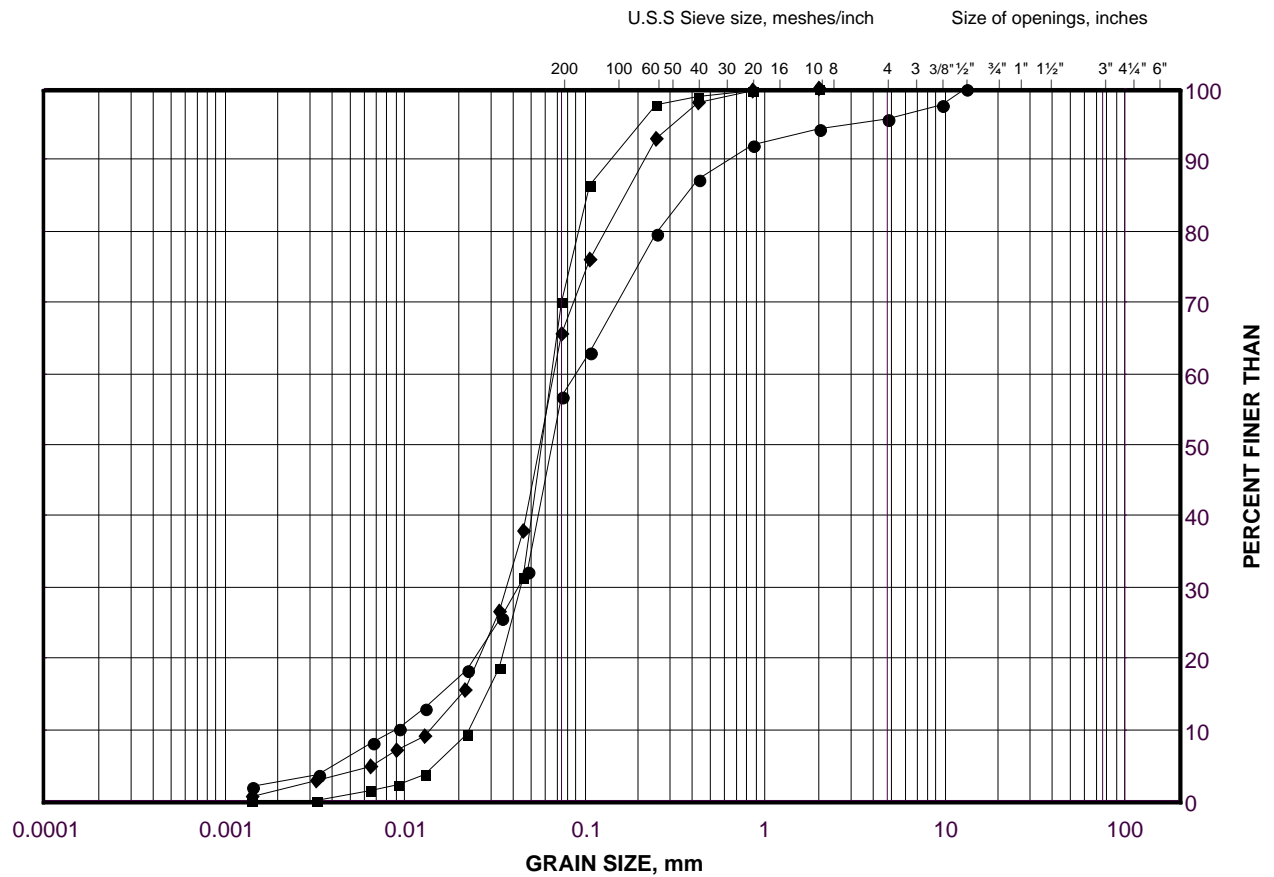
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

Sandy SILT (ML) to SILT (ML/SM) and sand Interlayers

FIGURE D-6B



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

LEGEND

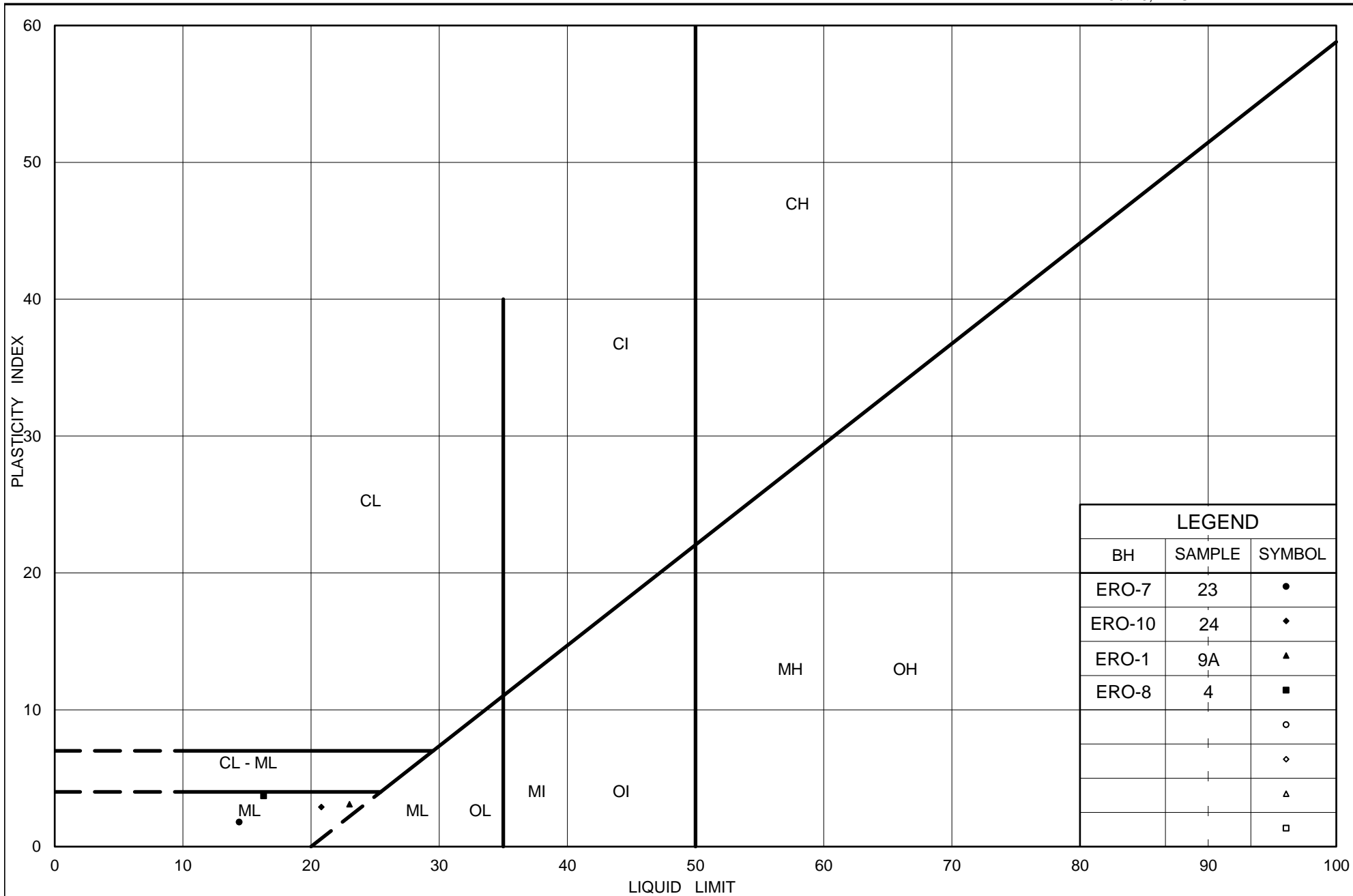
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ES1-1	10	253.7
■	ERO-10	22	223.9
◆	ERO-1	3	242.7

Project Number: 18105050

Checked By: AMP

Golder Associates

Date: 03-Jun-20



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PLASTICITY CHART

SILT (ML) of slight plasticity to Sandy SILT (ML) of slight plasticity Interlayers

Figure No. D-7

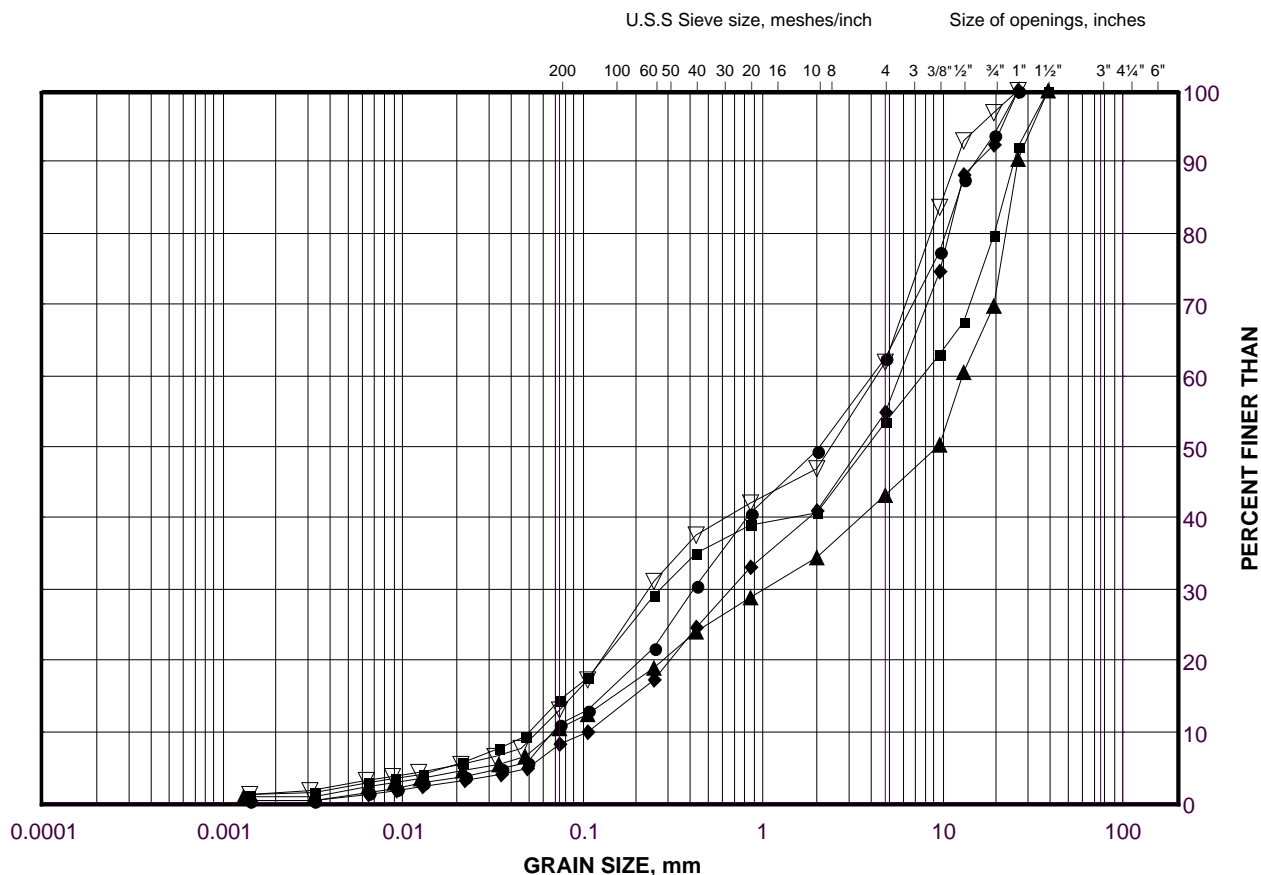
Project No. 18105050-ERO

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SAND (SP-SM) and gravel to GRAVEL (GP-GM) and sand Interlayers

FIGURE D-8



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-8	20	222.1
■	ERO-7	20	220.5
◆	ERO-6	21	217.8
▲	ERO-3	26	209.7
▽	ERO-6	9	236.1

Project Number: 18105050

Checked By: AMP

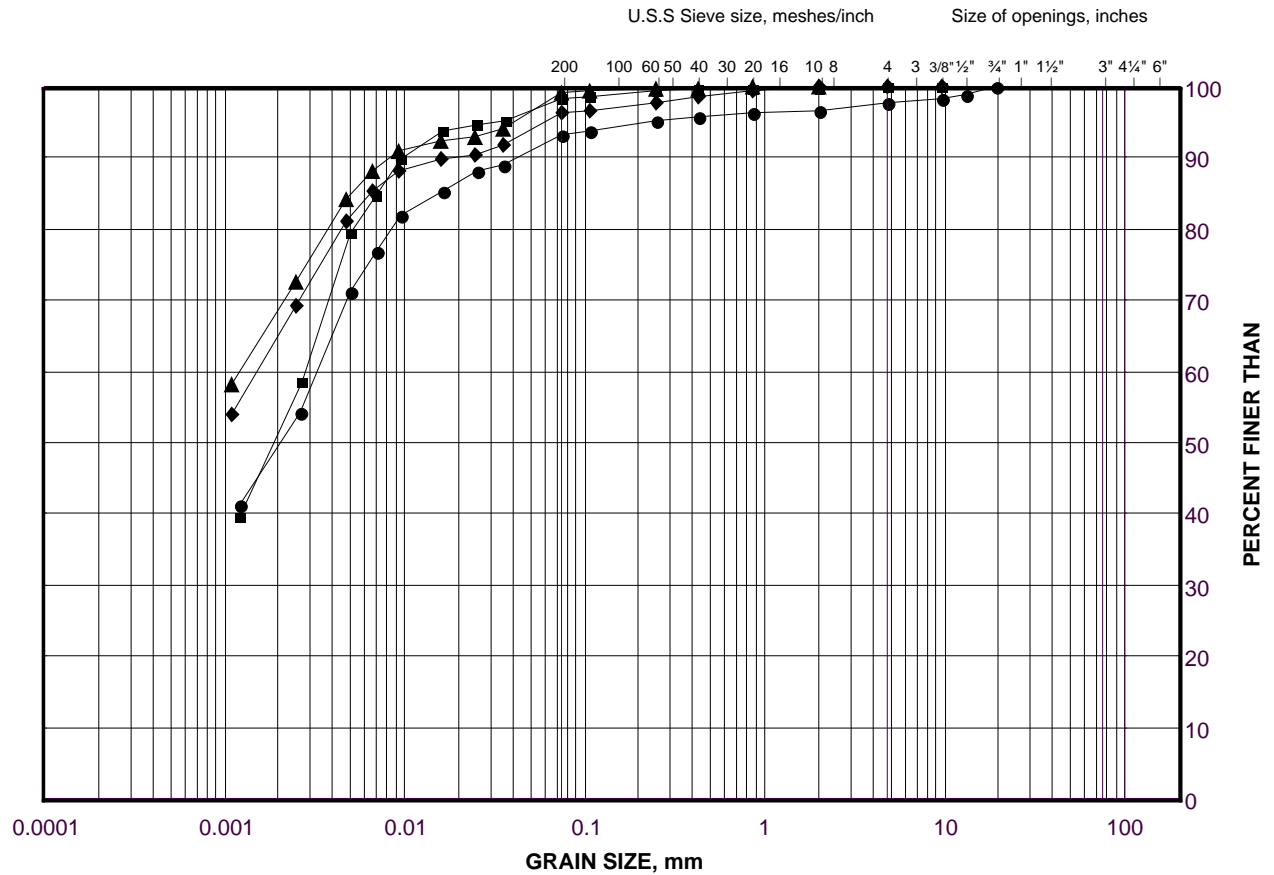
Golder Associates

Date: 03-Jun-20

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI) to CLAY (CH)

FIGURE D-9



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

LEGEND

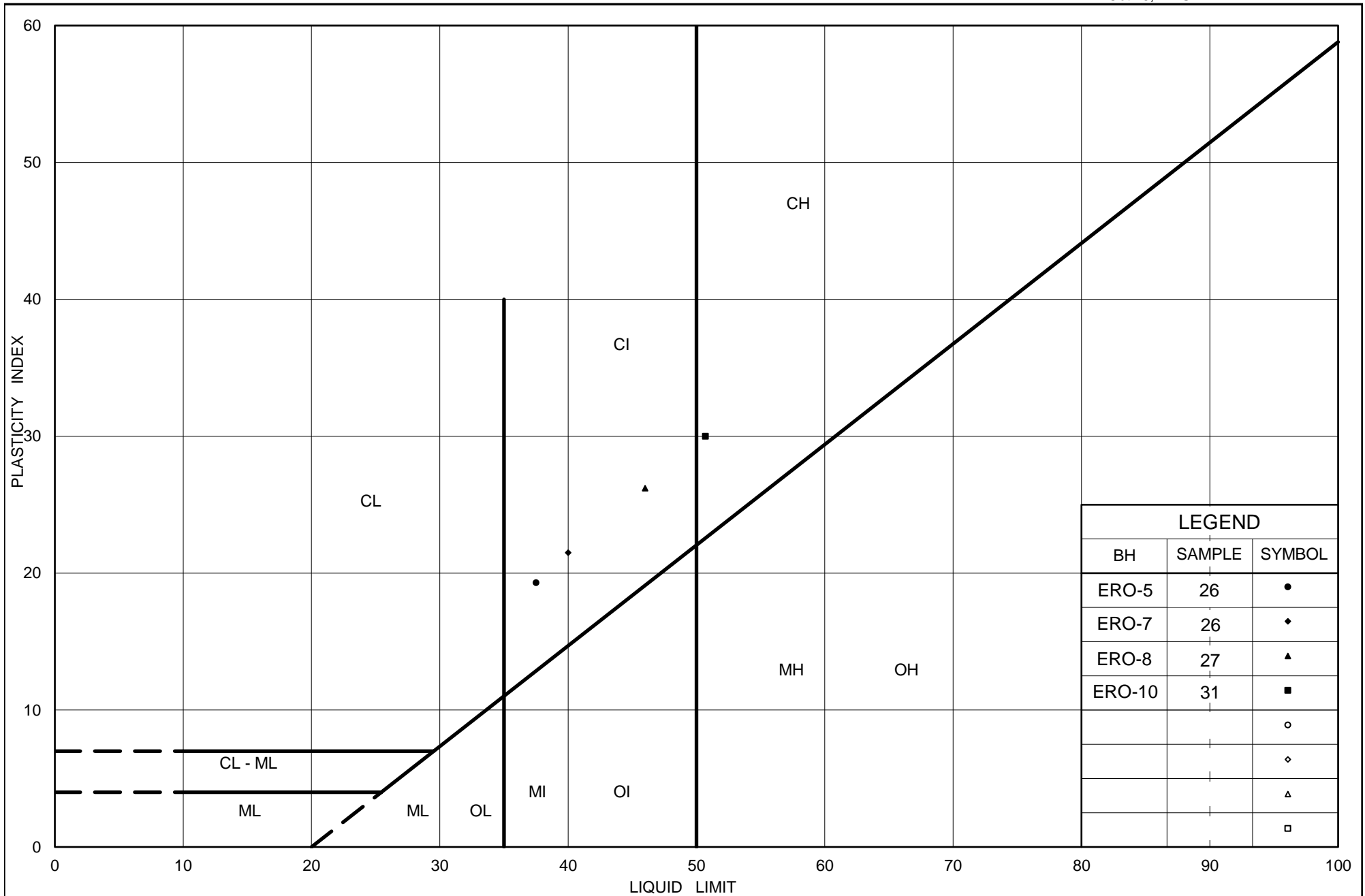
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-7	26	211.4
■	ERO-5	26	211.4
◆	ERO-8	27	211.4
▲	ERO-10	31	210.1

Project Number: 18105050

Checked By: AMP

Golder Associates

Date: 03-Jun-20



Ministry of Transportation

Ontario

PLASTICITY CHART

SILTY CLAY (CI) to CLAY (CH)

Figure No. D-10

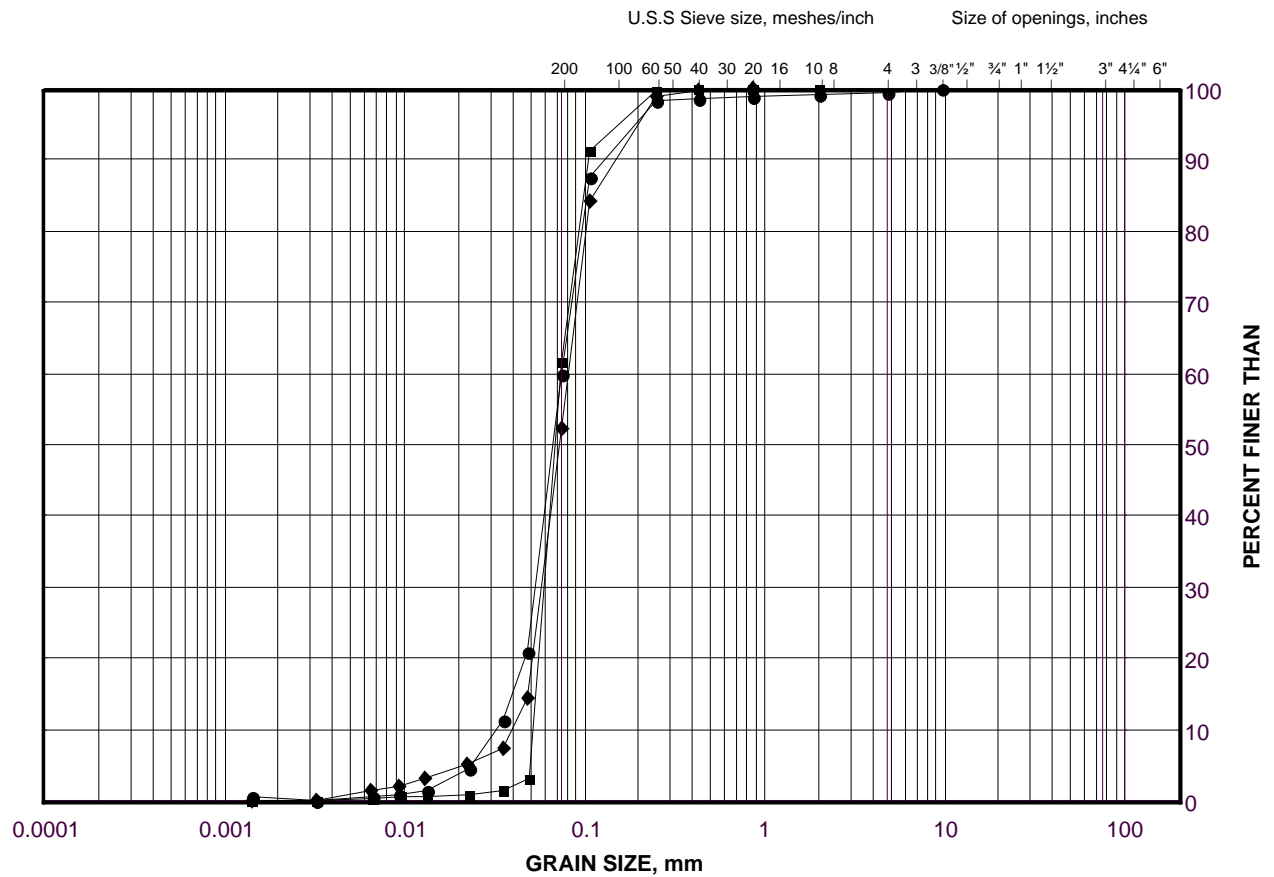
Project No. 18105050-ERO

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILT (ML/SM) and sand

FIGURE D-11



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

LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	ERO-6	28	207.2
■	ERO-5	29	206.7
◆	ERO-10	32	207.1

Project Number: 18105050

Checked By: AMP

Golder Associates

Date: 03-Jun-20

APPENDIX E

**Analytical Laboratory
Test Results**



Your Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Your C.O.C. #: 702394-01-01

Attention: Anastasia Poliacik

Golder Associates Ltd
100 Scotia Crt
Whitby, ON
CANADA L1N 8Y6

Report Date: 2019/06/19
Report #: R5762201
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9G1458

Received: 2019/06/13, 15:30

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date	Date	Laboratory Method	Reference
		Extracted	Analyzed		
Chloride (20:1 extract)	6	2019/06/17	2019/06/18	CAM SOP-00463	SM 4500-Cl E m
Conductivity	6	2019/06/17	2019/06/17	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	6	2019/06/14	2019/06/14	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	6	2019/06/13	2019/06/18	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	6	2019/06/17	2019/06/18	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.



Your Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Your C.O.C. #: 702394-01-01

Attention: Anastasia Poliacik

Golder Associates Ltd
100 Scotia Crt
Whitby, ON
CANADA L1N 8Y6

Report Date: 2019/06/19
Report #: R5762201
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: B9G1458
Received: 2019/06/13, 15:30

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: Ema.Gitej@bvlabs.com

Phone# (905)817-5829

=====

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		JZK729			JZK729		
Sampling Date		2019/05/24 14:00			2019/05/24 14:00		
COC Number		702394-01-01			702394-01-01		
	UNITS	SRW-1 SA5 10'-11'6"	RDL	QC Batch	SRW-1 SA5 10'-11'6" Lab-Dup	RDL	QC Batch

Calculated Parameters							
Resistivity	ohm-cm	7600		6175720			
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	32	20	6180398			
Conductivity	umho/cm	132	2	6180198	124	2	6180198
Available (CaCl2) pH	pH	7.62		6176791			
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	6180400	<20	20	6180400
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate							

BV Labs ID		JZK730		JZK731		JZK732		
Sampling Date		2019/06/12 14:00		2019/05/15 14:00		2019/06/04 14:00		
COC Number		702394-01-01		702394-01-01		702394-01-01		
	UNITS	NRW-2 SA5 10'-11'6"	RDL	ERO-4 SA4 25'-27'	RDL	ERO-6 SA5 10'-11'6"	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	2100		300		550		6175720
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	190	20	2000	100	820	20	6180398
Conductivity	umho/cm	481	2	3330	2	1830	2	6180198
Available (CaCl2) pH	pH	8.01		8.02		8.15		6176791
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	<20	20	<20	20	6180400
RDL = Reportable Detection Limit QC Batch = Quality Control Batch								



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		JZK733		JZK734		
Sampling Date		2019/06/04 14:00		2019/05/28 14:00		
COC Number		702394-01-01		702394-01-01		
	UNITS	ERO-7 SA4 10'-11'6"	RDL	ERO-8 SA4 7'6"-9'	RDL	QC Batch
Calculated Parameters						
Resistivity	ohm-cm	270		4200		6175720
Inorganics						
Soluble (20:1) Chloride (Cl-)	ug/g	2100	100	46	20	6180398
Conductivity	umho/cm	3730	2	239	2	6180198
Available (CaCl2) pH	pH	7.75		7.89		6176791
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	<20	20	6180400
RDL = Reportable Detection Limit						
QC Batch = Quality Control Batch						



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

TEST SUMMARY

BV Labs ID: JZK729
Sample ID: SRW-1 SA5 10'-11'6"
Matrix: Soil

Collected: 2019/05/24
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine

BV Labs ID: JZK729 Dup
Sample ID: SRW-1 SA5 10'-11'6"
Matrix: Soil

Collected: 2019/05/24
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine

BV Labs ID: JZK730
Sample ID: NRW-2 SA5 10'-11'6"
Matrix: Soil

Collected: 2019/06/12
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine

BV Labs ID: JZK731
Sample ID: ERO-4 SA4 25'-27'
Matrix: Soil

Collected: 2019/05/15
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine

BV Labs ID: JZK732
Sample ID: ERO-6 SA5 10'-11'6"
Matrix: Soil

Collected: 2019/06/04
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

TEST SUMMARY

BV Labs ID: JZK733
Sample ID: ERO-7 SA4 10'-11'6"
Matrix: Soil

Collected: 2019/06/04
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine

BV Labs ID: JZK734
Sample ID: ERO-8 SA4 7'6"-9'
Matrix: Soil

Collected: 2019/05/28
Shipped:
Received: 2019/06/13

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	6180398	2019/06/17	2019/06/18	Deonarine Ramnarine
Conductivity	AT	6180198	2019/06/17	2019/06/17	Kazzandra Adeva
pH CaCl2 EXTRACT	AT	6176791	2019/06/14	2019/06/14	Surinder Rai
Resistivity of Soil		6175720	2019/06/18	2019/06/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	6180400	2019/06/17	2019/06/18	Deonarine Ramnarine



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.7°C
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Results relate only to the items tested.



BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
6176791	SAU	Spiked Blank	Available (CaCl ₂) pH	2019/06/14		100	%	97 - 103
6176791	SAU	RPD	Available (CaCl ₂) pH	2019/06/14	0.56		%	N/A
6180198	KAD	Spiked Blank	Conductivity	2019/06/17		105	%	90 - 110
6180198	KAD	Method Blank	Conductivity	2019/06/17	<2		umho/cm	
6180198	KAD	RPD [JZK729-01]	Conductivity	2019/06/17	6.0		%	10
6180398	DRM	Matrix Spike	Soluble (20:1) Chloride (Cl ⁻)	2019/06/18		NC	%	70 - 130
6180398	DRM	Spiked Blank	Soluble (20:1) Chloride (Cl ⁻)	2019/06/18		104	%	70 - 130
6180398	DRM	Method Blank	Soluble (20:1) Chloride (Cl ⁻)	2019/06/18	<20		ug/g	
6180398	DRM	RPD	Soluble (20:1) Chloride (Cl ⁻)	2019/06/18	3.2		%	35
6180400	DRM	Matrix Spike [JZK729-01]	Soluble (20:1) Sulphate (SO ₄)	2019/06/18		109	%	70 - 130
6180400	DRM	Spiked Blank	Soluble (20:1) Sulphate (SO ₄)	2019/06/18		103	%	70 - 130
6180400	DRM	Method Blank	Soluble (20:1) Sulphate (SO ₄)	2019/06/18	<20		ug/g	
6180400	DRM	RPD [JZK729-01]	Soluble (20:1) Sulphate (SO ₄)	2019/06/18	NC		%	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).





BV Labs Job #: B9G1458
Report Date: 2019/06/19

Golder Associates Ltd
Client Project #: 18105050
Site Location: HWY 400/ESSA ROAD
Sampler Initials: ML

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

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