



FOUNDATION INVESTIGATION AND DESIGN REPORT

Noise Barrier Wall No. 1 - East of Highway 11/12,
Between Old Barrie Road and Coldwater Road West
Bridge Replacement and Interchange Reconfigurations at Highway
11/12 (Coldwater Road) and Highway 11/12
(Old Barrie Road), Orillia

Ministry of Transportation, Ontario

GWP 2129-18-00

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PART A

**FOUNDATION INVESTIGATION REPORT
NOISE BARRIER WALL NO. 1 – EAST OF HIGHWAY 11/12 BETWEEN OLD
BARRIE ROAD AND COLDWATER ROAD WEST
BRIDGE REPLACEMENT AND INTERCHANGE RECONFIGURATIONS AT
HIGHWAY 11/12 (COLDWATER ROAD) AND HIGHWAY 11/12 (OLD BARRIE
ROAD), ORILLIA
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 2129-18-00**

1.0 INTRODUCTION

Golder Associates Ltd. ("Golder"), member of WSP, has been retained by McIntosh Perry Consulting Engineers Ltd. ("MP") on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services associated with the replacement of bridges and interchange reconfiguration/reconstruction at Highway 11/12 /Coldwater Road and Highway 11/12/Old Barrie Road. This report presents the results of the foundation investigation for the proposed noise barrier wall east of Highway 11/12 between Old Barrie Road and Coldwater Road.

The purpose of this foundation investigation is to establish the subsurface conditions along the alignment of the proposed noise barrier wall by methods of borehole drilling, in-situ testing, and laboratory testing on selected soil samples.

This report summarizes the factual results of field and laboratory work (including field investigation procedures, borehole stratigraphy, and geotechnical and analytical laboratory test results) and provides a description of the interpreted soil and groundwater conditions along the proposed noise barrier wall.

2.0 PROJECT AND SITE DESCRIPTION

The orientation stated in the text of this report is referenced to project north and therefore may differ from magnetic north shown on Drawing 1. For this report, Highway 11 (in the vicinity of the City of Orillia) is considered oriented in a south-north direction.

2.1 Project Description

The overall assignment includes the preparation of two Design-Build Ready packages for two separate contracts. The first contract includes: the replacement of the Coldwater Road Underpass; the reconfiguration/reconstruction of the Highway 11 and Highway 12/Coldwater Road West interchange; construction of a noise barrier wall; and a stormwater management pond north of the proposed carpool lot. The second contract includes: the replacement of the Old Barrie Road Underpass; the reconfiguration/reconstruction of the Highway 11 and Highway 12/Old Barrie Road interchange, including the construction of deep cuts and high fill embankments; construction of a retaining wall; and construction of a noise barrier wall.

The proposed noise barrier wall, located on the east side of Highway 11, between Old Barrie Road and Coldwater Road West (refer to Drawing 1), is part of the Coldwater Road Design-Build Ready package. The noise barrier wall is proposed to be about 500 m long and constructed between Highway 11 and the residential units west of Laurentian Lane. However, the noise barrier wall details, including the exact location and alignment of the wall has not been finalized.

2.2 Site Description

Highway 11/12 at the location of the proposed noise barrier wall consists of a divided highway comprised of two lanes in each direction. Highway 11/12 is also constructed in a shallow earth cut and the ground surface slopes upwards from the highway towards the east. The topography along the alignment of the proposed wall is relatively flat, but the ground surface slopes downwards from the southern limit (about Elevation 280.5 m) to the northern limit (about Elevation 271.5 m). The proposed noise barrier wall is situated between Highway 11/12 and residential neighbourhood immediate to the east of the Highway. The vegetation is generally comprised of grasses and occasional trees, but the northern/north-eastern area is densely populated with trees.

3.0 INVESTIGATION PROCEDURES

The field work for the proposed noise barrier wall was carried out between April 13 and April 29, 2021, during which time a total of seven boreholes were advanced in the vicinity of proposed noise barrier wall alignment. The locations of the boreholes are shown in plan on Drawing 1 and the subsurface conditions encountered in the boreholes are shown in detail on the borehole records provided in Appendix A. Lists of abbreviations, terms, and symbols are also provided in Appendix A to assist in the interpretation of the borehole records.

The boreholes were advanced using a D-50 track-mounted drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced using 210 mm outer diameter, continuous flight hollow stem augers. Soil samples were typically obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in general accordance with the Standard Penetration Test (SPT) procedures.

Water levels were observed in the open boreholes during and immediately following the drilling operations. Standpipe piezometers were installed in two selected boreholes to permit monitoring of the groundwater level. The groundwater monitoring wells consist of a 50 mm outer diameter Schedule 40 PVC pipe, with a slotted screen surrounded with a sand filter pack, sealed at a selected depth within the boreholes. The annulus surrounding the monitoring well pipe above the well screen and sand filter pack was backfilled to the ground surface with bentonite. Borehole NW1-1, NW1-2 and NW1-4 to NW1-6 was backfilled in accordance with Ontario Regulation 903 Wells (as amended). The piezometer in Borehole NW1-3 and NW1-7 will remain operational so that it can be used by the Design-Builder in the future bid or execution phase; it is then to be decommissioned by the successful Design-Build Contractor.

All other boreholes were backfilled with bentonite upon completion of drilling operations in accordance with Ontario Regulation 903 (*Wells*), as amended.

Prior to commencement of the field work, Golder arranged for the clearance of underground utilities. The field work was supervised by a member of Golder's engineering staff, who observed the borehole drilling, in-situ testing, and soil sampling operations, and logged the boreholes in the field. The soil samples were placed in appropriate containers, labelled, and transported to Golder's Mississauga geotechnical laboratory where the samples underwent further visual and tactile examination and geotechnical laboratory testing.

Geotechnical index testing, such as water content, Atterberg limits, and grain size distribution, was carried out on selected soil samples in accordance with MTO and/or ASTM Standards, as appropriate, and the results of which are presented in Appendix B. In addition, two soil samples were submitted for corrosivity testing, under chain-of-custody procedures, to Bureau Veritas Laboratories (a Standards Council of Canada (SCC) accredited laboratory) of Mississauga, Ontario. The samples were analyzed for a suite of corrosivity parameters which includes: conductivity/resistivity; soluble chloride and soluble sulphate concentrations, sulphide concentrations; and pH. The results of the corrosivity testing are presented in Appendix C.

The as-drilled borehole locations and corresponding ground surface elevations were surveyed on-site by Callon Dietz Inc. of London, Ontario, and where necessary, the borehole locations and ground surface elevations were adjusted by Golder's field personnel using field survey equipment. The borehole survey information, including northing/easting coordinates (reference to the NAD83 Canadian Spatial Reference System (CSRS) V6:2010 MTM Zone 10 coordinate system), latitude/longitude coordinates, and corresponding ground surface elevations (referenced to the Canadian Geodetic Vertical Datum (CGVD) 1928:1978), as well as borehole depths are provided on the borehole records in Appendix A and summarized below.

Borehole No.	Coordinates (MTM NAD 83 Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
NW1-1	4,940,341.2 (44.603065)	309,108.7 (-79.445722)	273.4	7.7
NW1-2	4,940,289.8 (44.602603)	309,049.8 (-79.446464)	271.6	8.0
NW1-3	4,940,216.0 (44.601939)	309,037.5 (-79.446619)	274.4	8.0
NW1-4	4,940,138.3 (44.60124)	309,029.7 (-79.446718)	277.1	7.1
NW1-5	4,940,069.1 (44.600617)	309,026.1 (-79.446764)	278.4	7.9
NW1-6	4,939,999.4 (44.59999)	309,012.7 (-79.446934)	278.9	7.8
NW1-7	4,939,934.2 (44.599403)	309,011.7 (-79.446947)	280.3	7.9

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 11/12 lies within the Simcoe Uplands, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984). The soil deposits are typically glacial tills comprised of sandy loam, deposited in broad, rolling plains which are separated by steep-sided, flat-floored valleys. In some areas within the Simcoe Uplands, localized areas of near-surface sands and silts have been deposited.

4.2 Subsurface Conditions

The subsurface soil and groundwater conditions encountered in the boreholes advanced at the site, together with the results of the in-situ and geotechnical/analytical laboratory testing, are presented on the record of boreholes in Appendix A and the details of the laboratory results are presented in Appendices B and C. The results of in-situ tests as presented on the record of boreholes are uncorrected for overburden pressure and energy transfers. The 'N'-values are based on SPT sampling procedures carried out with a standard weight (i.e., 140 lbs), and an automatic hammer.

The stratigraphic boundaries shown on the borehole records have been inferred from observations of drilling progress, generally non-continuous sampling and in-situ testing, and therefore represent transitions between soil types rather than exact planes of geologic change. Further, subsurface conditions will vary between and beyond the borehole locations.

In general, the subsurface soils encountered at the site consist of topsoil, underlain by silty sand fill which in turn is underlain by a glacial till deposit comprised of sandy silt to silty sand to silty gravel and sand. In places, the glacial till deposit is underlain by lacustrine deposit comprised of silty sand. At the northern limit of the proposed noise barrier wall, the fill is underlain by a deposit of clayey silt which is underlain by a deposit of gravelly silty sand to sandy gravel.

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

4.2.1 Topsoil

An approximately 130 mm to 360 mm thick layer of topsoil was encountered at the ground surface in all boreholes. The top of the topsoil layer was encountered at elevations ranging between 280.5 m and 271.6 m.

4.2.2 SILT (ML) and sand to SILTY SAND (SM) (FILL)

A layer of fill comprised of silt and sand to silty sand to gravelly silty sand was encountered below the topsoil at all borehole locations. The encountered fill thickness was typically between 0.3 m and 1.1 m, with an exception at Borehole NW1-1 where the fill thickness was 2.9 m. Although there was no indication of construction debris, cobbles, and/or rock fragments, such obstructions may be present within the fill. The top of the fill was encountered at depths ranging between about 0.1 m and 0.4 m below ground surface (between Elevation 280.2 m and 271.4 m).

The SPT 'N'-values measured within the fill generally range between 1 blow and 12 blows per 0.3 m of penetration, indicating a very loose to compact state of compactness. A 'N'-value of 43 blows per 0.3 m of penetration was measured within the fill encountered in Borehole NW1-5, indicating a dense state of compactness. The higher blow count can likely be attributed to the gravelly nature of the fill.

The water contents measured on ten samples recovered from the fill range between about 5% and 24%.

The results of grain size distribution tests carried out on six samples of the silt and sand to silty sand to gravelly silty sand fill deposit are presented on Figure B1 in Appendix B.

Atterberg limits tests were carried out on the fine-grained portion of two samples of the silty sand deposit recovered from Boreholes NW1-1 and NW1-3. The results carried out on the sample from Borehole NW1-3 indicate that the material is classified as a non-plastic, while the test carried out on the sample from Borehole NW1-1 measured a liquid limit of about 21%, plastic limit of about 18%, which corresponds to a plasticity index of about 3%. The Atterberg limits test results are presented on Figure B2 in Appendix B and indicate that the material is classified as a silt of slight plasticity.

4.2.3 CLAYEY SILT (CL)

An approximately 2.6 m thick cohesive deposit comprised of clayey silt, trace sand was encountered underlying the silty sand fill in Borehole NW1-1. The top of the cohesive deposit was encountered at a depth of about 3.0 m below ground surface corresponding to approximately Elevation 270.4 m).

The SPT 'N'-values measured within the cohesive deposit range from 4 blows to 5 blows per 0.3 m of penetration, suggested a firm consistency.

A water content measured on a sample of the cohesive deposit is about 29%.

Grain size distribution testing was carried out on a sample of clayey silt deposit, and the results are presented on Figure B3 in Appendix B.

Atterberg limits testing was carried out on a sample of the cohesive deposit, which measured a liquid limit of 29% and a plastic limit of 20%, corresponding to a plasticity index of about 9%. The Atterberg limit test results are presented on Figure B4 in Appendix B and indicate that the soil is classified as a clayey silt of low plasticity.

4.2.4 Sandy SILT (ML) to SILTY SAND (SM) to SILTY GRAVEL (GM/SM) and Sand (TILL)

A glacial till deposit comprised of sandy silt to silty sand to silty gravel and sand, containing crushed rock fragments was encountered below the fill in all boreholes, except in Borehole NW1-1. In Boreholes NW1-2 to NW1-7, the top of the till deposit was encountered at depths ranging from about 0.7 m to 1.4 m below ground surface (between Elevation 279.8 m and Elevation 270.9 m). In Boreholes NW1-2, NW1-3, and NW1-7, the till deposit was fully penetrated and extends to depths ranging from about 5.5 m to 7.1 m (between Elevation 275.0 m and Elevation 266.0 m). The thickness of the till deposit in these boreholes ranges between about 4.8 m and 5.7 m. Boreholes NW1-4, NW1-5 and NW1-5 were terminated within the till deposit at depths ranging from about 7.1 m to 7.9 m (i.e., Elevations ranging from about 270.1 to 271.3m) below ground surface, respectively. Auger grinding was noted during borehole advancement in the till deposit (as shown on the respective borehole records), which suggests the presence of cobbles, boulders and/or rock fragments.

The SPT 'N'-values measured within the till deposit generally ranges from 17 blows to 75 blows per 0.3 m of penetration, indicating a compact to very dense state of compactness. Higher SPT 'N'-values ranging between 50 blows and 98 blows for less than 0.3 m of penetration were also measured within the till deposit and can be likely attributed to cobbles, boulders and/or rock fragments.

The water contents measured on samples of the till deposit generally range between approximately 2% and 13%.

Grain size distribution testing was carried out on samples of the silty sand to silty gravel portion of the till deposit, and two samples of the sandy silt portion of the till deposit. The results of tests carried out on the silty sand to silty gravel till samples are presented on Figure B5A in Appendix B, while the results of tests carried out on the sandy silt till samples are presented on Figure B5B in Appendix B. Atterberg limit testing was also carried out on the fine-grained portion of five samples of the till deposit. The tests measured liquid limits between about 14% and 16%, plastic limits between about 11% and 15%, corresponding to plasticity indices between about 1% and 3%. The Atterberg limit test results are presented on Figure B6 in Appendix B and indicate that the material is classified as a silt of slight plasticity.

4.2.5 SILTY SAND (SM) to Gravelly SILTY SAND (SM) to Sandy GRAVEL (GP)

A granular deposit comprised of gravelly silty sand to sandy gravel, containing crushed rock fragments was encountered below the cohesive deposit in Borehole NW1-1, and a deposit of silty sand was encountered below the glacial till deposit in Boreholes NW1-2, NW1-3 and NW1-7. Auger grinding was noted in Borehole NW1-1. The top of the gravelly silty sand to sandy gravel deposit in Borehole NW1-1 was encountered at a depth of about 5.6 m below ground surface corresponding to approximately Elevation 267.8 m. The top of the silty sand deposit was encountered at depths ranging between about 5.5 m and 7.1 m below ground surface (between Elevation 275.0 m and Elevation 266.0 m). Boreholes NW1-1 to NW1-3 and NW1-7 were terminated within the granular deposit at depths ranging between 7.7 m and 8.0 m (between Elevation 272.6 m and Elevation 263.5 m).

The SPT 'N'-values measured within the granular deposit generally range from 54 blows to 81 blows per 0.3 m of penetration, indicating a very dense state of compactness. Higher 'N'-values ranging between 50 blows and 90 blows for less than 0.3 m of penetration were also measured within the granular deposit and can likely be attributed to the presence of cobbles, boulders and/or rock fragments.

The water content measured on three samples of the granular deposit recovered from Boreholes NW1-1 to NW1-3 range from about 1 % to 3%. The water content measured on a sample recovered from Borehole NW1-7 is about 16%.

Grain size distribution testing was carried out on three samples of the silty sand deposit, and the results are presented on Figure B7 in Appendix B.

4.3 Groundwater Conditions

In general, the soil samples recovered from the boreholes were moist. The groundwater levels were measured in open boreholes upon completion of drilling operations. Standpipe piezometers were installed in Boreholes NW1-3 and NW1-7 to monitor the groundwater level at the site. Standpipe piezometer installation details, where applicable, and groundwater level measurements are presented below.

Borehole No.	Piezometer / Sand Pack Details (m) [Screened Stratigraphy]	Water Level		Date of Water Level Reading	Remarks
		Depth (m)	Elevation (m)		
NW1-1	No piezometer installation	6.7	266.7	29 April 2021	Water level measured in open borehole upon completion of drilling
NW1-2	No piezometer installation	Dry	--	13 April 2021	Water level measured in open borehole upon completion of drilling
NW1-3	3.8 – 8.1 (270.6 – 266.3) [Silty Sand Till to Silty Gravel and Sand Till]	Dry	--	13 April 2021 (upon completion of drilling)	Standpipe piezometer dry during measurements
		Dry	--	28 October 2021	
		Dry	--	21 January 2022	
NW1-4	No piezometer installation	Dry	--	14 April 2021	Water level measured in open borehole upon completion of drilling
NW1-5	No piezometer installation	Dry	--	14 April 2021	Water level measured in open borehole upon completion of drilling
NW1-6	No piezometer installation	Dry	--	15 April 2021	Water level measured in open borehole upon completion of drilling
NW1-7	4.0 – 7.9 (276.5 – 272.6) [Silty Sand Till / Silty Sand]	5.7	274.6	15 April 2021 (upon completion of drilling)	--
		Dry	--	28 October 2021	
		6.7	273.8	21 January 2022	

The groundwater level observations/measurements at this site will be subject to seasonal fluctuations and precipitation events; therefore, the groundwater level should be expected to be higher during wet periods or during any period of heavy and/or sustained precipitation.

4.4 Analytical Testing

Two soil samples were collected from two boreholes and submitted to Bureau Veritas Laboratories for analysis of parameters used to assess corrosion potential and sulphate attack. A summary of the results is presented in the following table. The Certificates of Analysis are provided in Appendix C.

Borehole No.	Sample No.	Sample Depth [Elevation] (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (µohm/cm)	Resistivity (ohm-cm)
NW1-1	3B	1.7 – 2.1 [271.7 – 271.3]	Silty Sand (Fill)	<20	<20	7.23	98	10,000
NW1-5	3	1.5 – 2.1 [276.9 – 276.3]	Silty Sand of slight plasticity (Till)	<20	<20	7.91	112	8,900

The sulphide concentration measured on the soil sample recovered from Boreholes NW1-1 was also analyzed and was less than 0.5 mg/kg.

5.0 CLOSURE

This Foundation Investigation Report was prepared Mr. Matthew Thibeault, P.Eng. and Mr. William Cavers, P.Eng., a MTO Foundations Designated Contact, conducted an independent technical and quality review of this report.

Signature Page

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BL/TZ/CN/MT/ml/ca

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PART B

**FOUNDATION DESIGN REPORT
NOISE BARRIER WALL NO. 1 – EAST OF HIGHWAY 11/12 BETWEEN OLD
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(OLD BARRIE ROAD), ORILLIA
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 2129-18-00**

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides geotechnical parameters and recommendations for the design of the proposed noise barrier wall foundations. The proposed noise barrier wall is located east of Highway 11/12 between Old Barrie Road and Coldwater Road West in Orillia, Ontario. These recommendations are based on the interpretation of the factual data obtained from the boreholes advanced during the current subsurface field investigation.

The design report with the interpretation and recommendations is intended for the use of MTO and its designers, to provide the designers with sufficient information to carry out design of the noise barrier wall support structure foundations and shall not be used or relied upon for any other purpose or by any other parties, including the constructor or design-build contactor.

Contractors must make their own interpretation based on the information presented in the Foundation Investigation Report (i.e., 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. Contractors must make their own interpretation of the information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.1 General

The proposed noise barrier wall, located on the east side of Highway 11/12, between Old Barrie Road and Coldwater Road West (refer to Drawing 1), is part of the Coldwater Road Design-Build Ready package. The noise barrier wall is proposed to be about 500 m long and constructed between Highway 11/12 and the residential units west of Laurentian Lane. However, the noise barrier wall details, including the location and alignment of the wall has not been finalized.

6.2 Design of Noise Barrier Wall Foundations

Geotechnical parameters for design of the footings/caisson foundations for the proposed noise barrier wall are provided in Table A following the text of this report. The geotechnical parameters are based on subsurface conditions encountered in the boreholes advanced in the vicinity of the proposed noise barrier wall. The stratigraphy presented in Table A has been idealized. The geotechnical parameters presented in Table A are based on field and laboratory test data as well as empirical correlations (NAVFAC (1986), Bowles (1984) and Kulhawy and Mayne, (1990)). The estimated geotechnical parameters were adjusted using engineering judgment based on precedent experience in similar soil conditions.

Where both undrained shear strength (s_u) and drained parameters (effective cohesion, c' , and effective friction angle, ϕ') have been given in Table A for a cohesive deposit, the footing/caisson should be checked for both the total and effective stress conditions, and the greater of the two calculated footing/caisson depths shall govern.

The design of caissons subjected to lateral loads should consider such factors as the relative rigidity of the caisson to the surrounding soil, the fixity condition at the head of the caisson, the structural capacity of the caisson to withstand bending moments, the soil resistance that can be mobilized, the tolerable lateral deflections at the head of the caisson and group effects (if applicable). For a longer, more flexible caisson, the maximum yield moment of the caisson may be reached prior to mobilization of the lateral geotechnical resistance. For design purposes, both the structural and geotechnical resistances should be evaluated to establish the governing case.

The resistance to lateral loading in front of a single caisson may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h (kPa/m), is based on the equations provided below (CFEM, 1992, as referenced in the *Commentary of the CHBDC, 2019*). Additional assessment of the deformation response may be developed and provided in the form of p-y curves if the structural engineers' initial analyses suggest that the values derived from subgrade reaction theory do not adequately characterize the response of the caissons at this site.

For non-cohesive soils:

$$k_h = \frac{n_h z}{B}$$

where: n_h = coefficient related to soil density (kPa/m)
 z = depth below the top of the caisson (m)
 B = caisson diameter or width (m)

For cohesive soils:

$$k_h = \frac{67s_u}{B}$$

where: s_u = undrained shear strength of the soil (kPa)
 B = caisson diameter or width (m)

The values of n_h (Terzaghi, 1955 and Reese, 1975) and s_u , provided in Table A, shall be incorporated into the calculations of the coefficient of horizontal subgrade reaction (k_h) within the fill and native overburden, to be used for the structural analysis of the caissons at this site.

The passive resistance within the upper 1.6 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*). Passive resistance below the depth of frost penetration provided in Table A should be reduced by an appropriate factor considering the allowable wall movement in accordance with Figure C6.27 of the *Canadian Highway Bridge Design Code* (CHBDC, 2019).

A consequence factor (Ψ) of 1.0 and a geotechnical resistance factor of 0.5 (assuming a "typical" consequence level and a "typical" degree of site understanding as outlined in the 2019 *Canadian Highway Bridge Design Code and its Commentary* (CHBDC, 2019) should be applied to this unfactored lateral resistance to obtain the factored ultimate lateral geotechnical resistance.

6.3 Construction Considerations

The footings/caissons for the noise barrier wall should be constructed in accordance with OPSS.PROV 903 (*Deep Foundations*). The remainder of the noise barrier wall should be in accordance with OPSS.MUNI 760 (*Construction Specification for Noise Barrier Systems*), as amended by SSP 760F01. Table A presents the recommended soil design parameters, which should be added as a designer fill in to SSP 760F01 for the contract documents.

6.3.1 Control of Soil and Groundwater

All open boreholes were dry upon completion of drilling, except in open Borehole NW1-1 where the groundwater level was measured at a depth of about 6.7 m below ground surface. In the piezometer installed in Borehole NW1-7, the groundwater level was measured at a depth of about 5.7 m below ground surface; however, the groundwater level at the site is expected to fluctuate and be higher during periods of heavy or sustained precipitation.

The fills and native soils encountered at the proposed noise barrier wall are generally classified as coarse-grained soils and are dry, consequently, these soils may slough into unsupported auger holes during footing/caisson installation. Therefore, appropriate equipment and procedures will be required to minimize ground loss during drilling and concrete placement. This could include the use of drilling mud or temporary caisson liners (assuming obstructions will not impede advancement of temporary caisson liners).

Consistent with good practice, surface water should be directed away from the footing/caisson excavations during construction. However, the risks associated with surface water are considered very low based on the foundation locations, and given that these single footings/caissons will be drilled and reinforcing steel/concrete placed relatively quickly, that any entry of surface water to the footing/caisson would only affect the base and not the sides (as the predominant loading condition is lateral).

6.3.2 Obstructions

Construction debris, cobbles, and rock fragments or should be anticipated within the fill, while rock fragments, cobbles and/or boulders should be anticipated within the glacial till deposit when advancing caissons. Construction equipment must be capable of handling these obstructions during construction of the caissons. An NSSP should be included in the Contract Documents to warn the Contractor of the presence of these potential obstructions within the fill and glacial till deposits. An example of the NSSP is provided in Appendix D. Note that the extent and depth of the potential obstructions may vary between and beyond the boreholes.

6.4 Analytical Testing of Construction Materials

The results of analytical tests carried out on two soil samples recovered from boreholes advanced in the vicinity of the proposed noise barrier wall are presented in Section 4.4 and on the *Certificates of Analysis* in Appendix C.

The analytical test results 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 soil samples is less than 0.002%, which is below the moderate degree of exposure (i.e., below the class S3 exposure limits); suggesting that the effects of sulphate from the granular fill and the glacial till deposit in contact with the concrete footings/caissons below the ground surface may not needed to be considered. However, if the proposed foundations will be exposed to de-icing salt or other chemicals, consideration should also be given by the designer to designing the concrete structure for a “C” type exposure class as defined by CSA A23.1 Table A.

The pH levels and resistivity analytical test results of the soil samples were also compared to the *MTO Gravity Pipe Design Guidelines* (MTO, 2014) to assess the relative level of corrosion potential on any buried steel elements in contact with the fill/soil. The pH levels measured on the soil samples were about 7.2 and 7.9, suggesting the granular fill and glacial till deposits are basic (i.e., pH levels greater than 7). These pH levels are not considered detrimental to steel durability given that the pH levels are less than 8.5. The resistivity (R) measured on the two samples were about 8,900 ohm cm to 10,000 ohm cm, which indicates that the soil corrosiveness is very low ($10,000 > R > 6,000$) as per Table 3.2 of the *MTO Gravity Pipe Design Guideline* (2014). Therefore, corrosion protection may not need to be considered for steel foundation elements in contact with the fill/soil.

These recommendations are provided as guidance only. Ultimately, it is the 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 Mr. Bryan Lui, P.Eng., Mr. Tomasz Zalucki, P.Eng., and Mr. Christopher Ng, P.Eng. Mr. Matthew Thibeault, P.Eng. and Mr. William Cavers, P.Eng., an MTO Foundations Designated Contact, conducted an independent technical and quality review of this report.

Signature Page

Golder Associates Ltd.



Matthew Thibeault, P.Eng.
Senior Geotechnical Engineer



William Cavers, P.Eng.
MTO Foundations Designated Contact

BL/TZ/CN/MT/ml/ca

[https://golderassociates.sharepoint.com/sites/120052/project files/6 deliverables/2. reporting/05 - noise barrier wall 1/final/19135676-r-rev0-noise barrier wall 1 fidr 26aug_22.docx](https://golderassociates.sharepoint.com/sites/120052/project%20files/6%20deliverables/2.%20reporting/05%20-%20noise%20barrier%20wall%201/final/19135676-r-rev0-noise%20barrier%20wall%201%20fidr%2026aug_22.docx)

REFERENCES

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

Ministry of Transportation, Ontario Special Provisions:

SSP 760F01 Amendment to OPSS 760

Ontario Provisional Standard Drawings (OPSD):

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications (OPSS):

OPSS.PROV 903 Construction Specification for Deep Foundations
OPSS.MUNI 760 Construction Specification for Noise Barrier Systems

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

Tables

Table A: Geotechnical Design Parameters for Noise Barrier Wall No. 1

Approximate Noise Barrier Wall Location	Relevant Boreholes	Fill / Soil Stratum	Approximate Depth ² (m)	Design Groundwater Depth ³ (m)	Geotechnical Design Parameters ⁴							
					s_u (kPa)	n_h (kPa/m)	φ' (o)	γ (kN/m ³)	γ' (kN/m ³)	K_o ⁸	K_a ⁸	K_p ^{5,6,7,8}
East of Highway 11/12 NBL, between Old Barrie Road and Coldwater Road West	NW1-1 to NW1-7	Very Loose to Compact Silt and Sand to Silty Sand (Fill)	0.0 – 1.4 (0.0 – 3.0 at north-east limit of wall)	5.5	--	3,000	30	19	9.2	0.50	0.33	3.00
		Firm Clayey Silt (northern limit of wall; Borehole NW1-1)	3.0 – 5.6 at north-east limit of wall		50	--	30	19	9.2	0.50	0.33	3.00
		Compact to Very Dense Sandy Silt to Silty Sand to Silty Gravel and Sand (Till)	1.4 – 5.6		--	20,000 (above ground water level) 15,000 (below ground water level)	36	21	11.2	0.41	0.26	3.85
		Very Dense Silty Sand to Gravelly Silty Sand to Sandy Gravel	5.5 – 8.1		--	30,000	36	21	11.2	0.41	0.26	3.85

NOTES:

1. Refer to Drawing 1 for the approximate location of the proposed noise barrier wall.
2. Depths are given relative to the borehole ground surface elevations; the ground surface elevations at the borehole locations should be compared to the ground surface elevations at the proposed noise barrier wall, and the depths to various soil strata adjusted accordingly.
3. Groundwater elevation is based on measurements in open boreholes and in standpipe piezometers installed at the site. Given the variability in the ground surface elevation along the alignment of the proposed noise barrier wall, a design groundwater elevation is not provided.
4. The geotechnical design parameters are as follows:

s_u = undrained shear strength (kPa).

n_h = coefficient related to soil density (kPa/m).

φ' = effective (drained) friction angle (°).

K_a = active earth pressure coefficient.

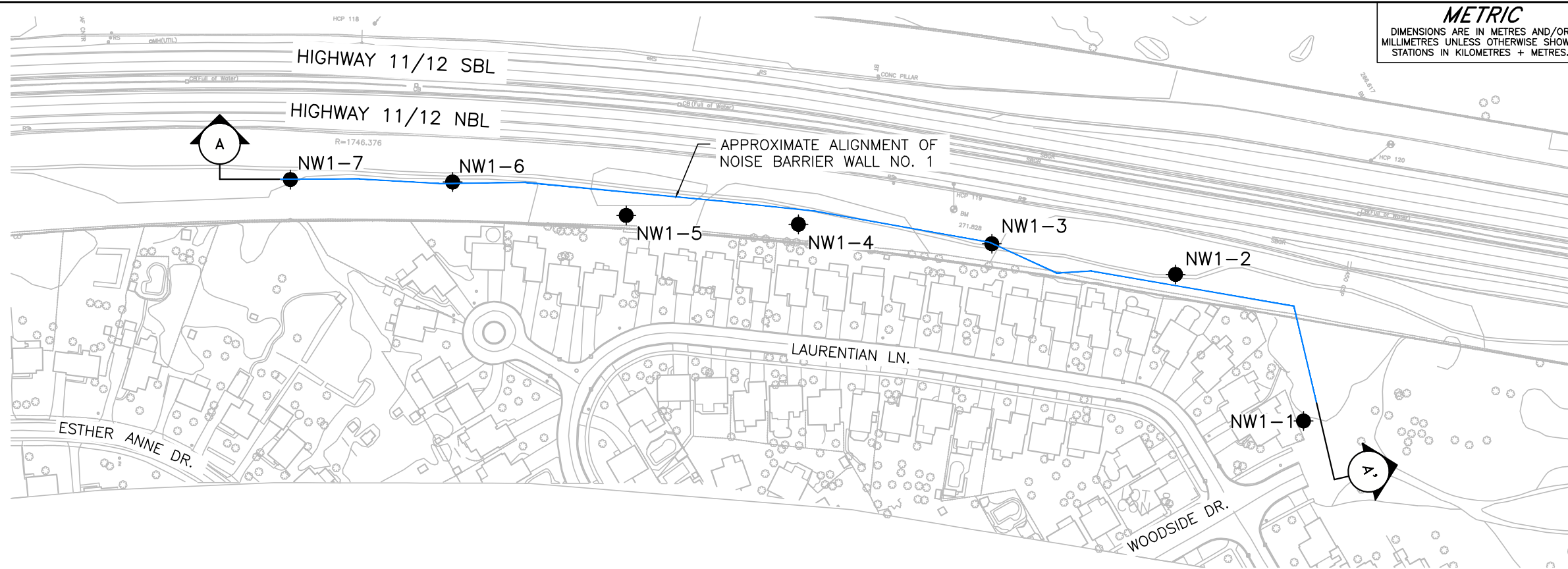
K_p = passive earth pressure coefficient.

K_o = earth pressure coefficient at rest.

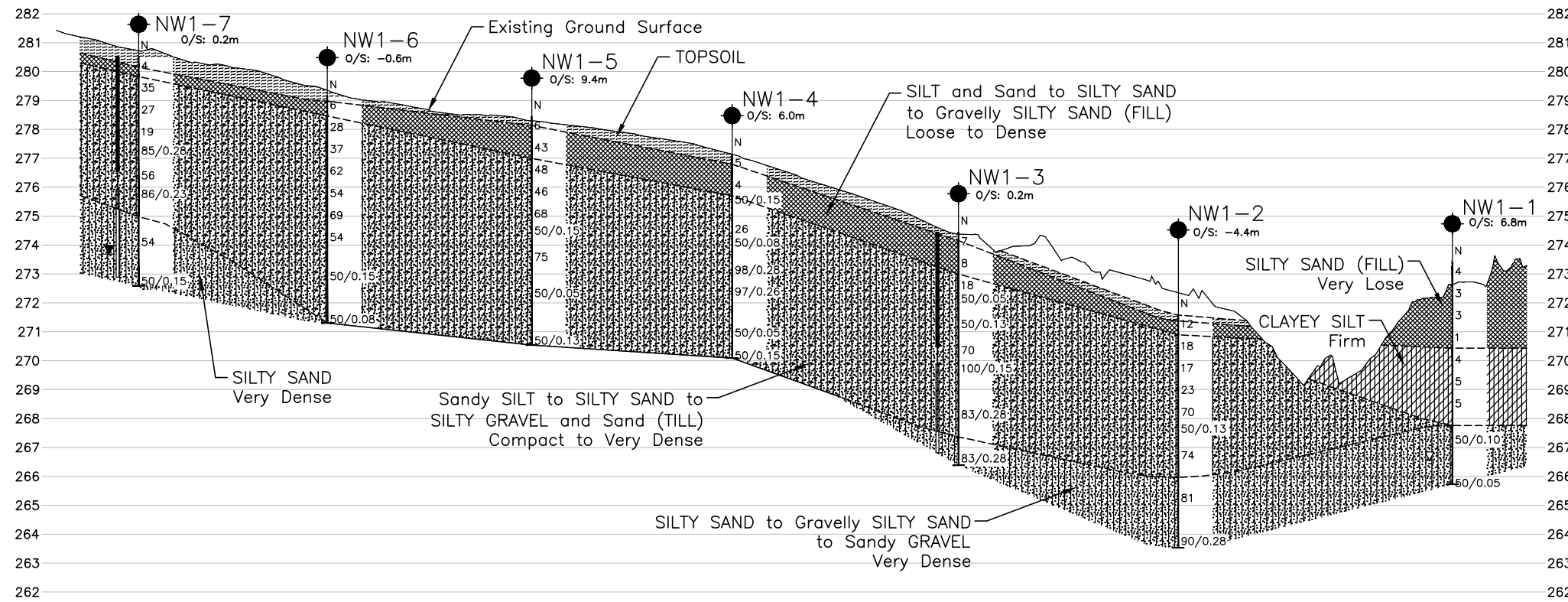
γ = bulk unit weight (kN/m³).

γ' = effective unit weight (below the groundwater level) (kN/m³).
5. The passive resistance in the upper 1.6 m should be neglected to account for frost action.
6. Where footings/caissons are to be installed on or near a slope (i.e., sloping downwards from the proposed noise barrier wall), the passive resistance shall be reduced accordingly.
7. The total passive resistance below frost depth may be calculated based on the values of K_p provided above but reduced by an appropriate factor that considers allowable wall movement in accordance with Figure C6.27 of the Canadian Highway Bridge Design Code (CHBDC, 2019) to account for large strains required to mobilize full passive resistance.
8. For cohesive soils (e.g., clayey silt), an assessment for the effective stress, drained (φ') and total stress, undrained (s_u) cases should be made to establish the more conservative earth pressure condition for design purposes.

Drawings



PLAN
SCALE
20 0 20 40 m



PROFILE A-A'
VERTICAL SCALE
2 0 2 4 m
HORIZONTAL SCALE
20 0 20 40 m



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

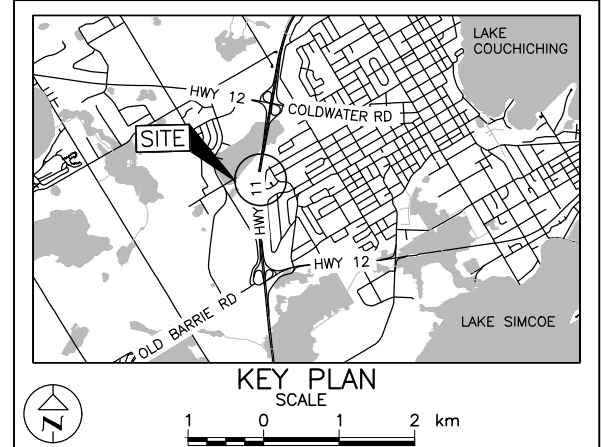
CONT No.
GWP No. 2494-15-00



HIGHWAY 11/12
NOISE BARRIER WALL NO.1
BOREHOLE LOCATION PLAN AND
SOIL STRATA

SHEET

WSP GOLDER



LEGEND

- Borehole - Current Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer (Jan. 21, 2022)
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES (MTM83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
NW1-1	273.4	4940341.2	309108.7
NW1-2	271.6	4940289.8	309049.8
NW1-3	274.4	4940216.0	309037.5
NW1-4	277.2	4940138.3	309029.7
NW1-5	278.4	4940069.1	309026.1
NW1-6	279.2	4939999.4	309012.7
NW1-7	280.5	4939934.2	309011.7

NOTES

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

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

REFERENCE

Base plans provided in digital format by McIntosh Perry, drawing file nos. x_197147_BASE.dwg, received May 19, 2021.
Noise barrier wall alignment provided in digital format by McIntosh Perry, drawing file nos. Noise Wall Locations.pdf, received March 19, 2021.

NO.	DATE	BY	REVISION
1			
Geocres No. 31D-795			
HWY. 11 AND 12		PROJECT NO. 19135676	DIST. .
SUBM'D. BL	CHKD. BL	DATE: 2022-08-25	SITE: .
DRAWN: DD	CHKD. TZ	APPD. CN	DWG. 1

APPENDIX A

Record of Boreholes

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	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
		2.00 to 4.75	(10) to (4)
SAND	Coarse	0.425 to 2.00	(40) to (10)
	Medium	0.075 to 0.425	(200) to (40)
	Fine		
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

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

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

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

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (*q_t*), porewater pressure (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

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

SOIL TESTS

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

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

COARSE-GRAINED SOILS

Compactness¹

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

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 grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

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.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = 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 = $\tan \delta$
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or q'	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

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

Notes: 1
2

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

PROJECT	19135676	RECORD OF BOREHOLE No. NW1-1		Sheet 1 of 1	METRIC
G.W.P.	2494-15-00	LOCATION	N 4940341.2; E 309108.7 NAD83 / MTM Zone 10 (LAT. 44.603065; LONG. -79.445722)		ORIGINATED BY MH
DIST	Central HWY 11/12	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers		COMPILED BY BL
DATUM	CGVD28 Surface Elevation:273.4 m	DATE	Apr 29, 2021		CHECKED BY TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined	20	40	60	80	100	W _p	W						
											NP Nonplastic										
0.0	TOPSOIL (130 mm)		1A																		
273.3 0.1	SILTY SAND (SM) of slight plasticity, trace gravel to SILTY SAND (SM), trace gravel (FILL) Very loose Brown Moist		1B	SS	4		273														
			2	SS	3																
			3A				272														
			3B	SS	3																
			4	SS	1		271														
270.4 3.0	CLAYEY SILT (CL), trace sand Firm Brown Moist		5	SS	4		270														
			6	SS	5																
			7	SS	5		269														
							268														
267.8 5.6	Gravelly SILTY SAND (SM) to sandy GRAVEL (GP), containing crushed rock fragments Very dense Brown Moist - 6.1 to 6.2 m: Grinding of augers noted (between Elevation 267.3 m and Elevation 267.2 m)		8	SS	50/0.10		267														
265.7 7.7	End of Borehole Note: 1. Water level measured in open borehole at a depth of about 6.7 m below ground surface (Elevation 266.7 m) upon completion of drilling.		9	SS	50/0.05		266														
							265														
							264														

⁺³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT 19135676

RECORD OF BOREHOLE No. NW1-2

Sheet 1 of 1

METRIC

G.W.P. 2494-15-00

LOCATION N 4940289.8; E 309049.8 NAD83 / MTM Zone 10 (LAT. 44.602603; LONG. -79.446464)

ORIGINATED BY MH

DIST Central HWY 11/12





BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY BL

DATUM CGVD28 Surface Elevation:271.6 m

DATE Apr 13, 2021

CHECKED BY TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m ³	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0	TOPSOIL (200 mm)		1A				271	20	40	60	80	100	20	40	60		2	40	50	8	
271.4 0.2	SILT (ML) and sand of slight plasticity, trace gravel (FILL) Compact Brown		1B	SS	12																
270.9 0.7	Moist Sandy SILT (ML), trace gravel, containing crushed rock fragments (TILL) Compact to very dense Brown Moist		2	SS	18		270														
			3	SS	17												2	21	(77)		
			4	SS	23		269														
			5	SS	70		268										7	23	60	10	
			6	SS	50/0.13																
			7	SS	74		267														
266.0							266														
5.6	SILTY SAND (SM) Very dense Brown Moist		8	SS	81		265										0	76	(24)		
263.5			9	SS	90/0.28		264														
8.0	End of Borehole Note: 1. Open borehole dry upon completion of drilling.						263														
							262														

+³, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE

PROJECT 19135676

RECORD OF BOREHOLE No. NW1-3

Sheet 1 of 1

METRIC

G.W.P. 2494-15-00

LOCATION N 4940216; E 309037.5 NAD83 / MTM Zone 10 (LAT. 44.601939; LONG. -79.44662)

ORIGINATED BY MH

DIST Central HWY 11/12





BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY BL

DATUM CGVD28 Surface Elevation:274.4 m

DATE Apr 13, 2021

CHECKED BY TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined					PL W _p	NMC W	LL W _L						
0.0	TOPSOIL (310 mm)		1A																		
274.1			1B	SS	7		274							○							
0.3	SILTY SAND (SM), some gravel, containing rootlets (FILL) Loose Brown Moist													○				14	43	36 7	
273.0			2	SS	8									○							
1.4	SILTY SAND (SM), trace to some gravel to SILTY GRAVEL (GM/SM) and sand, containing crushed rock fragments (TILL) Compact to very dense Brown Moist - 2.3 m: Grinding of augers noted (Elevation 272.2 m) - 3.0 to 3.3 m: Grinding of augers noted (between Elevation 271.4 m and Elevation 271.1 m)						273														
			3	SS	18																
			4	SS	50/0.05		272														
			5	SS	50/0.13									○				41	39	17 3	
							271														
			6	SS	70																
							270														
			7	SS	100/0.15									○							
							269														
			8	SS	83/0.28		268							○							
267.4																					
7.1	SILTY SAND (SM), trace gravel Very dense Brown Moist						267							○							
266.4			9	SS	83/0.28									○				1	80	18 1	
8.0	End of Borehole Notes: 1. Standpipe piezometer noted dry upon drilling of completion. 2. Standpipe piezometer noted dry on October 28, 2021. 3. Standpipe piezometer noted dry on January 21, 2022.						266														
							265														

+³, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE

PROJECT 19135676

RECORD OF BOREHOLE No. NW1-4

Sheet 1 of 1

METRIC

G.W.P. 2494-15-00

LOCATION N 4940138.3; E 309029.7 NAD83 / MTM Zone 10 (LAT. 44.60124; LONG. -79.446718)

ORIGINATED BY MH

DIST Central HWY 11/12




BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY BL

DATUM CGVD28 Surface Elevation:277.2 m

DATE Apr 14, 2021

CHECKED BY TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)				UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL							
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined					W _p	W	W _i							
													NP Nonplastic									
0.0	TOPSOIL (360 mm)		1A	SS	5		277															
276.8																						
0.4	SILTY SAND (SM), trace gravel, containing rootlets (FILL) Loose Brown Moist		1B																			
			2	SS	4		276							○				5	50	38	7	
275.7																						
1.4	SILTY SAND (SM), trace gravel, containing crushed rock fragments (TILL) Compact to very dense Brown Moist - 1.5 to 1.7 m: Grinding of augers noted (between Elevation 275.6 m and Elevation 275.5 m) - 2.3 m: Grinding of augers noted (Elevation 274.9 m)		3	SS	50/0.15		275															
			4	SS	26									○								
			5	SS	50/0.08		274															
			6	SS	98/0.28		273															
			7	SS	97/0.26		272							○				3	57	34	6	
			8	SS	50/0.05		271															
			9	SS	50/0.15		270							○								
270.1	- 6.9 m: Grinding of augers noted (Elevation 270.2 m)																					
7.1	End of Borehole Note: 1. Open borehole dry upon completion of drilling.						270															
							269															
							268															

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT 19135676

RECORD OF BOREHOLE No. NW1-5

Sheet 1 of 1

METRIC

G.W.P. 2494-15-00

LOCATION N 4940069.1; E 309026.1 NAD83 / MTM Zone 10 (LAT. 44.600617; LONG. -79.446764)

ORIGINATED BY MH

DIST Central HWY 11/12












BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY BL

DATUM CGVD28 Surface Elevation:278.4 m




DATE Apr 14, 2021

CHECKED BY TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)				UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS	
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL								
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L								
							20	40	60	80	100	20	40	60	NP Nonplastic								
0.0	TOPSOIL (300 mm)		1A				278																
278.1	Gravelly SILTY SAND (SM), containing rootlets (FILL) Loose to dense Brown Moist		1B	SS	6																		
0.3																							
					2	SS	43																
277.0							277																
1.4	SILTY SAND (SM) of slight plasticity, trace to some gravel, containing crushed rock fragments (TILL) Dense to very dense Brown Moist		3	SS	48																		
					4	SS	46																
							276																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)		5	SS	68																		
					6	SS	50/0.15																
							275																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)		7	SS	75																		
					8	SS	50/0.05																
							274																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)		9	SS	50/0.13																		
							273																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)																						
							272																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)																						
							271																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)																						
							270																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)																						
							269																
	- 3.8 m: Grinding of augers noted (Elevation 274.6 m)																						
270.5	End of Borehole																						
7.9	Note: 1. Open borehole dry upon completion of drilling.																						

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT	19135676	LOCATION	N 4939999.4; E 309012.7 NAD83 / MTM Zone 10 (LAT. 44.59999; LONG. -79.446934)	Sheet 1 of 1	METRIC
G.W.P.	2494-15-00	BOREHOLE TYPE	210 mm O.D. Continuous Flight Hollow Stem Augers	ORIGINATED BY	MH
DIST	Central HWY 11/12	DATE	Apr 15, 2021	COMPILED BY	BL
DATUM	CGVD28 Surface Elevation:279.2 m			CHECKED BY	TZ/CN

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane					W _p	W	W _i						
								Remoulded Pocket Pen Quick Triaxial Unconfined					NP Nonplastic								
							20	40	60	80	100	20	40	60							
0.0	TOPSOIL (180 mm)		1A				279														
279.0 0.2	SILTY SAND (SM) (FILL) Loose Brown Moist		1B	SS	6																
278.5 0.7	SILTY SAND (SM) of slight plasticity, trace to some gravel, containing crushed rock fragments (TILL) Compact to very dense Brown Moist - 0.8 to 1.4 m: Grinding of augers noted (between Elevation 278.4 m and Elevation 277.8 m)		2	SS	28		278														
			3	SS	37		277										20	46	27 7		
			4	SS	62		276														
	- 3.0 m: Grinding of augers noted (Elevation 276.1 m)		5	SS	54		275														
			6	SS	69		274														
			7	SS	54		273														
			8	SS	50/0.15		272														
271.3 7.8	End of Borehole Note: 1. Open borehole dry upon completion of drilling.		9	SS	50/0.08												3	50	37 10		
							271														
							270														

⁺3, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE

PROJECT 19135676

RECORD OF BOREHOLE No. NW1-7

Sheet 1 of 1

METRIC

G.W.P. 2494-15-00

LOCATION N 4939934.2; E 309011.7 NAD83 / MTM Zone 10 (LAT. 44.599403; LONG. -79.446947)

ORIGINATED BY MH

DIST Central HWY 11/12





BOREHOLE TYPE 210 mm O.D. Continuous Flight Hollow Stem Augers

COMPILED BY BL

DATUM CGVD28 Surface Elevation:280.5 m

DATE Apr 15, 2021

CHECKED BY TZ/CN

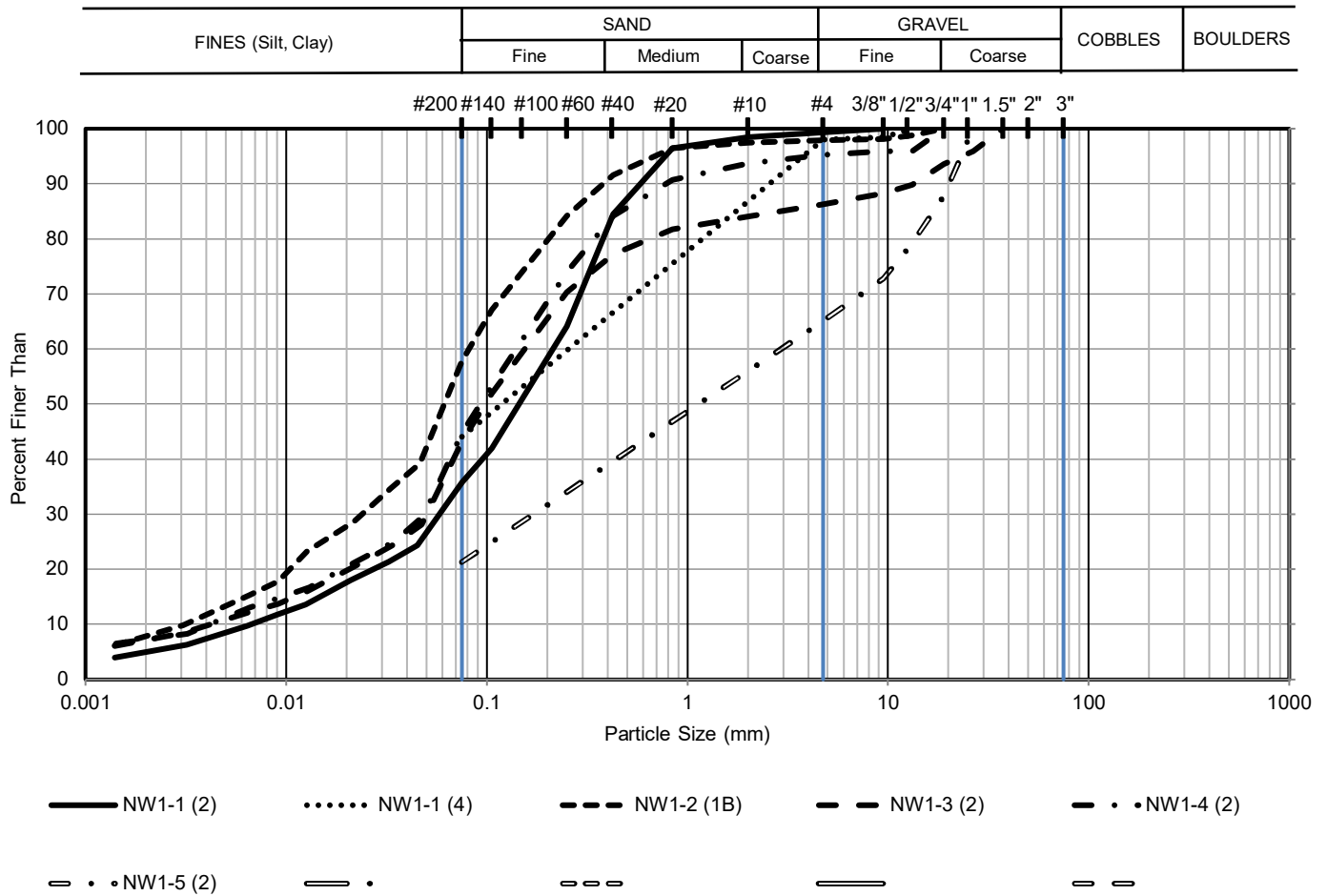
SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L						
0.0	TOPSOIL (360 mm)		1A	SS	4		280														
280.2			1B																		
0.4	SILTY SAND (SM), containing rootlets (FILL)																				
279.8	Loose																				
0.7	Brown																				
	Moist																				
	SILTY SAND (SM) of slight plasticity, some gravel, containing crushed rock fragments (TILL)		2	SS	35								○					11	45	36	8
	Compact to very dense																				
	Brown																				
	Moist																				
	- 1.5 to 2.1 m: Grinding of augers noted (between Elevation 279.0 m and Elevation 278.4 m)		3	SS	27		279														
	- 2.3 to 2.9 m: Grinding of augers noted (between Elevation 278.2 m and Elevation 277.6 m)		4	SS	19		278						○								
			5	SS	85/0.28		277														
	- 3.8 to 4.4 m: Grinding of augers noted (between Elevation 276.7 m and Elevation 276.1 m)		6	SS	56		276						○					13	43	(44)	
			7	SS	86/0.23		275														
275.0	- 5.3 m: Grinding of augers noted (Elevation 275.2 m)																				
5.5	SILTY SAND (SM)		8	SS	54		274														
	Very dense																				
	Brown																				
	Wet																				
272.6			9	SS	50/0.15		273						○					0	81	17	2
7.9	End of Borehole																				
	Notes:																				
	1. Water level in standpipe piezometer measured at a depth of about 5.7 m below ground surface (Elevation 274.6 m) upon completion of drilling.						272														
	2. Standpipe piezometer dry on October 28, 2021.																				
	3. Standpipe piezometer measured at a depth of about 6.7 m below ground surface (Elevation 273.8 m) on January 21, 2022.						271														

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

APPENDIX B

**Geotechnical Laboratory
Test Results**

GRAIN SIZE DISTRIBUTION



Borehole Number	Sample Number	Depth (m)	Elevation (m)
NW1-1	2	0.8 - 1.4	272.6 to 272.0
NW1-1	4	2.3 - 2.9	271.1 to 270.5
NW1-2	1B	0.2 - 0.6	271.4 to 271.0
NW1-3	2	0.8 - 1.4	273.7 to 273.1
NW1-4	2	0.8 - 1.4	276.4 to 275.8
NW1-5	2	0.8 - 1.4	277.7 to 277.1

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT

wsp **GOLDER**

YYYY-MM-DD 2022-02-23

DESIGNED -

PREPARED BL

REVIEWED TZ

APPROVED CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12, BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST; CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

SILT (ML) and sand, of slight plasticity to SILTY SAND (SM) of slight plasticity to Gravelly SILTY SAND (SM) (FILL)

PROJECT NO.

19135676

CONTROL

0

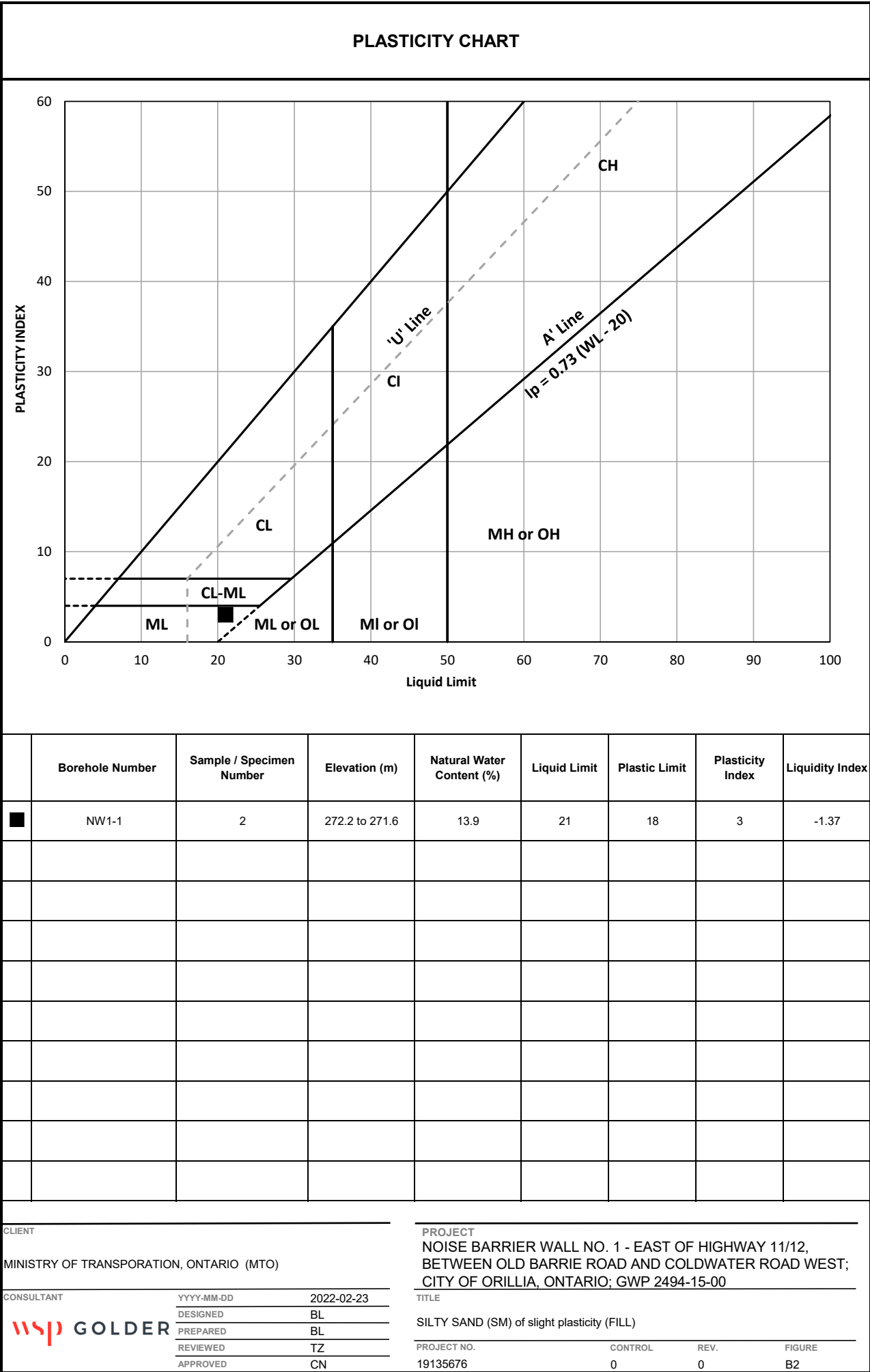
REV.

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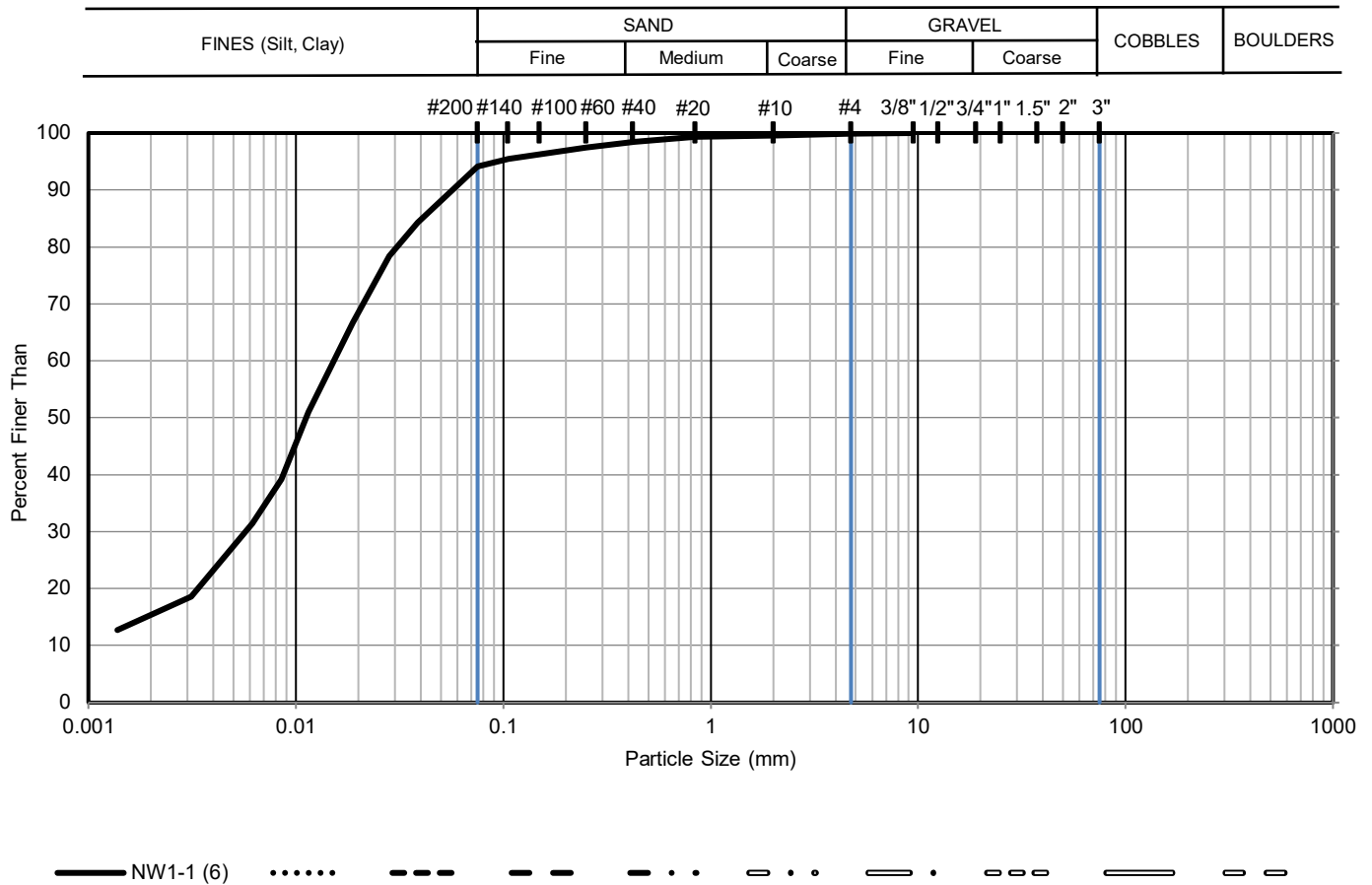
FIGURE

B1

PATH: https://golderrassociates.sharepoint.com/sites/120052/Project Files/6 Deliverables/05 - Noise wall 1/Appendix B - Geotechnical Laboratory Test Results/Excel working files | FILE NAME: Afterberg Output MTO (Figure B2, B4 and B6).xlsm



GRAIN SIZE DISTRIBUTION



Borehole Number	Sample Number	Depth (m)	Elevation (m)
NW1-1	6	3.8 - 4.4	268.7 to 268.1

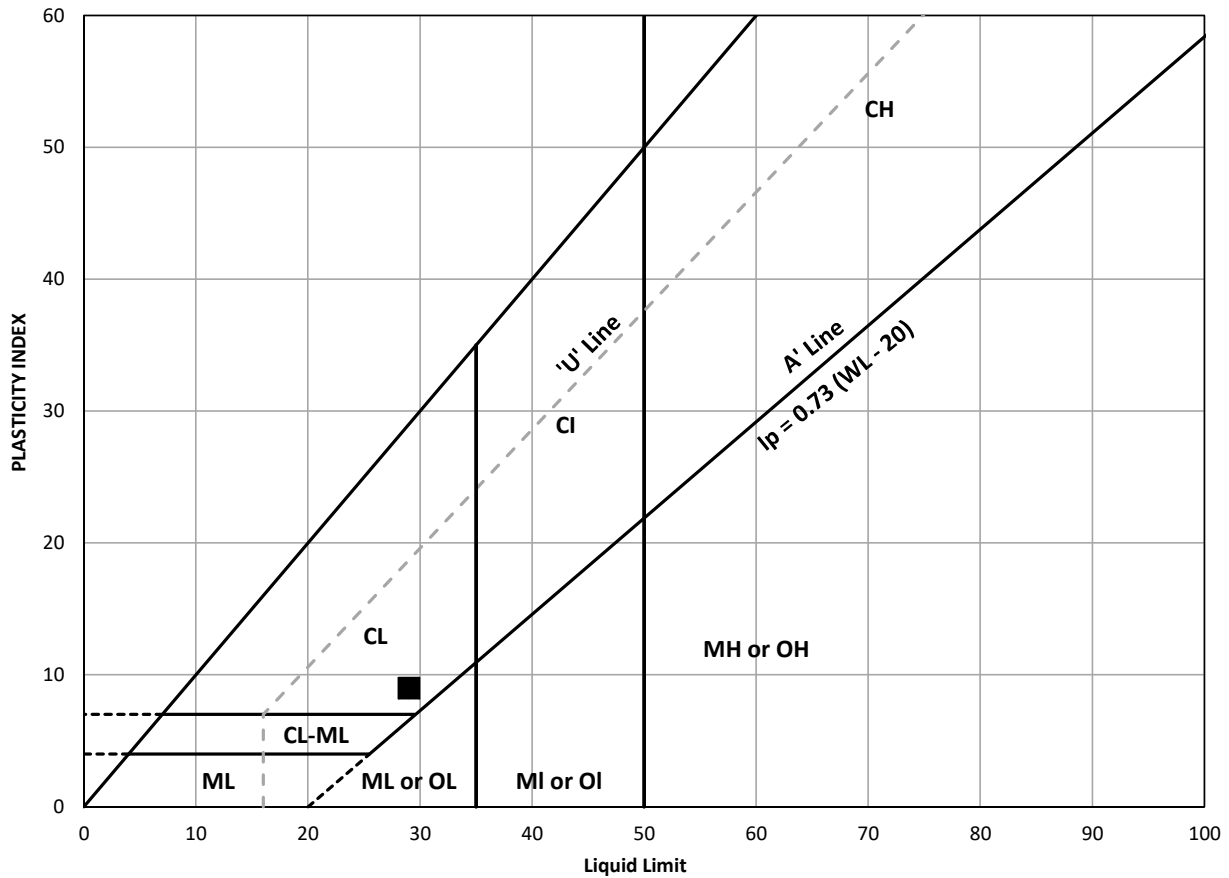
CLIENT	
MINISTRY OF TRANSPORTATION, ONTARIO (MTO)	
CONSULTANT	
YYYY-MM-DD	2022-02-23
DESIGNED	-
PREPARED	BL
REVIEWED	TZ
APPROVED	CN



PROJECT			
NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12, BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST; CITY OF ORILLIA, ONTARIO; GWP 2494-15-00			
TITLE			
CLAYEY SILT (CL)			
PROJECT NO.	CONTROL	REV.	FIGURE
19135676	0	0	B3

PATH: https://golderassociates.sharepoint.com/sites/120052/Project Files/6 Deliverables/05 - Noise wall 1/Appendix B - Geotechnical Laboratory Test Results/Excel working files | FILE NAME: Afterberg Output MTO (Figure B2, B4 and B6).xlsm

PLASTICITY CHART



	Borehole Number	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	NW1-1	6	269.1 to 268.5	28.5	29	20	9	0.94

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT



YYYY-MM-DD	2022-02-23
DESIGNED	BL
PREPARED	BL
REVIEWED	TZ
APPROVED	CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12,
BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST;
CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

CLAYEY SILT (CL)

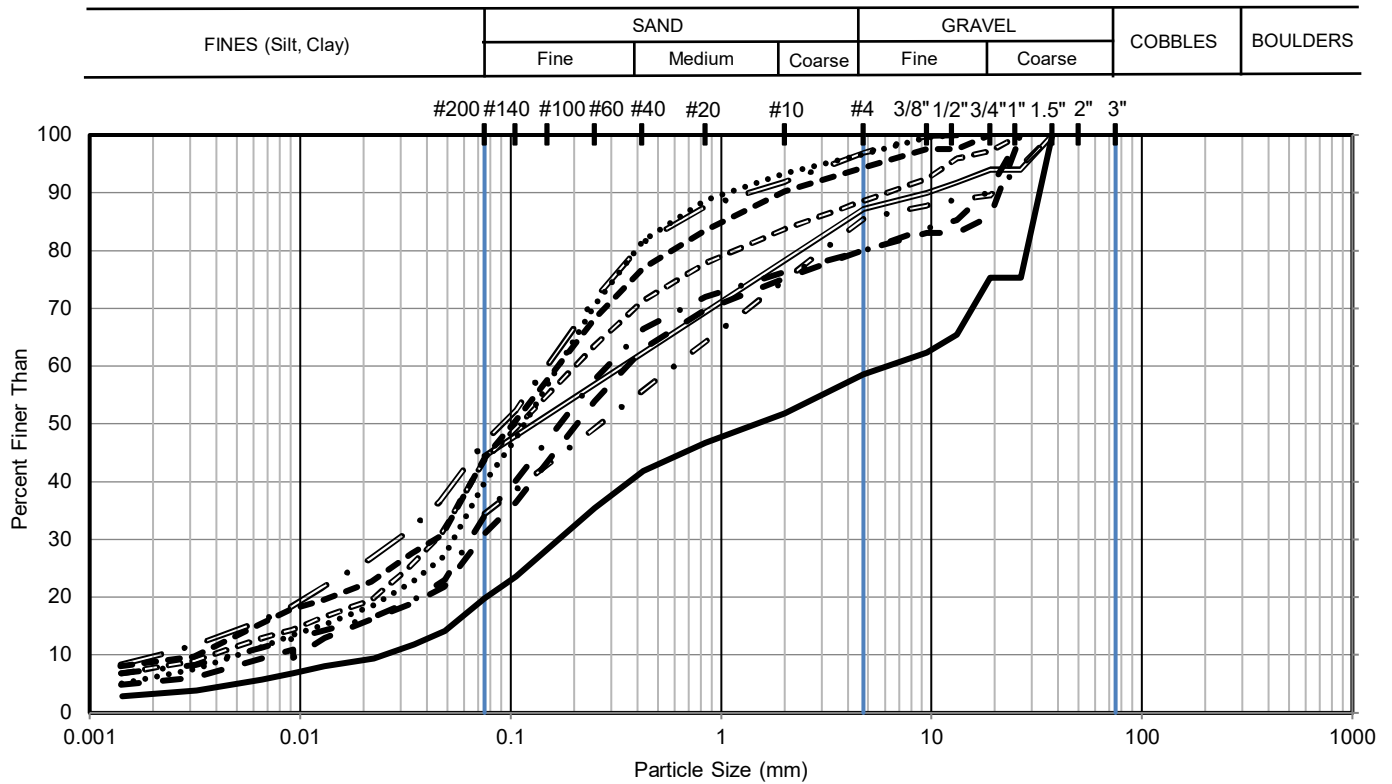
PROJECT NO.
19135676

CONTROL
0

REV.
0

FIGURE
B4

GRAIN SIZE DISTRIBUTION



Borehole Number	Sample Number	Depth (m)	Elevation (m)
NW1-3	5	3.0 - 3.3	271.4 to 271.1
NW1-4	7	4.6 - 5.0	272.6 to 272.2
NW1-5	3	1.5 - 2.1	276.9 to 276.3
NW1-5	6	3.8 - 4.1	274.6 to 274.3
NW1-6	3	1.5 - 2.1	277.6 to 277.0
NW1-6	6	3.8 - 4.4	275.3 to 274.7
NW1-6	9	7.6 - 7.8	271.5 to 271.3
NW1-7	2	0.8 - 1.4	279.7 to 279.1
NW1-7	6	3.8 - 4.4	276.7 to 276.1

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT

wsp **GOLDER**

YYYY-MM-DD 2022-02-23

DESIGNED -

PREPARED BL

REVIEWED TZ

APPROVED CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12, BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST; CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

SILTY SAND (SM) of slight plasticity to SILTY SAND (SM) to SILTY GRAVEL (GM/SM) and sand (TILL)

PROJECT NO.

19135676

CONTROL

0

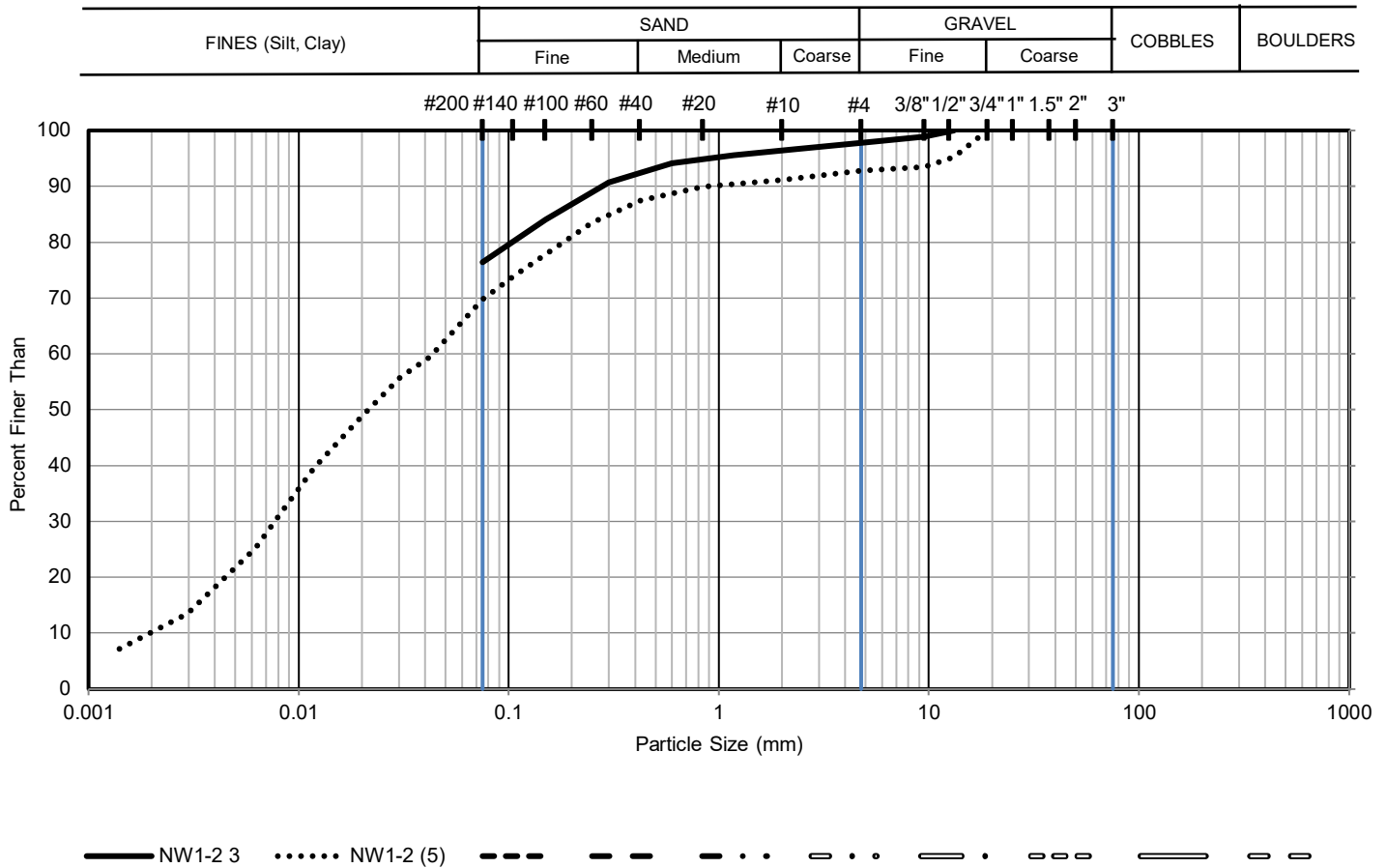
REV.

0

FIGURE

B5A

GRAIN SIZE DISTRIBUTION



Borehole Number	Sample Number	Depth (m)	Elevation (m)
NW 1-2	3	1.5 - 2.1	270.1 to 269.5
NW 1-2	5	3.0 - 3.7	268.5 to 267.9

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT



YYYY-MM-DD 2022-02-23

DESIGNED -

PREPARED BL

REVIEWED TZ

APPROVED CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12, BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST; CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

Sandy SILT (ML) (TILL)

PROJECT NO.

19135676

CONTROL

0

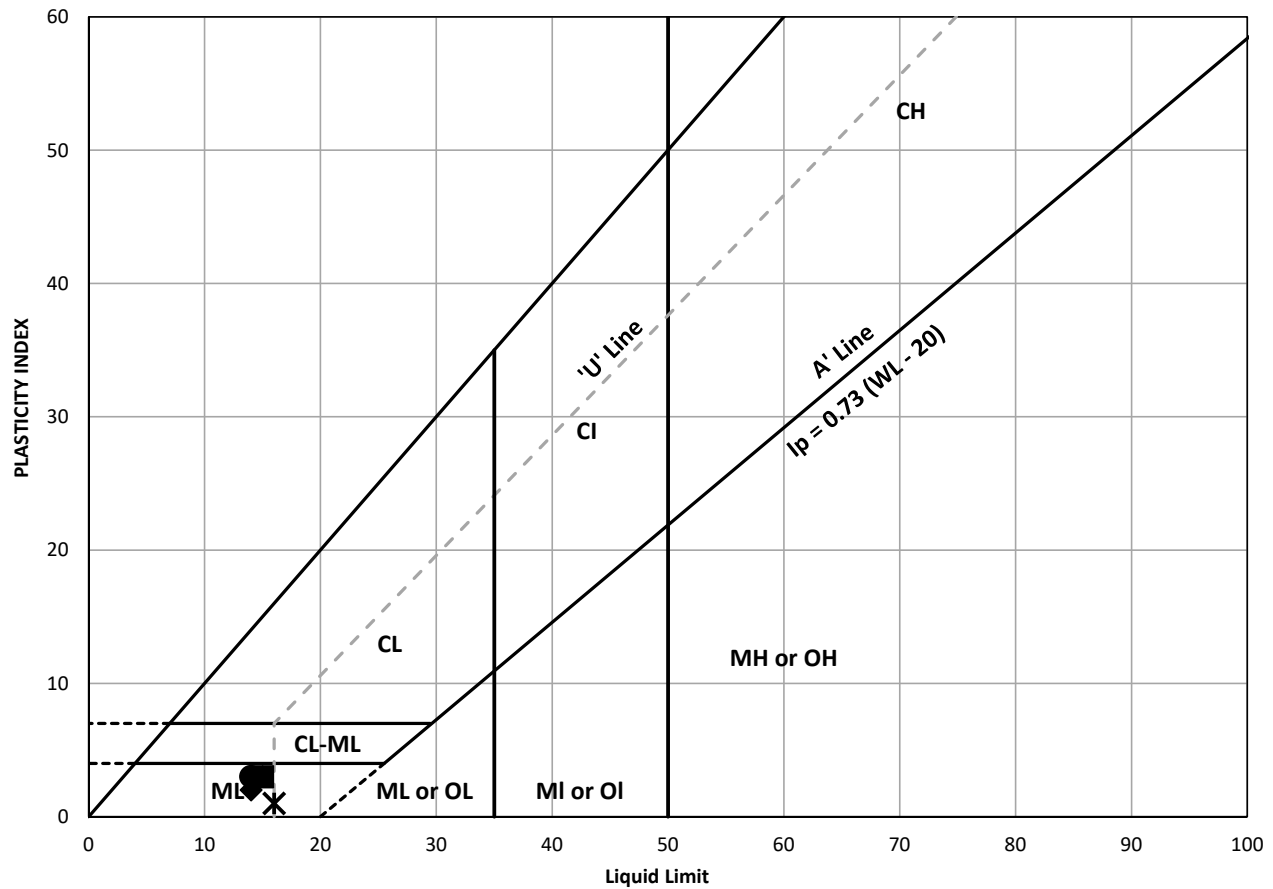
REV.

0

FIGURE

B5B

PLASTICITY CHART



	Borehole Number	Sample / Specimen Number	Elevation (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	NW1-5	3	276.9 to 276.3	7.9	15	12	3	-1.37
◆	NW1-5	6	274.6 to 274.3	5.6	14	12	2	-3.20
▲	NW1-6	3	277.6 to 277.0	7.9	15	12	3	-1.37
●	NW1-6	9	271.5 to 271.3	8.9	14	11	3	-0.70
*	NW1-7	2	279.8 to 279.1	8.1	16	15	1	-6.90

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT

wsp **GOLDER**

YYYY-MM-DD	2022-02-23
DESIGNED	BL
PREPARED	BL
REVIEWED	TZ
APPROVED	CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12,
BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST;
CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

SILTY SAND (SM) of slight plasticity (TILL)

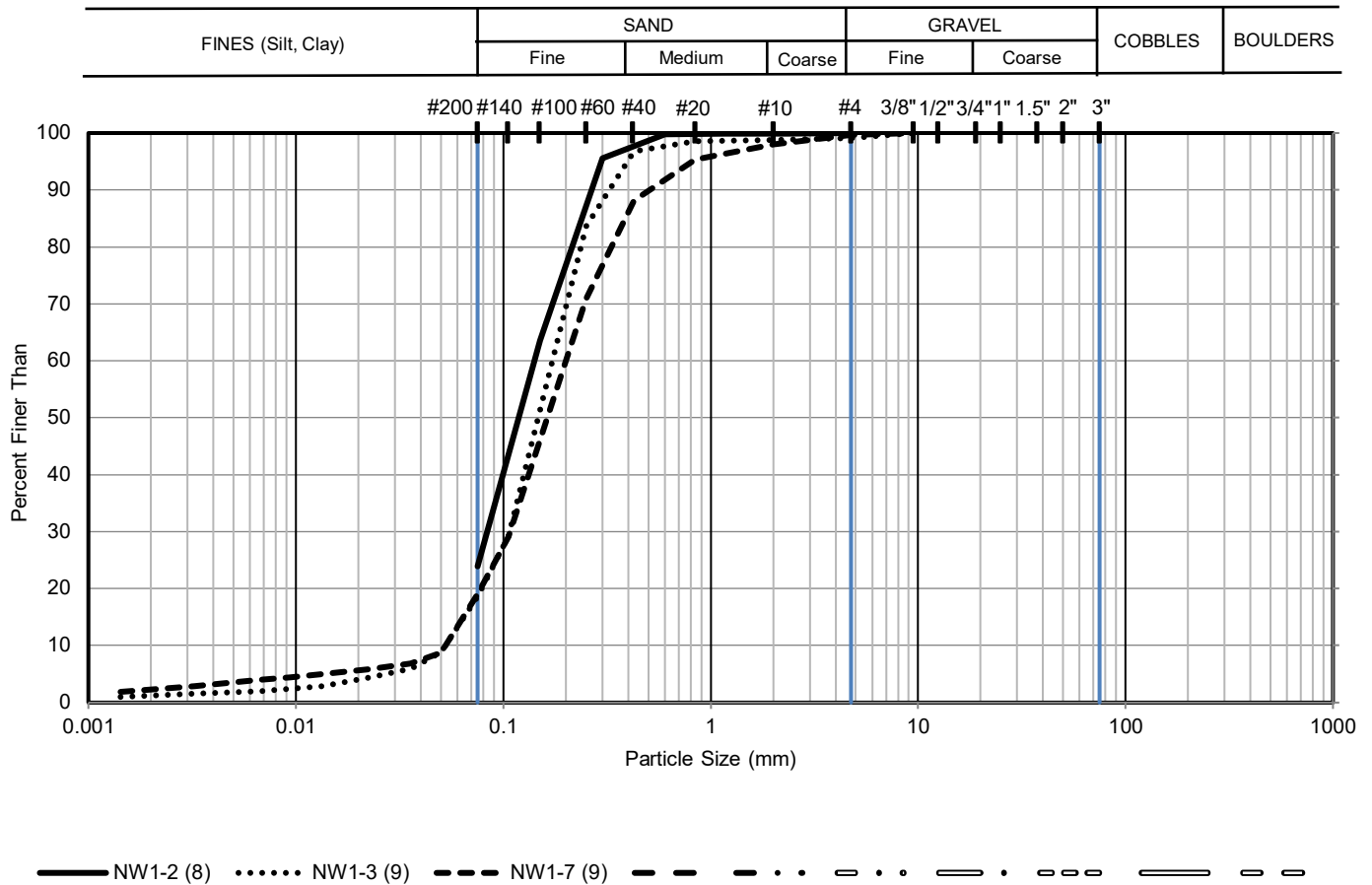
PROJECT NO.
19135676

CONTROL
0

REV.
0

FIGURE
B6

GRAIN SIZE DISTRIBUTION



Borehole Number	Sample Number	Depth (m)	Elevation (m)
NW1-2	8	6.1 - 6.6	265.5 to 265.0
NW1-3	9	7.6 - 8.1	266.8 to 266.4
NW1-7	9	7.6 - 7.9	272.9 to 272.6

CLIENT

MINISTRY OF TRANSPORTATION, ONTARIO (MTO)

CONSULTANT

wsp GOLDER

YYYY-MM-DD 2022-02-23

DESIGNED -

PREPARED BL

REVIEWED TZ

APPROVED CN

PROJECT

NOISE BARRIER WALL NO. 1 - EAST OF HIGHWAY 11/12, BETWEEN OLD BARRIE ROAD AND COLDWATER ROAD WEST; CITY OF ORILLIA, ONTARIO; GWP 2494-15-00

TITLE

SILTY SAND (SM)

PROJECT NO.

19135676

CONTROL

0

REV.

0

FIGURE

B7

APPENDIX C

**Analytical Laboratory
Test Results**



Your Project #: 19135676
Site Location: HWY11/12, ORILLIA
Your C.O.C. #: n/a

Attention: Alysha Kobylinski

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/05/13
Report #: R6632619
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1C0789

Received: 2021/05/05, 15:00

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	1	2021/05/10	2021/05/10	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	1	2021/05/10	2021/05/10	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	1	N/A	2021/05/10	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	1	N/A	2021/05/09	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	1	2021/05/07	2021/05/07	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	1	2021/05/05	2021/05/11	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	1	2021/05/10	2021/05/10	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.

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

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

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

(1) This test was performed by Bureau Veritas Calgary via Mississauga

(2) Offsite analysis requires that subcontracted moisture be reported.



Your Project #: 19135676
Site Location: HWY11/12, ORILLIA
Your C.O.C. #: n/a

Attention: Alysha Kobylnski

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/05/13
Report #: R6632619
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1C0789
Received: 2021/05/05, 15:00

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: emese.gitej@bureauveritas.com
Phone# (905)817-5829

=====

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BUREAU
VERITAS

BV Labs Job #: C1C0789
Report Date: 2021/05/13

Golder Associates Ltd
Client Project #: 19135676
Site Location: HWY11/12, ORILLIA
Sampler Initials: MH

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		PMM360			PMM360		
Sampling Date		2021/04/29			2021/04/29		
COC Number		n/a			n/a		
	UNITS	NW1-1 SA 3B	RDL	QC Batch	NW1-1 SA 3B Lab-Dup	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	10000		7336760			
Inorganics							
Soluble (20:1) Chloride (Cl ⁻)	ug/g	<20	20	7342971	<20	20	7342971
Conductivity	umho/cm	98	2	7343102	105	2	7343102
Available (CaCl ₂) pH	pH	7.23		7339223			
Soluble (20:1) Sulphate (SO ₄)	ug/g	<20	20	7343008			
Sulphide	mg/kg	<0.5 (1)	0.5	7349124			
Physical Testing							
Moisture-Subcontracted	%	12	0.30	7350533			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate (1) Analyzed past method specified hold time. Sample contained greater than 10% headspace at time of extraction.							



BUREAU
VERITAS

BV Labs Job #: C1C0789
Report Date: 2021/05/13

Golder Associates Ltd
Client Project #: 19135676
Site Location: HWY11/12, ORILLIA
Sampler Initials: MH

TEST SUMMARY

BV Labs ID: PMM360
Sample ID: NW1-1 SA 3B
Matrix: Soil

Collected: 2021/04/29
Shipped:
Received: 2021/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7342971	2021/05/10	2021/05/10	Avneet Kour Sudan
Conductivity	AT	7343102	2021/05/10	2021/05/10	Amanpreet Sappal
Moisture (Subcontracted)	BAL	7350533	N/A	2021/05/10	Margarita Aguilera
Sulphide in Soil	SPEC	7349124	N/A	2021/05/09	Bailey Morrison
pH CaCl2 EXTRACT	AT	7339223	2021/05/07	2021/05/07	Neil Dassanayake
Resistivity of Soil		7336760	2021/05/11	2021/05/11	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7343008	2021/05/10	2021/05/10	Avneet Kour Sudan

BV Labs ID: PMM360 Dup
Sample ID: NW1-1 SA 3B
Matrix: Soil

Collected: 2021/04/29
Shipped:
Received: 2021/05/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7342971	2021/05/10	2021/05/10	Avneet Kour Sudan
Conductivity	AT	7343102	2021/05/10	2021/05/10	Amanpreet Sappal



BUREAU
VERITAS

BV Labs Job #: C1C0789
Report Date: 2021/05/13

Golder Associates Ltd
Client Project #: 19135676
Site Location: HWY11/12, ORILLIA
Sampler Initials: MH

GENERAL COMMENTS

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

Package 1	9.0°C
-----------	-------

Results relate only to the items tested.

BUREAU
VERITAS

BV Labs Job #: C1C0789

Report Date: 2021/05/13

QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 19135676

Site Location: HWY11/12, ORILLIA

Sampler Initials: MH

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7339223	Available (CaCl ₂) pH	2021/05/07			100	97 - 103			0.51	N/A
7342971	Soluble (20:1) Chloride (Cl ⁻)	2021/05/10	107	70 - 130	110	70 - 130	<20	ug/g	NC	35
7343008	Soluble (20:1) Sulphate (SO ₄)	2021/05/10	NC	70 - 130	110	70 - 130	<20	ug/g	3.2	35
7343102	Conductivity	2021/05/10			103	90 - 110	<2	umho/cm	6.9	10
7349124	Sulphide	2021/05/09	92	75 - 125	82	75 - 125	<0.5	mg/kg	1.6	30
7350533	Moisture-Subcontracted	2021/05/10					<0.30	%		

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).



BUREAU
VERITAS

BV Labs Job #: C1C0789
Report Date: 2021/05/13

Golder Associates Ltd
Client Project #: 19135676
Site Location: HWY11/12, ORILLIA
Sampler Initials: MH

VALIDATION SIGNATURE PAGE

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

Brad Newman, B.Sc., C.Chem., Scientific Service Specialist

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Sandy (Wei) Yuan, M.Sc., QP, Scientific Specialist

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6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
CAM FCD-01191/6

CHAIN OF CUSTODY RECORD

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required	
Company Name: Golder Associates Ltd.		Company Name: Golder Associates Ltd.		Quotation #: _____		<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS	
Contact Name: Canada Accounts Payable		Contact Name: Alysha Kobylinski		P.O. #/ AFE#: 19135676		Rush TAT (Surcharges will be applied) <input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days	
Address: 6925 Century Ave. Suite 100		Address: 6925 Century Ave. Suite 100		Project #: _____			
Mississauga, ON		Mississauga, ON L5N 7K2		Site Location: Hwy 11/12, Orillia			
Phone: 905-567-4444 Fax: 905-567-6561		Phone: 647-239-0174 Fax: 905-567-6561		Site #: _____		Date Required: _____	
Email: canadaaccounts payableinvoices@golder.com		Email: akobylinski@golder.com 120052@golder.com		Site Location Province: Ontario		Rush Confirmation #: _____	
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY				Sampled By: MH/ACK			
Regulation 153 <input checked="" type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table _____ FOR RSC (PLEASE CIRCLE) Y / N		Other Regulations <input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO <input type="checkbox"/> Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____		Analysis Requested <div style="display: flex; justify-content: space-between;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);"># OF CONTAINERS SUBMITTED</div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">FIELD FILTERED (CIRCLE) Metals / Hg / CrVI</div> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">Corrosivity pkg (Cl, SO4, pH, EC/Resistivity and Sulphide)</div> </div>		LABORATORY USE ONLY <div style="display: flex;"> <div style="border: 1px solid black; padding: 2px;"> CUSTODY SEAL Y <input checked="" type="checkbox"/> N </div> <div style="border: 1px solid black; padding: 2px;"> COOLER TEMPERATURES <div style="display: flex;"> <div style="border: 1px solid black; padding: 2px;">Present</div> <div style="border: 1px solid black; padding: 2px;">Intact</div> </div> </div> </div>	
Include Criteria on Certificate of Analysis: Y / N						COOLING MEDIA PRESENT: Y / <input checked="" type="checkbox"/> N	
SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS						COMMENTS	
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	Corrosivity pkg (Cl, SO4, pH, EC/Resistivity and Sulphide)
1 NW1-1 SA 3B		2021-04-29	PM	SOIL	2	X	
2							
3							
4							
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)
		2021-05-05		<i>Em/AL-644524 R0002</i>		2021-05-05	15:00
<div style="float: right; text-align: right;"> 05-May-21 15:00 Ema Gitej </div>							



Your Project #: 1935676
Site Location: HWY 11/12, ORILLIA
Your C.O.C. #: n/a

Attention: Alysha Kobylinski

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/05/04
Report #: R6620214
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1A5636

Received: 2021/04/21, 14:19

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	1	2021/05/03	2021/05/03	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	1	2021/05/03	2021/05/03	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	1	2021/05/03	2021/05/03	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	1	2021/04/27	2021/05/03	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	1	2021/05/03	2021/05/03	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.

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

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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 #: 1935676
Site Location: HWY 11/12, ORILLIA
Your C.O.C. #: n/a

Attention: Alysha Kobylnski

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2021/05/04
Report #: R6620214
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1A5636
Received: 2021/04/21, 14:19

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: emese.gitej@bureauveritas.com
Phone# (905)817-5829

=====

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BV Labs Job #: C1A5636

Report Date: 2021/05/04

Golder Associates Ltd

Client Project #: 1935676

Site Location: HWY 11/12, ORILLIA

Sampler Initials: MH

RESULTS OF ANALYSES OF SOIL

BV Labs ID		PJJ339		
Sampling Date		2021/04/15		
COC Number		n/a		
	UNITS	NW1-5 SA 3 5-7	RDL	QC Batch
Calculated Parameters				
Resistivity	ohm-cm	8900		7321702
Inorganics				
Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	7330430
Conductivity	umho/cm	112	2	7330583
Available (CaCl2) pH	pH	7.91		7330496
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	7330442
RDL = Reportable Detection Limit				
QC Batch = Quality Control Batch				



BUREAU
VERITAS

BV Labs Job #: C1A5636
Report Date: 2021/05/04

Golder Associates Ltd
Client Project #: 1935676
Site Location: HWY 11/12, ORILLIA
Sampler Initials: MH

TEST SUMMARY

BV Labs ID: PJJ339
Sample ID: NW1-5 SA 3 5-7
Matrix: Soil

Collected: 2021/04/15
Shipped:
Received: 2021/04/21

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7330430	2021/05/03	2021/05/03	Deonarine Ramnarine
Conductivity	AT	7330583	2021/05/03	2021/05/03	Tarunpreet Kaur
pH CaCl2 EXTRACT	AT	7330496	2021/05/03	2021/05/03	Neil Dassanayake
Resistivity of Soil		7321702	2021/05/03	2021/05/03	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7330442	2021/05/03	2021/05/03	Avneet Kour Sudan



BUREAU
VERITAS

BV Labs Job #: C1A5636

Report Date: 2021/05/04

Golder Associates Ltd

Client Project #: 1935676

Site Location: HWY 11/12, ORILLIA

Sampler Initials: MH

GENERAL COMMENTS

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

Package 1	7.0°C
-----------	-------

Results relate only to the items tested.



BUREAU
VERITAS

BV Labs Job #: C1A5636

Report Date: 2021/05/04

QUALITY ASSURANCE REPORT

Golder Associates Ltd

Client Project #: 1935676

Site Location: HWY 11/12, ORILLIA

Sampler Initials: MH

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7330430	Soluble (20:1) Chloride (Cl ⁻)	2021/05/03	NC	70 - 130	102	70 - 130	<20	ug/g	10	35
7330442	Soluble (20:1) Sulphate (SO ₄)	2021/05/03	125	70 - 130	111	70 - 130	<20	ug/g	NC	35
7330496	Available (CaCl ₂) pH	2021/05/03			100	97 - 103			0.80	N/A
7330583	Conductivity	2021/05/03			103	90 - 110	<2	umho/cm	2.7	10

N/A = Not Applicable

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

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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 \leq 2x RDL).



BUREAU
VERITAS

BV Labs Job #: C1A5636
Report Date: 2021/05/04

Golder Associates Ltd
Client Project #: 1935676
Site Location: HWY 11/12, ORILLIA
Sampler Initials: MH

VALIDATION SIGNATURE PAGE

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

Brad Newman, B.Sc., C.Chem., Scientific Service Specialist

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APPENDIX D

Non-Standard Special Provisions

DEEP FOUNDATIONS (CAISSONS FOR NOISE BARRIER WALL) - Item No.

Non-Standard Special Provision

Amendment to OPSS.PROV 903

903.01 SCOPE

Section 903.01 of OPSS.PROV 903 is amended by the addition of the following:

This specification covers the requirements for the supply and installation of caisson foundations for the noise barrier wall.

903.07 CONSTRUCTION

Section 903.07.03.02.01 of OPSS.PROV 903 is amended by the addition of the following:

Section 903.07.03.02.01 General

Augering for caissons for the noise barrier wall will extend through fills, clayey silt deposits, glacial till deposits, and granular lacustrine deposits. The fills and overburden soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caisson installation. Additionally, construction debris, rock fragments, cobbles, and boulders, or other obstructions may be encountered within the fill, while the glacial till deposits may contain cobbles and boulders. Appropriate equipment and construction procedures will be required to penetrate the fills, overburden, and the potential obstructions, and advance the caissons to reach the design founding levels. Temporary liners may be required to provide support through the fills and overburden soils and minimize ground loss during drilling, caisson installation, and concrete placement.

Where the caisson holes for the noise barrier wall are filled with water during construction, concrete shall be placed by tremie methods in accordance with the requirements of OPSS.PROV 903.

“height” NOISE BARRIER SYSTEM - Item No.

“height” NOISE BARRIER SYSTEM INCLUDING PRECAST NOISE/TRAFFIC BARRIER - Item No.

NOISE BARRIER SYSTEM ON STRUCTURES - Item No.

NOISE BARRIER ACCESS - Item No.

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: [*Designer Fill-In for Table A, See Notes to Designer].

**Table A
Soil Design Parameters**

Location	Soil Design Parameter

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: [** Designer Fill-In, See Notes to Designer]

760.04.01.03 Acoustics

The minimum acoustical characteristic of the noise barrier system shall be such that the noise barrier is: [***Designer Fill-In, See Notes to Designer]

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: [**** Designer Fill-in – See Notes to Designer]

in the proportion of _____

Number of textures _____

in the proportion of _____

Number of colours adjacent to residential property: [**** Designer Fill-In, See Notes to Designer].

in the proportion of _____

Number of textures _____

in the proportion of _____

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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