FINAL REPORT

Foundation Investigation and Design Report

West Noise Barrier Wall Replacement
Highway 401/Bloor Street/Harmony Road Interchange Reconstruction
City of Oshawa, Ontario
MTO G.W.P 2146-20-00

Submitted to:

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PART A

FOUNDATION INVESTIGATION REPORT
WEST NOISE BARRIER WALL REPLACEMENT
HIGHWAY 401/BLOOR STREET/HARMONY ROAD INTERCHANGE
RECONSTRUCTION, CITY OF OSHAWA, ONTARIO
MTO G.W.P. 2146-20-00

1.0 INTRODUCTION

WSP Golder (formerly Golder Associates Ltd., now a member of WSP Canada Inc.) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for Highway 401 / Bloor Street / Harmony Road interchange reconstruction in the City of Oshawa, Ontario.

This report presents the results of the foundation investigation carried out for the proposed noise barrier walls to be constructed on the north and south sides of Highway 401 from about 225 m west of Wilson Road South to near the Harmony Creek Tributary about 350 m east of Wilson Road. This section of noise barrier walls is referred to as the west noise walls, as additional noise walls will be constructed east of this location under a separate contract.

The purpose of this investigation is to establish the subsurface soil conditions at the proposed noise barrier wall locations by borehole drilling and laboratory testing of selected soil samples. The results of foundation investigations for the east noise walls and other works associated with the interchange reconstruction are presented in separate reports.

This report was developed based on information from the current foundation investigation, supplemented with relevant information from Golder's previous foundation investigation carried out within the project limits. The results of the relevant previous foundation investigation are presented in the following report:

- **MTO GEOCRES 30M15-132:** "Noise Barrier Wall Replacement, Highway 401 from West of Wilson Road to Harmony Road, Oshawa, Ontario, Assignment No.: 2011-E-0018", Golder Report No. 11-1184-0109 (8), dated June 2013.

2.0 SITE DESCRIPTION

Existing noise barrier walls are currently located along the north and south side of Highway 401, and these will replaced with new walls behind the existing alignment as part of the planned Highway 401 widening and future interchange improvements. The proposed western section of noise walls included in this contract extends from west of Wilson Road easterly to near the Harmony Creek tributary, as shown on Drawing 1 and as follows:

- **North Noise Barrier Wall:** This proposed noise barrier wall extends along the north side of Highway 401 from about 225 m west of Wilson Road South to the Harmony Creek Tributary about 350 m east of Wilson Road, between approximately Station 14+350 and 14+925 (about 575 m long).
- **South Noise Barrier Wall:** This proposed noise barrier wall extends along the south side of Highway 401 from about 225 m west of Wilson Road South to 325 m east of Wilson Road, between approximately Station 14+350 and 14+900 (about 450 m long).

The terrain along the proposed noise barrier wall alignments is rolling and generally declines eastward toward the Harmony Creek tributary. The ground surface along the north noise barrier wall ranges from about Elevation 98 m at the west limit to about Elevation 84 m at the east limit. The ground surface along the south noise barrier wall ranges from about Elevation 100 m at the west limit to about Elevation 87 m at the east limit.

The land along the proposed noise barrier wall alignments, behind the existing walls and within MTO's right-of-way, is vegetated with grasses, bushes and trees. In general, the area surrounding the proposed noise walls consists of residential properties.

3.0 INVESTIGATION PROCEDURES

3.1 2013 Subsurface Investigation (GEOCRES No. 30M15-135)

In 2013, Golder carried out a foundation investigation in support of the foundation design for the then-proposed noise walls (MTO GEOCRES 30M15-132, as referenced in Section 1.0 of this report). Three boreholes (designated as BH1, BH11, and BH12) were advanced in the vicinity of the proposed noise walls. The approximate borehole locations are shown on Drawing 1.

The boreholes were drilled using continuous flight solid-stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm nominal outside diameter split-spoon sampler driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure. The groundwater conditions were observed in the open boreholes during drilling. Index and classification testing (water content, Atterberg limits and grain size distributions) was completed on selected samples.

The ground surface elevations and coordinates of the previous boreholes were obtained from a Global Positioning System (GPS). The borehole locations (in MTM NAD 83 Zone 10 northing and easting coordinates and latitude and longitude), the ground surface elevations (referenced to Geodetic datum), and borehole depths are summarized below.

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing, m (Latitude, °)	Easting, m (Longitude, °)		
BH1	4,860,782.2 (43.885111)	357,899.1 (-78.839179)	99.0	4.8
BH11	4,860,923.1 (43.886345)	358,370.6 (-78.833297)	89.1	5.0
BH12	4,860,923.2 (43.886342)	358,425.3 (-78.832616)	88.6	5.0

3.2 Current Subsurface Investigation

The field work for the current subsurface investigation was carried out between December 14, 2021 and February 15, 2022. A total of six boreholes (designated as Boreholes SNW-1 to SNW-4, WRO-4A/B/C, and WRO-8) were advanced in the vicinity of the proposed south noise barrier wall and ten boreholes (designated as Boreholes NNW-1 to NNW-8, WRO-1, and WRO-5) were advanced in the vicinity of the proposed north noise barrier wall.

The investigation was carried out using track-mounted Marl T5 and CME55 drill rigs supplied and operated by Drilltech of Newmarket, Ontario and Davis Drilling of Milton, Ontario, respectively. The boreholes were generally advanced through the overburden using 152 mm outside diameter solid-stem augers. 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 American Society for Testing and Materials (ASTM) procedure D1586-18. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested 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. Where soft cohesive soils were encountered, field vane shear tests using standard ‘N’ size vanes were carried out to assess the undrained shear strengths of the cohesive soils. Rock coring was carried in Boreholes WRO-1, WRO-4C, WRO-5, and WRO-8 out suing HW-size casing and an HQ core barrel. Water was sourced off-site for coring operations.

The groundwater conditions were noted in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in seven boreholes (Boreholes SNW-1, SNW-4, NNW-1, NNW-5, NNW-8, WRO-4A,

and WRO-5) to allow for monitoring of the groundwater level. The remaining boreholes were backfilled with cement bentonite grout in accordance with Ontario Regulation 903 (as amended) and the ground surface was restored to near original condition as practicable.

The field work was observed by members of WSP 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 WSP Golder's Whitby laboratory where the samples underwent further visual examination. Geotechnical laboratory testing (water content, grain size distribution, and Atterberg limits) was carried out on selected soil samples, in accordance with MTO and / or ASTM Standards, as appropriate. In addition, six 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 Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD), weathering and strength indices, and discontinuity characterises of the bedrock core samples from Boreholes WRO-1, WRO-4C, WRO-5, and WRO-8 were recorded in the field based on visual observation and measurement. The bedrock was sequentially photographed, packed, and transported to WSP Golder's Mississauga laboratory for further visual examination. Laboratory testing consisting of uniaxial compressive strength (UCS) testing was caried out on selected specimens of the bedrock core samples by Geomechanica Inc. of Mississauga, Ontario.

The borehole locations were surveyed by WSP Golder using a hand-held Trimble GPS unit with a horizontal and vertical accuracy of about 0.1 m, and compared to the existing terrain model provided by AECOM. 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 / HT2_0). 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 Noise Barrier Wall (North of Highway 401)	NNW-1	4,860,842.8 (43.885658)	357,872.1 (-78.839508)	97.4	8.1
	NNW-2	4,860,854.4 (43.885759)	357,929.5 (-78.838793)	94.9	6.4
	NNW-3	4,860,881.6 (43.885998)	358,013.6 (-78.837744)	93.3	6.7
	NNW-4	4,860,933.7 (43.886455)	358,173.6 (-78.835748)	91.4	5.2
	NNW-5	4,860,958.3 (43.886670)	358,254.5 (-78.834738)	90.1	5.9
	NNW-6	4,860,978.1 (43.886842)	358,337.7 (-78.833700)	89.8	6.7
	NNW-7	4,860,997.2 (43.887009)	358,412.6 (-78.832767)	88.5	6.7
	NNW-8	4,861,013.7 (43.887153)	358,479.8 (-78.831929)	85.5	5.2
	WRO-1	4,860,901.5 (43.886172)	358,077.6 (-78.836946)	92.4	21.9
	WRO-5	4,860,911.2 (43.886258)	358,108.2 (-78.836565)	91.5	20.4

Location	Borehole ID	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
South Noise Barrier Wall (South of Highway 401)	SNW-1	4,860,798.8 (43.885257)	357,946.5 (-78.838587)	95.1	8.2
	SNW-2	4,860,824.3 (43.885481)	358,026.5 (-78.837589)	93.8	6.7
	SNW-3	4,860,875.1 (43.885925)	358,207.4 (-78.835332)	90.5	6.7
	SNW-4	4,860,901.5 (43.886157)	358,285.2 (-78.834363)	89.2	6.7
	WRO-4A	4,860,842.5 (43.885640)	358,098.3 (-78.836694)	92.2	9.6
	WRO-4B	4,860,842.3 (43.885638)	358,096.9 (-78.836711)	92.5	22.1
	WRO-4C	4,860.841.8 (43.885634)	358,096.2 (-78.836720)	92.5	22.1
	WRO-8	4,860,854.6 (43.885746)	358,132.0 (-78.836274)	92.1	22.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984) and *Urban Geology of Canadian Cities* (Brennand, 1998). The Iroquois Plain extends around the western shores of Lake Ontario. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in this area of the Iroquois Plain are typically comprised of glaciolacustrine clays, silts and sands to gravelly sands, which are underlain by an extensive till deposit that is mapped in this area as the Bowmanville Till. Mire recent alluvial deposits of gravel, sand, silt and/or clay are present in the creek valleys.

Bedrock underlying the City of Oshawa is Ordovician shales of the lower Whitby formation, alternately known as Collingwood shale, as indicated in *Aggregate Resources Inventory of the City of Oshawa, Regional Municipality of Durham, Southern Ontario* (Scott and Billings, 1981). The lower Whitby formation is described as a black fossiliferous and highly proliferous calcareous shale.

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 and B. 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 A and B to assist in the interpretation of the borehole records. The geotechnical laboratory test results and analytical laboratory test results from the current investigation are presented in Appendices C and D, respectively.

The results of the in-situ field tests (i.e., SPT “N”-values and undrained shear strengths) as presented on the borehole records and in this section of the Foundation Investigation Report 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 the proposed noise walls as shown on Drawings 1 to 2 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 proposed north and south alignments of the west noise walls consist of fill which is underlain, at some locations, by an upper silty clay deposit, subsequently underlain by a till / till-like deposit that varies from cohesive to non-cohesive. The till / till-like deposit is generally underlain by a deposit of silty sand, which is further underlain by a lower silty clay deposit. Shale bedrock was encountered below the silty sand and silty clay deposits. A 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.

4.2.1 Topsoil

An approximately 50 mm to 250 mm thick layer of topsoil was encountered at ground surface in Boreholes BH1, BH11, BH12, NNW-1, NNW-4 to NNW-8, SNW-1, SNW-2, WRO-5, and WRO-8.

4.2.2 Fill

A 0.5 m to 3.6 m thick layer of cohesive / non-cohesive fill was encountered at ground surface or below the surficial topsoil layer in all boreholes, excluding Borehole NNW-1. The fill extends to depths below ground surface ranging from 0.7 m to 3.7 m (Elevations 96.9 m to 81.8 m, generally declining eastward toward the creek). The cohesive fill consists of clayey silt, trace to sandy to clay. The non-cohesive fill consists of sandy silt, trace to some gravel to silty sand, some gravel. Trace organics were noted within the fill in Boreholes BH1 and BH12, and rootlets were noted within the fill in Borehole SNW-2.

The SPT “N”-values measured within the cohesive fill range from 4 blows to 18 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency. Two in-situ shear vane tests within the cohesive fill in Boreholes SNW-1 and SNW-4 measured about 24 kPa and greater than 96 kPa, indicating a firm to stiff consistency. The SPT “N”-values measured within the non-cohesive fill range from 6 blows to 19 blows per 0.3 m of penetration, indicating a loose to compact state of compactness.

Grain size distribution testing was carried out on one sample of the cohesive fill and the results are presented on Figure C-1 in Appendix C. Atterberg limits testing was carried out on two samples of the cohesive fill and the results are presented on Figure C-2 in Appendix C. The Atterberg limits tests measured liquid limits ranging from about 35% to 56%, plastic limits ranging from about 17% to 24%, and plasticity indices ranging from about 18% to 32%, indicating the material ranges from low plasticity to high plasticity. The natural water content measured on samples of the cohesive fill ranges from about 13% to 55%.

Grain size distribution testing was carried out on one sample of the non-cohesive fill and the results are presented on Figure C-3 in Appendix C. The natural water content measured on samples of the non-cohesive fill ranges from about 6% to 19%.

4.2.3 Upper Silty Clay to Clayey Sand

A 1.5 m to 5.2 m thick upper deposit of silty clay to clayey sand was encountered underlying the fill in Boreholes NNW-2, NNW-3, NNW-5, NNW-6, SNW-2, SNW-3, SNW-4, WRO-4, WRO-5 and WRO-8 at depths below ground surface ranging from about 0.7 m to 1.5 m (Elevations 93.5 m to 87.8 m) and extending to depths below ground

surface ranging from about 2.2 m to 6.7 m (Elevations 90.8 m to 82.5 m). The elevation of the surface and base of this layer generally declines to the east, toward the creek tributary.

The SPT “N”-values measured within the upper silty clay to clayey sand deposit range from 3 blows to 26 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency. In-situ field vane tests within the upper silty clay deposit measured about 40 kPa to greater than 96 kPa, indicating a firm to stiff consistency.

Grain size distribution testing carried out on nine samples of the upper silty clay to clayey sand deposit and the results are shown on Figures C-4A and C-4B in Appendix C. Atterberg limits testing was carried out on eleven samples of the upper silty clay deposit and the results are presented on Figure C-5A and C-5B in Appendix C. The Atterberg limits testing measured liquid limits ranging from about 21% to 45%, plastic limits ranging from about 13% to 19%, and plasticity indices ranging from about 9% to 27%, indicating the material is of low to intermediate plasticity. The natural water content measured on samples of the upper silty clay to clayey sand deposit ranges from about 7% to 39%.

4.2.4 Upper Silty Sand Interlayer

A 0.7 m to 2.4 m thick upper silty sand interlayer was encountered underlying the upper silty clay in Borehole NNW-2, within the upper silty clay deposit in Boreholes NNW-5 and SNW-4, and within the till deposit in Borehole WRO-8 at depths below ground surface ranging from about 2.8 m to 6.3 m (Elevations 90.0 m to 85.5 m) and extending to depths below ground surface ranging from about 3.5 m to 8.7 m (Elevations 89.3 m to 83.4 m).

The SPT “N”-values measured within the upper silty sand interlayer range from 13 blows to 72 blows per 0.3 m of penetration, with one SPT “N”-value was measured 106 blows for 0.28 m of penetration, indicating a compact to very dense state of compactness.

Grain size distribution testing carried out on two samples of the upper silty sand interlayer and the results are shown on Figures C-6 in Appendix C. The natural water content measured on samples of the upper silty sand interlayer ranges from about 8% to 22%.

4.2.5 Till/Till-like Deposit

A 0.8 m to 7.8 m thick glacially derived cohesive and non-cohesive till / till-like deposit was encountered in all boreholes except Boreholes NNW-5 and SNW-4. The till / till-like deposit was encountered at depths below ground surface ranging from about 0.3 m to 14.8 m (Elevations 97.1 m to 77.3 m) and extending to depths below ground surface ranging from 4.8 m to 17.8 m (Elevations 74.3 m to 94.2 m).

The cohesive till / till-like deposit consists clayey silt, some sand, trace gravel to clayey sand, some gravel of clayey sand, some gravel and the non-cohesive till / till-like deposit consists of silty sand, trace gravel to sandy silty gravel. A 100 mm thick sand seam was encountered in Borehole WRO-5 at a depth below ground surface of 9.5 m (Elevation 82.0 m). Auger grinding / bouncing of the SPT spoon was observed within Boreholes NNW-1, SNW-1, WRO-5, WRO-8, and BH11, indicating the potential presence of cobbles/boulders within the deposit. Heaving / flowing sands were observed within Borehole WRO-4A at a depth below ground surface of 9.1 m (Elevation 83.4 m).

The deposit has been classified herein as a till / till-like deposit based on the results grain size distribution curves, observed auger grinding, and our understanding of the geology in the area.

The SPT “N”-values measured within the cohesive portion of the till / till-like deposit range from 5 blows per 0.3 m of penetration to 100 blows per 0.13 m of penetration, suggesting a firm to hard consistency. The SPT “N”-values

measured within the non-cohesive portion of the till / till-like deposit range from 4 blows per 0.3 m of penetration to 100 blows per 0.07 m of penetration, indicating a loose to very dense state of compactness.

Grain size distribution testing was carried out on eight samples of the cohesive till / till-like deposit and the results are presented on Figure C-7A and C-7B in Appendix C. Atterberg limits testing was carried out on seven samples of the cohesive till / till-like deposit and the results are presented on Figure C-8 in Appendix C. The Atterberg limits testing measured liquid limits ranging from 15% to 20%, plastic limits ranging from 10% to 13%, and plasticity indices ranging from 5% to 8%, indicating the cohesive till / till like material is of low plasticity. The natural water content measured on samples of the cohesive portion of the till / till-like deposit ranges from about 8% to 21%.

Grain size distribution testing was carried out on fifteen samples of the non-cohesive till / till-like deposit and the results are presented on Figure C-9A to C-9C in Appendix C. Atterberg limits testing carried out on seven samples of the non-cohesive till / till-like deposit indicated the non-cohesive portion of the deposit is non plastic. The natural water content measured on samples of the non-cohesive portion of the till / till-like deposit ranges from about 4% to 26%.

4.2.6 Lower Silty Sand

A 0.9 m to 6.1 m thick lower deposit of non-cohesive silty sand, trace to some gravel, was encountered beneath the till / till-like deposit in Boreholes WRO-1, WRO-4B. and WRO-5, and interlayered within the till / till-like deposit in Borehole WRO-8. at depths below ground surface ranging from 8.7 m to 17.8 m (Elevation 83.7 m to 74.3 m), extending to depths below ground surface ranging from 14.8 m to 18.7 m (Elevations 77.7 m to 73.4 m).

Trace organics were observed within the silty sand in Borehole WRO-8 and WRO-B5. Trace organics and shell fragments were observed within the silty sand deposit in Boreholes WRO-1 and WRO-4B between depths below ground surface of 10.2 m and 13.3 m (Elevations 82.2 m and 79.0 m), suggesting the silty sand deposit is from the former Lake Iroquois lakebed.

The SPT “N”-values measured within the lower silty sand deposit range from 8 blows to 57 blows per 0.3 m of penetration, with one SPT “N”-value of 100 blows per 0.14 m of penetration, indicating a loose to very dense state of compactness.

Grain size distribution testing was carried out on four samples of the silty sand and the results are presented on Figure C-10 in Appendix C. Organic content testing was carried out on three samples of the lower silty sand deposit and indicate an organic content of about 1%. The water content measured on samples of the lower silty sand deposit range from 12% to 21%.

4.2.7 Lower Silty Clay

A 1.5 m to 3.8 m thick lower deposit of silty clay, trace sand, trace gravel was encountered underlying the lower silty sand deposit in Boreholes WRO-1, WRO-4B, and WRO-5 at depths below ground surface ranging from 10.2 m to 14.8 m (Elevations 81.3 m to 76.7 m), extending to depths below ground surface ranging from 11.7 m to 18.6 m (Elevations 79.8 m to 73.9 m).

The SPT “N”-values measured within the lower silty clay deposit range from 13 blows to 43 blows per 0.3 m of penetration, indicating a stiff to hard consistency.

Grain size distribution testing was carried out on two samples of lower silty clay deposit are presented on Figure C-11 in Appendix C. Atterberg limits testing was carried out on two samples of the lower silty clay deposits

are presented on Figure C-12 in Appendix C. The Atterberg limits testing measured liquid limits ranging from about 38% to 40%, plastic limits ranging from about 16% to 18%, and plasticity indices of about 22%, indicating the material is of intermediate plasticity. The natural water content measured on samples of the lower silty clay deposit range from about 16% to 27%.

4.2.8 Residual Soil

A 0.6 m and 0.1 m thick deposit of residual soil was encountered underlying the lower silty clay deposit in Boreholes WRO-1 and WRO-5 at depths below ground surface of 18.0 m and 17.1 m (Elevations 74.4 m).

A single SPT "N" value measured within the residual soil deposit was greater than 30 blows per 0.03 m of penetration, suggesting a hard consistency.

The water content measured on one sample of the residual soil deposit was about 8%.

4.2.9 Bedrock

Bedrock was encountered and core samples were recovered in Boreholes WRO-1, WRO-4C, WRO-5 and WRO-8, and the bedrock surface was inferred from augering and/or split-spoon sampling in Borehole WRO-4B; all of these deeper boreholes were drilled in the vicinity of the Wilson Road overpass. The depths to bedrock below ground surface, and the corresponding bedrock surface elevation are summarized below. Photographs of the recovered core samples are presented on Figures B-1A to B-4B in Appendix B.

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
WRO-1	18.6	73.9	Bedrock Cored
WRO-4B	18.6	73.9	Split Spoon Sample
WRO-4C	18.7	73.8	Bedrock Cored
WRO-5	17.2	74.3	Bedrock Cored
WRO-8	18.7	73.4	Bedrock Cored

Based on a review of the bedrock core samples from the current investigation, the bedrock consists of shale of the Whitby Formation. In general, the bedrock samples are described as slightly weathered to fresh, thinly bedded, fine grained, faintly porous, very weak to strong, grey. The degree of weathering of the bedrock samples (i.e. fresh to moderately weathered – W1 to W3), and the strength classification of the intact rock mass based on field identification (i.e. weak to very strong – R2 to R4) are described in accordance with the International Society for Rock Mechanics (ISRM)[1] standard classification system.

The Rock Quality Designation (RQD) measured on the core samples ranges from about 0% to 100%, and is generally greater than 50%, indicating a rock mass of poor to excellent quality, and generally fair to excellent

[1] International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

quality, as per Table 3.10 of CFEM (2006)[2]. The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered is between 0% and 100% and between 0% and 100%, respectively.

Uniaxial compressive strengths (UCS) obtained from UC tests (ASTM D7012) carried out on selected core samples of the shale bedrock are summarised in the table below and the details are presented on the Rock Laboratory Test Result report from Geomechanica in Appendix C.

Borehole No.	Sample Depth (m)	UCS (MPa)	Bulk Density (g/cm^3)
WRO-1	21.3 – 21.5	107.3	2.7
WRO-4C	21.4 – 21.5	47.5	2.6
WRO-4C	21.7 – 21.9	80.1	2.6
WRO-5	20.0 – 20.2	86.5	2.6
WRO-8	20.8 – 21.0	50.9	2.6
WRO-8	21.0 – 21.3	53.9	2.6

Based on the laboratory UCS results, in accordance with Table 3.5 in CFEM (2006)[4], the shale bedrock is generally classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

4.3 Groundwater Conditions

Details of the water levels observed in the boreholes upon completion of drilling are summarized on the borehole records in Appendix A and B. A 50 mm diameter PVC standpipe piezometer, equipped with stickup casing, was installed in seven 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; in general, the groundwater level declines from west to east, toward the creek valley. 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.

[2] Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

Borehole	Screened Stratigraphy	Screened Depth (m) (Elevation) (m)	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date of Measurement
NNW-1	Silty sand till	3.1 – 6.1 (94.3 - 91.3)	97.4	Dry	Dry	04-Mar-2022
				7.3	91.0	20-May-2022
NNW-5	Silty sand / silty clay	3.7 – 5.2 (86.4 – 84.9)	90.1	2.8	87.3	04-Mar-2022
				2.9	87.2	20-May-2022
NNW-8	Silty clay fill / Silty sand (till-like)	3.7 – 5.2 (81.8 – 80.3)	85.5	0.1[1]	85.4	04-Mar-2022
				0.8	84.7	20-May-2022
SNW-1	Silty clay till	4.6 – 7.6 (90.5 – 87.5)	95.1	0.7	94.3	04-Mar-2022
				1.1	93.9	20-May-2022
SNW-4	Silty sand / silty clay to clayey silt	2.3 – 5.3 (86.9 – 83.9)	89.2	4.1	85.1	11-Feb-2022
				3.0	86.2	04-Mar-2022
				2.8	86.4	20-May-2022
WRO-4A	Silty sand till	4.6 – 7.6 (87.9 – 84.9)	92.5	3.8	88.7	13-Jan-2022
				3.9	88.6	14-Feb-2022
				3.8	88.7	04-Mar-2022
				3.8	88.7	20-May-2022
WRO-5	Clayey sand till / silty clay	7.6 – 10.7 (83.9 – 80.8)	91.5	4.3	87.2	14-Feb-2022
				4.3	87.2	04-Mar-2022
				4.3	87.2	20-May-2022

Note 1. Groundwater frozen in piezometer during 04-Mar-2022 reading.

4.4 Analytical Testing

Six 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 D.

Borehole	Sample	Sample Depth (Elevation) (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (umho/cm)	Resistivity (ohm-cm)
NNW-2	4	2.3 - 2.9 (92.6 - 92.0)	Clayey Silt	390	<20	7.75	745	1,300
NNW-7	2	0.8 - 1.4 (87.7 - 87.1)	Clay	<20	<20	7.69	188	5,300
NNW-8	3	1.5 - 2.1 (84.0 - 83.4)	Silty Clay	110	<20	7.90	377	2,700
SNW-1	2	0.8 - 1.4 (94.3 - 93.7)	Clayey Silt	41	<20	7.73	309	3,200
SNW-2	3	1.5 - 2.1 (92.3 - 91.7)	Silty Clay	400	<20	7.94	848	1,200
SNW-4	2	0.8 - 1.4 (88.4 - 87.8)	Clayey Silt	360	<20	7.89	895	1,100

5.0 CLOSURE

This Foundation Investigation Report was prepared by Jordan Schaaf, E.I.T., and was reviewed by Michael Bentley, P.Eng., geotechnical engineer and Anastasia Poliacik, P.Eng., senior geotechnical engineer with WSP Golder. Lisa Coyne, P.Eng., a Fellow and Designated MTO Foundations Contact with WSP Golder, conducted an independent technical and quality control review of this report.

Signature Page

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Geotechnical Engineer

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

JS/AMP/MB/LCC/ljv

https://golderassociates.sharepoint.com/sites/132178/project files/6 deliverables/2. foundations/2. west noise wall (contract a)/3. final/20350802 fidr rev0 wnw (gwp 2146-20-00).docx

PART B

FOUNDATION DESIGN REPORT
WEST NOISE BARRIER WALL REPLACEMENT
HIGHWAY 401/BLOOR STREET/HARMONY ROAD INTERCHANGE RECONSTRUCTION, CITY OF OSHAWA, ONTARIO
MTO G.W.P. 2146-20-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides foundation design recommendations for the construction of the Noise Barrier Walls to be constructed between approximately Station 14+350 and 14+925 along the north and south sides of Highway 401, as part of the Highway 401 / Bloor Street / Harmony Road interchange reconstruction in the City of Oshawa, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the previous and current subsurface investigations. The discussion and recommendations presented are intended to provide the designers with sufficient information to assess the feasible foundation alternatives and carry out the design of the underpass foundations.

The discussion and recommendations contained in this Foundation Design Report are intended for the use of MTO and their designers and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor or design-build proponents. Contractors undertaking the work must make their own interpretation based on the factual data presented in the Foundation Investigation Report (Part A of this report). Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

The proposed north and south noise wall alignments between about Station Station 14+350 and 14+925 are presented on Drawing 1. It is understood that the noise barrier walls will be approximately 5 m high. Typically, noise barrier walls are supported on piles placed in augered holes, with a diameter between 0.6 m and 0.9 m. Recommendations for support of the noise barrier walls using such augered foundations are presented in the subsequent sections of this report.

6.2 Foundation Design

Geotechnical parameters for design of the caisson foundations for the proposed noise barrier walls are provided in Table 1 following the text of this report, based on the subsurface conditions encountered in the boreholes advanced in the vicinity of the proposed noise barrier walls. The stratigraphy presented in Table 1 has been simplified from the detailed stratigraphic descriptions presented on the borehole records for the purposes of the noise barrier wall foundation design, and the design values and stations over which they apply has been further simplified in SP 760F01 amending OPSS 760 (*Noise Barrier Systems*) for the designer fill-in table of design parameters, a copy of which is included in Appendix E.

The geotechnical parameters presented in Table 1 and in SP 760F01 are based on field and laboratory test data as well as on accepted correlations (NAVFAC (1986), Bowles (1984) and Kulhawy and Mayne, (1990)) and the analysis was tempered by engineering judgment based on experience in similar soils.

Where both undrained shear strength (s_u) and drained parameters (effective cohesion, ($c_э$) and effective friction angle, ($\phi_э$)) have been given in Table 1 for a cohesive deposit, it is recommended that the caisson design be checked for both the undrained and the drained conditions, and the greater of the two calculated caisson depths shall govern.

The resistance within the upper 1.3 m below ground surface should be neglected to account for frost action within the depth of frost penetration zone as interpreted from OPSD 3090.101 (*Foundation Frost Penetration Depths for*

Southern Ontario). In addition, for foundation design, full resistance will be mobilized only where the ground surface in front of and behind the caissons is level (i.e., the zone width of soil in front of and behind the caissons is equal to or greater than eight caisson diameters). If the zone width of soil in front of and / or behind the caissons is insufficient for development of the full resistance (i.e., if there is sloping ground adjacent to the noise barrier wall), the magnitude of resistance may be determined by interpolating between zero resistance at ground surface and full resistance at the depth where the slope face is at a distance of eight caisson diameters away from the caissons.

6.3 Construction Considerations

The noise barrier walls should be constructed in accordance with OPSS 760 (*Noise Barrier Systems)* and SP 760F01. A copy of SP 760F01 is included in Appendix E with the fill-ins completed for the geotechnical parameters.

6.3.1 Control of Soil and Groundwater for Caissons

Caisson construction is anticipated to require augering / excavation through the existing fill and overburden deposits. The existing fill and overburden deposits contain granular layers (potentially saturated) which may be susceptible to disturbance during caisson excavation and construction (i.e., water-bearing non-cohesive layers). Wet non-cohesive soil layers and pockets should be expected to run or flow into the drilled hole during or after augering for foundations. In accordance with OPSS.PROV 903 (*Deep Foundations*), the contractor is required to maintain sidewall stability throughout the excavation of the caisson and concrete placement and therefore use of temporary liners or other appropriate methods will be required. A Notice to Contractor is included in Appendix E to advise the contractor of the potential flowing sand and groundwater conditions.

6.3.2 Obstructions in Overburden

Cobbles and boulders were encountered or are inferred to be present within the fill and till deposits and appropriate equipment and methods will needed to penetrate through such obstructions, if encountered. It is recommended that this information be incorporated into the Contract Documents in a Notice to Contractor (see Appendix E).

6.3.3 Analytical Testing of Construction Materials

The analytical test results for sulphate were compared to CSA A23.1 Table 3 (*Additional requirements for concrete subjected to sulphate attack*) to assess the potential severity of sulphate attack on concrete during its service life. The sulphate concentrations measured on the submitted soil samples are less than 0.002%, which is below the Moderate degree of exposure (i.e., below the Class S3 exposure limits), and the degree of sulphate attack is considered “Negligible” according to Table 7.2 in MTO’s Gravity Pipe Design Guidelines (2014). Therefore, based on the soil sample tested, when the designer is selecting the exposure class for the concrete structure, the effects of sulphates from within the site soils in contact with any portion of the proposed structure constructed below the ground surface may not need to be considered.

According to the MTO Gravity Pipe Design Guidelines (2014), the pH is not considered detrimental to steel durability as it is less than a pH of 8.0.

The analytical test results for resistivity were compared to Table 3.2 of MTO’s Gravity Pipe Design Guidelines (2016), to assess the relative level of corrosion potential on buried steel in contact with soil. The resistivity values measured on the submitted soil samples range from 1,100 ohm-cm to 5,300 ohm-cm which indicates that the soil corrosiveness is “Severe” (2,000 > R) to “Low” (6,000 > R > 4,500).

Given that the proposed structure will be exposed to de-icing salt/chemicals, consideration should be given by the designer to designing the concrete structure for a “C” type exposure class as defined by CSA A23.1 Table 1.

Ultimately, it is the structural designer’s decision to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 (Durability Requirements) are satisfied.

7.0 CLOSURE

This Foundation Design Report was prepared by Michael Bentley, P.Eng., geotechnical engineer and Anastasia Poliacik, P.Eng., senior geotechnical engineer with WSP Golder. Lisa Coyne, P.Eng., Fellow and MTO Foundations Designated Contact with WSP Golder, conducted an independent technical and quality control review of this report.

Signature Page

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Michael Bentley, P.Eng.
Geotechnical Engineer

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https://golderassociates.sharepoint.com/sites/132178/project files/6 deliverables/2. foundations/2. west noise wall (contract a)/3. final/20350802 fidr rev0 wnw (gwp 2146-20-00).docx

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Kulhway, F.H. and Mayne, P.W. 1990. *Manual on Estimating Soil Properties for Foundation Design*. EL-6800, Research Project 1493-6. Prepared for Electric Power Research Institute, Palo Alto, California

Ministry of Transportation, Ontario. 2014. *Gravity Pipe Design Guidelines*.

Unified Facilities Criteria, U.S. Navy. 1986. *NAVFAC Design Manual 7.02. Soil Mechanics, Foundation and Earth Structures.* Alexandria, Virginia.

ASTM International

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

ASTM D7012 Standard Test Method for Compressive Strength and Elastic moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature

Ontario Provisional Standard Drawing

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications

OPSS 760 Construction Specification for Noise Barrier Systems

OPSS.PROV 903 Construction Specification for Deep Foundations

Special Provisions

Special Provision No. 760F01 Amendment to OPSS 760

Ontario Water Resources Act

Ontario Regulation 903 Wells (as amended)

Ontario Occupational Health and Safety Act

Ontario Regulation 213/91 Construction Projects (as amended)

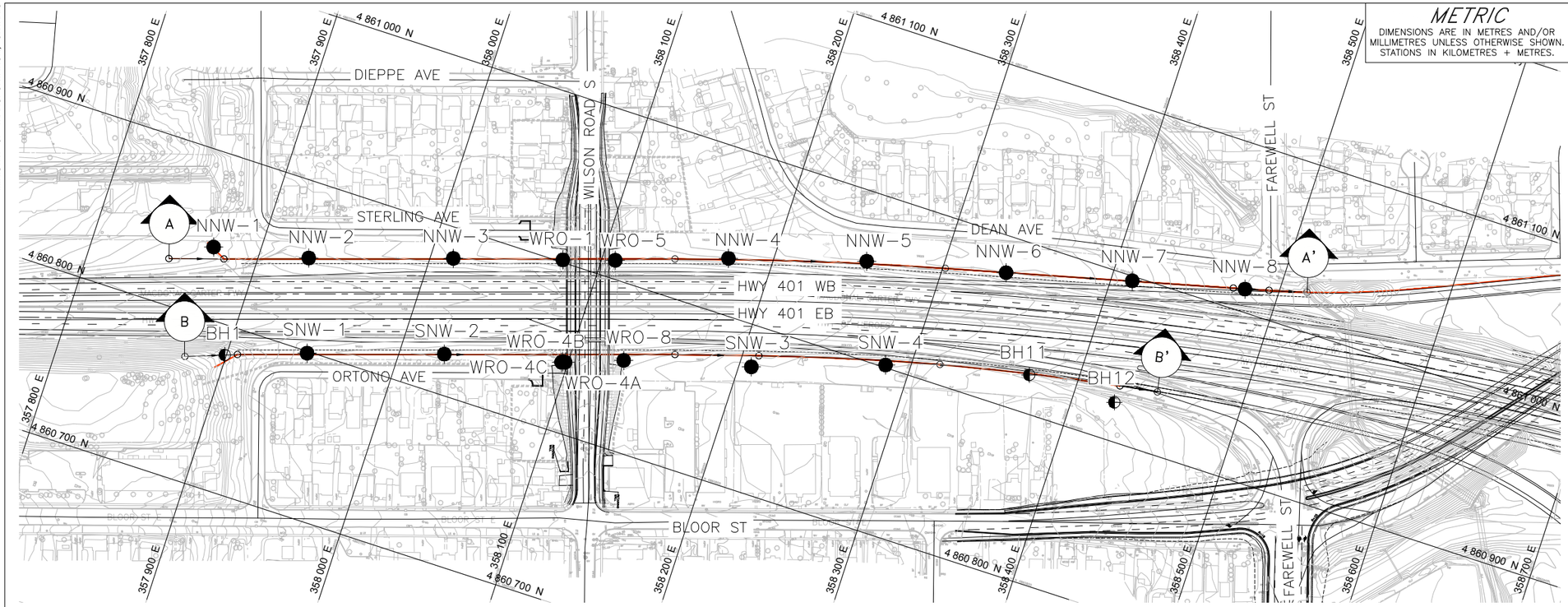
TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALLS

Noise Barrier Wall ID (Location)	Reference Boreholes	Ground Surface Elevation at Reference Boreholes (m)	Approximate Finished Ground Surface Elevation at Noise Wall Location (m)	Stratum	Depth below ground surface	Design Groundwater Level (m)	Design Parameters[2, 3]					
							S_u (kPa)	Φ'	γ (kN/m^3)	γ' (kN/m^3)	K_p	$K_{p2:1}$
North Noise Wall (West of Wilson Road)	NNW-1 to NNW-3, WRO-1	92.4 to 97.4		Firm clayey silt to sandy clayey silt (fill)	0.0 - 1.5	At depth of 2 m below existing ground surface	25	28	19	9	2.77	0.99
				Firm to very stiff silty clay	1.5 - 4.9		50	28	19	9	2.77	0.99
				Compact to very dense silty sand to sandy silty gravel (till / till-like) / hard clayey silt (till / till-like)	4.9 - 8.7		75	33	21	11	3.39	1.29
				Loose to very dense silty sand	8.7 - 14.8		-	31	20	10	3.12	1.18
				Stiff to hard silty clay	14.8 - 18.0		150	28	19	9	2.77	0.99
				Hard residual soil	18.0 - 18.6		200	35	21	11	3.69	1.40
				Bedrock	Below 18.6		-	-	-	-	-	-
North Noise Wall (East of Wilson Road)	NNW-4 to NNW-8, WRO-5	91.5 to 85.5		Firm to stiff clayey silt to clay (fill)	0.0 - 3.7	At depth of 2 m below existing ground surface	25	28	19	9	2.77	0.99
				Firm to very stiff clayey silt	3.7 - 5.9		45	28	19	9	2.77	0.99
				Loose to very dense sandy silt to silty sand (till / till-like) / hard clayey sand (till)	5.9 - 10.2		-	30	21	11	3.00	1.12
				Very stiff silty clay	10.2 - 11.7		150	28	19	9	2.77	0.99
				Compact to very dense silty sand	11.7 - 14.8		-	33	20	10	3.39	1.29
				Sitff to hard silty clay	14.8 - 17.3		150	28	19	9	2.77	0.99
				Hard residual soil	17.3 - 17.2		200	35	21	11	3.69	1.40
				Bedrock	Below 17.2		-	-	-	-	-	-
South Noise Wall (West of Wilson Road)	BH1, SNW-1, SNW-2, WRO-4A/B/C	99.0 to 92.5		Firm to stiff clayey silt to sandy clayey silt (fill)	0.0 - 2.1	At depth of 2 m below existing ground surface	25	28	19	9	2.77	0.99
				Firm to very stiff silty clay	1.5 - 4.9		50	28	19	9	2.77	0.99
				Compact to very dense silty sand to sandy silty gravel (till / till-like) / hard clayey silt (till / till-like)	4.9 - 8.7		75	33	21	11	3.39	1.29
				Loose to very dense silty sand	8.7 - 14.8		-	31	20	10	3.12	1.18
				Stiff to hard silty clay	14.8 - 18.0		150	28	19	9	2.77	0.99
				Hard residual soil	18.0 - 18.6		200	35	21	11	3.69	1.40
				Bedrock	Below 18.6		-	-	-	-	-	-
South Noise Wall (East of Wilson Road)	WRO-8, SNW-3, SNW-4, BH11, BH12	92.1 to 88.6		Firm to stiff clayey sand to clayey silt fill / loose to compact sandy silt fill	0.0 - 2.1	At depth of 2 m below existing ground surface	25	28	19	9	2.77	0.99
				Soft to very stiff clayey silt to silty clay	2.1 - 6.7		40	28	19	9	2.77	0.99
				Compact to very dense silty sand to gravelly silty sand till	6.7 - 10.2		-	33	21	11	3.39	1.29
				Compact to very dense silty sand	10.2 - 14.8		-	32	20	10	3.25	1.23
				Very stiff ot hard clayey silt (till-like)	14.8 - 17.8		150	30	21	11	3.00	1.12
				Very dense silty sand	17.8 - 18.7		-	32	20	10	3.25	1.23
				Bedrock	Below 18.7		-	-	-	-	-	-

NOTES:

1. Approximate stationing provided is based on Highway 401 stationing.
2. The approximate final ground surfaces represent the approximate average, maximum and minimum values; minor variations may occur and the proprietary noise barrier wall designer must assess and accommodate such elevations in their design.
3. Although Su, φ' and Kp parameters are given for the full depth of the soil, the passive resistance in the upper 1.3 m should be neglected in the design to account for frost action.
4. Design parameters:
   - s_u = undrained shear strength (kPa);
   - φ' = effective friction angle (degrees);
   - γ = bulk unit weight (kN/m3);
   - γ' = effective unit weight below the groundwater level (kN/m3);
   - K_p = passive earth pressure coefficient; and
   - $K_{p2:1}$ = passive earth pressure coefficient adjusted to account for 2H:1V sloping ground within two caisson diameters of the foundation element.
5. Where both undrained shear strength and effective friction angle parameters are provided for cohesive materials, the structural assessment should be completed for both undrained and drained conditions, and the selected design should be based on the more conservative approach.

MINISTRY OF TRANSPORTATION, ONTARIO



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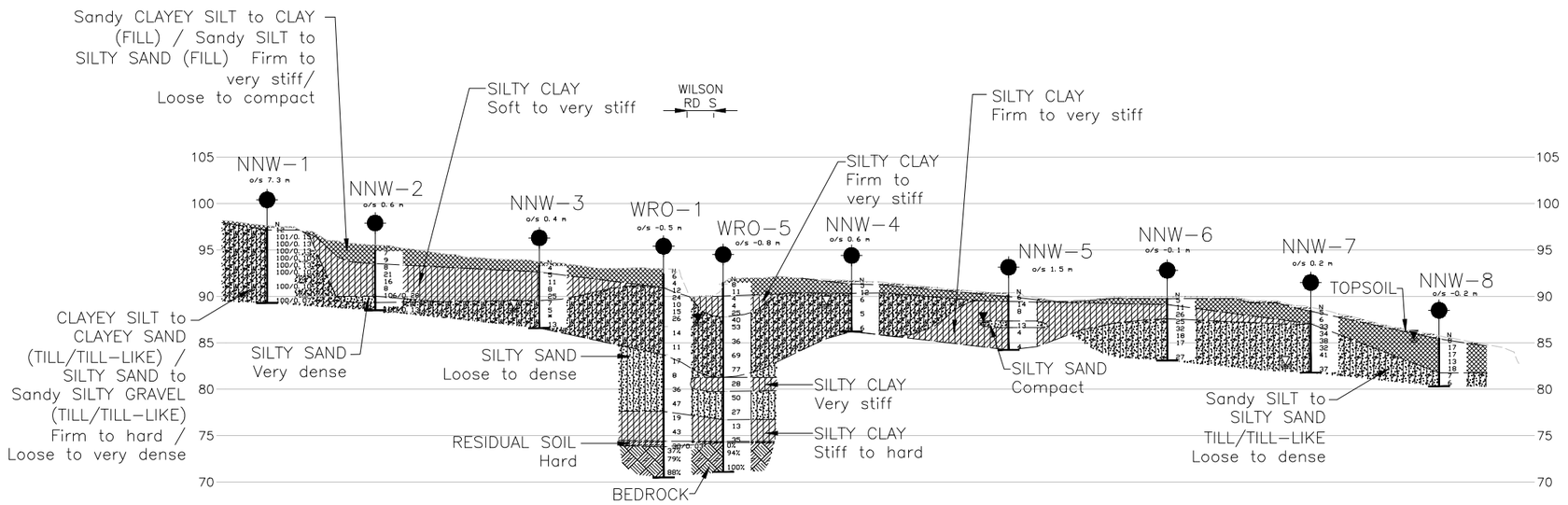

PROFILE A-A'

HORIZONTAL SCALE
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VERTICAL SCALE
6 0 6 12 m

REFERENCE

Base plans provided in digital format by Aecom, drawing file nos. 401_Bloor_Harmony_base.dwg, x-design.dwg, X-UU_21-23954-401-HARMONY-SUE1-Model_20210715.dwg and 60653736_S1 Wilson Rd_General Arrangement.dwg, received October 1, 2021.
Utilities plan provided in digital format by Aecom, file nos. 401_Bloor_Harmony_Utilities.dwg, X-Existing Storm-Model_ACAD13.dwg and X-HWY Existing Storm Sewer-Model_ACAD13.dwg, received November 17, 2021.

METRIC

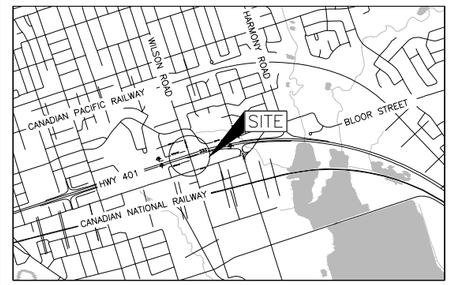
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 2146-20-00

HIGHWAY 401
NOISE BARRIER WALLS
BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET

wsp



KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on MMM DD, YYYY
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3
NNW-1	97.4	4860842.8	357872.1
NNW-2	94.9	4860854.4	357929.5
NNW-3	93.3	4860881.6	358013.6
NNW-4	91.4	4860933.7	358173.6
NNW-5	90.1	4860958.3	358254.5
NNW-6	89.8	4860978.1	358337.7
NNW-7	88.5	4860997.2	358412.6
NNW-8	85.5	4861013.7	358479.8
SNW-1	95.1	4860798.8	357946.5
SNW-2	93.8	4860824.3	358026.5
SNW-3	90.5	4860875.1	358207.4
SNW-4	89.2	4860901.5	358285.2
WRO-1	92.4	4860901.5	358077.6
WRO-4A	92.5	4860842.5	358098.3
WRO-4B	92.5	4860842.3	358096.9
WRO-4C	92.5	4860841.8	358096.2
WRO-5	91.5	4860911.2	358108.2
WRO-8	92.1	4860854.6	358132.0

LICENSED PROFESSIONAL ENGINEER L.C. COYNE Aug. 15, 2023 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M. J. BENTLEY 100547109 Aug. 15, 2023 PROVINCE OF ONTARIO

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.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M15-343

HWY. 401	PROJECT NO. 20350802		DIST. .
SUBM'D. AMP	CHKD. AMP	DATE: 08/15/2023	SITE: .
DRAWN: DD/SA	CHKD. MJB	APPD. LCC	DWG. 1

PLOT DATE: August 15, 2023
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MINISTRY OF TRANSPORTATION, ONTARIO

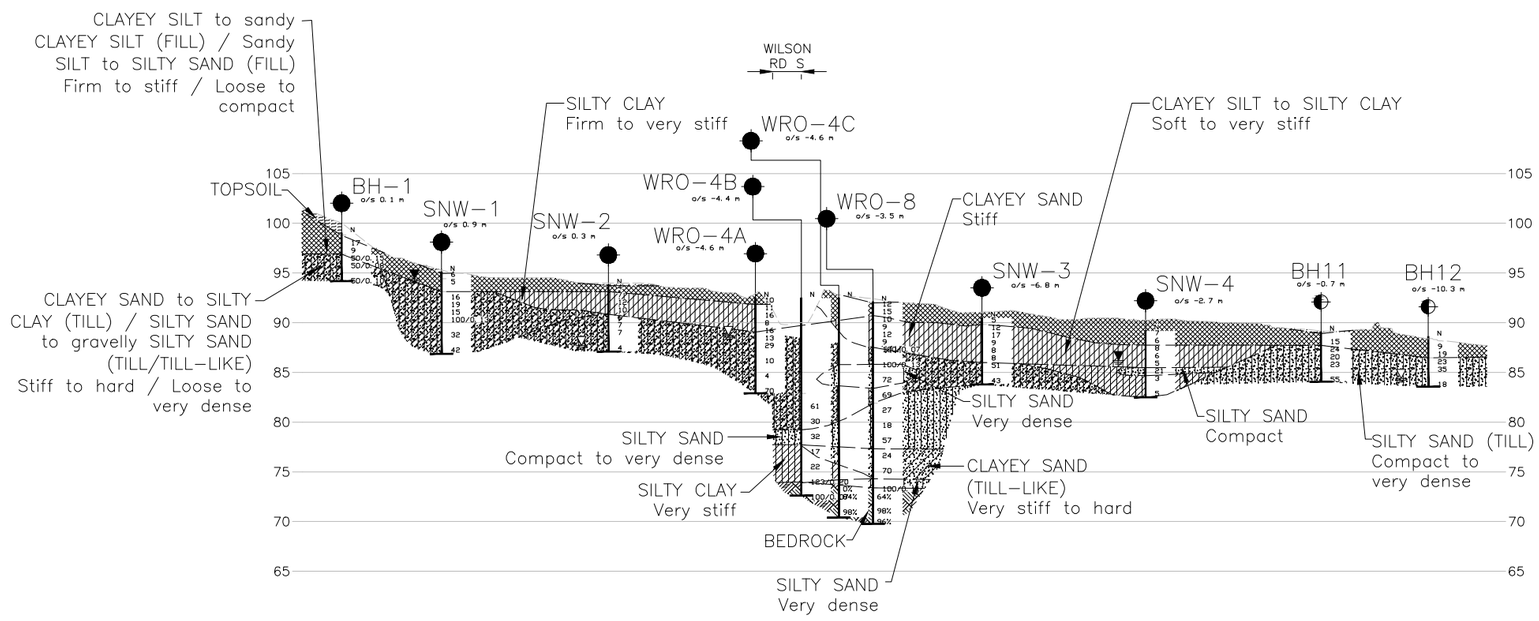
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 2146-20-00

HIGHWAY 401
NOISE BARRIER WALLS

SOIL STRATA

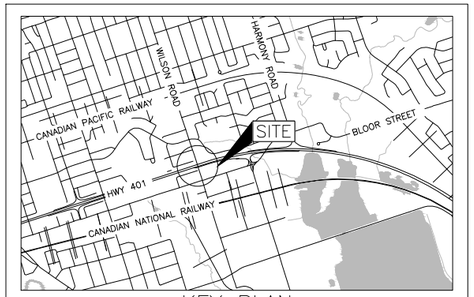
SHEET



PROFILE B-B'

VERTICAL SCALE
6 0 6 12 m

HORIZONTAL SCALE
30 0 30 60 m



KEY PLAN
SCALE
500 0 500 1000 m

LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation 1
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on MMM DD, YYYY
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3
SNW-1	95.1	4860798.8	357946.5
SNW-2	93.8	4860824.3	358026.5
SNW-3	90.5	4860875.1	358207.4
SNW-4	89.2	4860901.5	358285.2
WRO-4A	92.5	4860842.5	358098.3
WRO-4B	92.5	4860842.3	358096.9
WRO-4C	92.5	4860841.8	358096.2
WRO-8	92.1	4860854.6	358132.0

LICENSED PROFESSIONAL ENGINEER L.C. COYNE Aug. 15, 2023 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER M. J. BENTLEY 100547109 Aug. 15, 2023 PROVINCE OF ONTARIO

REFERENCE

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Utilities plan provided in digital format by Aecom, file nos. 401_Bloor_Harmony_Utilities.dwg, X-Existing Storm-Model_ACAD13.dwg and X-HWY Existing Storm Sewer-Model_ACAD13.dwg, received November 17, 2021.

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.

NO.	DATE	BY	REVISION

Geocres No. 30M15-343

HWY. 401	PROJECT NO. 20350802		DIST.
SUBM'D. AMP	CHKD. AMP	DATE: 08/15/2023	SITE:
DRAWN: DD/SA	CHKD. MJB	APPD. LCC	DWG. 2

PLOT DATE: August 15, 2023
FILENAME: s:\Clients\MTO\Hwy_401_Bloor-Harmony\99_PROJ\20350802_Aecom\40_PROD\0002_Noise_Wall_&_EW-Contract_1\20350802-0002-BG-0002.dwg

APPENDIX A

Borehole Records - 2013 Investigations (GEOCRES No. 30M15-132)

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.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* 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 cm^2 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, Gs)
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)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness[1]

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

1. 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 grainsize. 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.
2. 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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. 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.

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
υ	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 $\gamma = \rho \cdot g$ (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 = $(w_l - w_p)$
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
$C_{\alpha(e)}$	secondary compression index
C_α	rate of secondary compression
$C_{\alpha(\varepsilon)}$	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 = σ'_p / σ'_{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 δ
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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

Golder Associates

RECORD OF BOREHOLE No BH1

SHEET 1 OF 1 **METRIC**

PROJECT 11-1184-0109(8)

LOCATION N 4860782.2 ;E 357899.1 ORIGINATED BY JL

DIST Central HWY 401 BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer COMPILED BY AV

DATUM Geodetic DATE April 30, 2013 CHECKED BY TJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 15 30 45	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.0	GROUND SURFACE										
0.0	TOPSOIL (200 mm)										
0.2	Silty sand to sandy silt, trace to some clay, trace gravel, trace organics (FILL) Loose to compact Brown Moist		1	SS	17		98				
			2	SS	9						
96.9							97				
2.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Hard Grey Moist		3	SS	50/0.15						
			4	SS	50/0.08		96				
							95				
94.2			5	SS	50/0.10						
4.8	END OF BOREHOLE										

NOTE:

1. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH11

SHEET 1 OF 1 **METRIC**

PROJECT 11-1184-0109(8)

LOCATION N 4860923.1 ;E 358370.6 ORIGINATED BY JL

DIST Central HWY 401 BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer COMPILED BY AV

DATUM Geodetic DATE May 1, 2013 CHECKED BY TJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (15 30 45)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
89.1	GROUND SURFACE						89				
0.0	TOPSOIL (170 mm)										
0.2	Sandy silt, some gravel, trace clay (FILL) Compact Brown Moist		1	SS	15						
87.7							88				
1.4	Silty SAND, some gravel, trace to some clay (TILL) Compact to very dense Brown Moist		2	SS	24						
			3	SS	20		87				
			4	SS	23		86				
	Auger grinding indicating probable cobbles/boulders at a depth of 3.7 m						85				
84.1			5	SS	55						
5.0	END OF BOREHOLE										

NOTE:

1. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH12

SHEET 1 OF 1 **METRIC**

PROJECT 11-1184-0109(8)

LOCATION N 4860923.2 ;E 358425.3 ORIGINATED BY JL

DIST Central HWY 401 BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer COMPILED BY AV

DATUM Geodetic DATE May 1, 2013 CHECKED BY TJG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 15 30 45	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
88.6	GROUND SURFACE										
0.0	TOPSOIL (180 mm)										
0.2	Sandy silt, trace gravel, trace organics (FILL) Loose to compact Dark brown to black Moist		1	SS	9		88				
			2	SS	19		87				
86.5											
2.1	Silty SAND, trace to some gravel, trace to some clay (TILL) Compact to dense Brown becoming grey below a depth of 4.6 m Moist to wet		3	SS	23		86				
			4	SS	35	▽	85				
83.6			5	SS	18		84				
5.0	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.2 m below ground surface (Elev. 84.4 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX B

Borehole Records - 2021-22 Investigations

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.e.,* SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (*i.e.,* some sand)
≤ 10	trace (*i.e.,* 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 cm^2 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, Gs)
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)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness[1]

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

1. 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 grainsize. 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.
2. 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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. 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.

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
υ	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 $\gamma = \rho \cdot g$ (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 = $(w_l - w_p)$
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
$C_{\alpha(e)}$	secondary compression index
C_α	rate of secondary compression
$C_{\alpha(\varepsilon)}$	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 = σ'_p / σ'_{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 δ
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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 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
BD Bedding
BC Broken Core
CC Continuous Core
CL Closed
CO Contact
CU Curved
CT Coated
FLT Fault
FOL Foliation
FR Fracture
GO Gouge
IN Infilled
IR Irregular
JN Joint
KV Karstic Void
K Slickensided
LC Lost Core
MB Mechanical Break
PL Planar
PO Polished
RO Rough
SA Slightly Altered
SH Shear
SM Smooth
SR Slightly Rough
SY Stylolite
UN Undulating
VN Vein
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

RECORD OF BOREHOLE No NNW-1

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860842.8; E 357872.1 MTM NAD 83 ZONE 10 (LAT. 43.885658; LONG. -78.839508)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE February 8, 2022

ORIGINATED BY MJB
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.4	GROUND SURFACE										
0.0	TOPSOIL (250 mm)										
0.3	SILTY SAND (SM), trace to some gravel (TILL) Compact to very dense Brown to grey Dry		1	SS	12		97				
			2	SS	101/0.1						
			3	SS	100/0.1		96		○		2 30 46 22
	- Grey below a depth of 2.0 m (Elev. 95.4 m).		4	SS	100/0.1		95		○		
			5	SS	100/0.1						
			6	SS	100/0.1		94		○		
	- Auger grinding between a depth of 4.0 m to 4.3 m (Elev. 93.4 m to 93.1 m)						93				
			7	SS	100/0.1						
	- Auger grinding between a depth of 4.9 m to 5.2 m (Elev. 92.5 m to 92.2 m)						92				
	- Auger grinding between a depth of 6.1 m to 6.7 m (Elev. 91.3 m to 90.7 m)		8	SS	100/0.1	▼	91		○		4 35 43 18
			9	SS	100/0.0		90				
89.3											
8.1	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 6.9 m (Elev. 90.5 m) below ground surface upon completion of drilling.

2. Borehole dry inside open borehole upon completion of drilling borehole

3. Water measured in 50 mm dia. piezometer, with stickup casing, as follows:

Date	Depth (m)	Elev. (m)
4-Mar-22	Dry	Dry
20-Mar-22	6.4	91.0

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

RECORD OF BOREHOLE No NNW-2

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860854.4; E 357929.5 MTM NAD 83 ZONE 10 (LAT. 43.885759; LONG. -78.838793)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE February 9, 2022

ORIGINATED BY KC
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
94.9	GROUND SURFACE										
0.0	Sandy SILT (ML), trace gravel (FILL) Loose Brown Moist		1	SS	7						
			2	SS	9		94				0 39 48 13
93.5											
1.4	SILTY CLAY (Cl), trace to some sand, trace gravel Stiff to very stiff Brown to grey Moist		3	SS	8		93	>96+			0 10 60 30
			4	SS	21		92				
			5	SS	16						
	- Grey below a depth of 3.7 m (Elev. 91.2 m).		6	SS	8		91				
90.0			7A 7B	SS	106/0.28		90				
4.9	SILTY SAND (SM), trace gravel Very dense Grey Moist										
89.3											
5.6	CLAYEY SILT (CL) and sand, trace gravel (TILL) Hard Grey Moist		8	SS	100/0.13		89				2 36 40 22
88.5											
6.4	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

2. Water not encountered during drilling.

3. Water measured in open borehole at a depth of 6.4 m (Elev. 88.5 m) below ground surface upon completion of drilling borehole.

4. Undrained shear strength testing completed in second borehole adjacent to original borehole.

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

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RECORD OF BOREHOLE No NNW-3

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860881.6; E 358013.6 MTM NAD 83 ZONE 10 (LAT. 43.885998; LONG. -78.837744)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE February 7, 2022

ORIGINATED BY KC
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.3	GROUND SURFACE										
0.0 / 92.6	CLAYEY SILT (CL), trace sand (FILL) Firm Brown Moist		1	SS	4		93				
0.7 / 89.6	SILTY CLAY (CI), trace sand Firm to very stiff Brown Moist		2	SS	5		92				0 3 58 39
			3	SS	11						
			4	SS	8		91				
			5	SS	25		90				
3.7 / 86.6	CLAYEY SAND (SC), some gravel (TILL-Like) Firm to stiff Grey Moist - No sample recovery from Sample 7		6	SS	7	▽	89				
			7	SS	5						
			8	SS	*		88				11 42 34 13
			9	SS	13		87				14 47 33 6
6.7	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

1. Water encountered at a depth of 3.1 m below ground surface (Elev. 90.2 m) during drilling.

3. Water measured in open borehole at a depth of 4.6 m (Elev. 88.7 m) below ground surface upon completion of drilling borehole.

4. *N value for sample 8 not recorded in field.

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

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RECORD OF BOREHOLE No NNW-4

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860933.7; E 358173.6 MTM NAD 83 ZONE 10 (LAT. ; LONG.)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 17, 2021

ORIGINATED BY ZP
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
91.4	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (70 mm)										
	CLAYEY SILT (CL), trace to some sand (FILL) Firm to stiff Brown		1	SS	5		91		○		
90.3	Moist		2A / 2B	SS	12				○		
1.1	SILTY SAND (SM), trace gravel (TILL-LIKE) Loose to compact Brown to grey Moist		3	SS	6	▽	90				
							89	× + >96 +			
	- Grey below a depth of 3.1 m (Elev. 88.3 m).		4	SS	5		88		○	Non-plastic	7 47 38 8
								>96 +			
							87	>96 +			
86.2			5	SS	6						
5.2	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

2. Water encountered at a depth of 2.3 m (Elev. 89.1 m) below ground surface during drilling.

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

RECORD OF BOREHOLE No NNW-5

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860958.3; E 358254.5 MTM NAD 83 ZONE 10 (LAT. 43.886670; LONG. -78.834738)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 21, 2021

ORIGINATED BY NT
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
90.1	GROUND SURFACE						90				
0.0	TOPSOIL (150 mm)		1A	SS	6						
0.2	SILTY SAND (SM), trace clay (FILL) Loose Brown Moist		1B								
89.4							89				
0.7	SILTY CLAY (Cl), some sand, trace gravel Stiff Brown Moist		2	SS	14						
			3	SS	8		88				
87.3											
2.8	SILTY SAND (SM) Compact Brown Wet		4A	SS	13		87				0 85 11 4
86.6			4B								
3.5	SILTY CLAY (Cl), trace sand Firm Grey Moist - Grey below a depth of 3.5 m (Elev. 86.6 m).		5	SS	4		86				0 1 53 46
			6	SS	4		85				
84.2											
5.9	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 2.7 m (Elev. 87.4 m) below ground surface upon completion of drilling.

2. Water measured in open borehole at a depth of 2.7 m (Elev. 87.4 m) below ground surface upon completion of drilling.

3. Water measured in 50 mm dia. piezometer with stickup casing as follows:

Date	Depth (m)	Elev. (m)
4-Mar-22	2.8	87.3
20-May-22	2.9	87.2

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No NNW-6

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860978.1; E 358337.7 MTM NAD 83 ZONE 10 (LAT. 43.886842; LONG. -78.833700)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 17, 2021

ORIGINATED BY ZP
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
89.8	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (50 mm)										
89.1 / 0.7	CLAYEY SILT (CL) (FILL) Firm Brown Moist		1	SS	5						
	SILTY CLAY (Cl), trace sand, trace gravel Stiff to very stiff Brown Moist		2	SS	11		89	○			
87.6			3	SS	26		88	● ○			1 9 35 55
2.2	SILTY SAND (SM), some gravel to gravelly, trace to some clay (TILL) Compact to dense Brown to grey Moist		4	SS	25		87	○		Non-plastic	30 36 26 8
			5	SS	32						
			6	SS	18		86	○			12 42 35 11
	- Grey below a depth of 4.6 m (Elev. 85.2 m)		7	SS	17		85				
							84				
83.1			8	SS	27			○			
6.7	END OF BOREHOLE										

NOTE:

1. Borehole open and dry upon completion of drilling.

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

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RECORD OF BOREHOLE No NNW-7

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860997.2; E 358412.6 MTM NAD 83 ZONE 10 (LAT. 43.887009; LONG. -78.832767)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 17, 2021

ORIGINATED BY ZP
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
88.5	GROUND SURFACE										
0.0	TOPSOIL (100 mm)										
0.1	CLAY (CH) (FILL) Firm Brown Moist		1	SS	5		88				
			2	SS	6				56		
87.1							87				
1.5	Sandy SILT (ML), trace gravel (TILL) Dense Brown Moist - Wet sand lenses at 2.3 m depth		3	SS	33						
			4	SS	34		86				2 35 54 9
			5	SS	38		85				
	- Grey below a depth of 3.7 m (Elev. 84.8 m)		6	SS	32						7 26 58 9
			7	SS	41		84				
						▽	83				
81.8			8	SS	37		82				
6.7	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

2. Water measured in open borehole at a depth of 5.9 m (Elev. 82.6 m) below ground surface upon completion of drilling.

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No NNW-8

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4861013.7; E 358479.8 MTM NAD 83 ZONE 10 (LAT. 43.887153; LONG. -78.831929)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 17, 2021

ORIGINATED BY ZP
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
85.5	GROUND SURFACE										
0.0	TOPSOIL (70 mm)										
0.1	SILTY CLAY (CI), some sand (FILL) Stiff to very stiff Brown Moist		1	SS	8		85				
			2	SS	17						0 12 38 50
			3	SS	17		84				
			4	SS	13		83				
			5	SS	18		82				
81.8											
3.7	SILTY SAND (SM), some gravel (TILL-LIKE) Loose Grey Moist		6	SS	7		81				
80.3			7	SS	6					Non-plastic	15 51 22 12
5.2	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

2. Water measured in open borehole at a depth of 4.6 m (Elev. 80.9 m) below ground surface upon completion of drilling borehole.

3. Water measured in 50 mm dia. piezometer with stickup casing as follows:

Date	Depth (m)	Elev. (m)
4-Mar-22	0.1	85.4
20-May-22	0.8	84.7

- Water frozen in piezometer during Mar 4/22 reading.

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No SNW-1

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860798.8; E 357946.5 MTM NAD 83 ZONE 10 (LAT. 43.885257; LONG. -78.838587)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 15, 2021

ORIGINATED BY ZP
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
95.1	GROUND SURFACE						95				
0.0	TOPSOIL (130 mm)										
0.1	SILTY SAND (SM), some gravel (FILL) Loose Brown Moist		1	SS	6						
94.4							94				
0.7	CLAYEY SILT (CL) (FILL) Firm Brown Moist		2	SS	5			× +			
93.1							93	>96 +			
2.0	SILTY CLAY (CI), some sand to sandy, trace to some gravel (TILL) Stiff to hard Brown to grey Moist - Grey below a depth of 3.0 m (Elev.92.1 m).		3	SS	16				ϕ		0 16 50 34
			4	SS	19		92				
			5	SS	15		91		○		
	-SPT spoon bounding at a depth of 4.9 m (Elev. 90.2 m)		6	SS	100/0.1		90				
			7	SS	32		89		○ ϕ		2 23 37 38
			8	SS	42		88				
86.9							87				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.

2. Water encountered at a depth of 4.6 m (Elev. 90.5 m) below ground surface during drilling.

3. Water measured in piezometer as follows:

Date	Depth (m)	Elev. (m)
4-Mar-22	0.7	94.4
20-Mar-22	1.2	93.9

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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RECORD OF BOREHOLE No SNW-2

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)

LOCATION N 4860824.3; E 358026.5 MTM NAD 83 ZONE 10 (LAT. 43.885481; LONG. -78.837589)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE December 15, 2021

ORIGINATED BY NT
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
93.8	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (80 mm)										
93.1	CLAYEY SILT (CL), trace sand, containing rootlets (FILL) Firm Brown Moist		1	SS	4						
0.7	SILTY CLAY (Cl), trace sand Firm to stiff Brown Moist		2	SS	7		93				0 3 59 38
			3	SS	12		92				
90.8			4	SS	10		91				
3.0	SILTY SAND (SM), some gravel to gravelly, trace to some clay (TILL-LIKE) Loose Brown to grey Moist - Grey below a depth of 4.0 m (Elev. 89.8 m)		5	SS	6						
			6A 6B	SS	7		90			Non-plastic	13 41 33 13
			7	SS	7		89				
			8	SS	4	▽	88	>96 +		Non-plastic	26 38 28 8
87.1											
6.7	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.
2. Water measured in open borehole at a depth of 6.1 m (Elev. 87.7 m) below ground surface upon completion of drilling borehole.
3. Undrained shear strength testing completed in second borehole adjacent to original borehole.

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

RECORD OF BOREHOLE No SNW-3

SHEET 1 OF 1 **METRIC**

PROJECT 20350802
G.W.P. 2146-20-00
DIST Central HWY 401
DATUM CGVD28 / HT2_0 (Geodetic)
LOCATION N 4860875.1; E 358207.4 MTM NAD 83 ZONE 10 (LAT. 43.885925; LONG. -78.835332)
BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers
DATE February 10, 2022
ORIGINATED BY KC
COMPILED BY JNS
CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
90.5	GROUND SURFACE										
0.0 / 89.8	CLAYEY SILT (CL), trace sand (FILL) Firm Brown Wet		1	SS	5						
0.7	SILTY CLAY (CI), trace sand Stiff to very stiff Brown to grey Moist		2	SS	12						
			3	SS	17						
			4	SS	9						
			5	SS	8						0 3 43 54
	- Grey below a depth of 3.7 m (Elev. 90.2 m).		6	SS	8						
86.0											
4.5	Gravelly SILTY SAND (SM) (TILL) Dense to very dense Grey Moist		7	SS	51						
83.8			8	SS	43						19 40 28 13
6.7	END OF BOREHOLE										

NOTES:

1. Borehole open upon completion of drilling.
2. Borehole dry inside open borehole upon completion of drilling borehole.
3. Borehole shifted 6 m south of original staked located due to on site accessibility conditions.

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

PROJECT 20350802

RECORD OF BOREHOLE No SNW-4

SHEET 1 OF 1

METRIC

G.W.P. 2146-20-00 | LOCATION N 4860901.5; E 358285.2 MTM NAD 83 ZONE 10 (LAT. 43.886157; LONG. -78.834363) | ORIGINATED BY KC

DIST Central | HWY 401 | BOREHOLE TYPE Power Auger; 152 mm O.D. Solid Stem Augers | COMPILED BY JNS

DATUM CGVD28 / HT2_0 (Geodetic) | DATE February 11, 2022 | CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
89.2	GROUND SURFACE						89				
0.0	CLAYEY SILT (CL), trace sand to sandy (FILL) Firm Brown Moist		1	SS	7						
			2	SS	6		88	>96 +			
87.8											
1.5	SILTY CLAY (CI), trace sand Firm to stiff Brown Moist		3	SS	8						0 2 62 36
			4	SS	6		87	>96 +			
			5	SS	5		86	>96 +			
85.5											
3.7	SILTY SAND (SM) Compact Brown Wet		6	SS	21		85				0 81 16 3
84.7								>96 +			
4.5	CLAYEY SILT (CL), trace sand Soft to firm Grey Moist - Grey below a depth of 4.5 m (Elev. 84.7 m).		7	SS	3						0 4 58 38
							84				
			8	SS	5		83	× +			
82.5											
6.7	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of 5.3 m (Elev. 83.9 m) below ground surface upon completion of drilling.

2. Water encountered at a depthof 3.8 m below ground surface (Elev. 85.4 m) during drilling.

3. Water measured in open borehole at a depth of 4.6 m (Elev. 84.6 m) below ground surface upon completion of drilling borehole.

4. Undrained shear strength testing completed in second borehole 1 m west to original borehole.

3. Water measured in piezometer as follows:

Date	Depth (m)	Elev. (m)
11-Feb-22	4.1	85.1
4-Mar-22	3.0	86.2
20-May-22	2.8	86.4

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

PROJECT 20350802

RECORD OF BOREHOLE No WRO-1

SHEET 1 OF 2

METRIC

G.W.P. 2146-20-00 LOCATION N 4860901.5; E 358077.6 MTM NAD 83 ZONE 10 (LAT. 43.886172; LONG. -78.836946) ORIGINATED BY JL/JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE January 13, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.4	GROUND SURFACE						92				
0.0	Sandy CLAYEY SILT (CL) (FILL) Firm Dark brown to brown Moist		1	SS	6						
			2	SS	4				○		
91.0							91				
1.5	SILTY SAND (SM), some gravel to gravelly (TILL-LIKE) Compact Brown to grey Moist to wet		3	SS	12						
			4	SS	24		90		○		
	- Grey below a depth of 3.0 m (Elev. 89.4 m)		5	SS	10		89		○	Non-plastic	21 39 33 7
			6	SS	15				○		
	- Wet below a depth of 4.6 m (Elev. 87.8 m)		7	SS	26		88				
86.8							87				
5.6	Sandy SILTY GRAVEL (GM) (TILL-LIKE) Compact Grey Moist		8	SS	14		86		○	Non-plastic	43 25 24 8
			9	SS	11		85				
83.7							84				
8.7	SILTY SAND (SM) Loose to dense Grey Wet		10	SS	17		83		○		
	-Trace organics and shell fragments between a depth of 10.2 m and 13.3 m (Elev. 82.2 and 79.0 m)		11	SS	8		82		○	OC = 0.6%	
			12	SS	36		81		○	OC = 1.0%	0 65 28 7
			13	SS	47		80				
77.6							79				
14.8							78				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 20350802

RECORD OF BOREHOLE No WRO-1

SHEET 2 OF 2

METRIC

G.W.P. 2146-20-00 LOCATION N 4860901.5; E 358077.6 MTM NAD 83 ZONE 10 (LAT. 43.886172; LONG. -78.836946) ORIGINATED BY JL/JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE January 13, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	10 20 30		
	SILTY CLAY (Cl), trace sand Very stiff to hard Grey Moist		14	SS	19		77		○		
							76				
			15	SS	43				○ ——		0 6 47 47
74.4							75				
18.0	RESIDUAL SOIL Hard Brown Moist		16	SS	30/0.03						
73.8			1	RC	REC 0%		74		○		RQD = 0%
18.6	SHALE (BEDROCK)		2	RC	REC 100%						RQD = 37%
	Coring carried out between a depth of 18.5 m and 21.9 m (Elev. 73.9 m to 70.5 m). Refer to Record of Drillhole WRO-1.		3	RC	REC 100%		73				RQD = 79%
							72				
			4	RC	REC 93%						RQD = 88%
70.5							71				
21.9	END OF BOREHOLE										

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

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RECORD OF DRILLHOLE: WRO-1

PROJECT: 20350802

LOCATION: N 4860901.5 ;E 358077.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: January 13, 2022

DRILL RIG: CME-55

DRILLING CONTRACTOR: Davis Drilling

SHEET 1 OF 1

DATUM: CGVD28 / HT2_0 (Geodetic)

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
	Continued from Borehole WRO-1	73.92															
	RESIDUAL SOIL	18.47	1														
	Slightly weathered to fresh, thinly bedded, grey, fine grained, faintly porous, weak SHALE (Whitby Formation)	18.57	2							BD,PL,SM PC,CL BD,PL,SM PC,CL BD,CU,SM BD,IR,RO PC,CL BD,IR,RO BD,IR,RO	1 1 2 3 3 3	4 4 1 4 1 1	R4 R3 R2 R1	W1 W2 W3 W4 W5 W6			
19			3							BD,IR,RO JN,PL,SM BD,IR,RO PC,CL BD,IR,RO PC,CL BD,ST,SM PC,CL BD,PL,SM PC,CL	3 3 3 2 1	1 4 4 4 4					
20																	
21			4							BD,PL,SM PC,CL JN,IR,RO	2 3	4 1					UCS=107.3 MPa
		70.50															
22	END OF DRILLHOLE	21.89															
23																	
24																	
25																	
26																	
27																	

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

LOGGED: JS

CHECKED: ACK

GOLDER

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PROJECT 20350802

RECORD OF BOREHOLE No WRO-4A SHEET 1 OF 1 METRIC

G.W.P. 2146-20-00 LOCATION N 4860842.5; E 358098.3 MTM NAD 83 ZONE 10 (LAT. 43.885640; LONG. -78.836694) ORIGINATED BY ZP

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE December 14, 2021 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.5	GROUND SURFACE										
0.0	Sandy CLAYEY SILT (CL) (FILL) Stiff Dark brown Moist		1	SS	10		92				
91.8											
0.7	SILTY CLAY (Cl), trace sand Stiff to very stiff Brown Moist		2	SS	11						
			3	SS	16		91				
			4	SS	8		90				
	- Sandy, some gravel below a depth of 3.0 m (Elev. 89.5 m)		5	SS	16						
89.1							89				
3.4	SILTY SAND (SM), trace to some gravel (TILL-LIKE) Loose to very dense Grey Wet		6	SS	13						10 67 19 4
			7	SS	29		88				
			8	SS	10		87				
			9	SS	4		86				
							85			Non-plastic	16 43 32 9
	- 1.0 m of heave measured inside augers at a depth of 9.1 m (Elev. 83.4 m)		10	SS	70		84				
82.9							83				
9.6	END OF BOREHOLE DUE TO HEAVING SANDS										

NOTES:

1. Refer to Record of Borehole WRO-4B and WRO-4C for stratigraphy below a depth of 9.6 m (Elev. 82.9 m).

2. Borehole caved to a depth of 8.2 m (Elev. 84.3 m) upon completion of drilling.

3. Piezometer installed in a separate borehole 1 m east of the WRO-4A borehole location.

4. Water measured in 50 mm dia. PVC piezometer (stickup casing) as follows:

Date	Depth (m)	Elev. (m)
13-Jan-22	3.8	88.8
14-Feb-22	3.9	88.6
04-Mar-22	3.8	88.7
20-May-22	3.8	88.7

$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT 20350802

RECORD OF BOREHOLE No WRO-4B SHEET 1 OF 2 METRIC

G.W.P. 2146-20-00 LOCATION N 4860842.3; E 358096.9 MTM NAD 83 ZONE 10 (LAT. 43.885638; LONG. -78.836711) ORIGINATED BY JL

DIST Central HWY 401 BOREHOLE TYPE Power Auger; Mud Rotary COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE January 12, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
92.5	GROUND SURFACE						92				
0.0	Borehole straight drilled to a depth of 9.6 m (Elev. 82.9 m).						91				
							90				
							89				
							88				
							87				
							86				
							85				
							84				
82.9							83				
9.6	CLAYEY SAND (SC), trace gravel (TILL) Hard Grey Moist						82				
			11	SS	61		81				
			12	SS	30		80				7 43 38 12
79.2											
13.3	SILTY SAND (SM), trace organics and shell fragments Dense Grey Wet		13	SS	32		79			OC = 0.9%	
77.7							78				
14.8											

Continued Next Page

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

PROJECT 20350802

RECORD OF BOREHOLE No WRO-4B SHEET 2 OF 2 METRIC

G.W.P. 2146-20-00 LOCATION N 4860842.3; E 358096.9 MTM NAD 83 ZONE 10 (LAT. 43.885638; LONG. -78.836711) ORIGINATED BY JL

DIST Central HWY 401 BOREHOLE TYPE Power Auger; Mud Rotary COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE January 12, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY (Cl), trace sand, trace gravel Very stiff Grey Moist		14	SS	17		77		40		1 9 38 52
			15	SS	22		76				
							75				
73.9			16	SS	123/0.20		74				
18.6	Inferred SHALE (BEDROCK)										
72.6			17	SS	100/0.07		73				
19.9	END OF BOREHOLE										

NOTES:

1. Refer to Borehole WRO-4A for stratigraphy above a depth of 9.6 m (Elev. 82.9 m). Refer to Borehole WRO-4C for rock coring information.

2. Borehole caved to a depth of 12.2 m (Elev. 80.3 m) upon completion of drilling.

3. Water measured inside borehole at a depth of 4.0 m (Elev. 88.5 m) upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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PROJECT 20350802

RECORD OF BOREHOLE No WRO-4C SHEET 1 OF 2 METRIC

G.W.P. 2146-20-00 LOCATION N 4860841.8; E 358096.2 MTM NAD 83 ZONE 10 (LAT. 43.885634; LONG. -78.836720) ORIGINATED BY ZP

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 10, 2022 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
92.5	GROUND SURFACE										
0.0	Borehole straight drilled to a depth of 18.3 m (Elev. 74.2 m).						92 91 90 89 88 87 86 85 84 83 82 81 80 79 78				

Continued Next Page

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

PROJECT 20350802

RECORD OF BOREHOLE No WRO-4C SHEET 2 OF 2 METRIC

G.W.P. 2146-20-00 LOCATION N 4860841.8; E 358096.2 MTM NAD 83 ZONE 10 (LAT. 43.885634; LONG. -78.836720) ORIGINATED BY ZP

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 10, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	10 20 30		
	Borehole straight drilled to a depth of 18.3 m (Elev. 74.2 m).						77				
							76				
							75				
74.2											
73.8	SILTY SAND (SM) Grey Moist		1	SS	128/0.29		74				
18.7	SHALE (BEDROCK)		1	RC	REC 100%						RQD = 0%
	Coring carried out between a depth of 18.9 m and 22.1 m (Elev. 73.9 m to 70.4 m). Refer to Record of Drillhole WRO-4C.		2	RC	REC 100%		73				RQD = 84%
							72				
			3	RC	REC 98%		71				RQD = 98%
70.4											
22.1	END OF BOREHOLE										

$+^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

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PROJECT: 20350802

RECORD OF DRILLHOLE: WRO-4C

SHEET 1 OF 1

LOCATION: N 4860841.8 ;E 358096.2

DRILLING DATE: February 10, 2022

DATUM: CGVD28 / HT2_0 (Geodetic)

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Davis Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole WRO-4C		73.57															
19		Slightly weathered to fresh, thinly bedded, grey, fine grained, faintly porous, medium strong SHALE (Whitby Formation)		18.93	1							BD,PL,SM	1	1					
												BD,IR,SM	2	1					
												JN,PL,SM PC,CL	1	4					
												BD,ST,SM	2	1					
20					2							BD,CU,SM	2	1					
												BD,IR,SM	2	4					
												BD,PL,SM PC,CL	1	4					
												JN,IR,RO	3	1					
21												BD,PL,RO	1.5	1					
					3							BD,PL,RO	1.5	1					UCS=47.5 MPa
												BD,PL,RO PC,CL	1.5	4					
22				70.41								BD,PL,RO	1.5	1					UCS=80.1 MPa
		END OF DRILLHOLE		22.09															
23																			
24																			
25																			
26																			
27																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JS

CHECKED: ACK

GTA-RCK 054 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY\02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-MISS.GDT 4/25/22

PROJECT 20350802

RECORD OF BOREHOLE No WRO-5

SHEET 1 OF 2

METRIC

G.W.P. 2146-20-00 LOCATION N 4860911.2; E 358108.2 MTM NAD 83 ZONE 10 (LAT. 43.886258; LONG. -78.836565) ORIGINATED BY JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 11, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
91.5	GROUND SURFACE						
0.0	TOPSOIL (200 mm)						
0.2	SILTY CLAY (Cl), trace sand (FILL) Firm to very stiff Brown Moist		1	SS	8		
			2	SS	11		
90.0							
1.5	SILTY CLAY (Cl), trace sand to sandy, trace gravel to gravelly Firm to very stiff Brown Moist		3	SS	4		
			4	SS	4		
	- Gravelly, sandy below a depth of 3.0 m (Elev. 88.5 m)		5	SS	25		
87.8							
3.7	CLAYEY SAND (SC), some gravel (TILL) Hard Grey Moist		6	SS	40	▼	
			7	SS	53		
	- Auger grinding between a depth of 5.2 m to 5.5 m (Elev. 86.3 m to 86.0 m).						
			8	SS	36		
			9	SS	69		
			10	SS	77		
	-100 mm sand seam at a depth of 9.5 m (Elev. 82.0 m)						
81.3							
10.2	SILTY CLAY (Cl) Very stiff Grey Moist		11	SS	28		
79.8							
11.7	SILTY SAND (SM) Compact to dense Grey Moist		12	SS	50		
	- Trace organics between 13.3 m and 14.8 m (Elev. 78.2 m to 76.7 m).		13	SS	27		
76.7							
14.8							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	4	62	34
	13	40	31	16
	0	60	34	7

Continued Next Page

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

PROJECT 20350802

RECORD OF BOREHOLE No WRO-5 SHEET 2 OF 2 METRIC

G.W.P. 2146-20-00 LOCATION N 4860911.2; E 358108.2 MTM NAD 83 ZONE 10 (LAT. 43.886258; LONG. -78.836565) ORIGINATED BY JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 11, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY (Cl) Stiff to hard Grey Moist		14	SS	13		76				
							75				
74.4			15A 15B 15C	SS	35 REC						
17.3	RESIDUAL SOIL Hard Grey Moist		1	RC	100%		74				RQD = 0%
	SHALE (BEDROCK) Coring carried out between depth of 17.3 m to 20.4 m (Elev. 74.2 m to 71.1 m). Refer to Record of Drillhole WRO-5.		2	RC	REC 95%		73				RQD = 94%
			3	RC	REC 100%		72				RQD = 100%
71.1											
20.4	END OF BOREHOLE NOTE: 1. Water measured in 50 mm dia. PVC piezometer as follows: Date Depth (m) Elev. (m) 14-Feb-22 4.3 87.2 04-Mar-22 4.3 87.2 20-May-22 4.3 87.2										

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY\02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-GTA.GDT 2/3/23

PROJECT: 20350802

RECORD OF DRILLHOLE: WRO-5

SHEET 1 OF 1

LOCATION: N 4860911.2 ;E 358108.2

DRILLING DATE: February 11, 2022

DATUM: CGVD28 / HT2_0 (Geodetic)

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Davis Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole WRO-5		74.22															
18		Slightly weathered to fresh, thinly bedded, black, fine grained, faintly porous, medium strong SHALE (Whitby Formation)		17.28	1							BD,PL,SM CL	1	1					
												BD,PL,RO CL	1.5	1					
					2														Bentonite
19												BD,PL,SM CL	1	1					
					3														
20																			UCS=86.5 MP
				71.10															
		END OF DRILLHOLE		20.40															
21																			
22																			
23																			
24																			
25																			
26																			

FEATURES LEGEND

BROKEN CORE CLAY SEAM LIMESTONE LOST CORE

DEPTH SCALE

1 : 50

LOGGED: JS

CHECKED: ACK

GTA-RCK 054 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY\02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-MISS.GDT 4/25/22

PROJECT 20350802

RECORD OF BOREHOLE No WRO-8

SHEET 1 OF 2

METRIC

G.W.P. 2146-20-00 LOCATION N 4860854.6; E 358132.0 MTM NAD 83 ZONE 10 (LAT. 43.885746; LONG. -78.836274) ORIGINATED BY JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 15, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS
92.1 / 0.0	GROUND SURFACE TOPSOIL (100 mm)					
0.1	CLAYEY SAND (SC), some gravel (FILL) Stiff Brown Moist		1	SS	12	
			2	SS	15	
90.6 / 1.5	CLAYEY SAND (SC), some gravel Stiff Grey Moist		3	SS	10	
			4	SS	9	
			5	SS	12	
			6	SS	9	
87.5	-SPT spoon bouncing at 4.6 m depth (Elev. 87.5 m)		7	SS	100/0.07	
4.6	SILTY SAND (SM), some gravel (TILL) Very dense Grey Moist - Auger grinding between a depth of 4.6 m and 5.5 m (Elev. 87.5 m to 86.6 m)					
85.8			8A 8B	SS	100/0.13	
6.3	- Auger grinding between a depth of 6.3 m and 7.3 m (Elev. 85.8 m to 84.8 m) SILTY SAND (SM) Very dense Grey Wet					
			9	SS	72	
83.4 / 8.7	SILTY SAND (SM), some gravel (TILL) Very dense Grey Moist		10	SS	69	
81.9 / 10.2	SILTY SAND (SM) Compact to very dense Grey Moist to wet		11	SS	27	
	-Trace organics between a depth of 11.7 m and 13.3 m (Elev. 80.4 m to 78.8 m)		12	SS	18	
			13	SS	57	
77.3 / 14.8						

ELEVATION SCALE: 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
18	36	32	15
0	64	31	5

Continued Next Page

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

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-GTA.GDT 2/3/23

PROJECT 20350802

RECORD OF BOREHOLE No WRO-8

SHEET 2 OF 2

METRIC

G.W.P. 2146-20-00 LOCATION N 4860854.6; E 358132.0 MTM NAD 83 ZONE 10 (LAT. 43.885746; LONG. -78.836274) ORIGINATED BY JS

DIST Central HWY 401 BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers COMPILED BY MJB

DATUM CGVD28 / HT2_0 (Geodetic) DATE February 15, 2022 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	10 20 30		
	CLAYEY SAND (SC), trace gravel (TILL-LIKE) Very stiff to hard Grey Moist to wet						77				
			14	SS	24						1 53 28 18
							76				
			15	SS	70						
74.3							75				
17.8	SILTY SAND (SM), some gravel Very dense Grey Moist										
73.4			16	SS	100/0mm		74				
18.7	SHALE (BEDROCK)		1	RC	REC 0%						RQD = 0%
	Coring carried out between depth of 18.7 m to 22.3 m (Elev. 73.4 m to 69.8 m). Refer to Record of Drillhole WRO-8.		2	RC	REC 80%		73				RQD = 64%
			3	RC	REC 100%		72				RQD = 98%
							71				
			4	RC	REC 96%						RQD = 96%
69.8							70				
22.3	END OF BOREHOLE										

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY\02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-GTA.GDT 2/3/23

PROJECT: 20350802

RECORD OF DRILLHOLE: WRO-8

SHEET 1 OF 1

LOCATION: N 4860854.6 ;E 358132.0

DRILLING DATE: February 18, 2022

DATUM: CGVD28 / HT2_0 (Geodetic)

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME-55

DRILLING CONTRACTOR: Davis Drilling

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	ROCK STRENGTH INDEX	WEATHERING INDEX	FEATURES	R0/R1 ZONES	NOTES WATER LEVELS INSTRUMENTATION
		Continued from Borehole WRO-8		73.39															
19		Fresh, thinly bedded, black, fine-grained, faintly porous, medium strong SHALE (Whitby Formation)		18.71	1														
					2							BD,PL,SM SA,CL, <1 mm	1	2					
20												BD,PL,SM	1	1					
												BD,PL,RO	1	1					
												BD,PL,RO	1	1					
					3														UCS=50.9 MPa
21																			UCS=53.9 MPa
					4														
22				69.77															
		END OF DRILLHOLE		22.33															
23																			
24																			
25																			
26																			
27																			

FEATURES LEGEND

BROKEN CORE | CLAY SEAM | LIMESTONE | LOST CORE

DEPTH SCALE

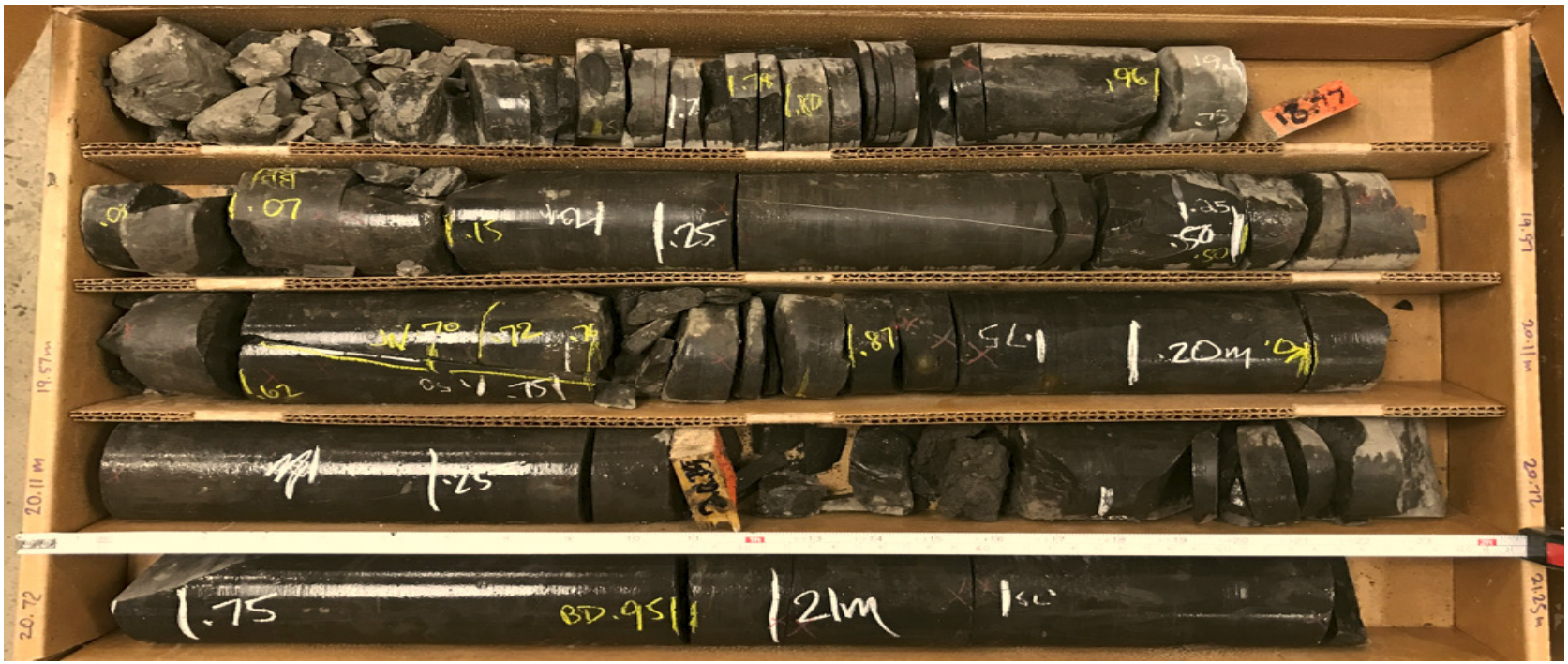
1 : 50

LOGGED: JS

CHECKED: ACK

GTA-RCK 054 S:\CLIENTS\MTO\HWY_401_BLOOR-HARMONY\02_DATA\GINT\HWY_401_BLOOR-HARMONY.GPJ GAL-MISS.GDT 4/25/22

Borehole WRO-1
Box 1 of 2



0 m | 0.25 m | 0.5 m | 0.75 m

0 ft | 1 ft | 2 ft

Scale

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

TITLE
Core Photographs
Borehole WRO-1 (18.47 m – 21.25 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-1A**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-1
Box 2 of 2

0 m | 0.25 m | 0.5 m | 0.75 m

0 ft | 1 ft | 2 ft

Scale

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

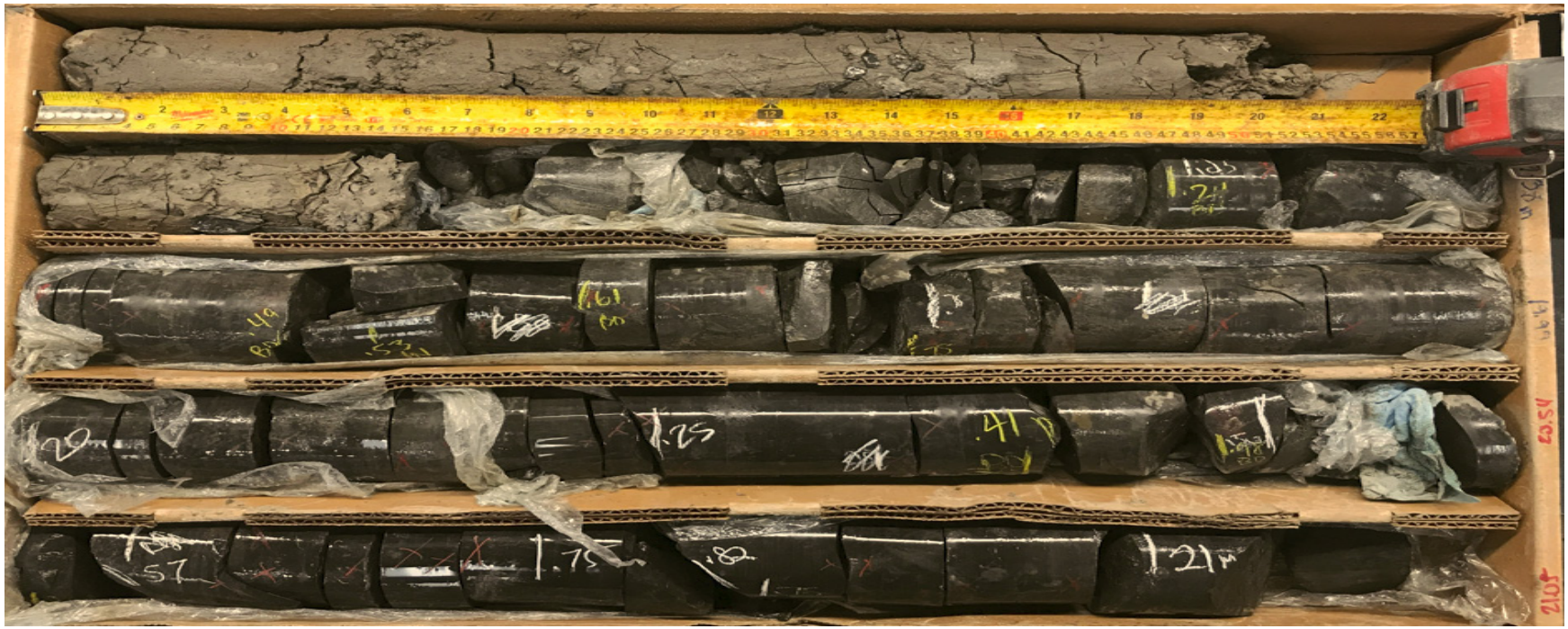
TITLE
Core Photographs
Borehole WRO-1 (21.25 m – 21.89 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-1B**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-4C
Box 1 of 2



0 m 0.25 m 0.5 m 0.75 m

0 ft 1 ft 2 ft

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

TITLE
Core Photographs
Borehole WRO-4 (18.93 m – 21.05 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-2A**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-4C
Box 2 of 2

0 m 0.25 m 0.5 m 0.75 m

0 ft 1 ft 2 ft

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

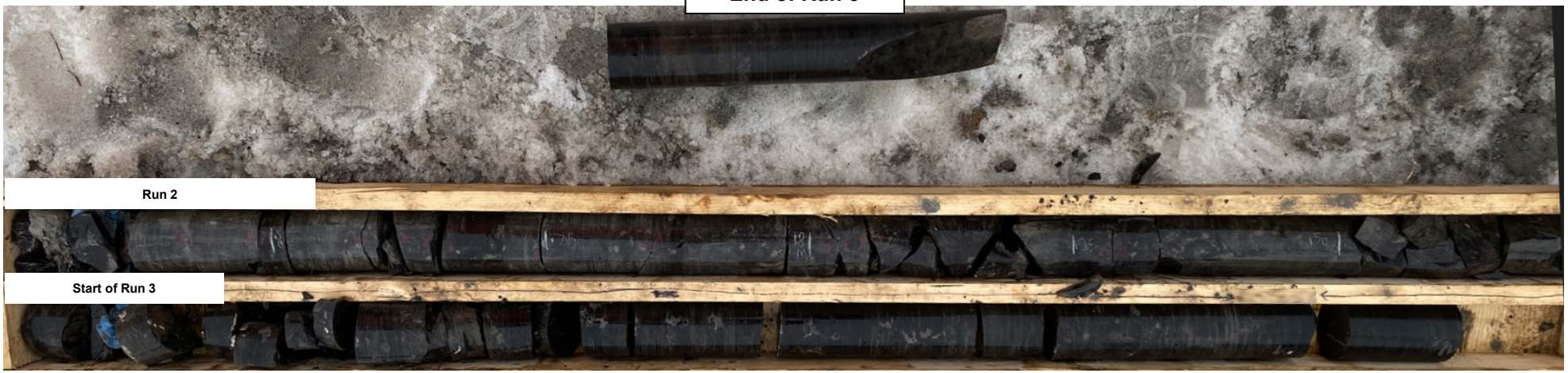
TITLE
Core Photographs
Borehole WRO-4 (21.05 m – 22.09 m)

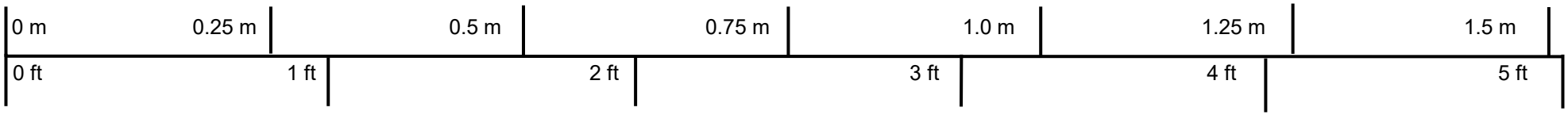
WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-2B**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-5





PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

TITLE
Core Photographs
Borehole WRO-5 (18.57 to 21.89 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-3**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-8
Box 1 of 2

0 m | 0.25 m | 0.5 m | 0.75 m

0 ft | 1 ft | 2 ft

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

TITLE
Core Photographs
Borehole WRO-8 (18.71 m to 21.28 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-4A**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

Borehole WRO-8
Box 2 of 2

0 m 0.25 m 0.5 m 0.75 m

0 ft 1 ft 2 ft

PROJECT
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction
City of Oshawa, Durham Region
MTO 2019-E-0077, GWP 2146-20-00

TITLE
Core Photographs
Borehole WRO-8 (21.84 m to 22.33 m)

WSP GOLDER

PROJECT No. 20350802			FILE No. 1203508027		
DRAFT	LJV	MAR 2022	SCALE	AS SHOWN	VER. 1.
CADD	--		**FIGURE B-4B**		
CHECK	AMP	MAR 2022			
REVIEW					

REVISION DATE: December, 2018 BY: MPL Project: 18109417

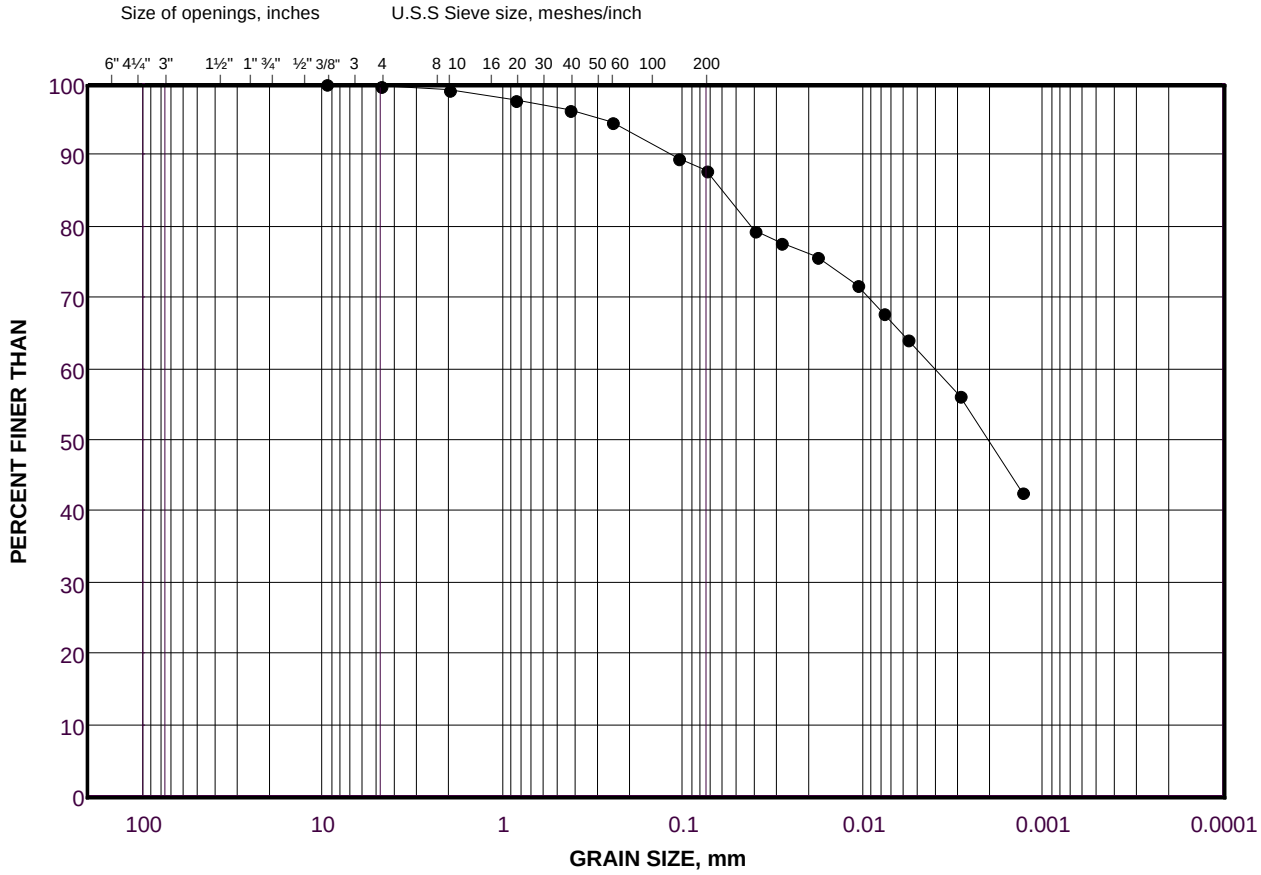
APPENDIX C

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to SILTY CLAY (CI) (FILL)

FIGURE C-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-8	2	84.4

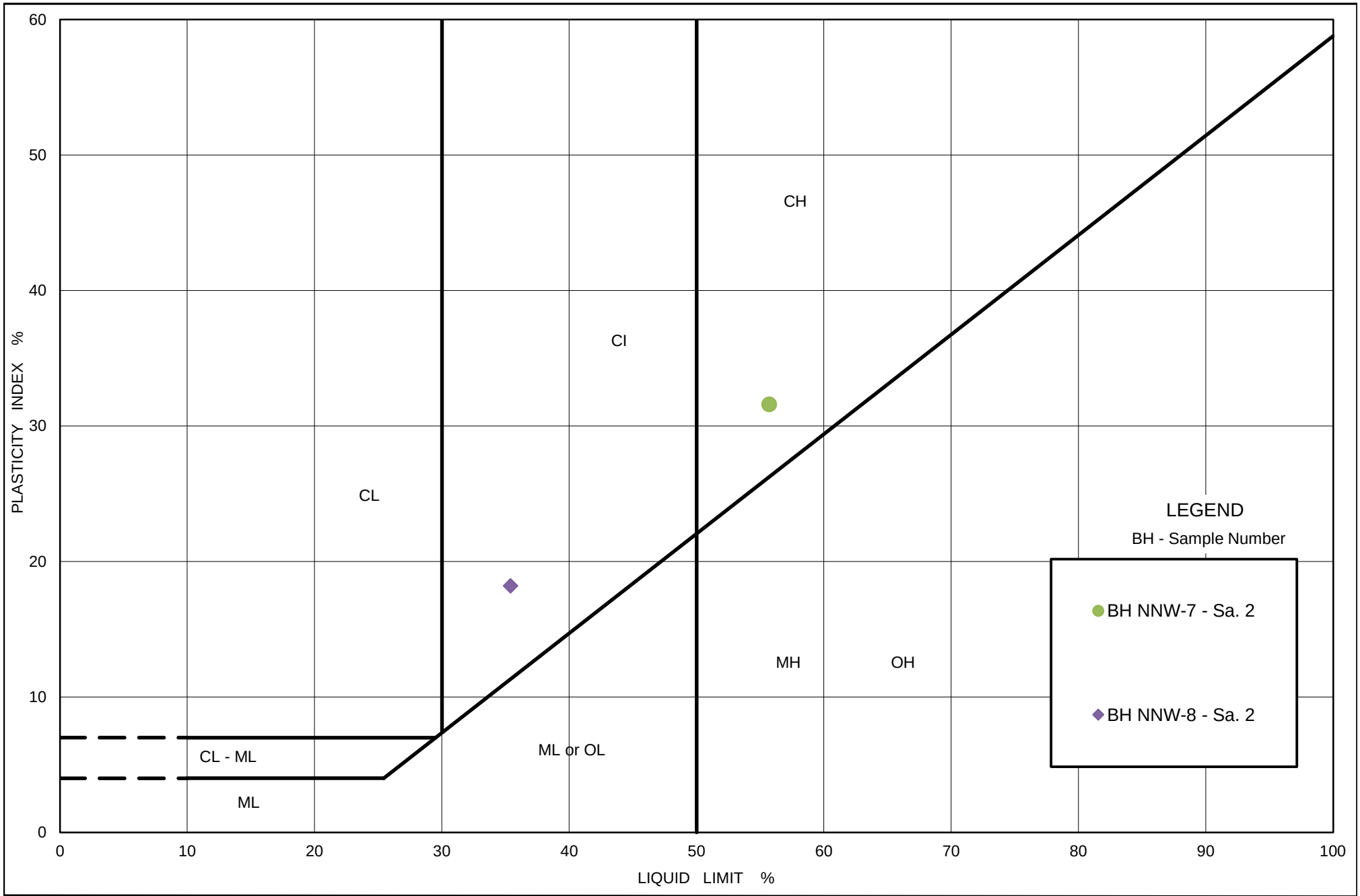
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 14-Mar-23

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

SILTY CLAY (CI) TO CLAY (CH) (FILL)

Figure No.: C-2

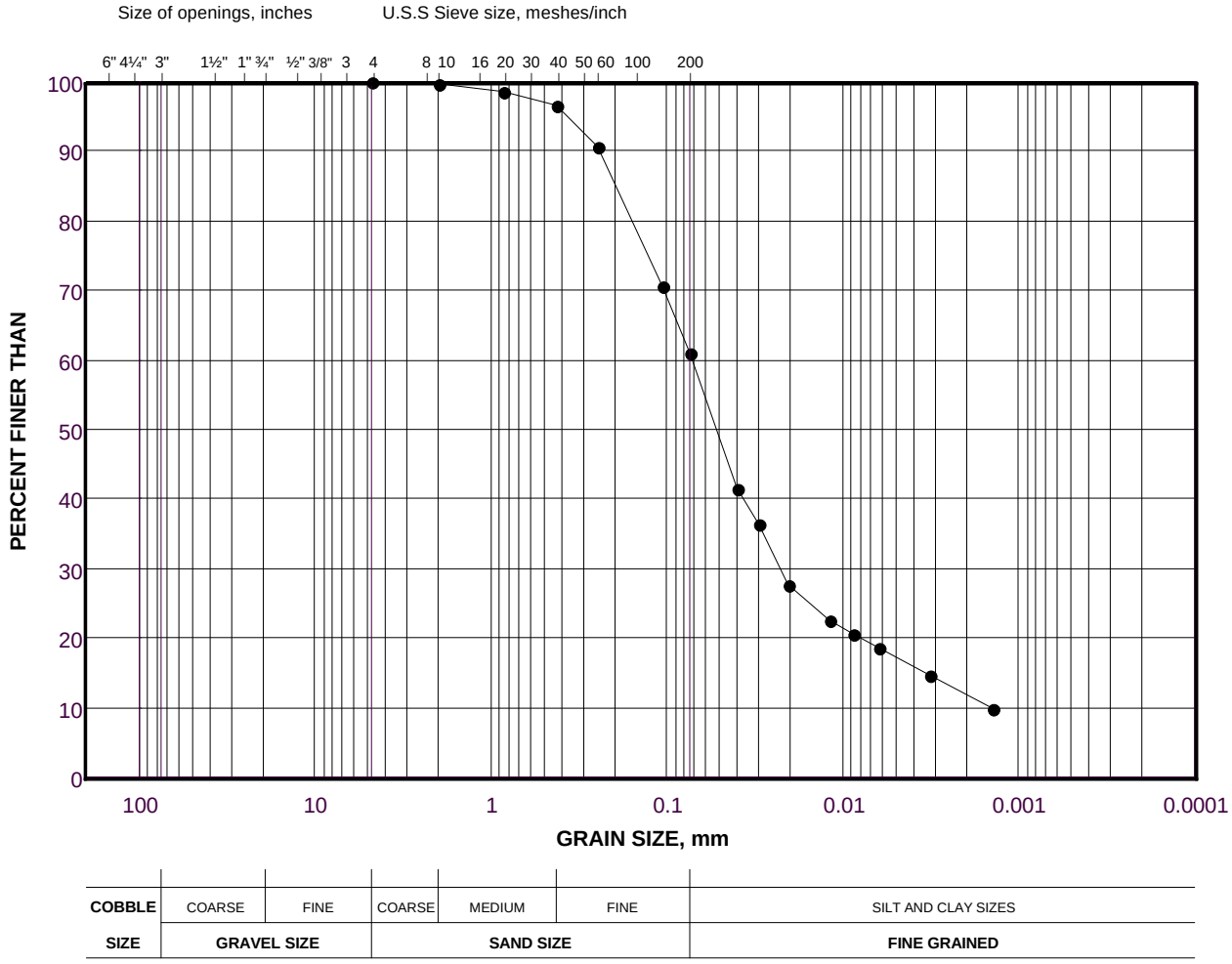
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

Sandy SILT (ML) (FILL)

FIGURE C-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-2	2	93.8

Project Number: 20350802-WNW-F1

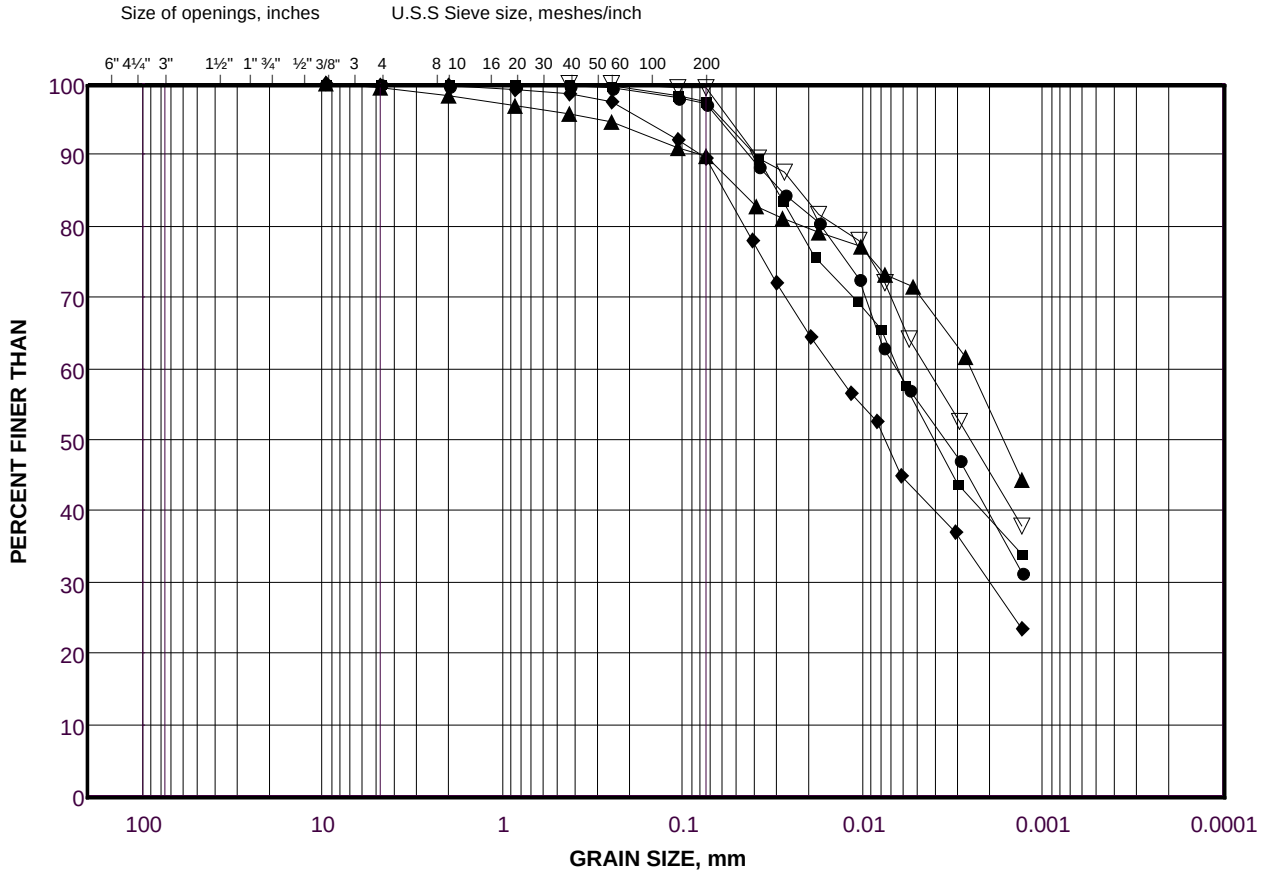
Checked By: AMP

Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION
CLAYEY SAND (SC) TO CLAYEY SILT (CL)
TO SILTY CLAY (CI)

FIGURE C-4A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-3	2	92.2
■	SNW-2	2	92.8
◆	NNW-2	3	93.1
▲	NNW-6	3	88.0
▽	NNW-5	5	90.8

Project Number: 20350802-WNW-F1

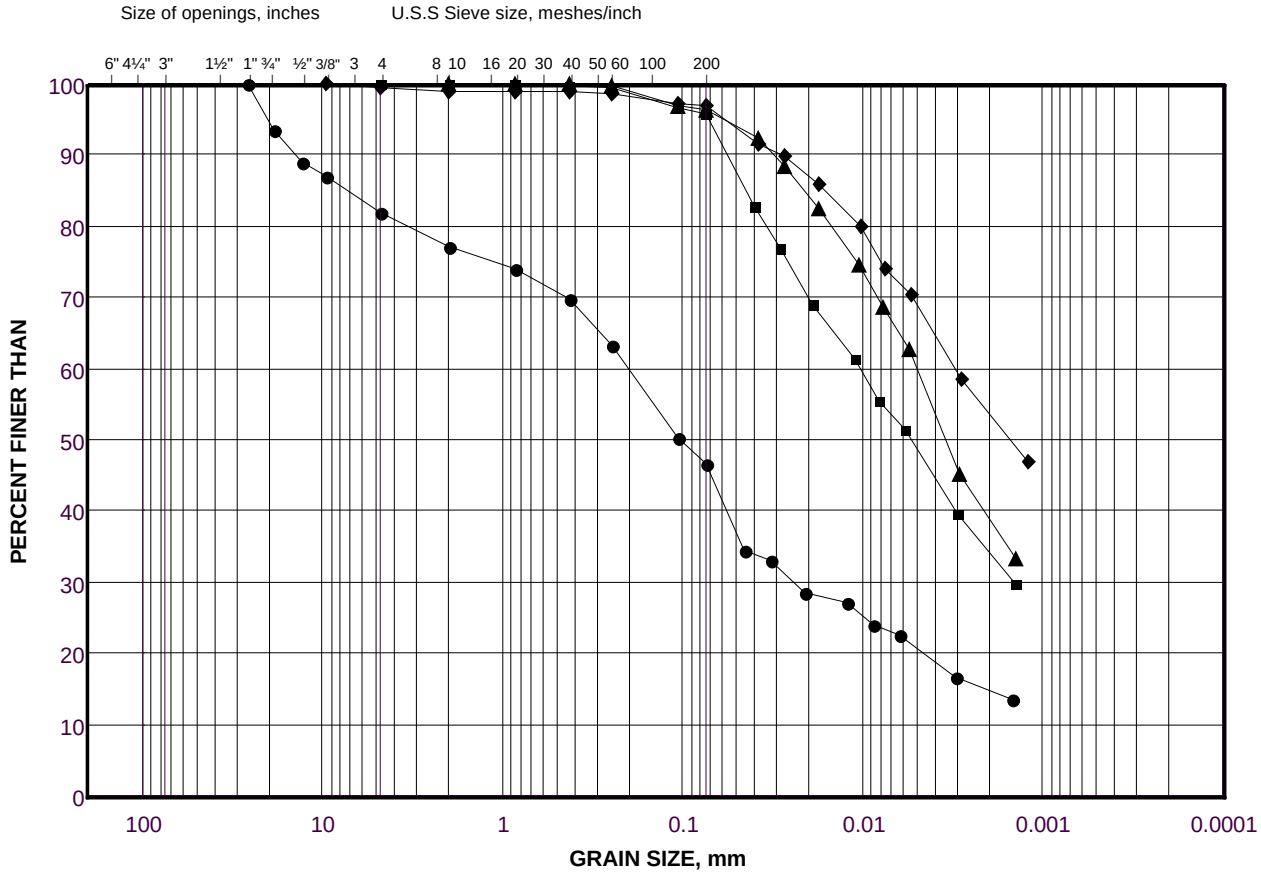
Checked By: AMP

Golder Associates

Date: 14-Mar-23

GRAIN SIZE DISTRIBUTION
CLAYEY SAND (SC) TO CLAYEY SILT (CL)
TO SILTY CLAY (CI)

FIGURE C-4B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-8	3	89.7
■	WRO-5	3	90.3
◆	SNW-3	5	90.5
▲	SNW-4	7	84.3

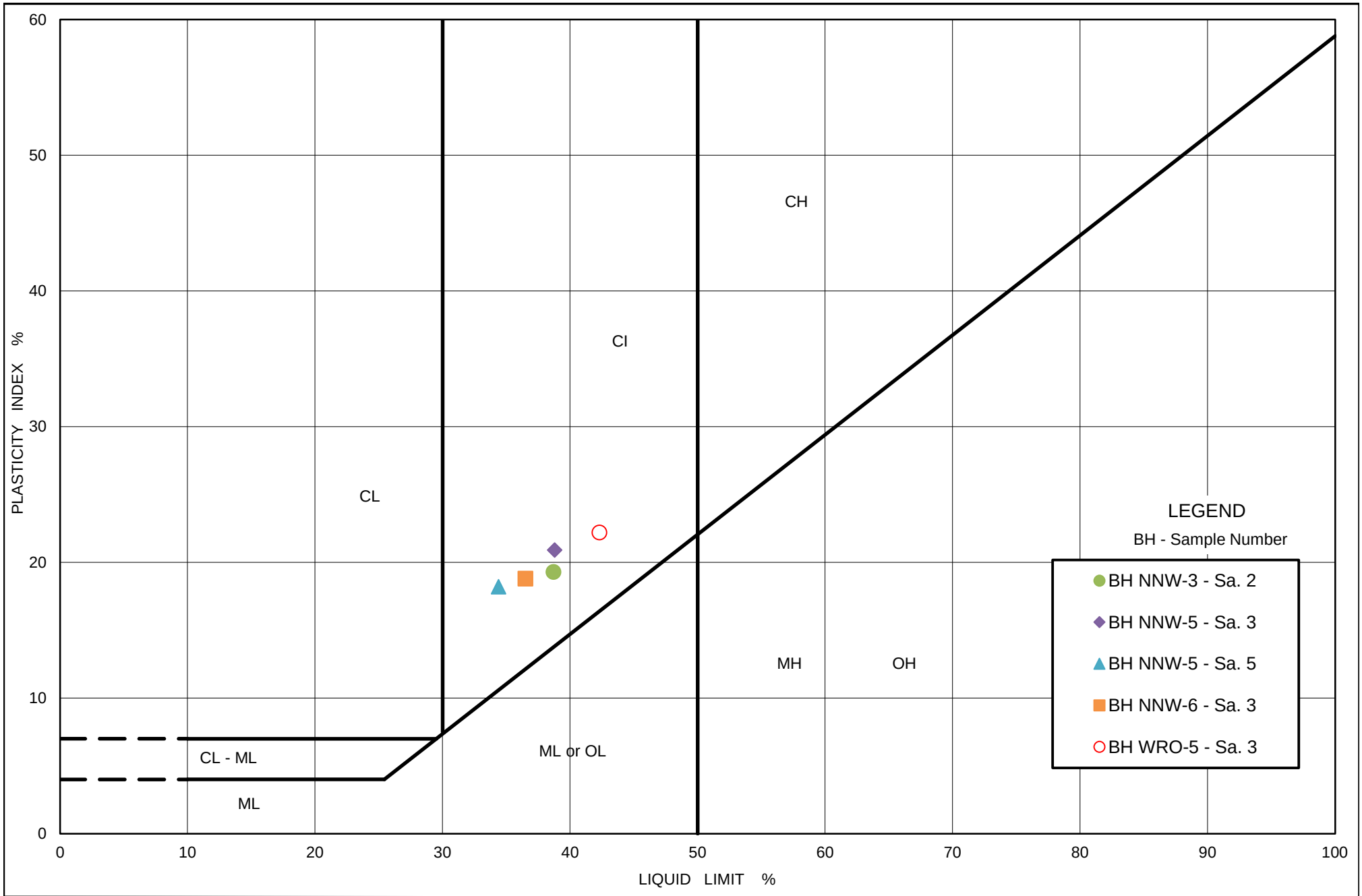
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 14-Mar-23

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

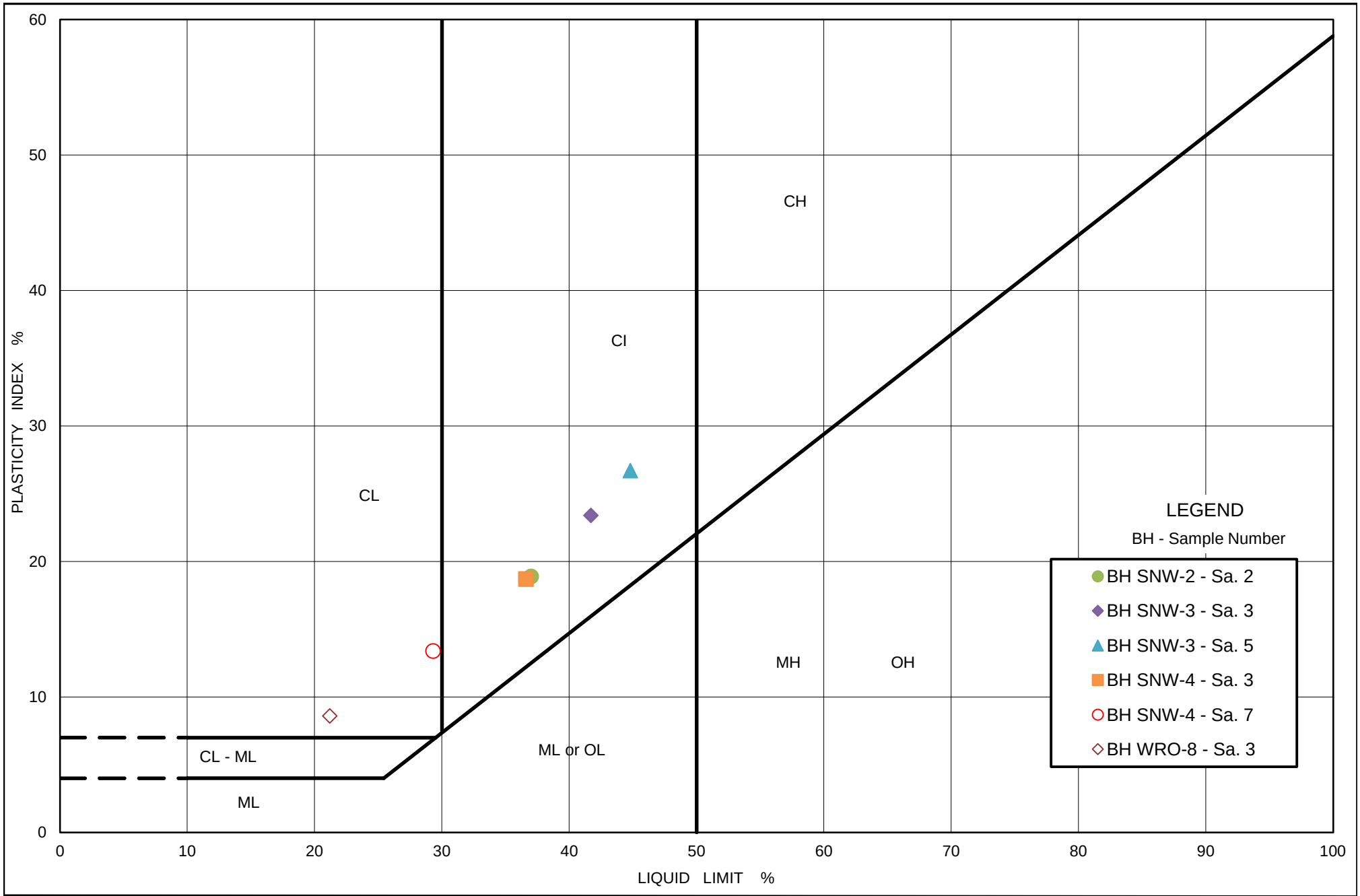
CLAYEY SAND (SC) to CLAYEY SILT (CL)
TO SILTY CLAY (CI)

Figure No.: C-5A

Project No.: 20350802-WNW-F1

Checked By: AMP

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

CLAEY SAND (SC) to CLAYEY SILT (CL)
TO SILTY CLAY (CI)

Figure No.: C-5B

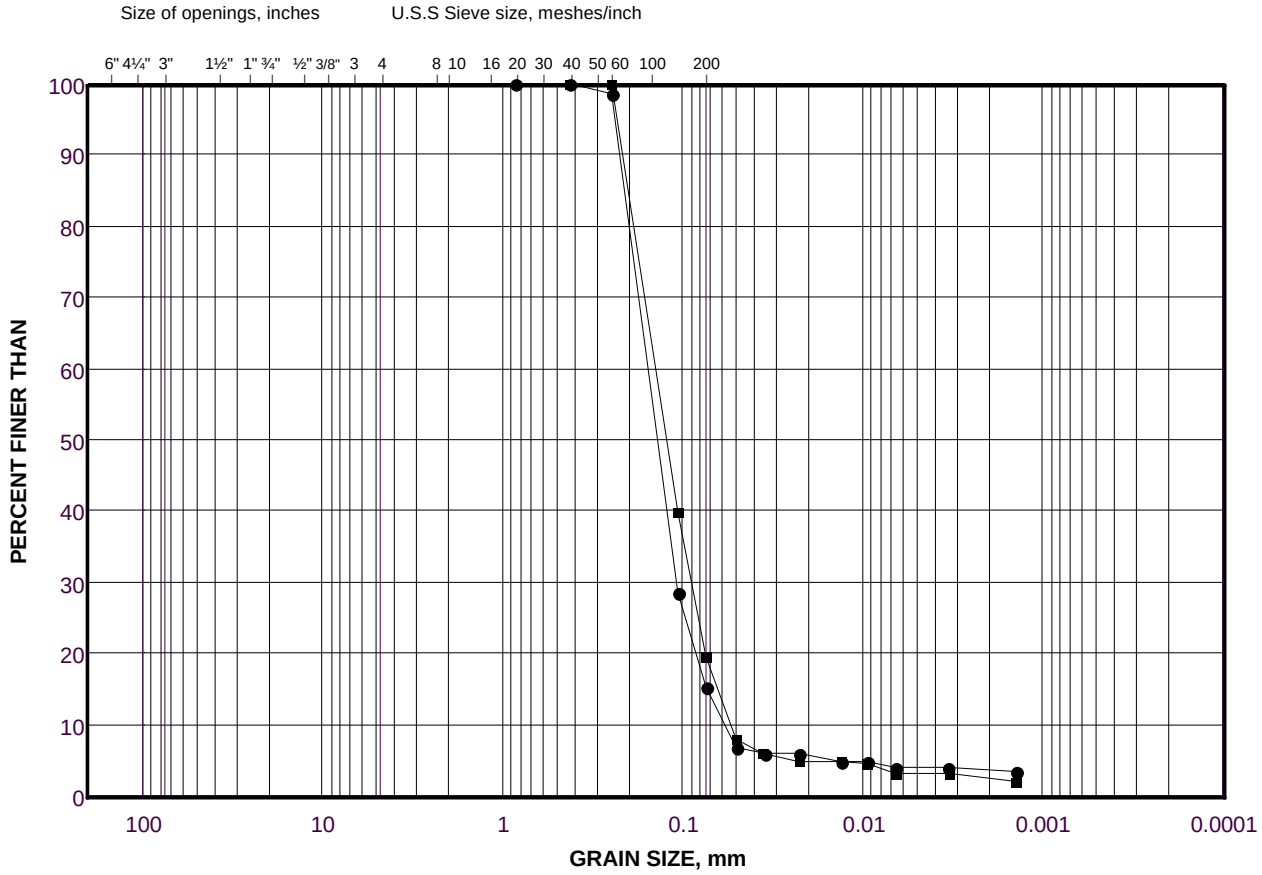
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE C-6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-5	4A	91.7
■	SNW-4	6	85.1

Project Number: 20350802-WNW-FI

Checked By: AMP

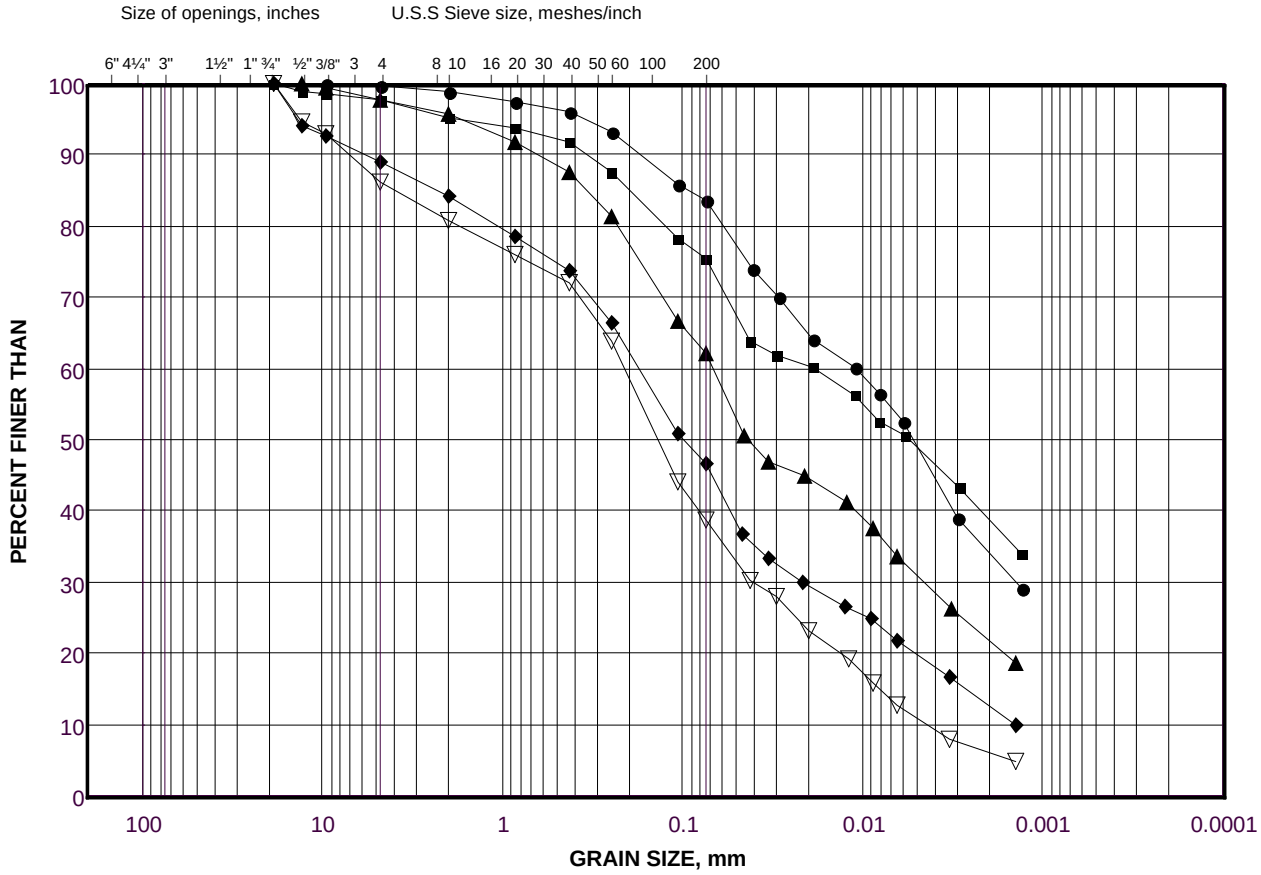
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

FIGURE C-7A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SNW-1	3	95.1
■	SNW-1	7	95.1
◆	NNW-3	8	93.3
▲	NNW-2	8	94.9
▽	NNW-3	9	93.3

Project Number: 20350802-WNW-F1

Checked By: AMP

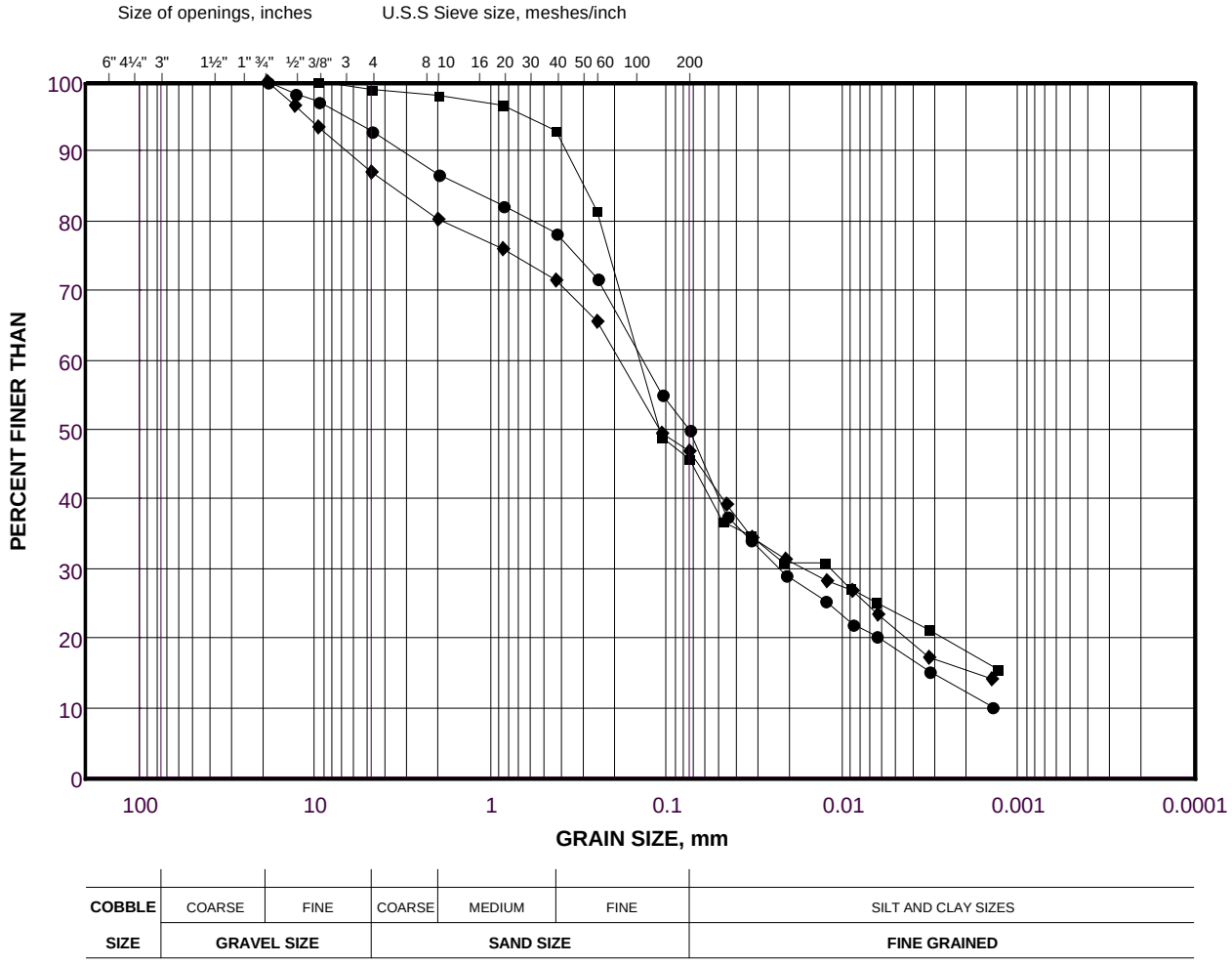
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

FIGURE C-7B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4B	12	92.5
■	WRO-8	14	92.1
◆	WRO-5	8	91.5

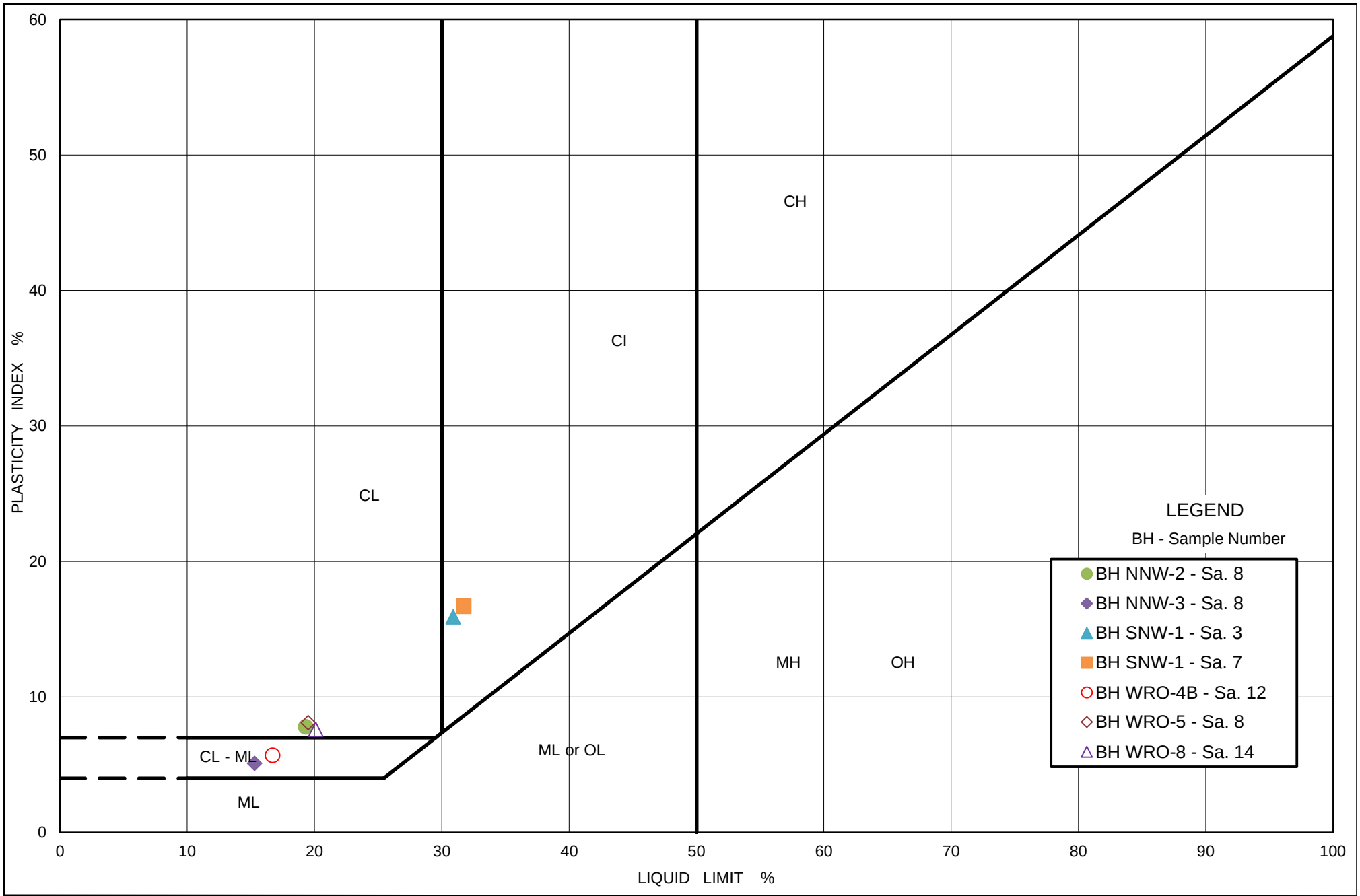
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 17-May-22

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

Figure No.: C-8

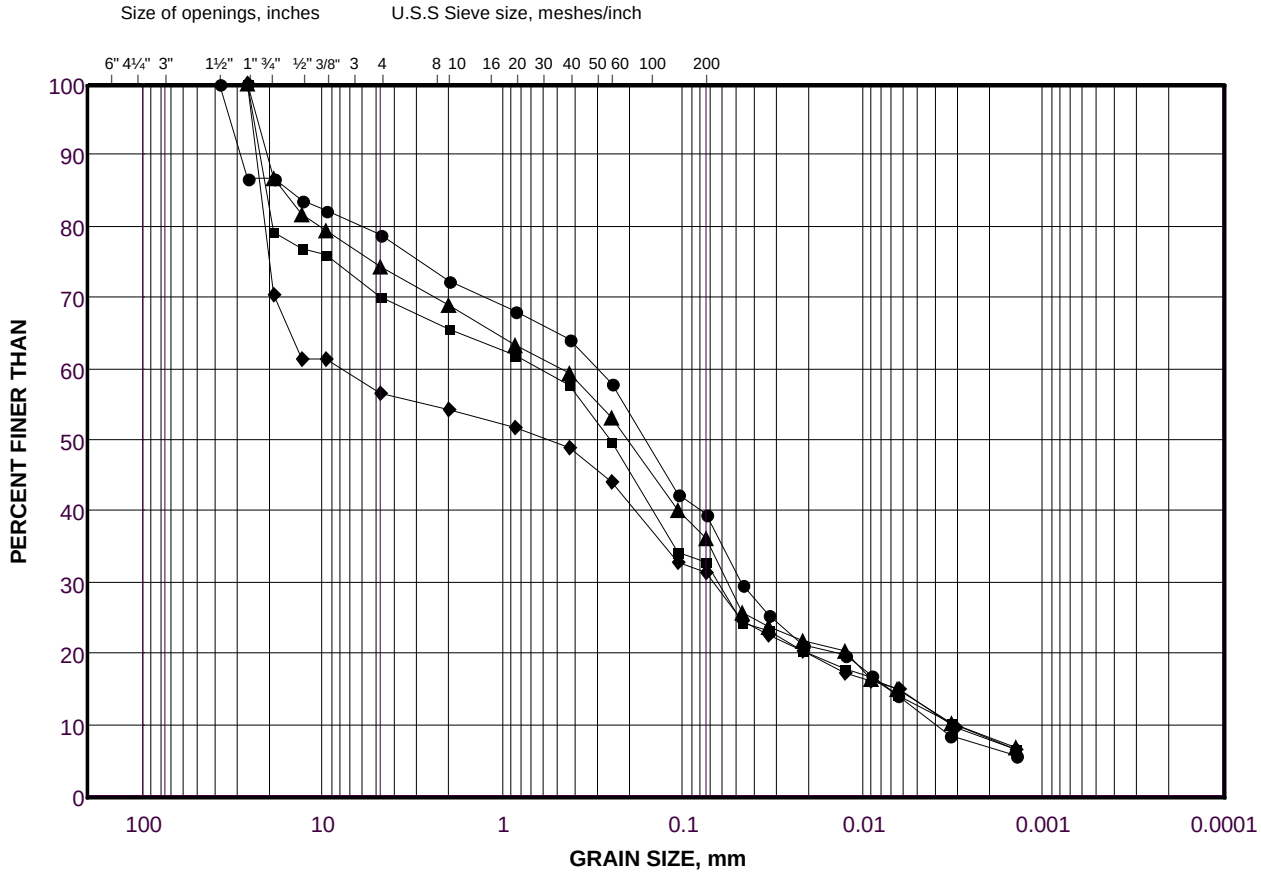
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

Gravelly SILTY SAND (SM) (TILL)

FIGURE C-9A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-1	5	92.4
■	NNW-6	4	89.8
◆	WRO-1	8	92.4
▲	SNW-2	8	93.8

Project Number: 20350802-WNW-F1

Checked By: AMP

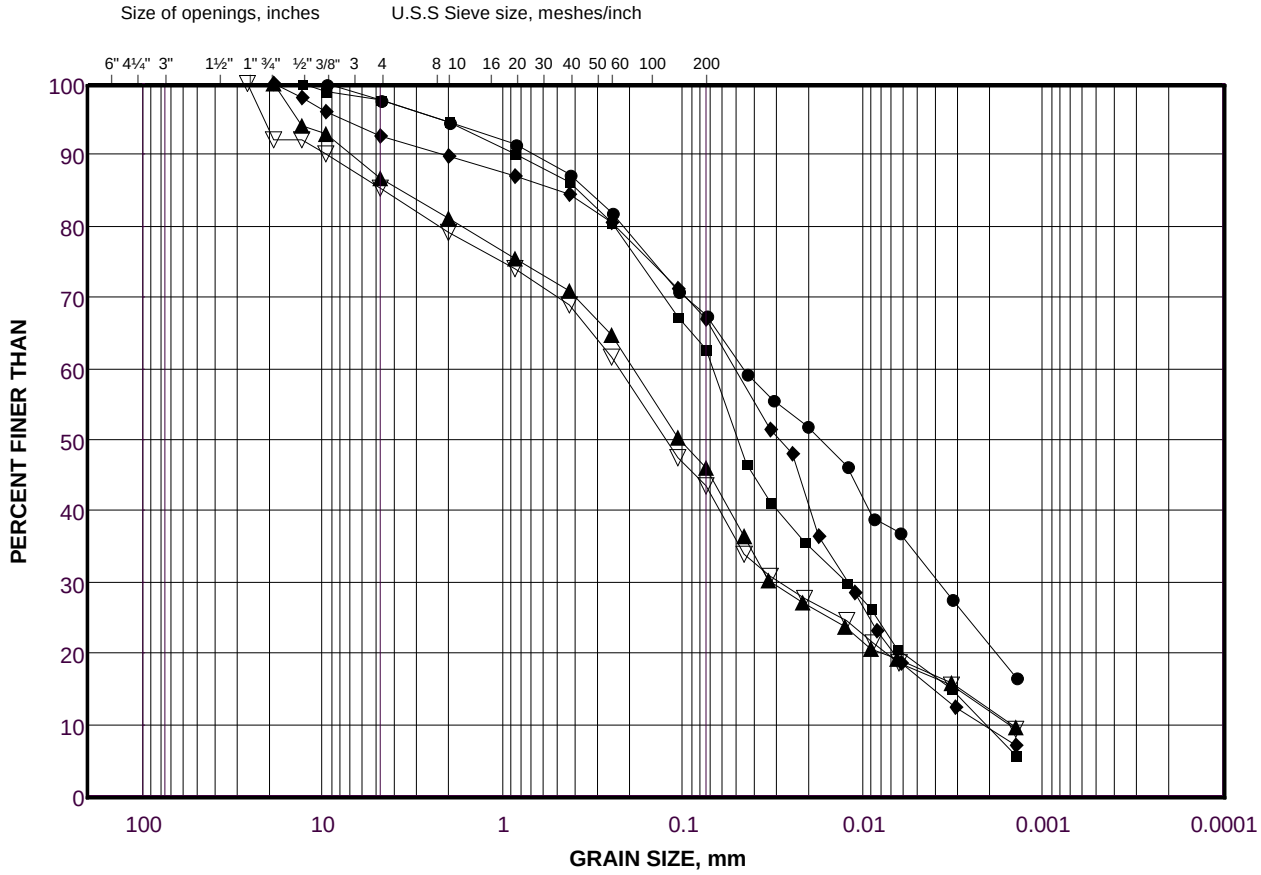
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) (TILL)

FIGURE C-9B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-1	3	97.4
■	NNW-7	4	88.5
◆	NNW-7	6	88.5
▲	SNW-2	6A	93.8
▽	NNW-8	7	85.5

Project Number: 20350802-WNW-F1

Checked By: AMP

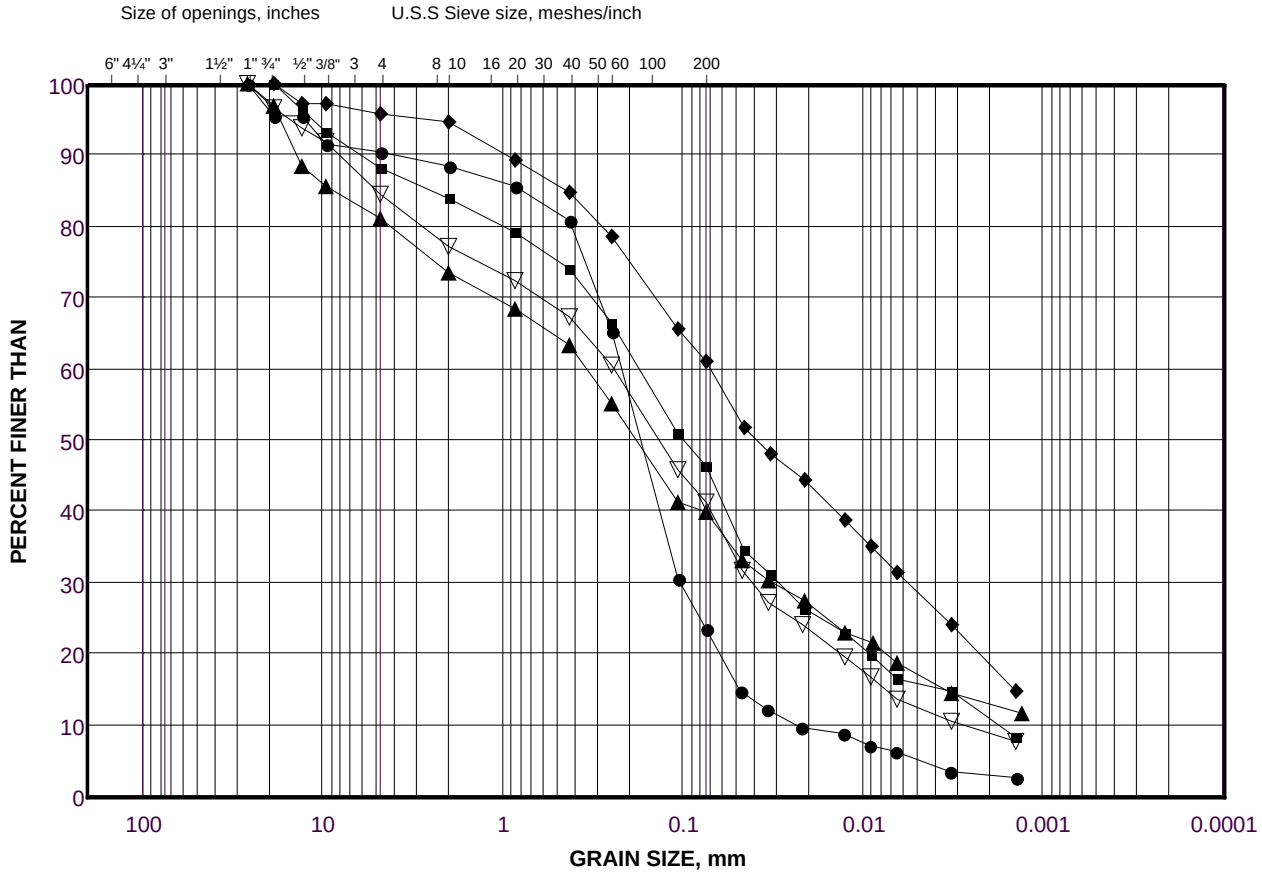
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) (TILL)

FIGURE C-9C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4	6	92.5
■	NNW-6	6	89.8
◆	NNW-1	8	97.4
▲	SNW-3	8	93.9
▽	WRO-4	9	92.5

Project Number: 20350802-WNW-F1

Checked By: AMP

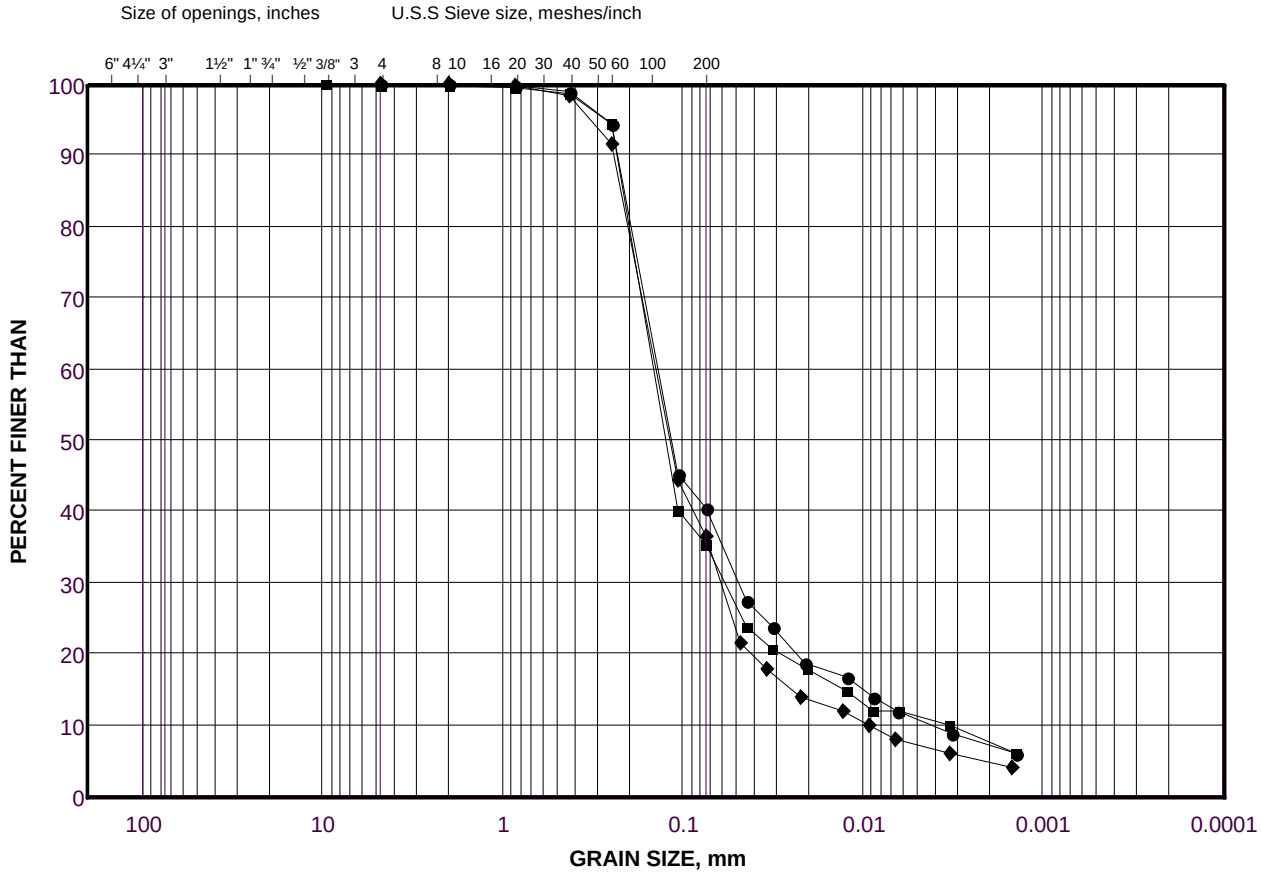
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE C-10



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-5	12	79.0
■	WRO-1	12	79.9
◆	WRO-8	13	78.1

Project Number: 20350802-WNW-F1

Checked By: AMP

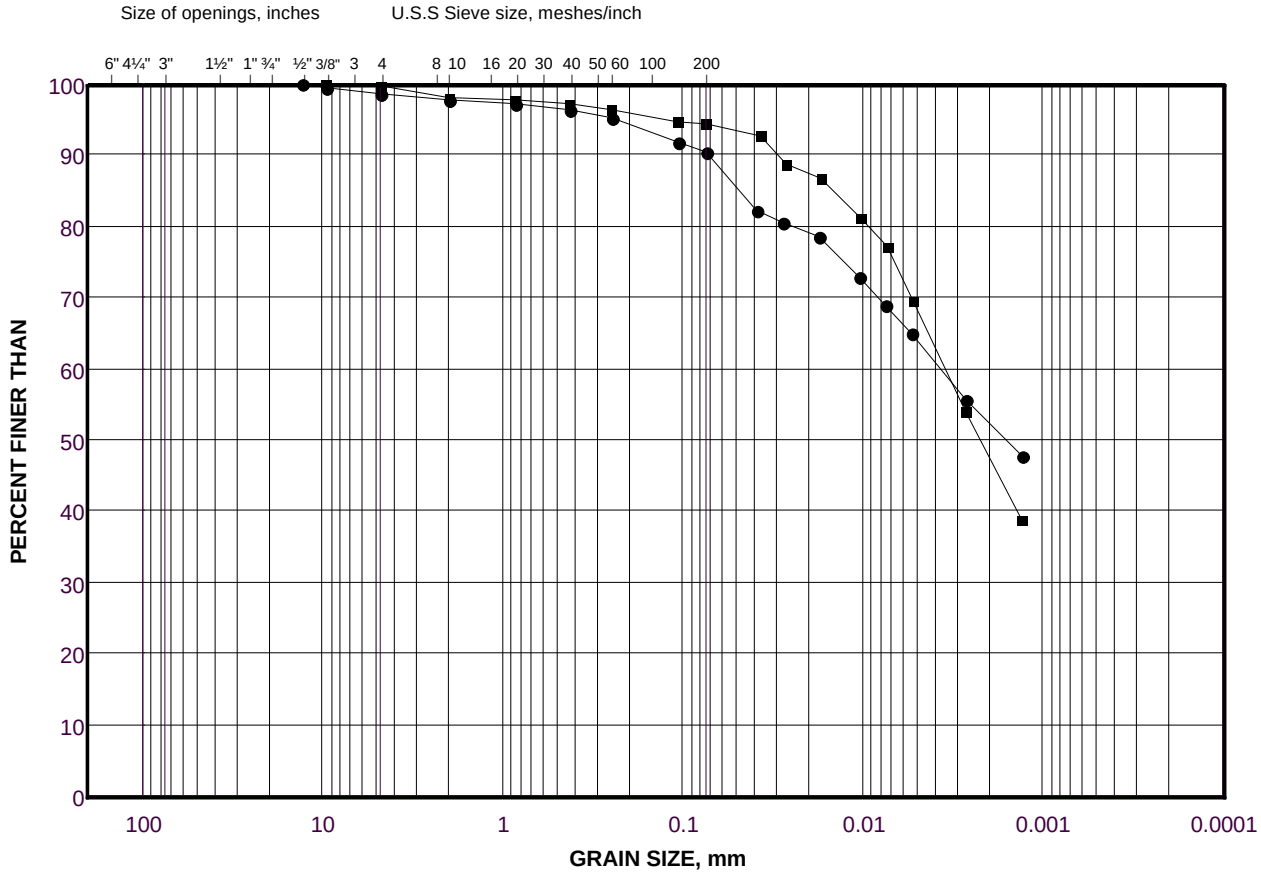
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI)

FIGURE C-11



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4B	14	76.9
■	WRO-1	15	75.3

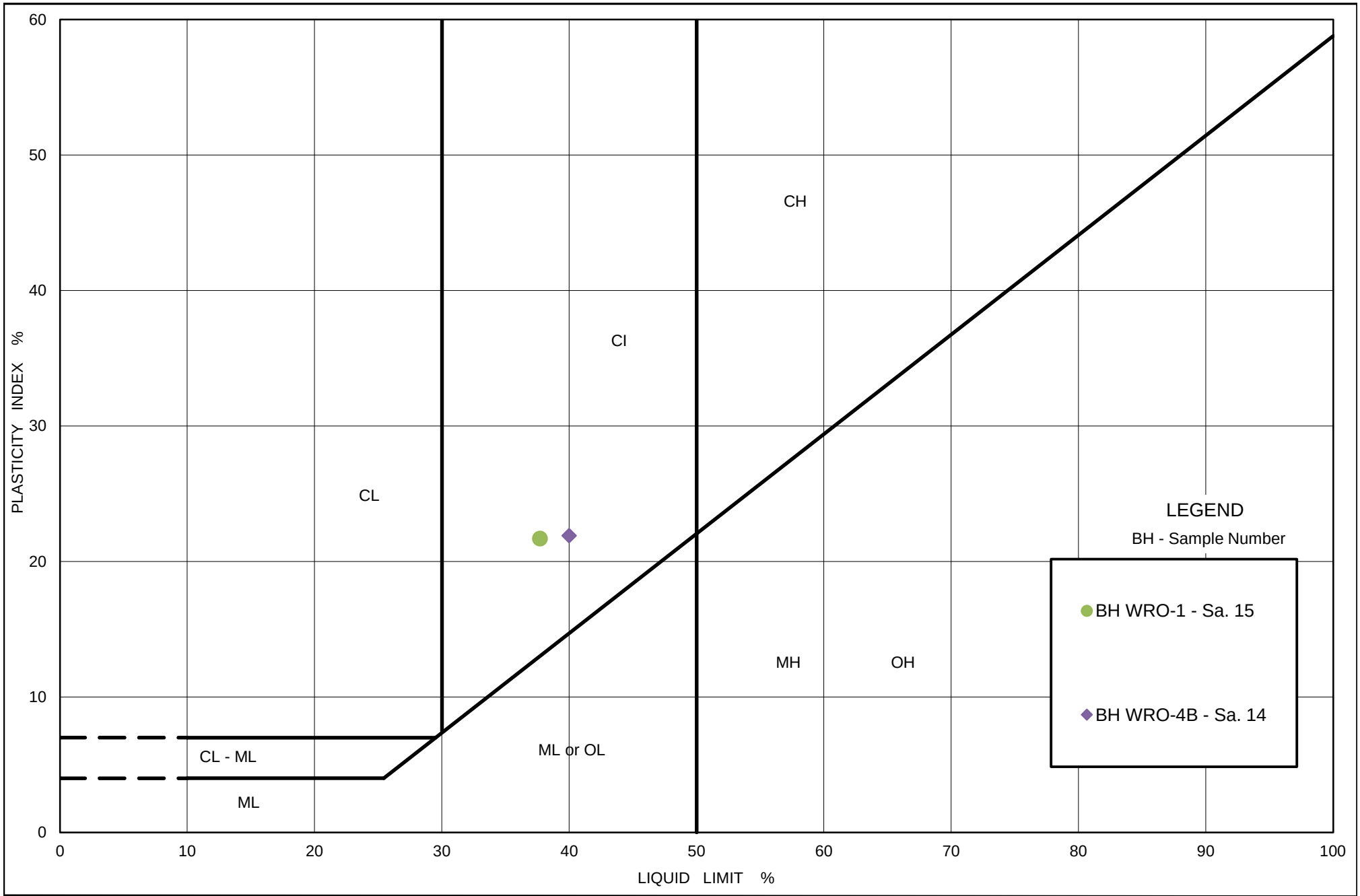
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 17-May-22

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



GOLDER

PLASTICITY CHART

SILTY CLAY (CI)

Figure No.: C-12

Project No.: 20350802-WNW-F1

Checked By: AMP

Geomechanica Inc.
Suite 900 – 390 Bay St.
Toronto Ontario
Canada M5H 2Y2

April 20, 2022

Ms. Anastasia Poliacik
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Re: UCS testing
(Golder Project 20350802)

Dear Ms. Poliacik:

On February 9th and March 8th, 2022 one (1) and five (5) HQ-sized core samples were received by Geomechanica Inc. via drop off by Golder personnel, respectively. These samples were identified as being from Golder Project No. 20350802. From these samples. six (6) UCS specimens were prepared and tested.

Details regarding the steps of specimen preparation and testing along with the results and photographs of the test specimen before and after testing are presented in the accompanying laboratory report and summary spreadsheet(s).

Sincerely,

Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

GEOMECHANICA

Rock Laboratory Testing Results

A report submitted to:

Anastasia Poliacik
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Prepared by:

Bryan Tatone, PhD, PEng

Omid Mahabadi, PhD, PEng
Geomechanica Inc.
#900-390 Bay St.
Toronto ON
M5H 2Y2 Canada
Tel: +1-647-478-9767
lab@geomechanica.com

April 20, 2022
Project number: 20350802

Abstract

This document summarizes the results of rock laboratory testing, including 6 Uniaxial Compressive Strength (UCS) tests. The UCS values along with photographs of specimens before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.150 mm/min (Figure 1). The specimen preparation and testing procedure included the following:

1. Unwrapping the core sample, inspecting it for damage, and re-wrapping it in electrical tape to preserve the moisture content and avoid potential damage during specimen preparation.
2. Diamond cutting the core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimens to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS).

Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness

criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C.

1.2 Results

The results of UCS testing are summarized in Table 1. Additional specimen and testing details are available in the summary spreadsheet that accompanies this report.

Table 1: Summary of UCS test results.

Sample	Depth (m)	Bulk density ρ (g/cm^3)	UCS (MPa)	Lithology	Failure description
WRO-1, SA1	21.25 - 21.54	2.669	107.3	Brown shale	3
WRO-4, SA1	21.36 - 21.51	2.596	47.5	Brown shale	1
WRO-4, SA2	21.69 - 21.88	2.593	80.1	Brown shale	1
WRO-5, SA1	19.97 - 20.16	2.614	86.5	Brown shale	1
WRO-8, SA1	20.77 - 21.02	2.573	50.9	Brown shale	1, 2
WRO-8, SA2	21.02 - 21.28	2.567	53.9	Brown shale	3

[1] Inclined shear fracture and axial splitting failure

[2] Failure partly along pre-existing structure

[3] Axial splitting failure

1.3 Specimen photographs

Photographs of the specimens before and after testing are presented in the Appendix of this report.

Appendices

Specimen sheets

- WRO-1, SA1
- WRO-4, SA1
- WRO-4, SA2
- WRO-5, SA1
- WRO-8, SA1
- WRO-8, SA2

GEOMECHANICA

Uniaxial Compression Test

Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-1, SA1	**Depth**	21.25 - 21.54

Specimen parameters	
Diameter (mm) [a]	62.81
Length (mm) [a]	128.67
Bulk density ρ (g/cm^3)	2.669
UCS (MPa)	107.3
Lithology	Brown shale
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Axial splitting failure;

Prior to testing

After testing

Remarks: Loading rate: 0.15 mm/min.

Performed by	BSAT/HS	**Date**	2022-02-15

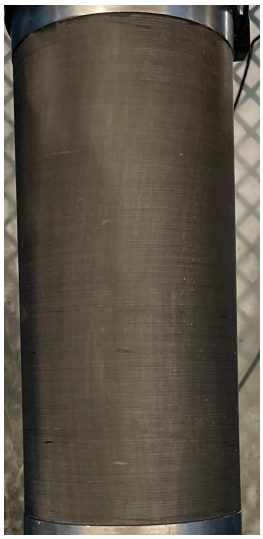
Uniaxial Compression Test

Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-4, SA1	**Depth**	21.36 - 21.51

Specimen parameters	
Diameter (mm) [a]	62.63
Length (mm) [a]	129.21
Bulk density ρ (g/cm^3)	2.596
UCS (MPa)	47.5
Lithology	Brown shale
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure;

Prior to testing



After testing

Remarks: Loading rate: 0.15 mm/min.

Performed by	HS/HS	**Date**	2022-03-15

Uniaxial Compression Test

Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-4, SA2	**Depth**	21.69 - 21.88

Specimen parameters	
Diameter (mm) [a]	62.80
Length (mm) [a]	130.19
Bulk density ρ (g/cm^3)	2.593
UCS (MPa)	80.1
Lithology	Brown shale
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure;

Prior to testing

After testing

Remarks: Loading rate: 0.15 mm/min.

Performed by	HS/HS	**Date**	2022-03-15

Uniaxial Compression Test

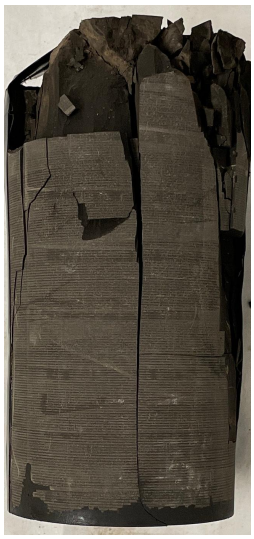
Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-5, SA1	**Depth**	19.97 - 20.16

Specimen parameters	
Diameter (mm) [a]	62.85
Length (mm) [a]	131.27
Bulk density ρ (g/cm^3)	2.614
UCS (MPa)	86.5
Lithology	Brown shale
Failure description [b]	1

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure;

Prior to testing

After testing



Remarks: Loading rate: 0.15 mm/min.

Performed by	HS/HS	**Date**	2022-03-15

Uniaxial Compression Test

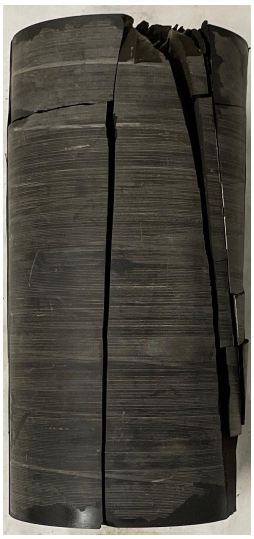
Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-8, SA1	**Depth**	20.77 - 21.02

Specimen parameters	
Diameter (mm) [a]	62.75
Length (mm) [a]	130.46
Bulk density ρ (g/cm^3)	2.573
UCS (MPa)	50.9
Lithology	Brown shale
Failure description [b]	1, 2

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [1] Inclined shear fracture and axial splitting failure; [2] Failure partly along pre-existing structure;

Prior to testing

After testing



Remarks: Loading rate: 0.15 mm/min. Specimen contained healed discontinuity.

Performed by	HS/HS	**Date**	2022-03-15

GEOMECHANICA

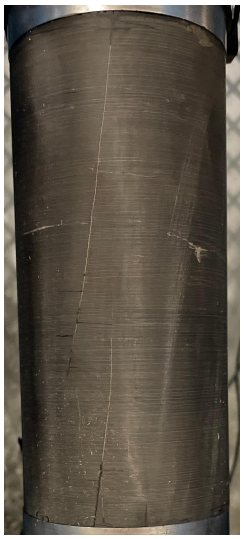
Uniaxial Compression Test

Client	Golder Associates Ltd.	**Project**	20350802
Sample	WRO-8, SA2	**Depth**	21.02 - 21.28

Specimen parameters	
Diameter (mm) [a]	62.71
Length (mm) [a]	131.21
Bulk density ρ (g/cm^3)	2.567
UCS (MPa)	53.9
Lithology	Brown shale
Failure description [b]	3

[a] Additional specimen measurement/details provided in accompanying summary spreadsheet.
[b] Failure description: [3] Axial splitting failure;

Prior to testing



After testing

Remarks: Loading rate: 0.15 mm/min. Specimen experienced pre-peak localized failure.

Performed by	HS/HS	**Date**	2022-03-15

APPENDIX D

Analytical Laboratory Test Results

Your Project #: 20350802-ENW
Your C.O.C. #: 847598-39-01

Attention: Anastasia Poliacik

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

Report Date: 2022/03/11
Report #: R7038519
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C246239
Received: 2022/02/22, 15:15

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (20:1 extract)	6	2022/02/28	2022/02/28	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	6	2022/02/25	2022/02/25	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	6	2022/02/24	2022/02/24	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	6	2022/02/23	2022/02/25	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	6	2022/02/28	2022/02/28	CAM SOP-00464	EPA 375.4 m

Remarks:

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

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas 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.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas 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 Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas 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 Bureau Veritas, results relate to the supplied samples tested.

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 #: 20350802-ENW
Your C.O.C. #: 847598-39-01

Attention: Anastasia Poliacik

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

Report Date: 2022/03/11
Report #: R7038519
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C246239
Received: 2022/02/22, 15:15

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ankita Bhalla, Project Manager
Email: Ankita.Bhalla@bureauveritas.com
Phone# (905) 817-5700
==========
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

Bureau Veritas Job #: C246239
Report Date: 2022/03/11

Golder Associates Ltd
Client Project #: 20350802-ENW
Sampler Initials: JS

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		RXI334	RXI335	RXI336	RXI337	RXI338	RXI339		
Sampling Date		2022/02/09 12:00	2022/02/17 12:00	2022/02/17 12:00	2022/02/15 12:00	2022/02/15 12:00	2022/02/11 12:00		
COC Number		847598-39-01	847598-39-01	847598-39-01	847598-39-01	847598-39-01	847598-39-01		
	UNITS	NNW2-SA4	NNW7-SA2	NNW8-SA3	SNW1-SS2	SNW2-SA3	SNW4-SA2	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	1300	5300	2700	3200	1200	1100		7846790
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	390	<20	110	41	400	360	20	7855222
Conductivity	umho/cm	745	188	377	309	848	895	2	7852335
Available (CaCl2) pH	pH	7.75	7.69	7.90	7.73	7.94	7.89		7849981
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	<20	<20	<20	<20	20	7855228

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

TEST SUMMARY

Bureau Veritas ID: RXI334 **Collected:** 2022/02/09
Sample ID: NNW2-SA4 **Shipped:**
Matrix: Soil **Received:** 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI335 **Collected:** 2022/02/17
Sample ID: NNW7-SA2 **Shipped:**
Matrix: Soil **Received:** 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI336 **Collected:** 2022/02/17
Sample ID: NNW8-SA3 **Shipped:**
Matrix: Soil **Received:** 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI337 **Collected:** 2022/02/15
Sample ID: SNW1-SS2 **Shipped:**
Matrix: Soil **Received:** 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI338 **Collected:** 2022/02/15
Sample ID: SNW2-SA3 **Shipped:**
Matrix: Soil **Received:** 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran

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Bureau Veritas Job #: C246239
Report Date: 2022/03/11

Golder Associates Ltd
Client Project #: 20350802-ENW
Sampler Initials: JS

TEST SUMMARY

Bureau Veritas ID: RXI338
Sample ID: SNW2-SA3
Matrix: Soil

Collected: 2022/02/15
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI339
Sample ID: SNW4-SA2
Matrix: Soil

Collected: 2022/02/11
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

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GENERAL COMMENTS

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

Package 1	1.3°C

Revised Report [2022/03/11]: Sample IDs amended as per COC.

Results relate only to the items tested.

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Bureau Veritas Job #: C246239
Report Date: 2022/03/11

Golder Associates Ltd
Client Project #: 20350802-ENW
Sampler Initials: JS

QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
7849981	TAK	Spiked Blank	Available (CaCl2) pH	2022/02/24		100	%	97 - 103
7849981	TAK	RPD	Available (CaCl2) pH	2022/02/24	0.059		%	N/A
7852335	KIT	Spiked Blank	Conductivity	2022/02/25		101	%	90 - 110
7852335	KIT	Method Blank	Conductivity	2022/02/25	<2		umho/cm	
7852335	KIT	RPD	Conductivity	2022/02/25	0.85		%	10
7855222	ADB	Matrix Spike	Soluble (20:1) Chloride (Cl-)	2022/02/28		NC	%	70 - 130
7855222	ADB	Spiked Blank	Soluble (20:1) Chloride (Cl-)	2022/02/28		102	%	70 - 130
7855222	ADB	Method Blank	Soluble (20:1) Chloride (Cl-)	2022/02/28	<20		ug/g	
7855222	ADB	RPD	Soluble (20:1) Chloride (Cl-)	2022/02/28	3.5		%	35
7855228	AKD	Matrix Spike	Soluble (20:1) Sulphate (SO4)	2022/02/28		148 (1)	%	70 - 130
7855228	AKD	Spiked Blank	Soluble (20:1) Sulphate (SO4)	2022/02/28		112	%	70 - 130
7855228	AKD	Method Blank	Soluble (20:1) Sulphate (SO4)	2022/02/28	<20		ug/g	
7855228	AKD	RPD	Soluble (20:1) Sulphate (SO4)	2022/02/28	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).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

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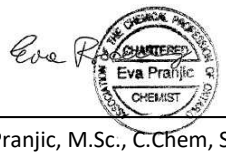
VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



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

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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APPENDIX E

Special Provisions and Notice to Contractor

SUBSURFACE CONDITIONS FOR CONSTRUCTION OF DRILLED SHAFTS AND AUGER HOLES

Notice to Contractor

The contractor is advised that drilled shaft (caisson) and auger hole installations may experience flowing sand conditions when advancing extend through non-cohesive soils under the groundwater table, and therefore soil sloughing, base instability as well as ground loss may be encountered. Appropriate construction equipment and procedures, including temporary liners and/or polymer slurry, will be required for support during caisson or auger hole construction.

The contractor is also advised of the presence of cobbles and boulders in the glacially-derived soils, in particular till or till-like soils at this site. The fill materials at this site are variable and may contain debris, cobbles and other obstructions. Considerations of the presence of these obstructions should be made in the selection of appropriate equipment and procedures for installation of drilled shafts (caissons) and auger holes.

NOISE BARRIER SYSTEM

Special Provision No. 760F01 March 2018

Amendment to OPSS 760, November 2014

760.03 DEFINITIONS

Section 760.03 of OPSS 760 is amended by the deletion of the definitions for **Certificate of Conformance** and **Quality Verification Engineer**.

760.04 DESIGN AND SUBMISSION REQUIREMENTS

760.04.01 Design Requirements

760.04.01.01 Footings

760.04.01.01.01 General

Clause 760.04.01.01.01 of OPSS 760 is amended by the addition of the following paragraph:

The soil design parameters for the design of footings shall be as specified in Table A:

Table A – Soil Design Parameters

Location	Soil Design Parameter
North of Highway 401, West of Wilson Road South	Ø = 28º
North of Highway 401, East of Wilson Road South	Ø = 28º
South of Highway 401, West of Wilson Road South	Ø = 28º
South of Highway 401, East of Wilson Road South	Ø = 28º

Subsection 760.04.01 of OPSS 760 is amended by the addition of the following clauses:

760.04.01.02 Wind Load

The wind load applied for the design of structure shall be: _____.

760.04.01.03 Acoustics

The minimum acoustical characteristic of the noise barrier system shall be such that the noise barrier is: Sound absorptive on both sides.

760.04.01.04 Aesthetics

The colour and texture for the noise barrier system shall be within the following parameters:

Number of colours adjacent to highway: 2

in the proportion of 50% / 50%

Number of textures: 2

in the proportion of 25% / 75%

Number of colours adjacent to residential property: 2

in the proportion of 50% / 50%

Number of textures: 2

in the proportion of 25% / 75

Final colour selections shall be determined by the Contract Administrator at the point of manufacture from samples prepared by the manufacturer.

If only one colour and texture are specified, the noise barrier shall be constructed using the colour and texture specified by the Contract Administrator following the award of the Contract. Final colour selection shall be determined at the point of manufacture from samples prepared by the manufacturer.

760.07 CONSTRUCTION

760.07.13 Quality Control

760.07.13.01 Interim Inspection of Footings and Posts

Clause 760.07.13.01 of OPSS 760 is deleted in its entirety and replaced with the following:

760.07.13.01 Inspection before Installation of Noise Barrier Panels

A Request to Proceed shall be submitted to the Contract Administrator after the construction of the noise barrier footings and posts and prior to the installation of the noise barrier panels

The installation of the noise barrier panels shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

760.07.13.02 Certificate of Conformance

Clause 760.07.13.02 of OPSS 760 is deleted in its entirety and replaced by the following:

760.07.13.02 Inspection after Installation of Noise Barrier System

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the noise barrier system.

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