REPORT

Foundation Investigation
CNR Overhead Widening
Site Nos. 3-301/1 (EBL) and 3-301/2 (WBL)
Ottawa, Ontario

G.W.P. 4145-10-00

Submitted to:

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Geocres Number: 31G5-288
Latitude 45.390195 Longitude: -75.592147 (EBL)
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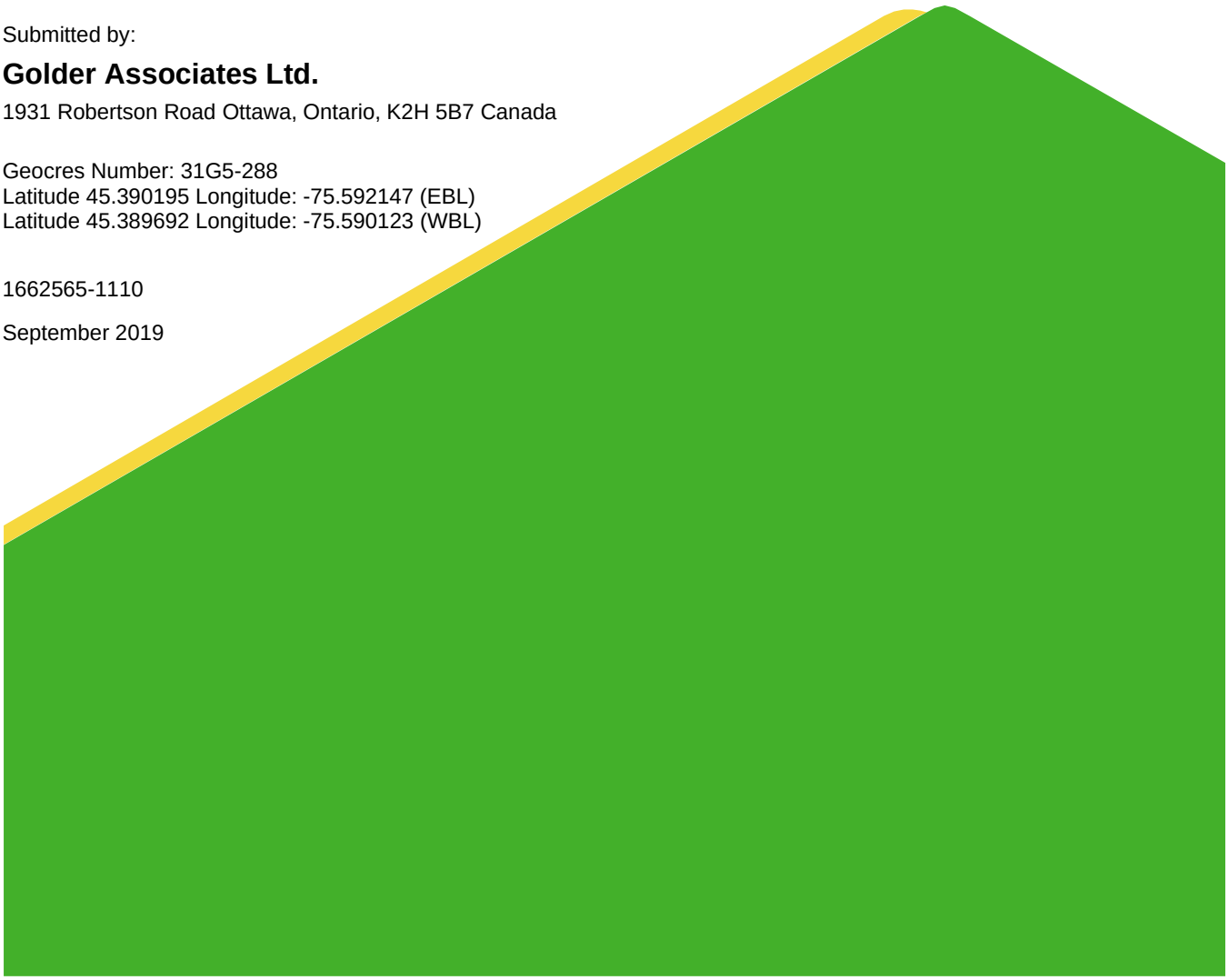

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Highway 417
Ottawa, Ontario
G.W.P. 4145-10-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP Canada Group Limited (WSP) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with numerous bridge and structural culvert rehabilitations and/or replacements on Highway 417 between the Aviation Parkway and Ramsayville Road, as well as the widening of Highway 417 from Ottawa Road 174 to Hunt Club Road in Ottawa, Ontario (Assignment number 4016-E-0008).

This report presents the results of the foundation investigation carried out to collect subsurface information required for the widening, seismic retrofit and temporary protection systems for the CNR Overhead structures, Site Nos. 3-301/1 and 3-301/2 located on the Highway 417 East Bound Lanes (EBL) and West Bound Lanes (WBL), respectively, in Ottawa, Ontario (G.W.P. 4145-10-00 and W.P. 266-00-01/266-00-02). The widening of the structures are to be carried out in accordance with the current version of the Canadian Highway Bridge Design Code (CHBDC, S6-14).

The terms of reference and scope of work for the foundation investigation are outlined in the MTO's Request for Proposal (RFP), dated May 2016, and subsequent addenda. Golder's scope of work for foundation engineering services associated with the Highway 417 CNR Overhead structures is contained in Table 17.8.3 of WSP's Technical Proposal for this assignment as well as in Change Request No. 2 dated April 6, 2018. The work has been carried out in accordance with Golder's Quality Control Plan for foundation engineering services for this project, dated March 13, 2017.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 General

The CNR Overhead bridges (Sites 3-301/1 and 3-301/2) are located approximately 800 m north of the Hunt Club Road interchange in Ottawa, Ontario. The existing EBL structure is located at about Station 18+069 and the WBL structure is located at about Station 18+274. At these locations, Highway 417 is a divided highway with two travel lanes in each direction and an on-ramp in the EB direction. The highway is separated by a grassed median area with an approximate width of 145 m. The CN rail line runs east-west beneath the EBL and WBL structures.

The existing bridges were constructed in 1975 and are five-span reinforced concrete slab on pre-stressed concrete girder structures. The overall EBL structure is about 72.8 m long, with 11.2 m, 16.8 m, 16.8 m, 16.8 m, and 11.2 m spans and varies in width from about 14.3 to 17.9 m. The overall WBL structure is about 70.8 m long, with 10.2 m, 16.8 m, 16.8 m, 16.8 m, and 10.2 m spans and is about 13.0 m wide. The bridge abutments are supported on "perched" foundations on battered steel HP12 x 74 (HP310 x 110) piles end bearing on bedrock. The pier foundations are supported on vertical and battered HP12 x 74 (HP310 x 110) steel piles end bearing on bedrock.

The existing pavement grade of Highway 417 is at about Elevation 76 m; the approach embankments are approximately 10 to 11 m in height. The existing embankment side slopes were constructed at about 2 horizontal to 1 vertical (2H:1V) with approximately 3 m wide mid-slope bench. Based on visual observation at the time of the site investigation, the existing embankment slopes appear to be performing satisfactorily. Either 914 mm or 1,829 mm diameter corrugated steel pipe (CSP) culverts exist below the lower portion of embankment foreslopes between Piers 1 and 2 and Piers 3 and 4 at both the EBL and WBL structures.

Selected site photographs taken by WSP personnel showing the existing structure and surrounding area are included in Appendix D.

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*[1], this section of Highway 417 lies on the boundary of the minor physiographic regions known as the Ottawa Valley Clay Plain and the Russell and Prescott Sand Plain, which lies within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock[2]. The Russell and Prescott Sand Plains are generally characterized by a sand mantle about 3 to 5 m thick overlying an extensive deposit of sensitive marine clay deposited within the Champlain Sea basin, underlain by glacial till and bedrock.

This region is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain at depth by igneous and metamorphic bedrock of the Precambrian Shield. Regional bedrock mapping indicates that the bedrock at this site is primarily limestone and shale of the Carlsbad Formation.[3]

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada[4]. The WQ zone constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and Cornwall. Within the WQ zone recent seismic activity has been concentrated in two subzones; one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes in the WQ zone includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake) of 6.2, and the 1944 Cornwall-Massena event which had a magnitude of 5.6.

The topography in the area of the bridge structures ranges from about Elevation 76 m at the EBL and WBL of Highway 417, sloping down towards the CN rail line at about Elevation 67 m. The areas to the southwest of the EBL bridge, and to the northeast of the WBL bridge are forested, while the other areas are sparsely vegetated.

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigation (2017)

The subsurface investigation for the bridge widenings was carried out between June 25 and July 7, 2017 and between August 20 and September 8, 2017. During that time, 14 boreholes (17-1101 to 17-1104, 17-1106 to 17-1111, and 17-1113 to 17-1116, inclusive) were advanced at the locations shown on Drawings 1 and 2. The boreholes were advanced as follows:

- Boreholes 17-1101, 17-1102, 17-1107, and 17-1108 were advanced through the north and south approach embankments of the EBL of Highway 417 using 108 mm inside diameter (200 mm outside diameter) continuous flight hollow stem augers on truck mounted drill rigs, supplied and operated by Forage Grenville Drilling of Grenville, Québec. Traffic control required to access the borehole locations was provided by

[1] Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources.

[2] Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

[3] MacDonald, G. and Harrison, J.E. 1976 : Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, Map 1508A, scale 1:125,000. Geology 1967.

[4] Natural Resources Canada (2016, February 10). Earthquake Zones in Eastern Canada, Retrieved from http://www.seismescanada.rncan.gc.ca/zones/eastcan-en.php#WQSZ

Beacon Lite Ltd. of Ottawa, Ontario. The boreholes were advanced through the overburden to practical refusal to auger or casing advancement at depths between about 16.2 and 20.6 m below the existing pavement grade. Boreholes 17-1102 and 17-1107 were then cored for about 3.7 and 3.0 m, respectively, into the bedrock using NQ-sized coring equipment. A water truck was on site to supply the drill rigs with water for the coring of the bedrock.

- Boreholes 17-1109, 17-1110, 17-1115, and 17-1116 were advanced through the north and south approach embankments of the WBL of Highway 417 also using 108 mm inside diameter (200 mm outside diameter) continuous flight hollow stem augers on truck mounted drill rigs, supplied and operated by Forage Grenville Drilling of Grenville, Québec. Traffic control required to access the borehole locations was provided by Beacon Lite Ltd. of Ottawa, Ontario. The boreholes were advanced through the overburden to practical refusal to auger advancement at depths between about 16.0 and 18.2 m below the existing pavement grade. Boreholes 17-1110 and 17-1115 were then cored for about 5.7 and 3.6 m, respectively, into the bedrock using NQ or HQ-sized coring equipment. A water truck was on site to supply the drill rigs with water for the coring of the bedrock.
- Boreholes 17-1106 and 17-1111 were advanced within the median of Highway 417 adjacent to the most southern piers of the EBL and WBL structures, in the area of the proposed widening, using 108 mm inside diameter (200 mm outside diameter) continuous flight hollow stem augers on a track mounted drill rig, supplied and operated by CCC Geotechnical and Environmental Drilling Ltd. of Ottawa, Ontario. Railway track protection required to access the borehole locations was provided by VIA Rail Canada Inc. An additional borehole (Borehole 17-1106A) was drilled adjacent to Borehole 17-1106 to retrieve a relatively undisturbed 73 millimetre diameter thin-walled Shelby tube samples of the clay using a fixed piston sampler. The boreholes were advanced through the overburden to practical refusal to auger or casing advancement at depths between about 11.2 and 12.2 m below the existing ground surface. The boreholes were then cored for about 1.5 to 4.1 m into the bedrock using NQ-sized coring equipment. A water truck was on site to supply the drill rigs with water for the coring of the bedrock.
- Boreholes 17-1103, 17-1104, 17-1113, and 17-1114 were advanced within the median of Highway 417 adjacent to the northern piers of the EBL and WBL structures, in the area of the proposed widening, using portable drilling equipment, supplied and operated by CCC Geotechnical and Environmental Drilling Ltd. of Ottawa, Ontario. Railway track protection required to access the borehole locations was provided by VIA Rail Canada Inc. The boreholes were advanced through the overburden to depths between about 7.8 and 13.6 m below the existing ground surface. The boreholes were then cored for about 3.0 to 3.5 m into the bedrock using BQ-sized coring equipment. A water truck was on site to supply the drill rigs with water for the coring of the bedrock.
- Boreholes 17-1105 and 17-1112 which were to be located within the median, adjacent to the piers south of the CNR rail line, could not be advanced due to restrictions from CN with regards to drilling in their right-of-way (i.e., no drilling was permitted south of the rail line due to buried utilities).

Samples of the overburden were obtained at vertical intervals of about 0.6 to 1.75 m, using a 50 mm outside diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. In-situ vane testing was carried out within the cohesive deposits, where possible, using either an MTO “N”-sized vane or a “B”-sized vane. Rotary diamond drilling (DD) techniques were also required to advance through cobbles and boulders at one location.

Monitoring wells were installed in Boreholes 17-1108 and 17-1115 to monitor the groundwater level at the site. The monitoring wells consist of 32 mm diameter rigid PVC pipes with 3.0 m long slotted screen sections, installed within silica sand backfill and sealed by a sections of bentonite pellet backfill. The groundwater levels in the monitoring wells were measured between September 24 and 25, 2017. The monitoring wells in Boreholes 17-1108 and 17-1115 were decommissioned between September 24 and 25, 2017. The monitoring wells were decommissioned by backfilling the monitoring well with bentonite, removing the top section of the monitoring well, and the asphalt patched upon completion.

A 63.5 mm inside diameter rigid PVC casing was grouted for the full advancement depth (i.e. through the overburden and into the bedrock) at Borehole 17-1110 to allow for Vertical Seismic Profile testing.

The boreholes were backfilled with bentonite pellets, mixed with native soils in the overburden and bentonite pellets in the bedrock, except as indicated previously for the monitoring wells. The site conditions were reinstated following completion of work.

The field work was supervised by members of Golder's technical staff, who located the boreholes, supervised the drilling, sampling, and in situ testing operations, logged the boreholes, and examined and cared for the soil and bedrock samples. The soil and bedrock samples were identified in the field, placed in appropriate containers, labelled, and transported to Golder's laboratory in Ottawa for further examination. Index and classification tests consisting of water content determinations, Atterberg Limit tests, and grain size distribution analyses were carried out on selected soil samples. In addition, consolidation tests were performed on selected Shelby tube samples from Boreholes 17-1106A and 17-1116. Unconfined compressive strength tests were also carried out on selected rock core samples. The laboratory tests were carried out to MTO and/or ASTM standards, as appropriate.

Soil samples from Boreholes 17-1102, 17-1103, 17-1104, 17-1106, 17-1107, 17-1110, 17-1111, 17-1113, 17-1114, and 17-1115 were submitted to Eurofins Environment Testing for chemical analyses related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The results of the chemical analysis are presented in Appendix E.

In addition to the borehole investigation, shear wave velocity profiling was carried out at two locations on the site on May 25, 2017, using the Multichannel Analysis of Surface Waves (MASW) method. The MASW lines were located within the grassed median of Highway 417, north and south of the CNR rail line, as shown in the technical memorandum provided in Appendix F. Shear wave velocity profiling using the Vertical Seismic Profile (VSP) method was also carried out at the site on July 27, 2017, within Borehole 17-1110. The MASW and VSP testing was carried out by personnel from Golder Associates' Mississauga and Ottawa offices. For each MASW line a series of 24 low frequency (4.5 Hz) geophones were laid out at approximately 3 m intervals and a 9.9 kg sledge hammer and 45 kg weight drop were used as the seismic sources. The source locations were offset at distances of 5, 10, and 15 m off the end and collinear with the geophone array. For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in the borehole at a known depth. The active seismic source can be either a compression or shear wave. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the borehole. Traffic control required to carry out the MASW and VSP testing was provided by Beacon Lite Ltd. of Ottawa, Ontario.

The MASW and VSP test results and report are presented in Appendix F and include the calculated shear wave velocity profile measured from the field testing and a graphical representation of the shear wave velocity profile with depth.

The borehole elevation were surveyed by Golder using a Trimble R8 GPS unit. The borehole locations, including MTM NAD83 Zone 9 northing and easting coordinates, ground surface elevations referenced to geodetic datum, and drilled depths are summarized in the following table and are shown on Drawings 1 and 2. Northing and easting grid coordinates and latitude and longitude geographic coordinates are also indicated on the Record of Borehole and Drillhole sheets.

Borehole Number	Borehole Location	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
17-1101	EBL North Approach Embankment	5028263.4	375871.3	75.8	20.6
17-1102	EBL North Abutment	5028251.0	375875.2	75.9	23.8
17-1103	EBL North Pier 1	5028229.6	375888.5	70.5	17.1
17-1104	EBL North Pier 2	5028213.6	375894.5	66.4	11.9
17-1106	EBL South Pier 4	5028182.6	375906.8	70.3	12.8
17-1106A	EBL South Pier 4	5028182.6	375906.8	70.3	13.2
17-1107	EBL South Abutment	5028160.3	375911.2	75.8	19.2
17-1108	EBL South Approach Embankment	5028156.3	375912.9	75.7	16.2
17-1109	WBL South Approach Embankment	5028103.2	376067.6	75.9	16.0
17-1110	WBL South Abutment	5028121.3	376057.8	76.0	21.9
17-1111	WBL South Pier 4	5028135.2	376046.0	70.4	16.3
17-1113	WBL North Pier 2	5028164.4	376031.8	66.9	10.8
17-1114	WBL North Pier 1	5028179.8	376023.8	70.4	15.3
17-1115	WBL North Abutment	5028195.6	376020.9	75.9	21.7
17-1116	WBL North Approach Embankment	5028207.2	376015.1	75.9	18.2

3.2 Previous Investigation (1972)

As part of the current assignment, previously collected subsurface information pertinent to the site was reviewed and compiled. This existing subsurface information was contained in the following report:

- Report prepared by MTO (then the Department of Transportation and Communications, Ontario) titled "*Foundation Investigation Report for Proposed Structures at the Crossing of the C.N.R. and Hwy. #417 (E.B.L. and W.B.L.) Regional Municipality of Ottawa-Carleton, District No. 9 (Ottawa), W.O. 71-11124 – W.P. 10-69-03 (E.B.L.), 10-69-04 (W.B.L.)*", dated February 28, 1972 (Geocres No. 31G5-79).

Sixteen boreholes were put down as part of the original investigation in 1972 along the then-proposed bridge alignments. The approximate borehole and ground surface elevations are shown on the Record of Borehole sheets included in Appendix C and are also shown on Drawings 1 and 2. The locations of the previous boreholes should be considered approximate since the locations were referenced to an imperial borehole location plan rather than metric MTM coordinates. The detailed subsurface soils and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the borehole records from the 1972 investigation.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The Record of Borehole and Drillhole sheets from the current investigation are presented in Appendix A. Photographs of the recovered bedrock core are included on Figures A1 to A22 also in Appendix A. The results of the laboratory testing carried out during the current investigation are presented on the Record of Boreholes sheets and on Figures B1 to B10 in Appendix B. These results are also presented on the Summary of Engineering Properties, Figure B11 in Appendix B. The Record of Borehole sheets and lab testing from the previous investigation are provided in Appendix C. The results of basic chemical analysis completed on select soil samples are provided in Appendix E.

The borehole locations and the interpreted stratigraphic profiles projected along the CNR Overhead EBL and WBL structures are shown on Drawings 1 and 2, respectively. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profiles are inferred from observations of drilling progress and non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

The MASW and VSP test results and report are presented in Appendix F and include the calculated shear wave velocity profile measured from the field testing and a graphical representation of the shear wave velocity profile with depth.

In general, the subsurface conditions at the site consist of a layer of fill underlain by a deposit of sensitive silty clay overlying glacial till and shale bedrock. Shale bedrock was indicated to be present at depths ranging from about 8 to 21 m below the existing ground surface (i.e., elevations ranging from about 55 to 60 m).
The groundwater level was encountered at depths of about 9 and 10 m below the existing ground surface (i.e., about Elevation 66 m).

A detailed description of the subsurface conditions encountered in the boreholes from the current investigation is as well as the 1972 investigation are provided in the following sections.

4.2 Pavement Structure, Topsoil, and Fill

Boreholes 17-1101, 17-1102, 17-1107 and 17-1108 were advanced through the pavement structure of the EBL of Highway 417 and Boreholes 17-1109, 17-1110, 17-1115, and 17-1116 were advanced through the pavement structure of the WBL of Highway 417. The asphaltic concrete was about 200 mm thick and was underlain by a granular base that ranges in thickness from about 300 to 500 mm and generally consists of gravelly sand to sandy gravel.

Topsoil fill was encountered at the ground surface at Boreholes 17-1103 and 17-1114. The topsoil has a thickness of about 200 mm.

A layer of embankment/grade fill exists at the ground surface, or below the topsoil or pavement structure, where encountered, in the boreholes advanced for the current investigation and extends to depths ranging from about 0.6 to 10.7 m below the ground surface (i.e., elevations ranging from about 64.1 to 66.0 m). The fill generally consists of granular fill with various compositions of sand and gravel (i.e., gravelly sand, sandy gravel, sand and gravel, silty sand, and sand). Sandy silty clay to clayey silt fill was encountered beneath the granular fill at Boreholes 17-1113 and 17-1114. Organic matter, cobbles, and boulders were also encountered within the fill.

SPT ‘N’ values measured in the fill generally range from about 7 to greater than 50 blows per 0.3 m of penetration indicating a loose to very dense compactness, but more typically compact to dense.

The results of grain size distribution testing carried out on several samples of the fill are provided on Figures B1a and B1b in Appendix B. The measured water content of the fill ranges from approximately 3 to 34 percent.

A layer of buried topsoil was encountered below the fill in Boreholes 17-1106, 17-1107, 17-1108, and 17-1109. The buried topsoil has a thickness ranging from about 0.3 to 0.8 m and extends to depths ranging from about 4.6 to 10.7 m (i.e., elevations ranging from about 65.0 to 65.7 m). The measured water content of two samples of the topsoil are about 24 and 39 percent.

An approximately 0.2 m thick layer of sandy silt containing organic matter underlies the fill at Borehole 17-1115.

4.3 Silty Clay, Clay and Clayey Silt

The fill, buried topsoil and sandy silt (where encountered) are underlain by a deposit of silty clay, clay and/or clayey silt (hereafter referred to as silty clay).

The upper portion of the silty clay deposit has been weathered to a grey brown crust as identified in the boreholes from the current investigation. The weathered crust has a thickness ranging from about 1.4 to 2.9 m and extends to depths ranging from about 3.1 to 13.1 m below the existing ground surface (i.e., Elevations ranging from 62.5 to 64.1 m). The depth of weathering was not identified on the Record of Borehole sheets from the previous investigation.

SPT ‘N’ values measured in the weathered silty clay crust range from 1 to 19 blows per 0.3 m of penetration, indicating that the deposit has a stiff to very stiff consistency.

The results of Atterberg limit testing on several samples of the weathered silty clay deposit from the current investigation gave plasticity index values ranging from about 31 and 59 percent and liquid limit values ranging from about 46 and 76 percent, indicating a deposit of intermediate to high plasticity. The results of the Atterberg limit testing are provided on Figure B2 in Appendix B. The measured water content of samples of the weathered silty clay deposit from the current investigation ranges from approximately 24 to 55 percent.

The results of grain size distribution testing carried out on two samples from the current investigation of the weathered silty clay crust are provided on Figure B3 in Appendix B.

The silty clay deposit below the depth of weathering is grey in colour. The silty clay has a thickness that ranges from about 1.6 to 5.0 m and extends to depths ranging from about 6.1 to 16.8 m below the existing ground surface (i.e., elevations ranging from about 59.1 to 61.3 m).

SPT ‘N’ values measured in the silty clay deposit range from “weight of hammer” to 5 blows per 0.3 m of penetration. In situ shear vane testing carried out within the unweathered silty clay deposit measured undrained shear strengths ranging from about 19 kPa to greater than 96 kPa. Lower values of 19 kPa and 23 kPa were measured at Boreholes 7 and 6, from the previous investigation prior to the construction of the embankment in the EBL and WBL, respectively, with the remainder of the boreholes showing values ranging from 31 kPa to greater than 96 kPa. The results of the in situ testing typically indicate a firm to very stiff consistency. Remolded strengths ranging from about 3 to 29 kPa were measured in the silty clay, indicating a medium to extra-sensitive deposit.

The results of Atterberg limit testing on several samples of the silty clay deposit from the current investigation gave plasticity index values ranging from about 10 to 44 percent and liquid limit values ranging from about 27 to 61 percent, indicating a deposit of low to high plasticity. The results of the Atterberg limit testing are provided on Figure B4 and Figure B11 in Appendix B. The measured water content on samples of the silty clay deposit from the current investigation ranges from approximately 33 to 63 percent.

The results of grain size distribution testing carried out on two samples of the clayey deposit from the current investigation are provided on Figure B5 in Appendix B.

The results of Atterberg limit testing, grain size distribution testing and measured water contents from the previous investigation are provided in Appendix C as well as on the Record of Borehole sheets also in Appendix C.

Laboratory oedometer consolidation testing was carried out on two samples of silty clay from Boreholes 17-1106A and 17-1116 from the current investigation as well as five samples from Boreholes 1, 2, 4, 8, and 9 from the 1972 investigation. The results of that testing are provided on Figures B6 and B7 in Appendix B for the current investigation and in Appendix C for the previous investigation, as well as summarized in the table below.

Borehole/ Sample Number	Sample Depth/ Elevation (m)	Unit Weight (kN/m^3)	σ_P' (kP)	σ_{VO}' (kP)	$\sigma_P' - \sigma_{vo}'$ (kPa)	Cc	Cr	e_o	OCR
17-1106A / 1	8.1 / 62.2	16.2	165	120	45	1.33	0.013	1.75	1.4
17-1116 / 18	14.1 / 61.8	17.1	275	250	25	0.76	0.011	1.33	1.1
1 / 3	3.0 / 62.8	16.3	297	-	-	1.17	-	1.68	-
2 / 2	2.2 / 63.5	17.8	335	-	-	0.30	-	1.12	-
4 / 4	4.2 / 61.6	18.0	240	-	-	0.92	-	1.27	-
8 / 2	2.1 / 63.9	17.1	335	-	-	0.76	-	1.30	-
9 / 4	3.9 / 62.1	16.2	211	-	-	1.58	-	1.77	-

Notes: σ_P' - Apparent preconsolidation pressure
σ_{VO}' - Computed existing vertical effective stress
Cc - Compression index
Cr - Recompression index
e_o - Initial void ratio
OCR - Overconsolidation ratio

The consolidation test results, undrained shear strengths, Atterberg limits and measured water contents are also presented on the Summary of Engineering Properties, Figure B11 in Appendix B.

4.4 Sandy Silt

A deposit of sandy silt was encountered below the silty clay in Borehole 17-1116. The sandy silt has a thickness of about 0.3 m and extends to a depth of about 15.8 m below the existing ground surface (i.e., Elevation 60.1 m).

4.5 Silt and Sand, Silty Sand, Sandy Silt and Clayey Silt Till

A deposit of glacial till was present below the silty clay and sandy silt, where encountered. The glacial till deposit generally consists of gravel, cobbles, and boulders in a matrix of sand, clay and silt in varying compositions (i.e., silt and sand, silty sand, sandy silt, and/or clayey silt) with trace to some clay. Gravelly silty sand, gravelly sandy silt as well as sand and gravel till deposits were also encountered. The glacial till extends to depths ranging from about 6.2 to 10.6 m below the existing ground surface (i.e., elevations ranging from about 55.2 to 59.9 m).

SPT ‘N’ values measured in the glacial till deposit range from ‘weight of hammer’ to greater than 50 blows per 0.3 m of penetration, but more generally ranging from 2 to 23 blows per 0.3 m of penetration, indicating a very loose to state of compact compactness. The higher blow counts could possibly reflect the presence of cobbles, boulders or the bedrock surface rather than the state of compactness of the soil matrix. Rotary diamond drilling techniques were also required to advance through the cobbles and boulders within the till at Borehole 17-1111.

The results of Atterberg limit testing on the percent passing the 425 µm sieve of 5 samples of the glacial till deposit from the current investigation gave plasticity index values ranging from about 6 to 8 percent and liquid limit values ranging from about 17 to 22 percent, indicating a silty clay to clayey silt of low plasticity. The results of the Atterberg limit testing are provided on Figure B8 in Appendix B. The measured water content on samples of the glacial till deposit ranges from about 6 to 24 percent.

The results of grain size distribution testing carried out on several samples of the glacial till from the current investigation are provided on Figures B9a and B9b in Appendix B.

The results of grain size distribution testing carried out on samples of the glacial till from the previous investigation are provided in Appendix C. The measured natural water contents within the glacial till from the previous investigation are shown on the Record of Borehole sheets also in Appendix C.

4.6 Bedrock

Refusal to auger, casing, or DCPT advancement was encountered in Boreholes 17-1101, 17-1108, 17-1109, and 17-1116 from the current investigation and Boreholes 3A, 4, 5, 5A, 6, 7, and 9 from the previous investigation. The refusal was encountered at depths ranging from about 5.6 to 20.6 m below the existing ground surface (i.e., elevations ranging from about 55.2 to 60.2 m); this has been inferred to represent the bedrock surface. However, refusal could also indicate cobbles or boulders within the glacial till.

Bedrock was proven beneath the glacial till in Boreholes 17-1102 to 17-1106, 17-1106A, 17-1107, and 17-1110 to 17-1115 from the current investigation and Boreholes 1, 1A, 2, 2A, 3, 4A, 8, and 10 from the previous investigation. The bedrock was encountered at depths ranging from about 6.2 to 20.1 m below the existing ground surface (i.e., elevations ranging from about 55.5 to 59.8 m). During the current investigation, the bedrock was cored between about 1.5 and 5.7 m depth using BQ, NQ or HQ-sized coring equipment. During the previous investigation, the bedrock was cored between about 0.6 and 3.0 m depth using BX coring equipment.

The following table summarizes the bedrock surface or refusal depths and elevations as encountered at the borehole locations for the current investigation.

Borehole Number	Borehole Location with respect to Bridge Structure	Existing Ground Surface Elevation (m)	Depth to Bedrock/ Refusal (m)	Bedrock Surface/ Refusal Elevation (m)
17-1101	EBL North Approach Embankment	75.8	20.6(1)	55.2(1)
17-1102	EBL North Abutment	75.9	20.1	55.8
17-1103	EBL North Pier 1	70.5	13.6	56.9
17-1104	EBL North Pier 2	66.4	8.8	57.7
17-1106	EBL South Pier 4	70.3	11.3	59.0
17-1106A	EBL South Pier 4	70.3	11.2	59.0

Borehole Number	Borehole Location with respect to Bridge Structure	Existing Ground Surface Elevation (m)	Depth to Bedrock/ Refusal (m)	Bedrock Surface/ Refusal Elevation (m)
17-1107	EBL South Abutment	75.8	16.2	59.7
17-1108	EBL South Approach Embankment	75.7	16.2(1)	59.6(1)
17-1109	WBL South Approach Embankment	75.9	16.0(1)	59.8(1)
17-1110	WBL South Abutment	76.0	16.2	59.8
17-1111	WBL South Pier 4	70.4	12.2	58.2
17-1113	WBL North Pier 2	66.9	7.8	59.1
17-1114	WBL North Pier 1	70.4	12.0	58.5
17-1115	WBL North Abutment	75.9	18.1	57.8
17-1116	WBL North Approach Embankment	75.9	18.2(1)	57.7(1)
1A	EBL West Approach Embankment	66.1	10.6	55.5
4A	EBL North Pier 1	66.0	9.0	57.0
5A	EBL South Pier 3	65.9	8.5(1)	57.4(1)
7	EBL North Pier 2	66.0	8.7(1)	57.3(1)
8	EBL	66.1	9.3	56.8
9	EBL South Pier 3	66.1	7.5(1)	58.6(1)
10	EBL	65.8	7.0	58.8
1	WBL South Pier 4	65.7	6.2	59.5
2	WBL	65.7	7.0	58.7
2A	WBL North Pier 1	65.8	6.4	59.4
3	WBL West Approach Embankment	66.0	8.1	57.9
3A	WBL West Approach Embankment	66.1	8.5(1)	57.6(1)
4	WBL	65.5	6.9(1)	58.6(1)
5	WBL	65.8	5.6(1)	60.2(1)
6	WBL East Approach Embankment	65.7	6.6(1)	59.1(1)

Note (1): Depth and elevation to bedrock inferred from refusal to auger, casing or DCPT advancement.

The bedrock encountered in these boreholes consist of slightly weathered to fresh, thinly to medium bedded, black to dark grey, fine grained, porous shale. The Rock Quality Designation (RQD) values measured on recovered bedrock core samples from the current investigation typically ranged from about 50 to 100 percent indicating a generally fair to excellent quality rock. However, an RQD value of 19 percent (indicating a very poor quality rock) was encountered in the upper 0.6 m (i.e., between about Elevations 55.2 and 55.6 m) of the bedrock at Borehole 17-1102 which is located adjacent to the north abutment of the EBL structure. In addition, RQD values ranging from 0 to 33 percent (indicating a very poor to poor quality rock) were measured for the full length of bedrock cored (i.e., between about Elevations 56.6 and 59.7 m) at Boreholes 17-1106, 17-1106A, and 17-1107 which are located adjacent to Pier 4 and the south abutment, respectively, of the EBL structure. An RQD value of 22 percent (indicating a very poor quality rock) was also measured in middle portion of the bedrock cored (i.e., between about Elevations 55.6 and 57.1 m) at Borehole 17-1111 which is located adjacent to Pier 4 of the WBL structure.

Photos of the bedrock core from the current investigation are provided in Figures A1 to A22 in Appendix A.

Results of unconfined compressive strength testing carried out on two bedrock core samples from Boreholes 17-1106A and 17-1113 were about 29 and 33 MPa, as shown on Figure B10 in Appendix B. These results indicate a medium strong bedrock.

4.7 Groundwater Conditions

The groundwater conditions observed in the open boreholes during drilling at Boreholes 17-1106, 17-1109, 17-1110, and 17-1111 were between about Elevations 61.0 and 64.6 m. However, these groundwater levels are not considered representative of stabilized groundwater conditions.

The groundwater levels in the monitoring wells installed in Boreholes 17-1108 and 17-1115, measured two to three months after well installation, are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Screened Interval Material	Water Level Depth (m)	Water Level Elevation (m)	Date of Reading
17-1108	75.7	Embankment Fill	9.4	66.3	September 24, 2017
17-1115	75.9	Embankment Fill/ Silty Clay	10.3	65.6	September 25, 2017

The groundwater levels measured within the open boreholes during the 1972 investigation indicated groundwater levels which ranged from about Elevation 64.6 to 66.1 m at the time of drilling. It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events. In addition, the groundwater levels from the 1972 investigation may not be representative of the current site conditions.

5.0 CLOSURE

This report was prepared by Mr. Alex Meacoe, P.Eng. It was reviewed by Mr. Michael Snow P.Eng., a senior geotechnical engineer and Principal with Golder. Mr. Fintan Heffernan, P.Eng., a Senior Consultant with Golder and the MTO Foundations Designated Contact, conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD.

Michael Snow, P.Eng.
Principal, Senior Geotechnical Engineer

Fintan J. Heffernan, P.Eng.
MTO Foundations Designated Contact

WAM/MSS/FJH/mvrd
https://golderassociates.sharepoint.com/sites/11263g/shared documents/01_foundations/6 - reports/1110 cnr/final/1662565-1110-r-rev0-cnr overpass-09_2019 fidr.docx

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MINISTRY OF TRANSPORTATION, ONTARIO

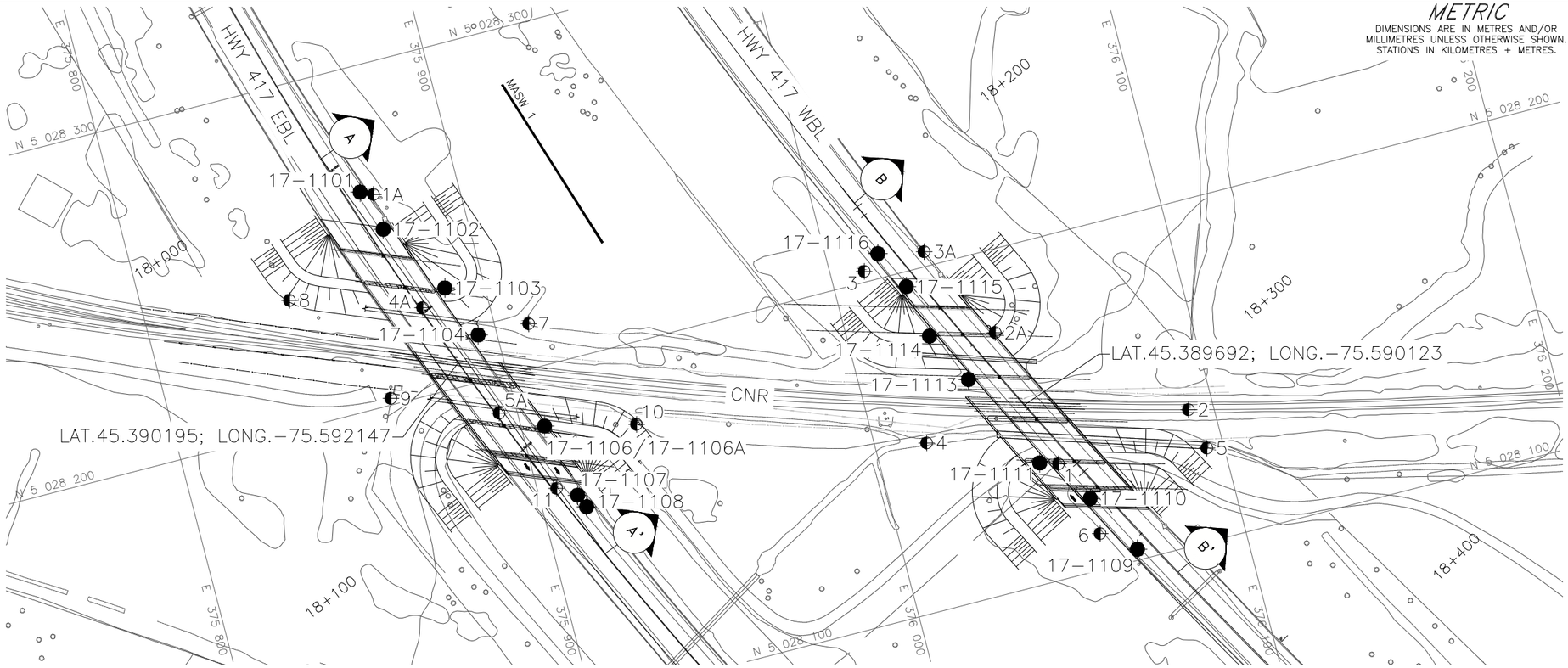
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 4145-10-00

CNR OVERHEAD WIDENING
SITE 3-301 (EBL)
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

GOLDER



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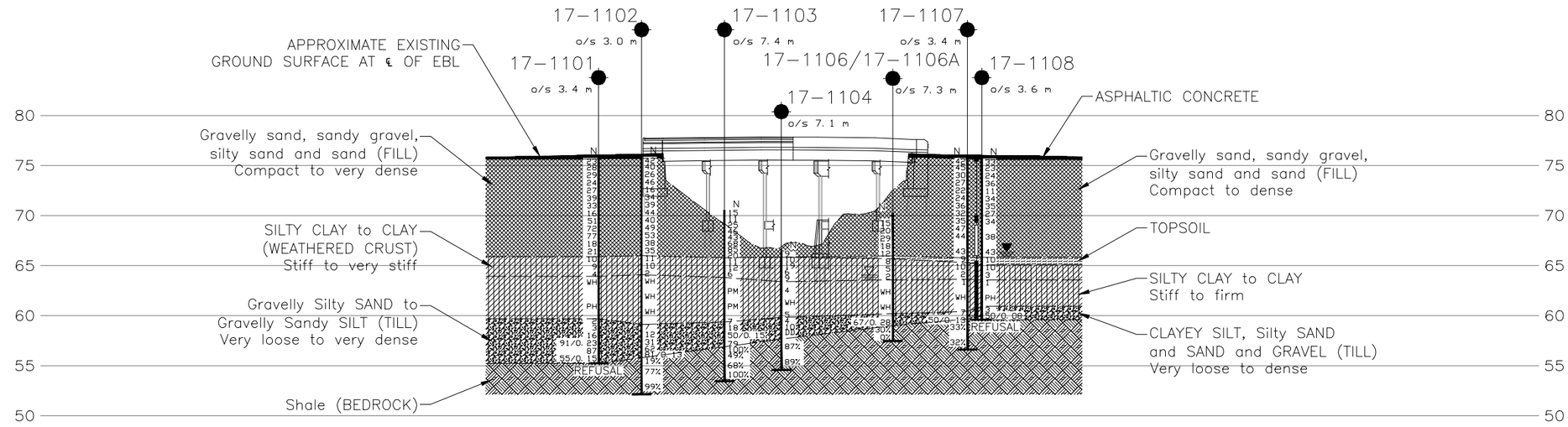

CROSS-SECTION A-A'
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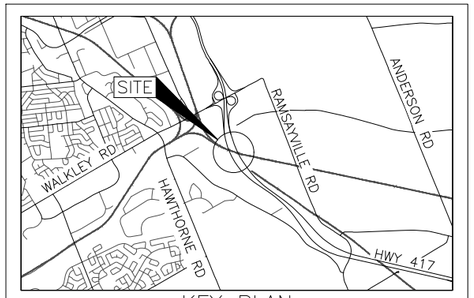
5 0 5 10 m



KEY PLAN
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LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation (Geocres No. 31G05-79)
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- DD — Diamond Drilling
- 100% — Rock Quality Designation (RQD)
- WL in piezometer, measured on SEPT. 24, 2017
- WL in open borehole, measured during drilling

BOREHOLE CO-ORDINATES NAD 83 (CSRS)/MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
17-1101	75.8	5028263.4	375871.3
17-1102	75.9	5028251.0	375875.2
17-1103	70.5	5028229.6	375888.5
17-1104	66.4	5028213.6	375894.5
17-1106/17-1106A	70.3	5028182.6	375906.8
17-1107	75.8	5028160.3	375911.2
17-1108	75.7	5028156.3	375912.9
17-1109	75.9	5028103.2	376067.6
17-1110	76.0	5028121.3	376057.8
17-1111	70.4	5028135.2	376046.0
17-1113	66.9	5028164.4	376031.8
17-1114	70.4	5028179.8	376023.8
17-1115	75.9	5028195.6	376020.9
17-1116	75.9	5028207.2	376015.1
1	65.7	5028133.5	376051.3
1A	66.1	5028261.7	375875.0
2	65.7	5028139.4	376092.6
2A	65.8	5028175.8	376042.9
3	66.0	5028203.1	376009.9
3A	66.1	5028204.3	376028.6
4	65.5	5028149.3	376015.1
4A	66.0	5028225.6	375880.6
5	65.8	5028127.0	376095.0
5A	65.9	5028189.7	375894.8
6	65.7	5028110.4	376058.1
7	66.0	5028213.1	375909.9
8	66.1	5028237.6	375843.1
9	66.1	5028201.9	375864.8
10	65.8	5028176.2	375933.3
11	65.9	5028163.8	375905.6

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.

Cross-section B-B' shown on Drawing 2.

REFERENCE

Base plans provided in digital format by WSP, drawing file nos. CNR_EBL_001_GA_I_NEW_ALIGNMENT.dwg and CNR_WBL_001_GA_I.dwg, received JAN. 8, 2018.

LICENSED PROFESSIONAL ENGINEER M.S. SNOW PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31G5-288

HWY. 417	PROJECT NO. 1662565/1110		DIST. EASTERN
SUBM'D. MJK	CHKD. MJK	DATE: 9/16/2019	SITE: .
DRAWN: JM	CHKD. MSS	APPD. FJH	DWG. 1

PLOT DATE: September 16, 2019
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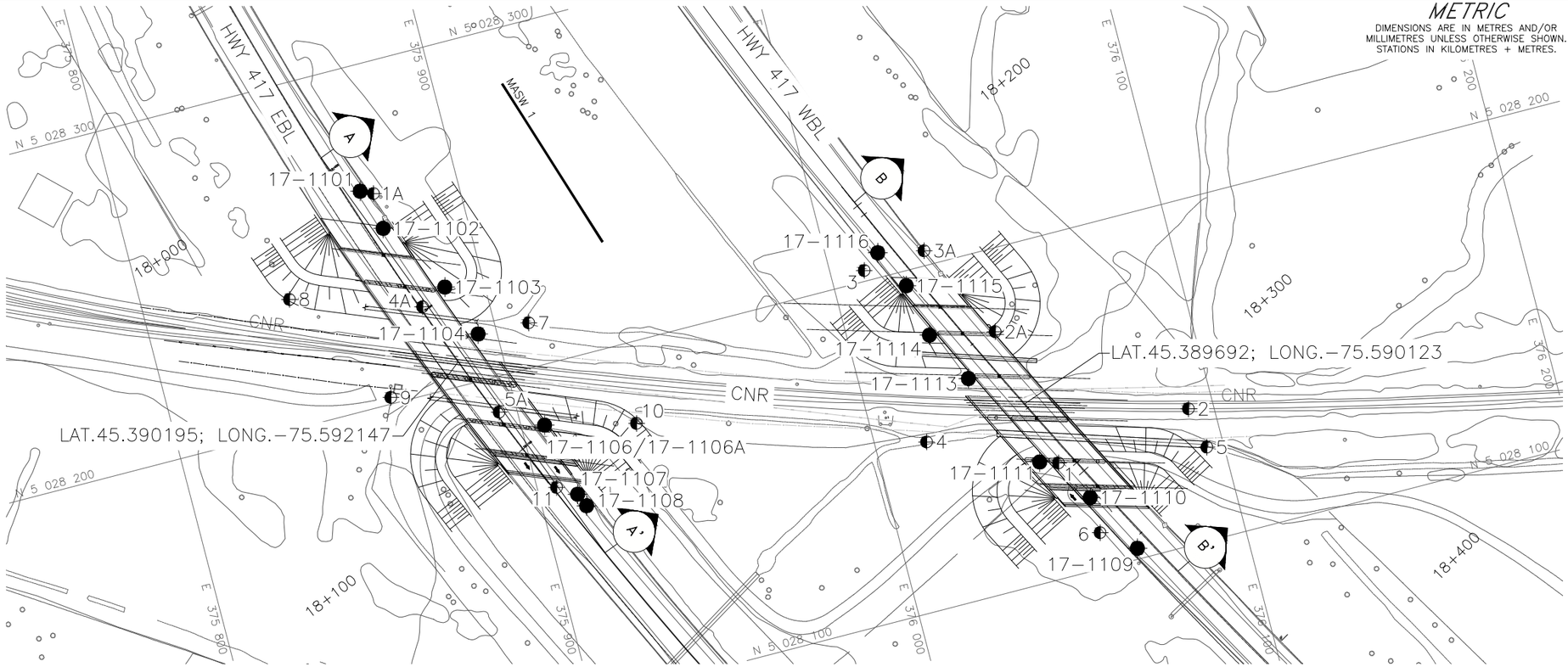
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE

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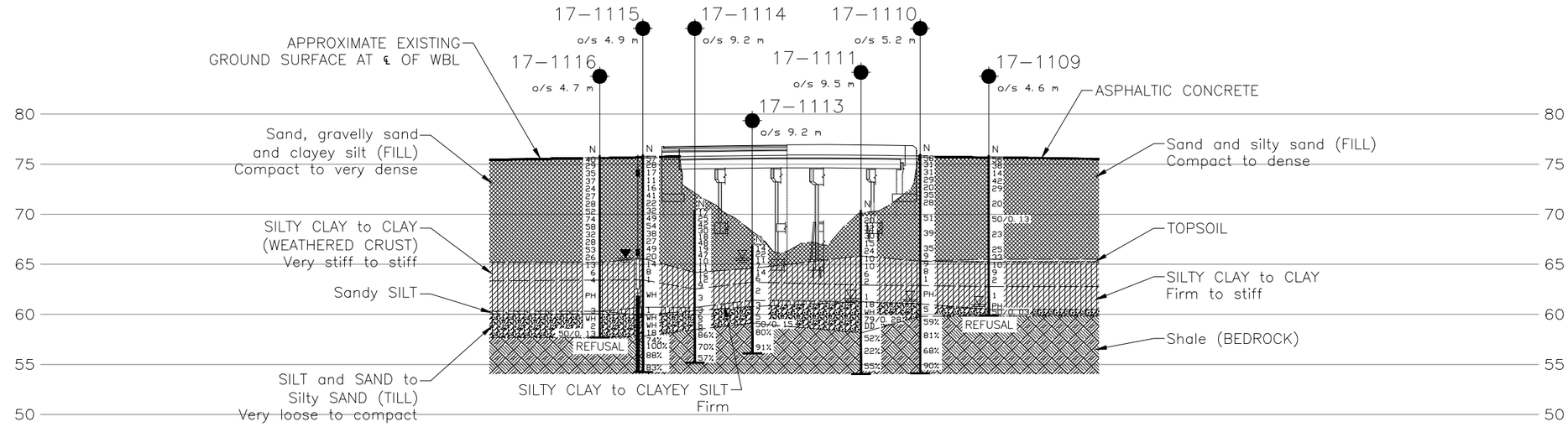

CROSS–SECTION B–B'

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15 0 15 30 m

5 0 5 10 m

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Cross–section A–A' shown on Drawing 1.

REFERENCE

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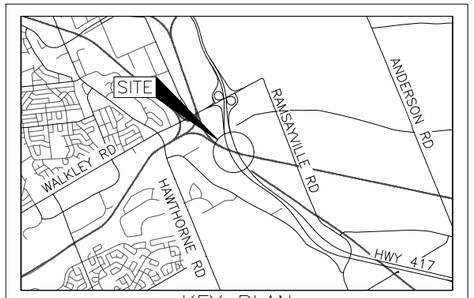
CONT No.

GWP No. 4145–10–00

SHEET

CNR OVERHEAD WIDENING
SITE 3–301/2 (WBL)
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA

GOLDER



KEY PLAN

SCALE

1 0 1 2 km

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17–1108	75.7	5028156.3	375912.9
17–1109	75.9	5028103.2	376067.6
17–1110	76.0	5028121.3	376057.8
17–1111	70.4	5028135.2	376046.0
17–1113	66.9	5028164.4	376031.8
17–1114	70.4	5028179.8	376023.8
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10	65.8	5028176.2	375933.3
11	65.9	5028163.8	375905.6

LICENSED PROFESSIONAL ENGINEER M.S. SNOW PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER F. J. HEFFERNAN PROVINCE OF ONTARIO SEPT. 13, 2019

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 31G5–288

HWY. 417	PROJECT NO. 1662565/1110		DIST. EASTERN
SUBM'D. MJK	CHKD. MJK	DATE: 9/16/2019	SITE: .
DRAWN: JM	CHKD. MSS	APPD. FJH	DWG. 2

PLOT DATE: September 16, 2019
FILENAME: N:\Active\Spatial_3M\MTO\Hwy417Rehab&Widening\GIS_DRGS\1662565_MTO_Hwy417Replacements\AS_BUILT\0004_CNR\1662565-0004-BS-0001.dwg

APPENDIX A

Borehole and Drillhole Records, Current Investigation

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes 17-1101 to 17-1104, 17-1106 to 17-1111, 17-1113 to 17-1116

Bedrock Core Photographs, Figures A1 to A22

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
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, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

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

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

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils
Consistency

	c_u, s_u kPa	c_u, s_u psf
Very soft	0 to 12	0 to 250
Firm Stiff	12 to 25	250 to 500
Very stiff	25 to 50	500 to 1,000
Hard	50 to 100	1,000 to 2,000
	100 to 200	2,000 to 4,000
	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

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

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

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, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

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^{o} 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

JN Joint
FLT Fault
SH Shear
VN Vein
FR Fracture
SY Stylolite
BD Bedding
FO Foliation
CO Contact
AXJ Axial Joint
KV Karstic Void
MB Mechanical Break

PL Planar
CU Curved
UN Undulating
IR Irregular
K Slickensided
PO Polished
SM Smooth
SR Slightly Rough
RO Rough
VR Very Rough

GOLDER

RECORD OF BOREHOLE No 17-1101

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00 LOCATION N 5028263.4; E 375871.3 NAD 83 MTM ZONE 9 (LAT. 45.390703; LONG. -75.592335) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NW Casing COMPILED BY ZS

DATUM Geodetic DATE June 25-26, 2017 CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.8	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Grey Moist		1	SS	23						
75.3											
0.5	(SP) Sand, trace gravel, contains organic matter (FILL) Compact Brown Moist		2	SS	28		75				
74.3											
1.5	(SP/GP) Sand and gravel, some silt, trace to some clay (FILL) Compact to dense Grey Moist		3	SS	29		74				
			4	SS	24		73		○		49 32 15 4
			5	SS	27						
			6	SS	39		72		○		
70.9			7	SS	33		71				
4.9	(SP/GP) Sand and gravel, trace to some silt (FILL) Compact Grey-brown Moist		8	SS	16				○		33 54 10 3
69.6							70				
6.3	(GP) Sandy gravel (FILL) Very dense Grey-brown Moist		9	SS	51						
			10	SS	72		69				
			11	SS	77		68				
67.4											
8.4	(SP) Sand, some silt (FILL) Compact Brown Moist to wet		12	SS	18		67		○		0 84 15 1
			13	SS	21						
65.9							66				

Continued Next Page

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

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1101

SHEET 2 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028263.4; E 375871.3 NAD 83 MTM ZONE 9 (LAT. 45.390703; LONG. -75.592335) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NW Casing COMPILED BY ZS

DATUM Geodetic DATE June 25-26, 2017 CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
9.9	(CI/CH) SILTY CLAY to CLAY, trace to some sand, contains rootlets (WEATHERED CRUST) Very stiff Grey-brown Moist		14	SS	10						
			15	SS	9		65				
			16	SS	4						
63.9							64				
11.9	(CI/CH) SILTY CLAY to CLAY, trace sand Stiff to firm Grey Moist to wet		17	SS	WH						
							63				
			18	TP	PH		62				
							61				
59.7							60				
16.1	(SM) Gravelly Silty SAND, trace to some clay, contains cobbles and boulders (TILL) Very loose to compact Dark brown to black Wet		19	SS	2						
			20	SS	3		59				21 40 28 11
			21	SS	16		58				
57.5											
18.3	(SM) Gravelly Silty SAND, contains cobbles and boulders (TILL) Very dense Dark grey Moist		22	SS	91/0.23		57				
			23	SS	87						
							56				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No 17-1101

SHEET 3 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028263.4; E 375871.3 NAD 83 MTM ZONE 9 (LAT. 45.390703; LONG. -75.592335)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NW Casing

COMPILED BY ZS

DATUM Geodetic

DATE June 25-26, 2017

CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
			24	SS	55/0.15						
55.2											
20.6	END OF BOREHOLE CASING REFUSAL										

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

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

GOLDER

RECORD OF BOREHOLE No 17-1102

SHEET 1 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028251.0; E 375875.2 NAD 83 MTM ZONE 9 (LAT. 45.390591; LONG. -75.592288)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE July 5-7, 2017

CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	GROUND SURFACE										
0.0 / 75.7	ASPHALTIC CONCRETE										
0.2 / 75.3	(SP) Gravelly sand (FILL) Grey Moist		1	SS	42						
0.6 / 74.4	(SP) Sand (FILL) Dense Brown Moist		2	SS	40		75		○		
1.5	(SP) Sand, some silt, trace to some gravel (FILL) Compact to dense Brown to dark brown Moist		3	SS	26		74				
			4	SS	46				○		
			5	SS	16		73				
			6	SS	34		72		○		11 71 15 3
			7	SS	39		71				
			8	SS	44						
			9	SS	40		70		○		
			10	SS	49		69				
			11	SS	53		68		○		
			12	SS	38		67				
66.8 / 9.2	(SM) Silty sand, trace gravel (FILL) Dense Brown Wet		13	SS	35						
66.0							66				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1102

SHEET 2 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028251.0; E 375875.2 NAD 83 MTM ZONE 9 (LAT. 45.390591; LONG. -75.592288)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE July 5-7, 2017

CHECKED BY WAM

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 ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
9.9	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		14	SS	11						
			15	SS	10		65			CHEM	
64.1			16	SS	2						
11.8	(CI/CH) SILTY CLAY to CLAY Stiff to firm Grey Moist to wet		17	SS	WH		64				
			18	SS	WH		63				
			19	SS	WH		62				0 1 64 35
59.1							61				
16.8	(ML) Gravelly Sandy SILT, trace clay, contains cobbles and boulders (TILL) Loose to compact Dark brown to black Wet		20	SS	7		60				
			21	SS	12		59				
57.6							58				
18.3	(SM) Gravelly Silty SAND, trace clay, contains cobbles and boulders (TILL) Dense to very dense Dark grey Wet		22	SS	31		57				
			23	SS	62						21 47 29 3
			24	SS	81/0.13		56				

Continued Next Page

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

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

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1102

SHEET 3 OF 4

METRIC

G.W.P. 4145-10-00 LOCATION N 5028251.0; E 375875.2 NAD 83 MTM ZONE 9 (LAT. 45.390591; LONG. -75.592288) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core COMPILED BY ZS

DATUM Geodetic DATE July 5-7, 2017 CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
55.8	*--- CONTINUED FROM PREVIOUS PAGE ---*										
20.1	Shale (BEDROCK) Bedrock cored from depths 20.1 m to 23.8 m For bedrock coring details refer to Record of Drillhole 17-1102		1	RC	REC 100%						RQD = 19%
			2	RC	REC 94%		55 54				RQD = 77%
			3	RC	REC 99%		53				RQD = 99%
52.1											
23.8	END OF BOREHOLE										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1102

SHEET 4 OF 4

LOCATION: N 5028251.0 ;E 375875.2

DRILLING DATE: July 5-7, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Grenville Drilling

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES
		BEDROCK SURFACE		55.80													
21	Rotary Drill / NQ Core	Shale (BEDROCK) Slightly weathered to fresh Thinly to medium bedded Black to dark grey Fine grained Slightly porous Medium strong		20.10	1	100											
22					2	100											
23					3	100											
				52.14													
		END OF DRILLHOLE		23.76													
24																	
25																	
26																	
27																	
28																	
29																	
30																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1103

SHEET 1 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028229.6; E 375888.5 NAD 83 MTM ZONE 9 (LAT. 45.390397; LONG. -75.592121) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Portable Drill, NQ/BW Casing/Rotary Drill, BW Casing COMPILED BY ZS

DATUM Geodetic DATE August 20-21, 2017 CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.5	GROUND SURFACE										
0.0	(SM) Silty sand, trace gravel (FILL/TOPSOIL) Dark brown Moist										
0.2	(SP) Sand, some gravel, trace to some silt, trace clay (FILL) Compact to dense Brown Moist		1	SS	15		70				
			2	SS	11						
			3	SS	25		69		○		20 66 10 4
			4	SS	46						
			5	SS	43		68				
67.5											
3.1	(SM) Gravelly silty sand (FILL) Very dense to compact Brown Moist		6	SS	68		67		○		
			7	SS	85						
			8	SS	20		66				
65.8											
4.7	(CI/CH) SILTY CLAY to CLAY, trace to some sand (WEATHERED CRUST) Very stiff Brown		9	SS	11						CHEM
			10	SS	12		65		⊢○⊣		
			11	SS	6		64				
63.8											
6.7	(CI/CH) SILTY CLAY to CLAY, trace sand Stiff to firm Grey							× + × +			
			12	SS	PM		63		⊢○		
							62	× + × +			
			13	SS	PM		61				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No 17-1103

SHEET 2 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028229.6; E 375888.5 NAD 83 MTM ZONE 9 (LAT. 45.390397; LONG. -75.592121)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Portable Drill, NQ/BW Casing/Rotary Drill, BW Casing

COMPILED BY ZS

DATUM Geodetic

DATE August 20-21, 2017

CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
60.2											
10.3	(CL-ML) SILTY CLAY to CLAYEY SILT, some sand Firm Grey Wet										
59.4			14	SS	7						
11.2	(SM) Gravelly Silty SAND, some clay, contains shale fragments, cobbles and boulders (TILL) Loose to compact Black Wet		15	SS	18		59				25 39 24 12
58.1											
12.4	(SM) Gravelly Silty SAND, contains cobbles and boulders (TILL) Very dense Dark brown Wet		16	SS	50/0.15		58				
			17	RC	DD						
			18	SS	79						
56.9			19	RC	DD		57				
13.6	Shale (BEDROCK) Bedrock cored from depths of 13.6 m to 17.1 m For bedrock coring details refer to Record of Drillhole 17-1103		1	RC	REC 100%						RQD = 100%
			2	RC	REC 90%		56				RQD = 49%
			3	RC	REC 91%						RQD = 68%
			4	RC	REC 100%		55				RQD = 100%
53.4							54				
17.1	END OF BOREHOLE										

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

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1103

SHEET 3 OF 3

LOCATION: N 5028229.6 ;E 375888.5

DRILLING DATE: August 20-21, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATHERING INDEX	FEATURES
		BEDROCK SURFACE		56.89													
14	Rotary Drill / BW Casing	Shale (BEDROCK) Fresh Thinly to medium bedded Black to dark grey Fine grained Porous Medium strong		13.63	1	100											
15					2	100											
16					3	100											
17				53.45	4	100											
		END OF DRILLHOLE		17.07													
18																	
19																	
20																	
21																	
22																	
23																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: WAM

GOLDER

RECORD OF BOREHOLE No 17-1104

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00 LOCATION N 5028213.6; E 375894.5 NAD 83 MTM ZONE 9 (LAT. 45.390253; LONG. -75.592046) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Rotary Drill, BW Casing COMPILED BY ZS

DATUM Geodetic DATE September 6-8, 2017 CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
66.4	GROUND SURFACE										
0.0 / 65.8	(SP) Sand, trace silt (FILL) Loose Brown Moist		1	SS	9		66				
0.6	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff Grey-brown Moist		2	SS	10						
			3	SS	19		65				
			4	SS	6						
			5	SS	9		64				
63.4											
3.1	(CI/CH) SILTY CLAY to CLAY Firm Grey Wet						63				
			6	SS	4						0 1 44 55
							62				
			7	SS	WH						
							61				
60.3											
6.1 / 59.8	(CL/ML) SILTY CLAY to CLAYEY SILT Stiff Grey Wet		8	SS	5		60				
6.6	(ML) Sandy CLAYEY SILT, some gravel, contains cobbles and boulders (TILL) Loose Dark grey Wet		9	SS	4						14 30 40 16
			10	SS	10		59				CHEM
			11	RC	DD						
57.6							58				
8.8	Shale (BEDROCK) Bedrock cored from depths of 8.8 m to 11.9 m For bedrock coring details refer to Record of Drillhole 17-1104		1	RC	REC 100%		57				RQD = 87%

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No 17-1104

SHEET 2 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00 LOCATION N 5028213.6; E 375894.5 NAD 83 MTM ZONE 9 (LAT. 45.390253; LONG. -75.592046) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Rotary Drill, BW Casing COMPILED BY ZS

DATUM Geodetic DATE September 6-8, 2017 CHECKED BY WAM

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) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Shale (BEDROCK) Bedrock cored from depths of 8.8 m to 11.9 m For bedrock coring details refer to Record of Drillhole 17-1104		1	RC	REC 100%		56				RQD = 87%
			2	RC	REC 100%		55				RQD = 89%
54.5 11.9	END OF BOREHOLE										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1104

SHEET 3 OF 3

LOCATION: N 5028213.6 ;E 375894.5

DRILLING DATE: September 6-8, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	DISCONTINUITY DATA: Jr	DISCONTINUITY DATA: Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WEATH-ERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES
		BEDROCK SURFACE		57.67													
9	Rotary Drill / BW Casing	Shale (BEDROCK) Slightly weathered to fresh Thinly to medium bedded Dark grey to black Fine grained Porous Medium strong		8.78	1	100											
10																	
11					2	100											
				54.58													
12		END OF DRILLHOLE		11.87													
13																	
14																	
15																	
16																	
17																	
18																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1106A

SHEET 1 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028182.6; E 375906.8 NAD 83 MTM ZONE 9 (LAT. 45.389973; LONG. -75.591894) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Rotary Drill, NW Casing COMPILED BY ZS

DATUM Geodetic DATE August 23-24, 2017 CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.3	GROUND SURFACE										
0.0	(SP) Sand, trace gravel (FILL) Compact Brown Moist						70				
67.3							69				
3.1	(SM) Gravelly silty sand, trace clay (FILL) Compact Brown Moist						68				
66.0							67				
4.3	(SM) Silty sand, contains organic matter (TOPSOIL) Black Moist						66				
65.7							65				
4.6	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist						64				
63.6							63				
6.7	(CL/CH) SILTY CLAY to CLAY Stiff Grey Wet		1	TP	PH		62		o	16.2	
							61				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1106A SHEET 2 OF 3 METRIC

PROJECT 1662565-1110
G.W.P. 4145-10-00 LOCATION N 5028182.6; E 375906.8 NAD 83 MTM ZONE 9 (LAT. 45.389973; LONG. -75.591894) ORIGINATED BY DG
DIST Eastern HWY 417 BOREHOLE TYPE Rotary Drill, NW Casing COMPILED BY ZS
DATUM Geodetic DATE August 23-24, 2017 CHECKED BY WAM

SOIL PROFILE			SAMPLES			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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
60.2 / 10.1	(SP/GP) SAND and GRAVEL, some silt, trace to some clay, contains shale fragments, cobbles and boulders (TILL) Very dense Grey Wet						60				
59.1 / 11.2	Shale (BEDROCK) Bedrock cored from depths of 11.2 m to 13.2 m For bedrock coring details refer to Record of Drillhole 17-1106A		1	RC	REC 100%		59			UCS = 32.8 MPa	RQD = 28%
			2	RC	REC 92%		58				RQD = 16%
57.1 / 13.2	END OF BOREHOLE Note(s): 1. Soil stratigraphy is inferred from Record of Borehole 17-1106.										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1106A

SHEET 3 OF 3

LOCATION: N 5028182.6 ;E 375906.8

DRILLING DATE: August 23-24, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH-ERING INDEX	FEATURES	
		BEDROCK SURFACE		59.03														
12	Rotary Drill / NW Casing	Shale (BEDROCK) Slightly weathered to fresh Highly fractured Thinly to medium bedded Dark grey to black Porous Medium strong		11.23	1	100-0												UCS = 32.8 MPa
13					2	0												
				57.08														
		END OF DRILLHOLE		13.18														
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

RECORD OF BOREHOLE No 17-1106

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028182.6; E 375906.8 NAD 83 MTM ZONE 9 (LAT. 45.389973; LONG. -75.591894)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/ Rotary Drill, NW Casing

COMPILED BY ZS

DATUM Geodetic

DATE August 22-23, 2017

CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.3	GROUND SURFACE										
0.0	(SP) Sand, trace gravel (FILL) Compact Brown Moist		1	SS	15		70				
			2	SS	20		69				
			3	SS	29		68		○		
67.3											
3.1	(SM) Gravelly silty sand, trace clay (FILL) Compact Brown Moist		4	SS	18		67				
			5	SS	12		66		○		20 52 22 6
66.0											
4.3	(SM) Silty sand, contains organic matter (TOPSOIL) Black Moist										
65.7											
4.6	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		6	SS	8						
			7	SS	5		65		⊢○⊣		
			8	SS	2	▽	64			CHEM	
63.6											
6.7	(CL/CH) SILTY CLAY to CLAY Stiff Grey Wet						63	× +			
			9	SS	WH		62	× + × +			
			10	SS	WH		61		⊢○		

Continued Next Page

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

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

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1106

SHEET 2 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028182.6; E 375906.8 NAD 83 MTM ZONE 9 (LAT. 45.389973; LONG. -75.591894) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/ Rotary Drill, NW Casing COMPILED BY ZS

DATUM Geodetic DATE August 22-23, 2017 CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
60.2											
10.1	(SP/GP) SAND and GRAVEL, some silt, trace to some clay, contains shale fragments, cobbles and boulders (TILL) Very dense Grey Wet						60				
			11	SS	67/0.28				○		38 36 18 8
59.1							59				
11.3	Shale (BEDROCK) Bedrock cored from depths of 11.3 m to 12.8 m For bedrock coring details refer to Record of Drillhole 17-1106		1	RC	REC 100%						RQD = 30%
							58				
57.5			2	RC	REC 5%						RQD = 0%
12.8	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 6.2 m below ground surface (Elev. 64.1), measured during drilling.										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1106

SHEET 3 OF 3

LOCATION: N 5028182.6 ;E 375906.8

DRILLING DATE: August 22-23, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH-ERING INDEX	FEATURES
		BEDROCK SURFACE		59.01													
12	Rotary Drill / NW Casing	Shale (BEDROCK) Slightly weathered to fresh Highly fractured Thinly to medium bedded Dark grey to black Fine grained Porous		11.25	1	0											
					2	0											
				57.47													
		END OF DRILLHOLE		12.79													
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE

1 : 50

LOGGED: DG

CHECKED: WAM

GOLDER

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

RECORD OF BOREHOLE No 17-1107

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028160.3; E 375911.2 NAD 83 MTM ZONE 9 (LAT. 45.389772; LONG. -75.591841)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE June 25-26, 2017

CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.8	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Grey Moist		1	SS	42						
75.3 / 0.5	(SP) Sand, some silt, trace to some gravel (FILL) Dense to compact Brown Moist		2	SS	45		75				
			3	SS	30		74		○		
			4	SS	27		73				
			5	SS	22					CHEM	
			6	SS	24		72		○		9 73 15 3
			7	SS	36		71				
70.5 / 5.3	(SP) Gravelly sand, some silt (FILL) Dense Brown Moist		8	SS	32		70				
			9	SS	35				○		
			10	SS	47		69				
			11	SS	44		68		○		25 57 15 3
							67				
			12	SS	43		66				

Continued Next Page

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

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

GOLDER

RECORD OF BOREHOLE No 17-1107

SHEET 2 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028160.3; E 375911.2 NAD 83 MTM ZONE 9 (LAT. 45.389772; LONG. -75.591841)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE June 25-26, 2017

CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
65.7											
10.1 / 65.3	(CI/CH) Silty clay, contains organic matter (TOPSOIL) Dark grey Moist		13	SS	9				○		
10.5	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		14	SS	10		65				
			15	SS	2		64		⊢○⊣		
63.6											
12.2	(CI/CH) SILTY CLAY to CLAY, contains silt seams Stiff to firm Grey Wet		16	SS	1		63	× + × +			
			17	SS	WH		62		⊢○		
60.4							61	× + × +			
15.4	(SM) Silty SAND, some gravel, contains shale fragments, cobbles and boulders (TILL) Loose to dense Dark grey Wet		18	SS	7		60		○		
59.7			19	SS	50/0.13						
16.2	Shale (BEDROCK) Bedrock cored from depths 16.2 m to 19.2 m For bedrock coring details refer to Record of Drillhole 17-1107		1	RC	REC 100%		59				RQD = 33%
			2	RC	REC 100%		58				RQD = 32%
56.6							57				
19.2	END OF BOREHOLE										

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

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

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 9/16/19 ZS

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1107

SHEET 3 OF 3

LOCATION: N 5028160.3 ;E 375911.2

DRILLING DATE: June 25-26, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Grenville Drilling

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES
		BEDROCK SURFACE		59.67													
17	Rotary Drill / NQ Core	Shale (BEDROCK) Slightly weathered Thinly to medium bedded Dark grey to black Fine grained Medium strong		16.15	1	100											
18					2	75											
19				56.62													
		END OF DRILLHOLE		19.20													
20																	
21																	
22																	
23																	
24																	
25																	
26																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1108

SHEET 1 OF 2

METRIC

G.W.P. 4145-10-00 LOCATION N 5028156.3; E 375912.9 NAD 83 MTM ZONE 9 (LAT. 45.389736; LONG. -75.591820) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY ZS

DATUM Geodetic DATE June 25-26, 2017 CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.7	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.3	(SP) Gravelly sand (FILL) Grey Moist		1	SS	33						
75.1 0.6	(GP) Sandy gravel (FILL) Grey Moist						75				
	(SP) Sand (FILL) Compact Brown Moist		2	SS	23				○		
73.9 1.8	(GP) Sandy gravel, some silt (FILL) Compact to dense Grey Moist		3	SS	24		74				
			4	SS	36		73		○		52 33 12 3
72.7 3.1	(SM/SP) Layered silty sand and sand (FILL) Compact Brown Moist		5	SS	11						
72.0 3.7	(GP) Sandy gravel (FILL) Compact Grey Moist		6	SS	34		72		○		
71.1 4.6	(SP) Sand (FILL) Compact Brown Moist		7	SS	35		71				
70.4 5.3	(GP) Sandy gravel (FILL) Compact Grey Moist		8	SS	27		70				
69.6 6.1	(SM) Sand, some gravel and silt (FILL) Compact Brown Moist		9	SS	34				○		19 65 13 3
			10	SS	38		69				
67.4 8.3	(SM) Silty sand (FILL) Compact Grey Wet						68				
			11	SS	43		67				
65.8							66				

Continued Next Page

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

GOLDER

RECORD OF BOREHOLE No 17-1108

SHEET 2 OF 2 **METRIC**

PROJECT 1662565-1110
G.W.P. 4145-10-00
DIST Eastern HWY 417
DATUM Geodetic

LOCATION N 5028156.3; E 375912.9 NAD 83 MTM ZONE 9 (LAT. 45.389736; LONG. -75.591820)
BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)
DATE June 25-26, 2017

ORIGINATED BY DG
COMPILED BY ZS
CHECKED BY WAM

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	25 50 75		
9.9 / 65.0	(CI/CH) Silty clay to clay, contains organic matter (TOPSOIL) Dark grey Moist		12	SS	10		65				
10.7	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		13	SS	10						0 5 44 51
			14	SS	3		64				
63.5											
12.2	(CI/CH) SILTY CLAY to CLAY Stiff Grey Wet		15	SS	1		63				
			16	TP	PH		62				
60.9											
14.8	(ML) CLAYEY SILT, some sand, trace gravel, contains silt seams, cobbles and boulders (TILL) Very loose Dark grey Wet		17	SS	3		61				2 13 60 25
59.6			18	SS	50/0.08		60				
16.2	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level in well screen at a depth of 9.4 m below ground surface (Elev. 66.3 m), measured on Sept. 24, 2017.

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

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

GOLDER

RECORD OF BOREHOLE No 17-1109

SHEET 1 OF 2

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028103.2; E 376067.6 NAD 83 MTM ZONE 9 (LAT. 45.389242; LONG. -75.589852)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE June 29, 2017

CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand, some silt (FILL) Dense Grey Moist		1	SS	56						
75.2											
0.7	(SP) Sand (FILL) Dense Brown Moist		2	SS	38		75				
74.8											
1.1	(GP) Sand and gravel, some silt, trace clay, contains shale fragments, cobbles and boulders (FILL) Compact to dense Grey Moist		3	SS	14		74		○		55 27 14 4
			4	SS	42		73				
			5	SS	29		72				
			6	SS	20		71		○		
			7	SS	50/0.13		70				
			8	SS	23		69				
							68				
66.8							67				
9.1	(SM) Silty sand (FILL) Compact Brown Moist		9	SS	25		66		○		

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1109

SHEET 2 OF 2

METRIC

G.W.P. 4145-10-00 LOCATION N 5028103.2; E 376067.6 NAD 83 MTM ZONE 9 (LAT. 45.389242; LONG. -75.589852) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY ZS

DATUM Geodetic DATE June 29, 2017 CHECKED BY WAM

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- *CONTINUED FROM PREVIOUS PAGE* ---							20 40 60 80 100	25 50 75		
65.5			10	SS	33						
10.4	(CI) Silty clay, contains organic matter (TOPSOIL)										
65.2	Dark grey										
10.7	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff Grey-brown Moist		11	SS	10		65				
			12	SS	9		64				
			13	SS	2						
62.8							63	>96 +			
13.1	(CI/CH) SILTY CLAY to CLAY Stiff to firm Grey Wet										
			14	SS	1		62				
						▽	61				
60.5											
15.4	(SM) Silty SAND, some gravel, contains cobbles and boulders (TILL) Grey Wet		15	TP	PH						
59.9			16	SS	50/0.03		60				
16.0	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 14.9 m below ground surface (Elev. 61.0), measured during drilling.

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

GOLDER

RECORD OF BOREHOLE No 17-1110

SHEET 1 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028121.3; E 376057.8 NAD 83 MTM ZONE 9 (LAT. 45.389406; LONG. -75.589974)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, HQ Core

COMPILED BY ZS

DATUM Geodetic

DATE July 3-5, 2017

CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.0	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Very dense Grey Moist		1	SS	58						
75.3											
0.7	(SP) Sand, trace to some silt, trace gravel (FILL) Compact to very dense Brown Moist		2	SS	31		75				
			3	SS	31		74				
			4	SS	29				○		
			5	SS	20		73				
			6	SS	35		72				
			7	SS	28		71		○		5 85 9 1
			8	SS	51		70				
			9	SS	39		69				
							68				
66.9							67				
9.1	(SM) Silty sand (FILL) Dense to loose Brown Moist		10	SS	35				○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1110

SHEET 2 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028121.3; E 376057.8 NAD 83 MTM ZONE 9 (LAT. 45.389406; LONG. -75.589974)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, HQ Core

COMPILED BY ZS

DATUM Geodetic

DATE July 3-5, 2017

CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
65.6			11	SS	9						
10.4	(ML) Sandy silt, contains organic matter (FILL)										
65.3	Dark grey										
10.7	Wet										
	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff Grey-brown Moist		12	SS	9		65				
			13	SS	8		64			CHEM	
			14	SS	1						
62.9							63	>96 +			
13.1	(CI/CH) SILTY CLAY to CLAY Stiff Grey Wet		15	TP	PH	▽	62				
61.1											
14.9	(ML/SP) SILT and SAND, some gravel and clay (TILL) Loose Dark grey Wet		16	SS	5		61				18 40 30 12
59.8											
16.2	Shale (BEDROCK) Bedrock cored from depths 16.2 m to 21.9 m For bedrock coring details refer to Record of Drillhole 17-1110		1	RC	REC 100%		60				RQD = 59%
			2	RC	REC 100%		59				RQD = 81%
			3	RC	REC 100%		58				RQD = 68%
							57				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1110

SHEET 3 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028121.3; E 376057.8 NAD 83 MTM ZONE 9 (LAT. 45.389406; LONG. -75.589974)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, HQ Core

COMPILED BY ZS

DATUM Geodetic

DATE July 3-5, 2017

CHECKED BY WAM

SOIL PROFILE			SAMPLES			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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Shale (BEDROCK) Bedrock cored from depths 16.2 m to 21.9 m For bedrock coring details refer to Record of Drillhole 17-1110		3	RC	REC 100%						RQD = 68%
			4	RC	REC 100%		55				RQD = 90%
54.1											
21.9	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 14.5 m below ground surface (Elev. 61.5), measured during drilling.										

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

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

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 9/16/19 ZS

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1110

SHEET 4 OF 4

LOCATION: N 5028121.3 ;E 376057.8

DRILLING DATE: July 3-5, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Grenville Drilling

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH-ERING INDEX	FEATURES
		BEDROCK SURFACE		59.80													
17	Rotary Drill / NQ Core	Shale (BEDROCK) Slightly weathered to fresh Thinly bedded Dark grey to black Fine grained Porous Medium strong		16.19	1	100											
18					2	100											
19					3	100											
20																	
21					4	100											
				54.11													
22		END OF DRILLHOLE		21.88													
23																	
24																	
25																	
26																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GOLDER

RECORD OF BOREHOLE No 17-1111

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028135.2; E 376046.0 NAD 83 MTM ZONE 9 (LAT. 45.389532; LONG. -75.590123)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NW Casing

COMPILED BY ZS

DATUM Geodetic

DATE August 24-25, 2017

CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.4	GROUND SURFACE										
0.0	(SM) Gravelly silty sand, trace clay (FILL) Compact to dense Brown Moist		1	SS	20		70				
			2	SS	32		69		○		24 50 22 4
			3	SS	30		68				
67.4											
3.1	(SM) Silty sand, trace gravel (FILL) Compact Brown Moist		4	SS	15		67				
			5	SS	24				○		
65.8							66				
4.6	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		6	SS	10				○		
			7	SS	10		65				
			8	SS	6		64		⊢○⊣		
			9	SS	2						
62.9							63	× +			
7.5	(CL/CH) SILTY CLAY to CLAY Stiff to firm Grey Wet							× +			
			10	SS	1	▽	62		⊢○		
61.3											
9.1	(ML/SP) SILT and SAND, some gravel and clay, contains cobbles and boulders (TILL) Compact to very loose Dark grey Wet		11	SS	18		61			CHEM	

Continued Next Page

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

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

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1111

SHEET 2 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028135.2; E 376046.0 NAD 83 MTM ZONE 9 (LAT. 45.389532; LONG. -75.590123) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NW Casing COMPILED BY ZS

DATUM Geodetic DATE August 24-25, 2017 CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	(ML/SP) SILT and SAND, some gravel and clay, contains cobbles and boulders (TILL) Compact to very loose Dark grey Wet		12	SS	WH		60		ϕ		15 43 30 12
			13	SS	79/0.28						
58.2			14	RC	DD		59				
12.2	Shale (BEDROCK) Bedrock cored from depths of 12.2 m to 16.3 m For bedrock coring details refer to Record of Drillhole 17-1111		1	RC	REC 100%		58				RQD = 52%
			2	RC	REC 95%		57				RQD = 22%
			3	RC	REC 99%		56				RQD = 55%
54.1							55				
16.3	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 8.8 m below ground surface (Elev. 64.6), measured during drilling.										

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

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1111

SHEET 3 OF 3

LOCATION: N 5028135.2 ;E 376046.0

DRILLING DATE: August 24-25, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH-ERING INDEX	FEATURES
		BEDROCK SURFACE		58.15													
13	Rotary Drill / NW Casing	Shale (BEDROCK) Slightly weathered Thinly to medium bedded Dark grey to black Fine grained Porous Medium strong		12.24	1	100											
14					2	100											
15					3	100											
16				54.05													
		END OF DRILLHOLE		16.34													
17																	
18																	
19																	
20																	
21																	
22																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GOLDER

RECORD OF BOREHOLE No 17-1113

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028164.4; E 376031.8 NAD 83 MTM ZONE 9 (LAT. 45.389797; LONG. -75.590301)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Portable Drill, BW Casing/Rotary Drill, BQ Rod

COMPILED BY ZS

DATUM Geodetic

DATE August 27-28, 2017

CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
66.9	GROUND SURFACE							
0.0	(SP) Sand, trace gravel, contains organic matter (FILL) Compact Brown to dark brown Moist to wet		1	SS	14			
			2	SS	22	▽		
65.4			3	SS	11			
1.5	(CL/ML) Sandy silty clay to clayey silt, trace gravel (FILL) Grey Moist		4	SS	7			
64.6								
2.3	(CI/CH) SILTY CLAY to CLAY, trace to some sand (WEATHERED CRUST) Very stiff Grey-brown Moist		5	SS	14			
			6	SS	6		CHEM	
63.2								
3.7	(CI/CH) SILTY CLAY to CLAY, trace sand Stiff to firm Grey Wet		7	SS	2			
61.4								
5.5	(ML) CLAYEY SILT, some sand Firm Grey Wet		8	SS	3			
60.8								
6.1	(ML/SP) SILT and SAND, some gravel and clay, contains cobbles and boulders (TILL) Very loose to loose Dark brown Wet		9	SS	7			
			10	SS	5			13 45 30 12
59.1			11	SS	50/0.15			
7.8	Shale (BEDROCK) Bedrock cored from depths of 7.8 m to 10.8 m For bedrock coring details refer to Record of Drillhole 17-1113		1	RC	REC 89%		UCS = 29.4 MPa	RQD = 80%
			2	RC	REC 99%			RQD = 91%

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 (%): 25 50 75

ELEVATION SCALE: 66 65 64 63 62 61 60 59 58 57

+ ³, × ³: Numbers refer to Sensitivity

○ ³% STRAIN AT FAILURE

Continued Next Page

GOLDER

RECORD OF BOREHOLE No 17-1113

SHEET 2 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00 LOCATION N 5028164.4; E 376031.8 NAD 83 MTM ZONE 9 (LAT. 45.389797; LONG. -75.590301) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Portable Drill, BW Casing/Rotary Drill, BQ Rod COMPILED BY ZS

DATUM Geodetic DATE August 27-28, 2017 CHECKED BY WAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%) 25 50 75		
56.1			2	RC	REC 99%						RQD = 91%
10.8	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 1.3 m below ground surface (Elev. 65.6), measured during drilling.										

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

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1113

SHEET 3 OF 3

LOCATION: N 5028164.4 ;E 376031.8

DRILLING DATE: August 27-28, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES	
		BEDROCK SURFACE		59.12														
8	Rotary Drill / BQ Rod	Shale (BEDROCK) Fresh Thinly to medium bedded Black to dark grey Fine grained Slightly porous Medium strong		7.77	1	100												UCS = 29.4 MPa
9																		
10					2	100												
				56.11														
		END OF DRILLHOLE		10.78														
11																		
12																		
13																		
14																		
15																		
16																		
17																		

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

RECORD OF BOREHOLE No 17-1114

SHEET 1 OF 3

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028179.8; E 376023.8 NAD 83 MTM ZONE 9 (LAT. 45.389935; LONG. -75.590399)

ORIGINATED BY DG

DIST Eastern HWY 417

BOREHOLE TYPE Portable Drill, NW-BW Casing/Rotary Drill, HW-BW Casing

COMPILED BY ZS

DATUM Geodetic

DATE August 29-30, 2017

CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
70.4	GROUND SURFACE										
0.0 / 0.2	(SM) Gravelly silty sand (TOPSOIL/FILL) Dark brown Moist		1	SS	17		70				
	(SP) Sand, trace to some gravel, trace silt (FILL) Compact to dense Brown Moist		2	SS	25				○		
			3	SS	42		69				
68.6 / 1.8	(SP) Gravelly sand, some silt (FILL) Compact to dense Brown Wet		4	SS	30				○		20 65 13 2
			5	SS	18		68				
67.1 / 3.4	(SP) Sand, some silt, trace clay (FILL) Compact to dense Grey-brown Moist		6	SS	48						
			7	SS	19		67				
			8	SS	47				○		0 80 16 4
65.5 / 4.9	(ML) Clayey silt, trace to some sand, contains organic matter (rootlets, wood) (FILL) Grey-brown Moist		9	SS	10						
			10	SS	11		65		○		0 11 50 39
64.2 / 6.3	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Very stiff Grey-brown Moist		11	SS	12		64				
			12	SS	12				⊢○⊣		
			13	SS	9		63				
62.5 / 7.9	(CL/CH) SILTY CLAY to CLAY Stiff to firm Grey Moist to wet							× +			
			14	SS	3		62	× +	⊢○		
60.7 / 9.8							61	× +			

Continued Next Page

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

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

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1114

SHEET 2 OF 3

METRIC

G.W.P. 4145-10-00 LOCATION N 5028179.8; E 376023.8 NAD 83 MTM ZONE 9 (LAT. 45.389935; LONG. -75.590399) ORIGINATED BY DG

DIST Eastern HWY 417 BOREHOLE TYPE Portable Drill, NW-BW Casing/Rotary Drill, HW-BW Casing COMPILED BY ZS

DATUM Geodetic DATE August 29-30, 2017 CHECKED BY WAM

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	25 50 75		
60.3 / 10.1	(ML) CLAYEY SILT Firm Dark grey Wet		15	SS	3						
	(SM) Silty SAND, some gravel and clay, contains cobbles and boulders (TILL) Very loose to loose Dark grey Wet		16	SS	6		60				19 42 27 12
			17	SS	2		59			CHEM	
58.4			18	SS	8						
12.0	Shale (BEDROCK) Bedrock cored from depths of 12.0 m to 15.3 m For bedrock coring details refer to Record of Drillhole 17-1114		1	RC	REC 100%		58				RQD = 86%
			2	RC	REC 100%		57				RQD = 70%
			3	RC	REC 100%		56				RQD = 57%
55.1											
15.3	END OF BOREHOLE										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1114

SHEET 3 OF 3

LOCATION: N 5028179.8 ;E 376023.8

DRILLING DATE: August 29-30, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: CCC

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATHERING INDEX	FEATURES
		BEDROCK SURFACE		58.48													
12	Rotary Drill / HW-BW Casing	Shale (BEDROCK) Slightly weathered Thinly to medium bedded Dark grey to black Fine grained Porous Medium strong		11.96	1	100											
13					2	100											
14					3	100-0											
15				55.17													
		END OF DRILLHOLE		15.27													
16																	
17																	
18																	
19																	
20																	
21																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

RECORD OF BOREHOLE No 17-1115

SHEET 1 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028195.6; E 376020.9 NAD 83 MTM ZONE 9 (LAT. 45.390079; LONG. -75.590435)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE June 28 - July 4, 2017

CHECKED BY WAM

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 (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Grey Moist		1	SS	57						
75.3											
0.6	(SP) Sand, some silt, trace gravel and clay (FILL) Compact to very dense Moist		2	SS	28		75		○		
			3	SS	17		74				
			4	SS	11		73				
			5	SS	16				○		
			6	SS	41		72				
			7	SS	22		71				
			8	SS	32				○		5 76 15 4
			9	SS	49		70			CHEM	
			10	SS	54		69		○		
			11	SS	38		68				
67.7											
8.2	(SP/SM) Sand, some silt to silty sand, contains silty clay layers (FILL) Compact to dense Brown Moist		12	SS	27		67				
			13	SS	49				○		
							66				

Continued Next Page

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

$○^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1115

SHEET 2 OF 4

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028195.6; E 376020.9 NAD 83 MTM ZONE 9 (LAT. 45.390079; LONG. -75.590435)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core

COMPILED BY ZS

DATUM Geodetic

DATE June 28 - July 4, 2017

CHECKED BY WAM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---								
65.5			14	SS	20				
10.5	(ML) Sandy SILT, contains organic matter (rootlets) Compact Grey Moist								
	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		15	SS	14		65		0 5 49 46
			16	SS	8		64		
63.4			17	SS	1				
12.5	(CI/CH) SILTY CLAY to CLAY, trace sand Stiff Grey Moist to wet						63		
			18	SS	WH		62		
60.7									
15.2	(CI/CH-ML) SILTY CLAY to CLAYEY SILT, contains silty sand seams Firm Grey Wet		19	SS	1		61		
59.9									
16.0	(ML/SP) SILT and SAND, some gravel and clay, contains cobbles and boulders (TILL) Very loose to compact Dark brown to black Wet		20	SS	WH		60		
			21	SS	WH		59		16 41 31 12
			22	SS	18		58		
57.8									
18.1	Shale (BEDROCK) Bedrock cored from depths 18.1 m to 21.7 m For bedrock coring details refer to Record of Drillhole 17-1115		1	RC	REC 100%				RQD = 74%
			2	RC	REC 100%		57		RQD = 100%
			3	RC	REC 97%				RQD = 88%
							56		

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 (%): 25 50 75

Continued Next Page

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

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

GOLDER

PROJECT 1662565-1110

RECORD OF BOREHOLE No 17-1115

SHEET 3 OF 4

METRIC

G.W.P. 4145-10-00 LOCATION N 5028195.6; E 376020.9 NAD 83 MTM ZONE 9 (LAT. 45.390079; LONG. -75.590435) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core COMPILED BY ZS

DATUM Geodetic DATE June 28 - July 4, 2017 CHECKED BY WAM

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) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 25 50 75	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Shale (BEDROCK) Bedrock cored from depths 18.1 m to 21.7 m For bedrock coring details refer to Record of Drillhole 17-1115		3	RC	REC 97%						RQD = 88%
			4	RC	REC 96%		55				RQD = 83%
54.2 21.7	END OF BOREHOLE NOTES: 1. Water level in well screen at a depth of 10.3 m below ground surface (Elev. 65.6 m), measured on Sept. 25, 2017.										

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

PROJECT: 1662565-1110

RECORD OF DRILLHOLE: 17-1115

SHEET 4 OF 4

LOCATION: N 5028195.6 ;E 376020.9

DRILLING DATE: June 28 - July 4, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75

DRILLING CONTRACTOR: Grenville Drilling

NOTE:
For abbreviations, symbols and descriptions refer to
LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WEATHERING INDEX (W1 W2 W3 W4 W5 W6)	FEATURES
		BEDROCK SURFACE		57.80													
19	Rotary Drill / NQ Core	Shale (BEDROCK) Slightly weathered to fresh Thinly to medium bedded Black to dark grey Fine grained Porous Medium strong		18.14	1	100											
					2	0											
20					3	0											
21					4	0											
				54.23													
		END OF DRILLHOLE		21.71													
22																	
23																	
24																	
25																	
26																	
27																	
28																	

DEPTH SCALE
1 : 50

GOLDER

LOGGED: RI
CHECKED: WAM

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-MISS.GDT 9/16/19 ZS

GOLDER

RECORD OF BOREHOLE No 17-1116

SHEET 1 OF 2

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00

LOCATION N 5028207.2; E 376015.1 NAD 83 MTM ZONE 9 (LAT. 45.390183; LONG. -75.590507)

ORIGINATED BY RI

DIST Eastern HWY 417

BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)

COMPILED BY ZS

DATUM Geodetic

DATE July 4-5, 2017

CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
75.9	GROUND SURFACE										
0.0	ASPHALTIC CONCRETE										
0.2	(SP) Gravelly sand (FILL) Dense Grey Moist		1	SS	40						
75.2											
0.7	(SP) Sand, trace gravel (FILL) Compact Brown Moist		2	SS	29		75				
74.4											
1.5	(SP/GP) Sand, some gravel, some silt (FILL) Dense to compact Grey Moist		3	SS	35		74				
			4	SS	37				○		55 30 12 3
72.6							73				
3.4	(SP) Sand, some gravel and silt (FILL) Compact to very dense Brown Moist		5	SS	24						
			6	SS	27		72				
			7	SS	28		71		○		
			8	SS	52						
			9	SS	74		70				
			10	SS	58		69		○		19 61 17 3
			11	SS	32						
67.7							68				
8.2	(SM) Silty sand, trace to some gravel, contains silty clay layers (FILL) Compact to very dense Brown Moist		12	SS	28						
			13	SS	53		67		○		
66.1											
9.8							66				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No 17-1116

SHEET 2 OF 2

METRIC

PROJECT 1662565-1110

G.W.P. 4145-10-00 LOCATION N 5028207.2; E 376015.1 NAD 83 MTM ZONE 9 (LAT. 45.390183; LONG. -75.590507) ORIGINATED BY RI

DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY ZS

DATUM Geodetic DATE July 4-5, 2017 CHECKED BY WAM

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 (%) (25 50 75)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
65.7 / 10.2	(SP) Sand, trace silt (FILL) Compact Grey-brown Wet		14	SS	26						
65.2 / 10.7	(ML) Sandy silt (FILL) Compact Grey Moist		15	SS	13		65				
	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Very stiff Grey-brown Moist		16	SS	6		64				
63.4 / 12.5	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Moist to wet		17	SS	4		63				
			18	TP	PH		62			17.1	
60.7 / 15.2	(CL) SILTY CLAY, trace sand Firm Grey Wet		19	SS	3		61				
60.4 / 15.8	(ML) Sandy SILT, trace gravel Dark grey Wet										
60.1	(ML/SP) SILT and SAND, some gravel and clay, contains cobbles and boulders (TILL) Very loose Dark brown to black Wet		20	SS	WH		60				16 41 31 12
			21	SS	2		59				
			22	SS	50/0.13		58				
57.7 / 18.2	END OF BOREHOLE AUGER REFUSAL										

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

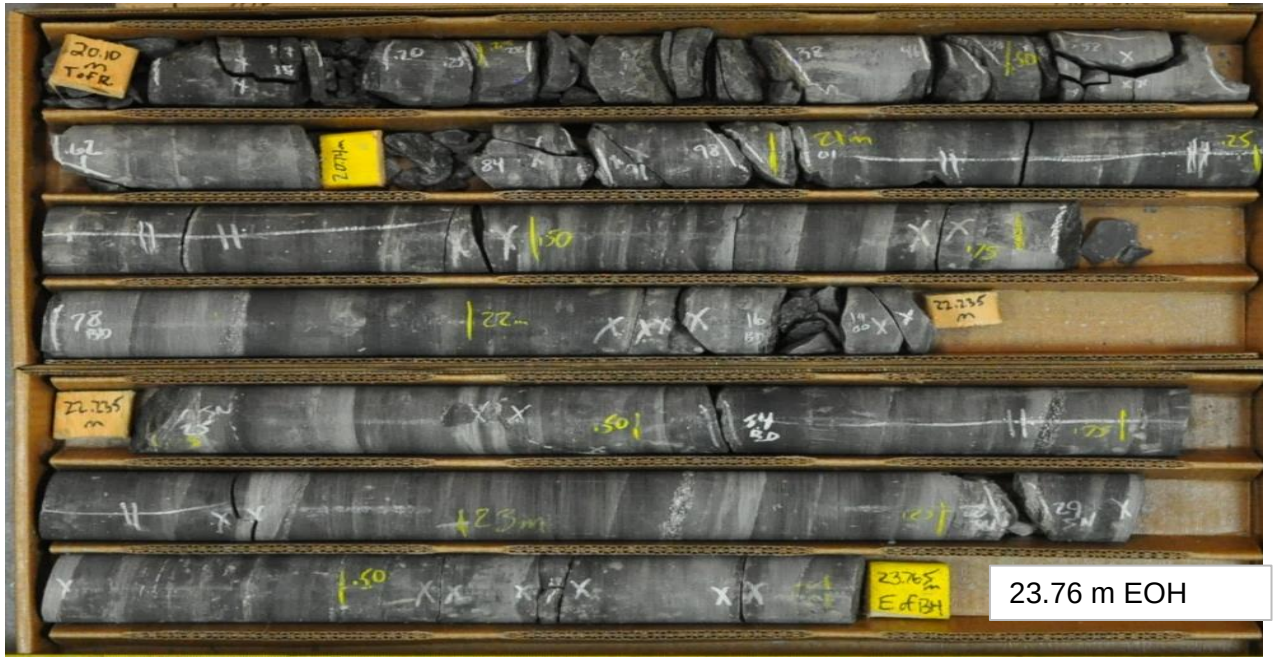
GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 9/16/19 ZS

BH 17-1102 (Dry)

Cored Length of 20.10 to 23.76 metres

Core Box 1 and 2 of 2

20.10 m Top of Bedrock



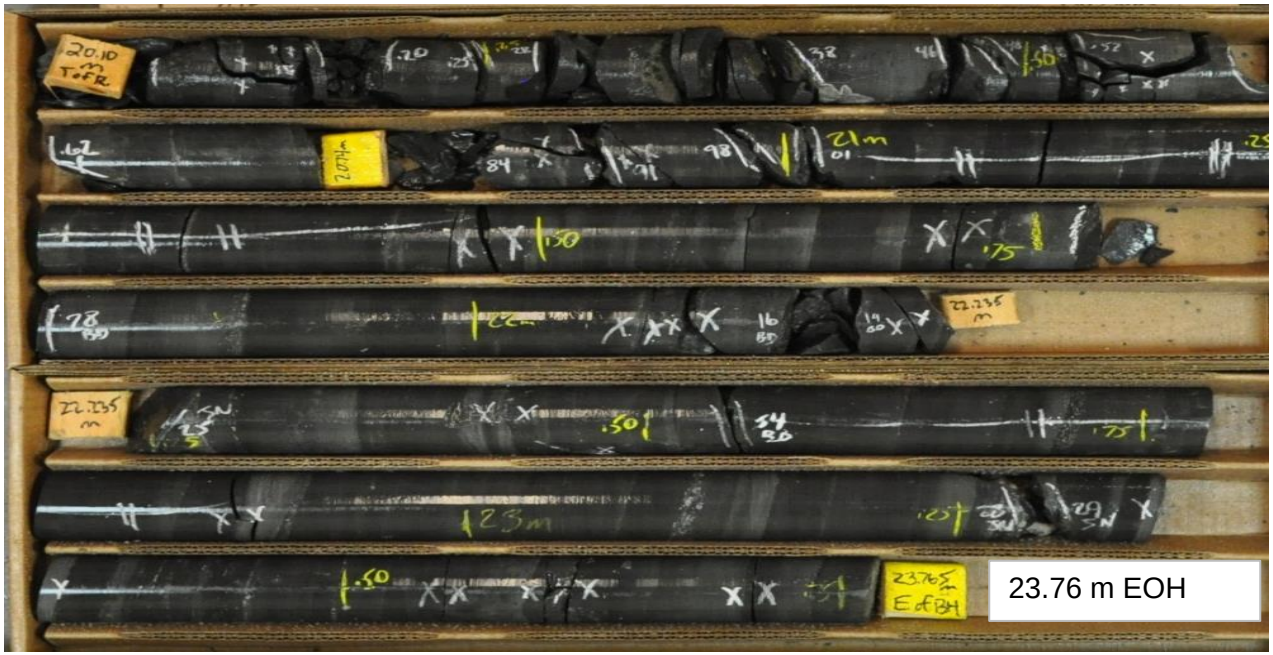
GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A1**

BH 17-1102 (Wet)

Cored Length of 20.10 to 23.76 metres

Core Box 1 and 2 of 2

20.10 m Top of Bedrock



23.76 m EOH

GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A2**

BH 17-1103 (Dry)

Cored Length of 12.55 to 17.07 metres

Core Box 1 and 2 of 2

12.55 m

13.63 m Top of Bedrock

Note: Material in core box from 12.55 to 13.63 is gravel and cobbles in Till.

GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A3**

BH 17-1103 (Wet)

Cored Length of 12.55 to 17.07 metres

Core Box 1 and 2 of 2

12.55 m

13.63 m Top of Bedrock

17.07 m EOH

Note: Material in core box from 12.55 to 13.63 is gravel and cobbles in Till.

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

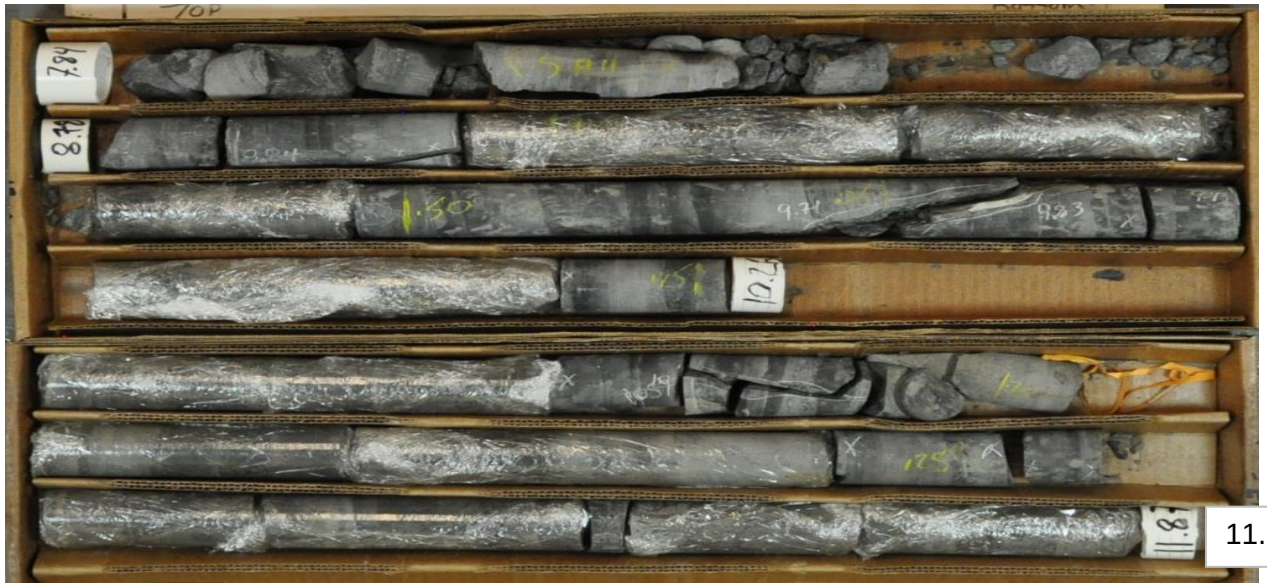
Figure A4

BH 17-1104 (Dry)

Cored Length of 8.78 to 11.87 metres

Core Box 1 and 2 of 2

8.78 m Top of Bedrock



11.87 m EOH

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A5

BH 17-1104 (Wet)

Cored Length of 8.78 to 11.87 metres

Core Box 1 and 2 of 2

8.78 m Top of Bedrock

11.87 m EOH

GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A6**

BH 17-1106 (Dry)

Cored Length of 11.25 to 12.79 metres

Core Box 1 of 1

11.25 m Top of Bedrock

12.79 m EOH

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

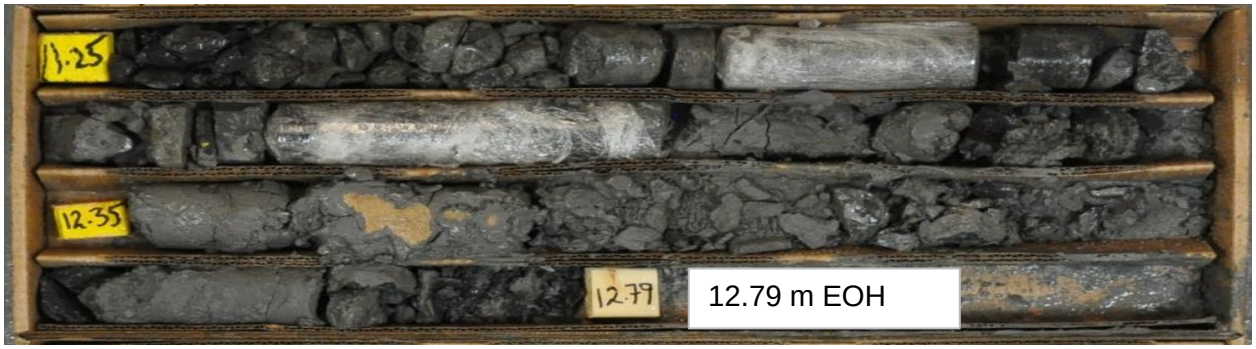
Figure A7

BH 17-1106 (Wet)

Cored Length of 11.25 to 12.79 metres

Core Box 1 of 1

11.25 m Top of Bedrock



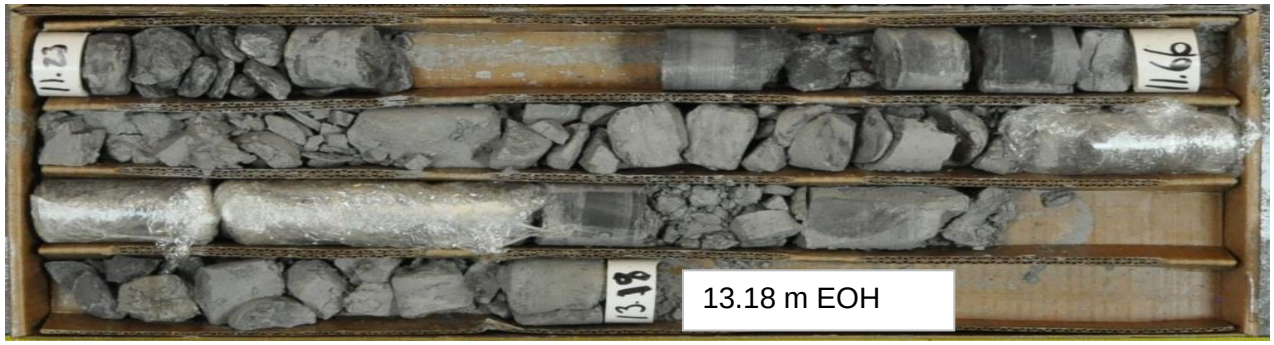
GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A8**

BH 17-1106A (Dry)

Cored Length of 11.23 to 13.18 metres

Core Box 1 of 1

11.23 m Top of Bedrock



GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

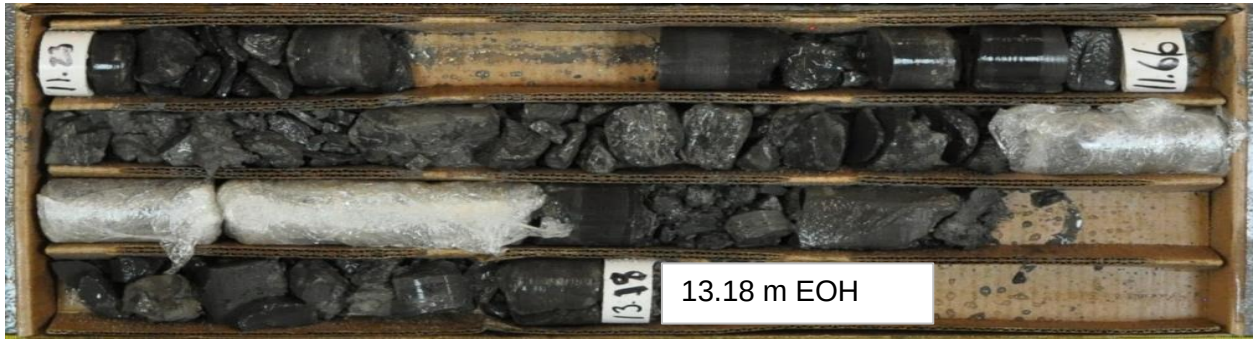
Figure A9

BH 17-1106A (Wet)

Cored Length of 11.23 to 13.18 metres

Core Box 1 of 1

11.23 m Top of Bedrock



GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A10**

BH 17-1107 (Dry)

Cored Length of 16.15 to 19.20 metres

Core Box 1 of 1

16.15 m Top of Bedrock

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A11

BH 17-1107 (Wet)

Cored Length of 16.15 to 19.20 metres

Core Box 1 of 1

16.15 m Top of Bedrock

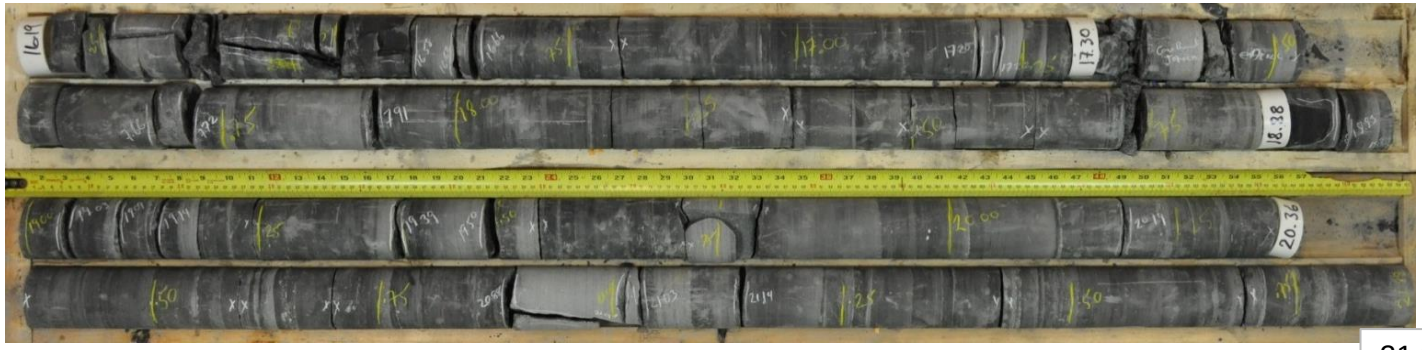
GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A12**

BH 17-1110 (Dry)

Cored Length of 16.19 to 21.88 metres

Core Box 1 and 2 of 2

16.19 m Top of Bedrock



21.88 m EOH

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A13

BH 17-1110 (Wet)

Cored Length of 16.19 to 21.88 metres

Core Box 1 and 2 of 2

16.19 m Top of Bedrock

21.88 m EOH

GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A14**

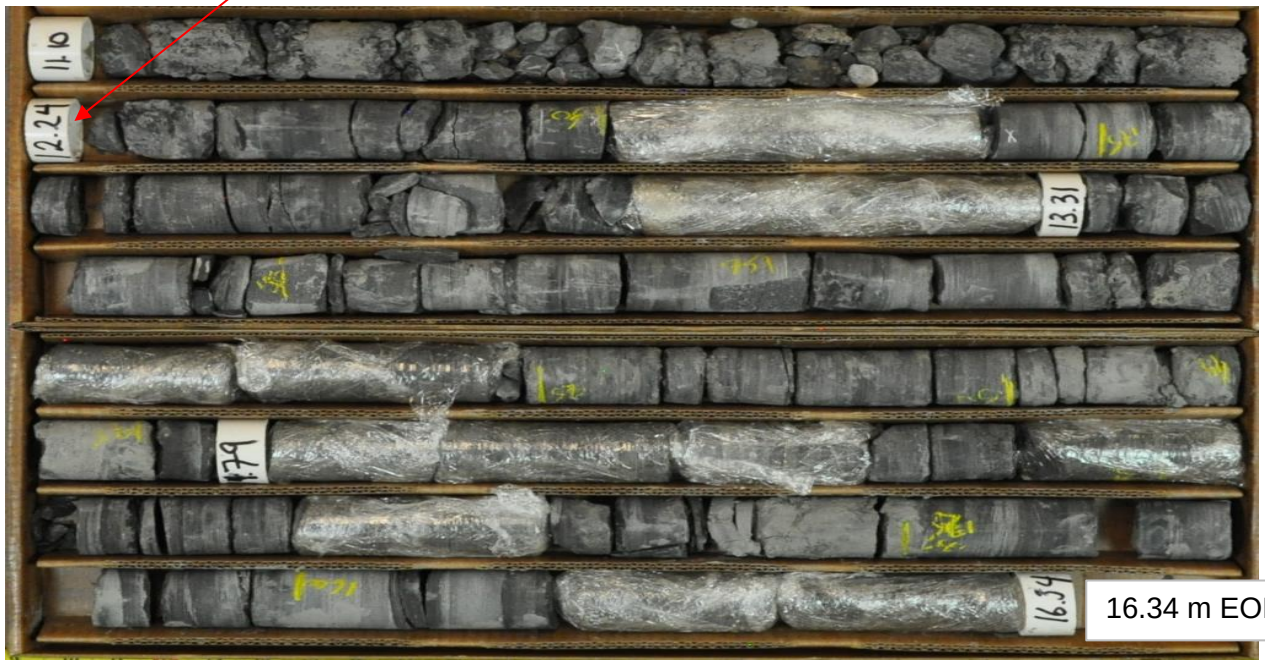
BH 17-1111 (Dry)

Cored Length of 11.10 to 16.34 metres

Core Box 1 and 2 of 2

11.10 m

12.24 m Top of Bedrock



16.34 m EOH

Note: Material in core box from 11.10 to 12.24 is gravel and cobbles in Till.

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A15

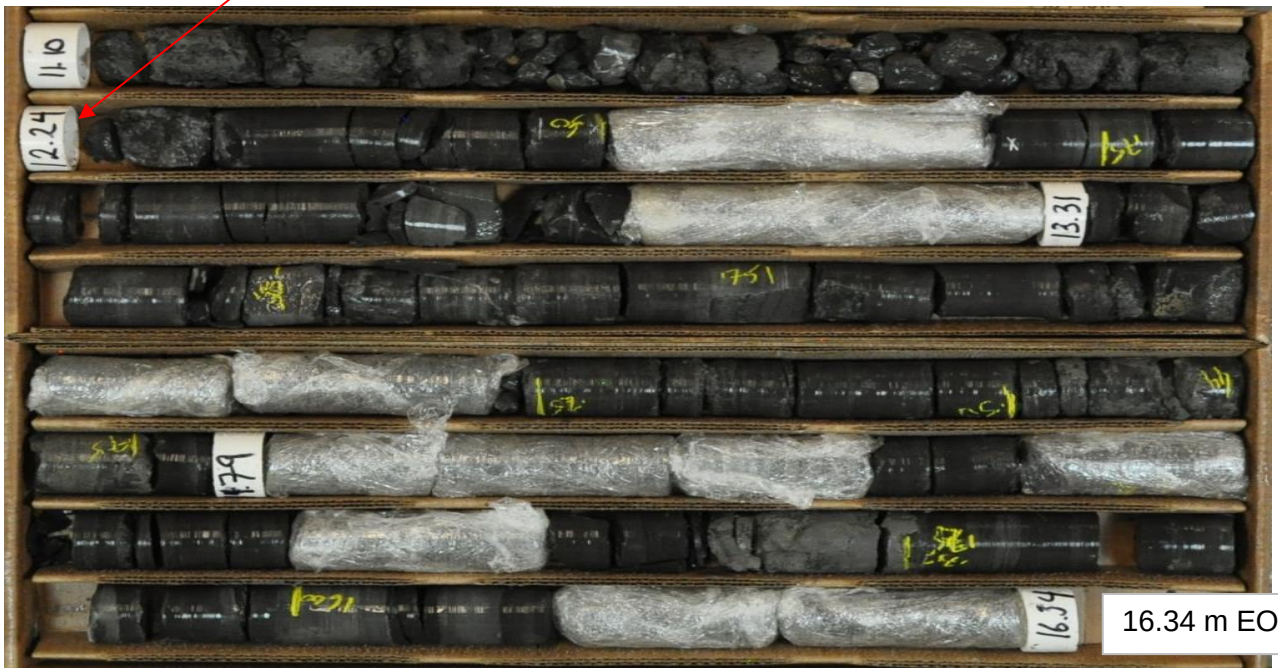
BH 17-1111 (Wet)

Cored Length of 11.10 to 16.34 metres

Core Box 1 and 2 of 2

11.10 m

12.24 m Top of Bedrock



16.34 m EOH

Note: Material in core box from 11.10 to 12.24 is gravel and cobbles in Till.

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

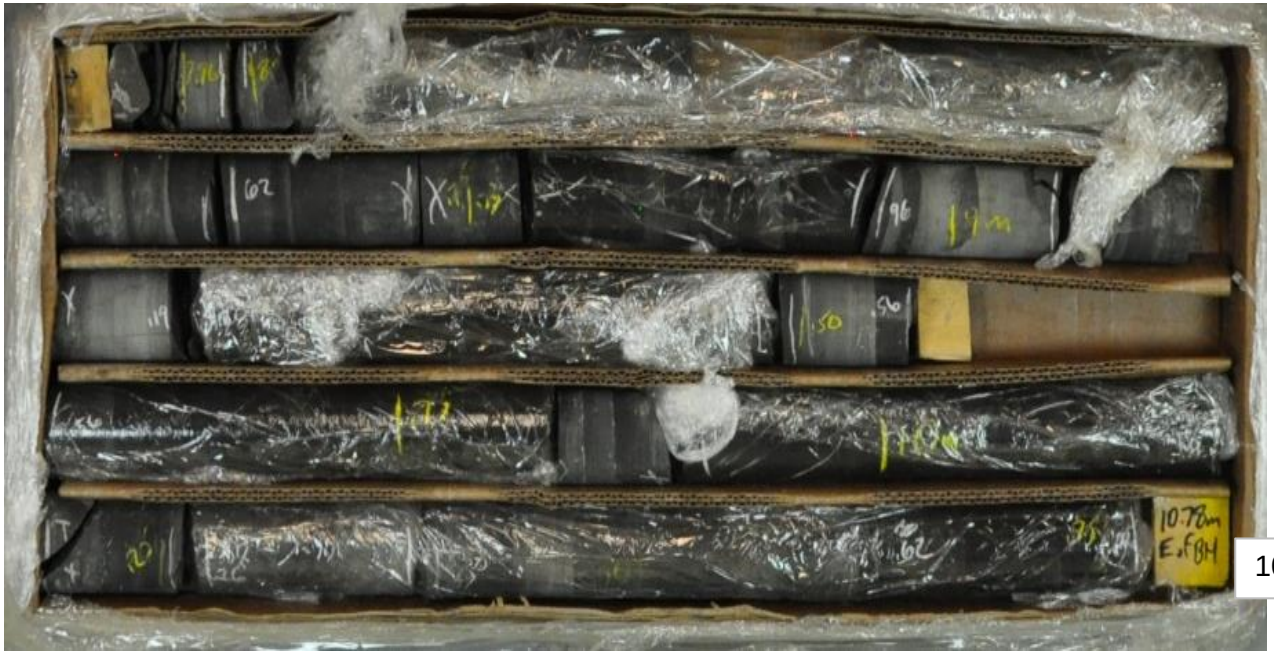
Figure A17

BH 17-1113 (Dry)

Cored Length of 7.77 to 10.78 metres

Core Box 1 of 1

7.77 m Top of Bedrock



10.78 m EOH

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A17

BH 17-1113 (Wet)

Cored Length of 7.77 to 10.78 metres

Core Box 1 of 1

7.77 m Top of Bedrock

10.78 m EOH

GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

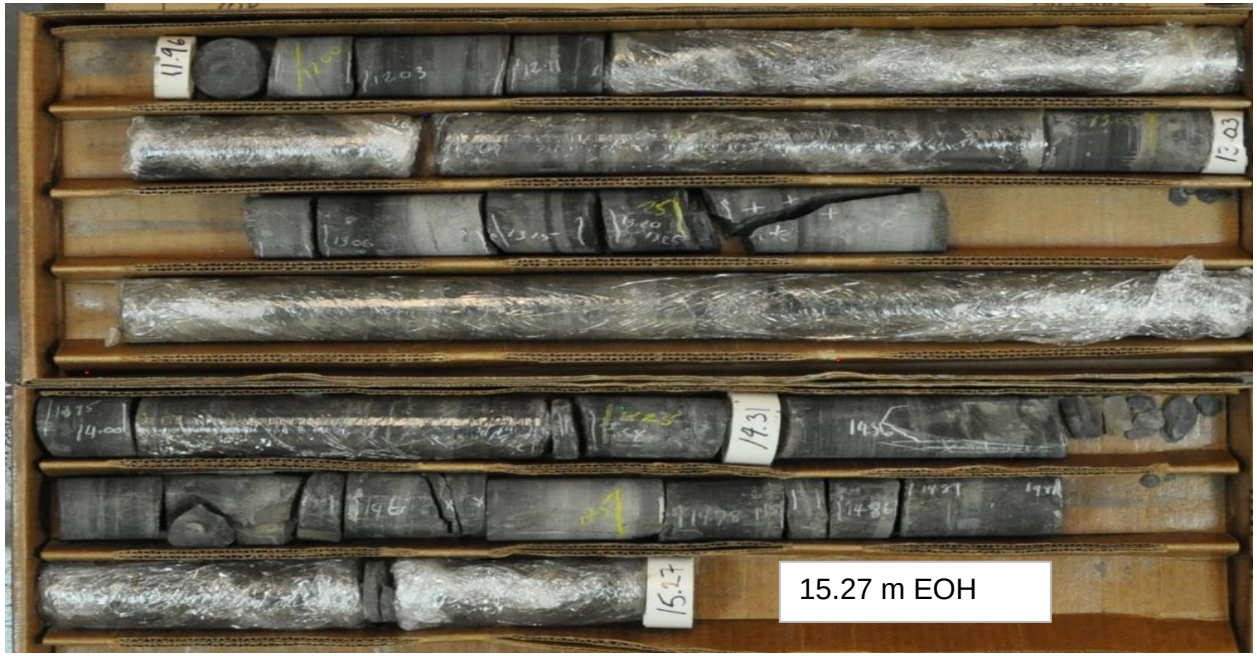
Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

Figure A18

BH 17-1114 (Dry)

Cored Length of 11.96 to 15.27 metres

Core Box 1 and 2 of 2



GOLDER

Foundation Investigation

CNR Overhead

Ottawa, Ontario

Project No.	1662565 / 1110
Drawn:	KS
Date:	2017-09-01
Checked:	SAT
Review:	FJH

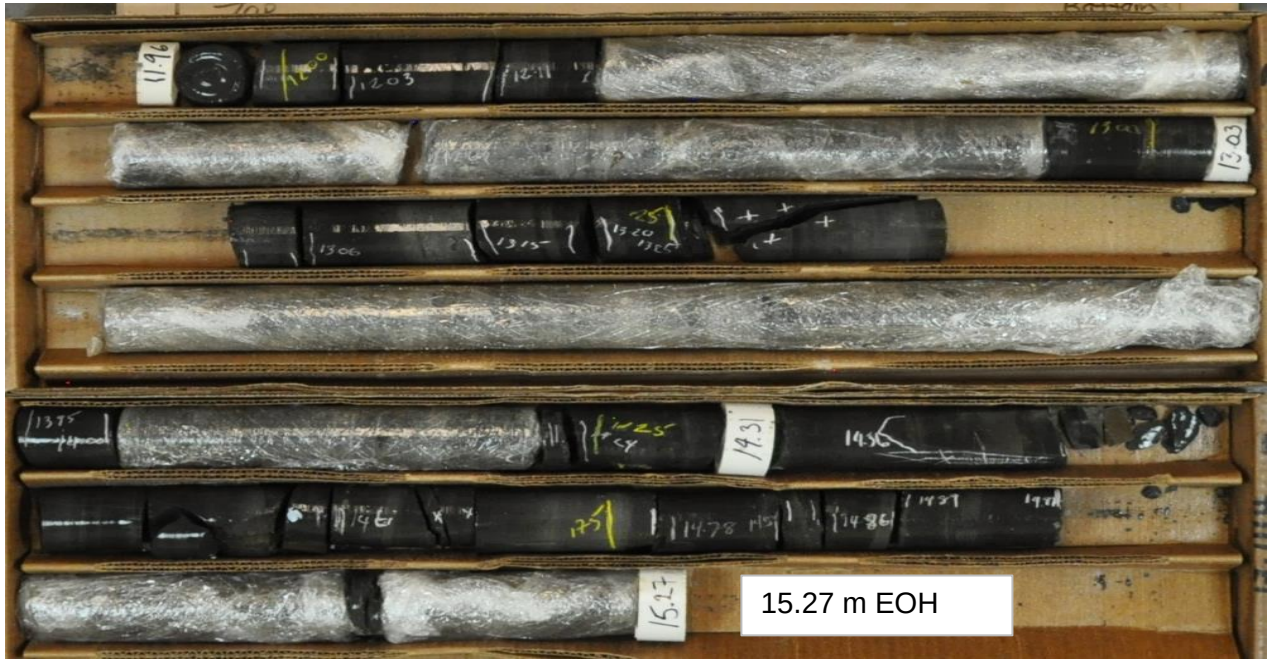
Figure A19

BH 17-1114 (Wet)

Cored Length of 11.96 to 15.27 metres

Core Box 1 and 2 of 2

11.96 m Top of Bedrock



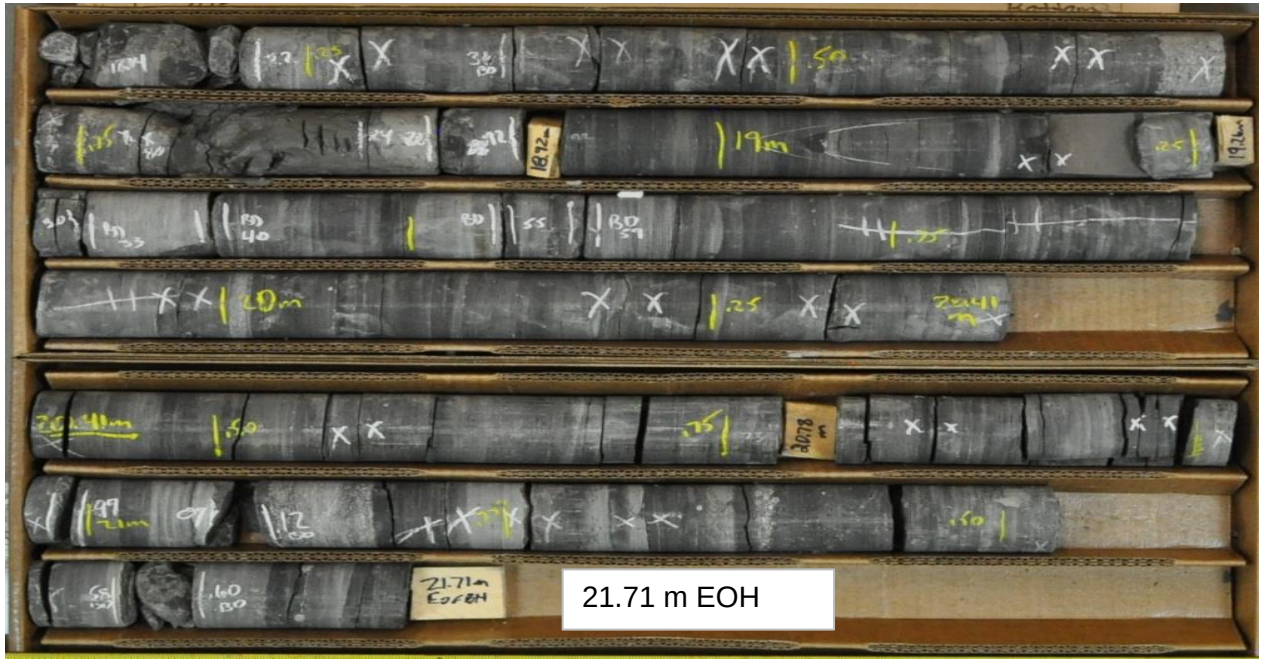
GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A20**

BH 17-1115 (Dry)

Cored Length of 18.14 to 21.71 metres

Core Box 1 and 2 of 2

18.14 m Top of Bedrock



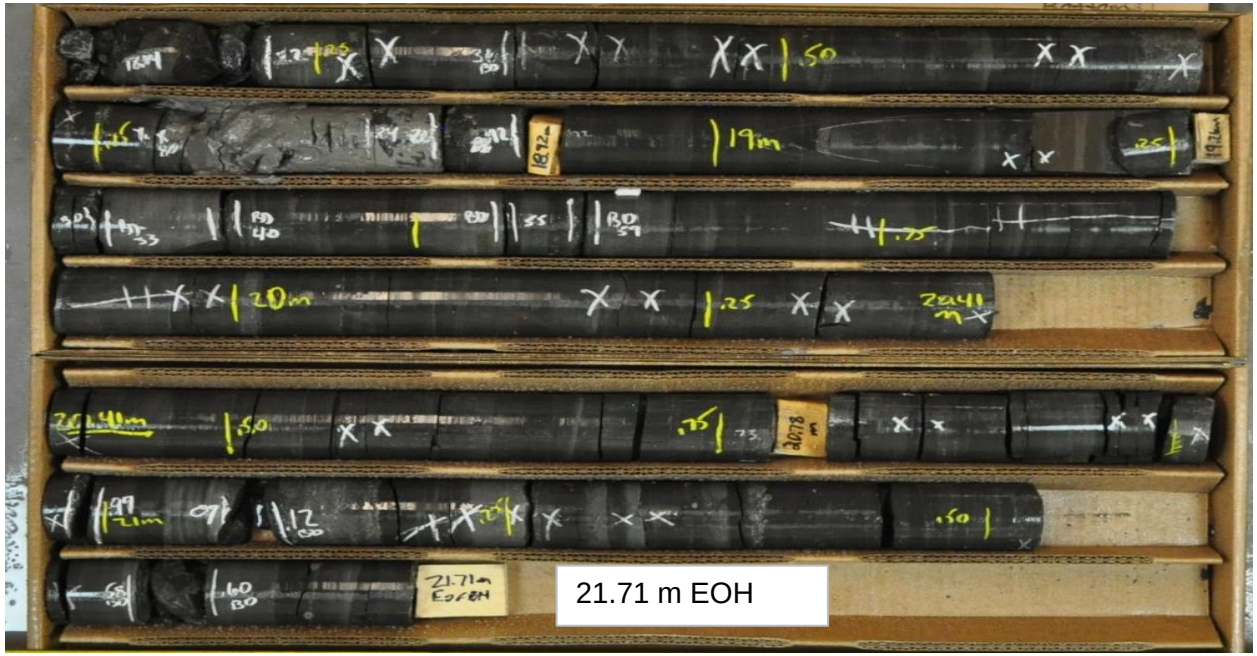
GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A21**

BH 17-1115 (Wet)

Cored Length of 18.14 to 21.71 metres

Core Box 1 and 2 of 2

18.14 m Top of Bedrock



GOLDER	**Foundation Investigation** **CNR Overhead** **Ottawa, Ontario**	Project No. 1662565 / 1110 Drawn: KS Date: 2017-09-01 Checked: SAT Review: FJH	**Figure A22**

APPENDIX B

Laboratory Test Results, Current Investigation

Figures B1a & B1b – Grain Size Distribution Test Results – Fill

Figure B2 – Plasticity Chart – Weathered Silty Clay to Clay

Figure B3 – Grain Size Distribution Test Results – Weathered Silty Clay to Clay

Figure B4 – Plasticity Chart – Unweathered Silty Clay to Clay

Figure B5 – Grain Size Distribution Test Results – Unweathered Silty Clay to Clay

Figures B6 & B7 – Consolidation Test Results

Figure B8 – Plasticity Chart – Silt and Sand, Silty Sand, and Clayey Silt Till

Figure B9a – Grain Size Distribution Test Results –Silty Sand, Sandy Silt, Sand and Gravel, and Clayey Silt Till

Figure B9b – Grain Size Distribution Test Results – Silt and Sand to Silty Sand Till

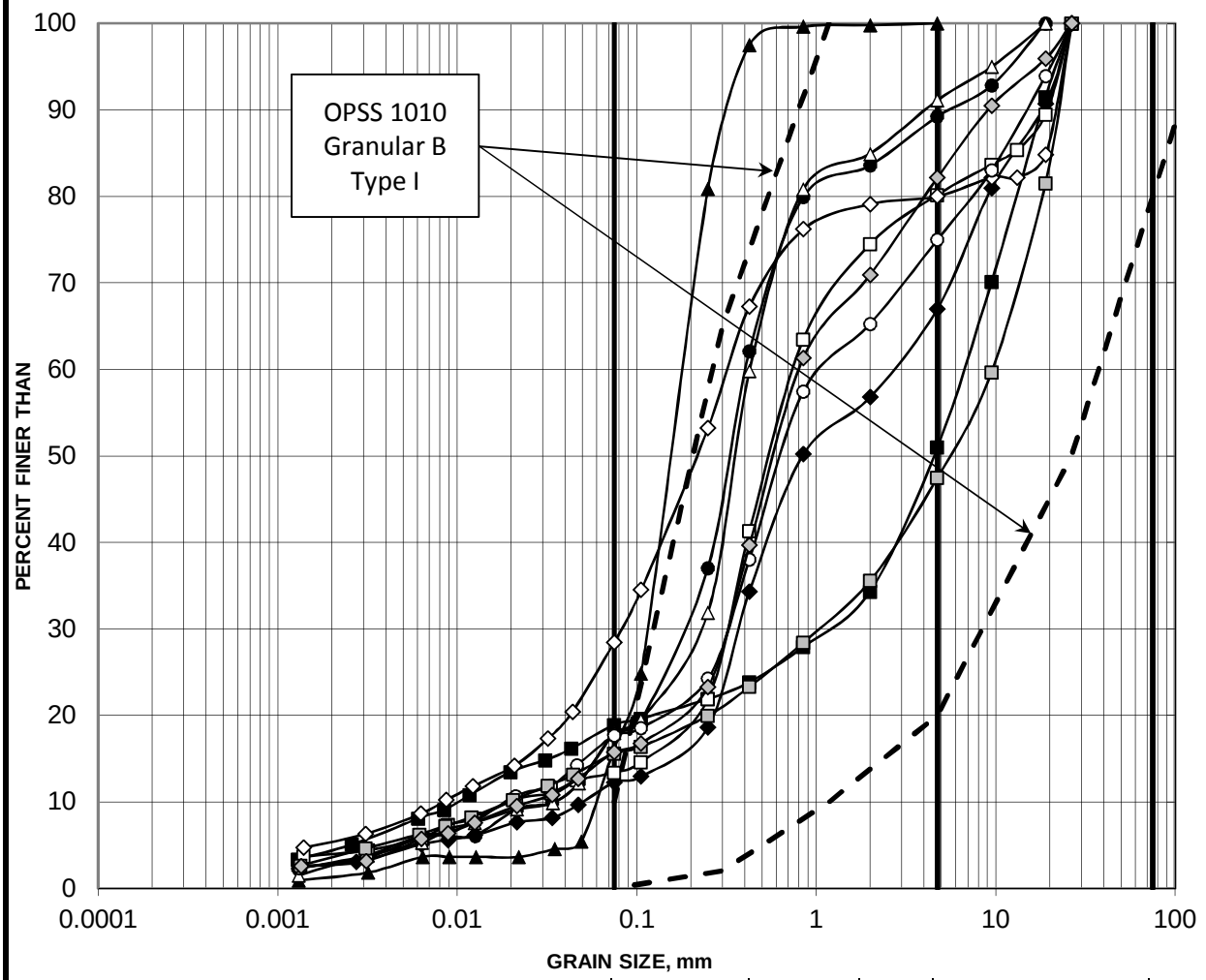
Figure B10 – Summary of Laboratory Compressive Strength Testing – Unconfined Compression Tests

Figure B11 – Summary of Engineering Properties

GRAIN SIZE DISTRIBUTION

FIGURE B1a

FILL



Borehole	Sample	Depth (m)
17-1101	4	2.29-2.90
17-1101	8	5.33-5.94
17-1101	12	8.38-8.99
17-1102	6	3.81-4.42
17-1103	3	1.22-1.83
17-1106	5A	3.81-4.27
17-1107	6	3.81-4.42
17-1107	11	7.62-8.23
17-1108	4	2.29-2.90
17-1108	9	6.10-6.71

Project: 1662565 /1110

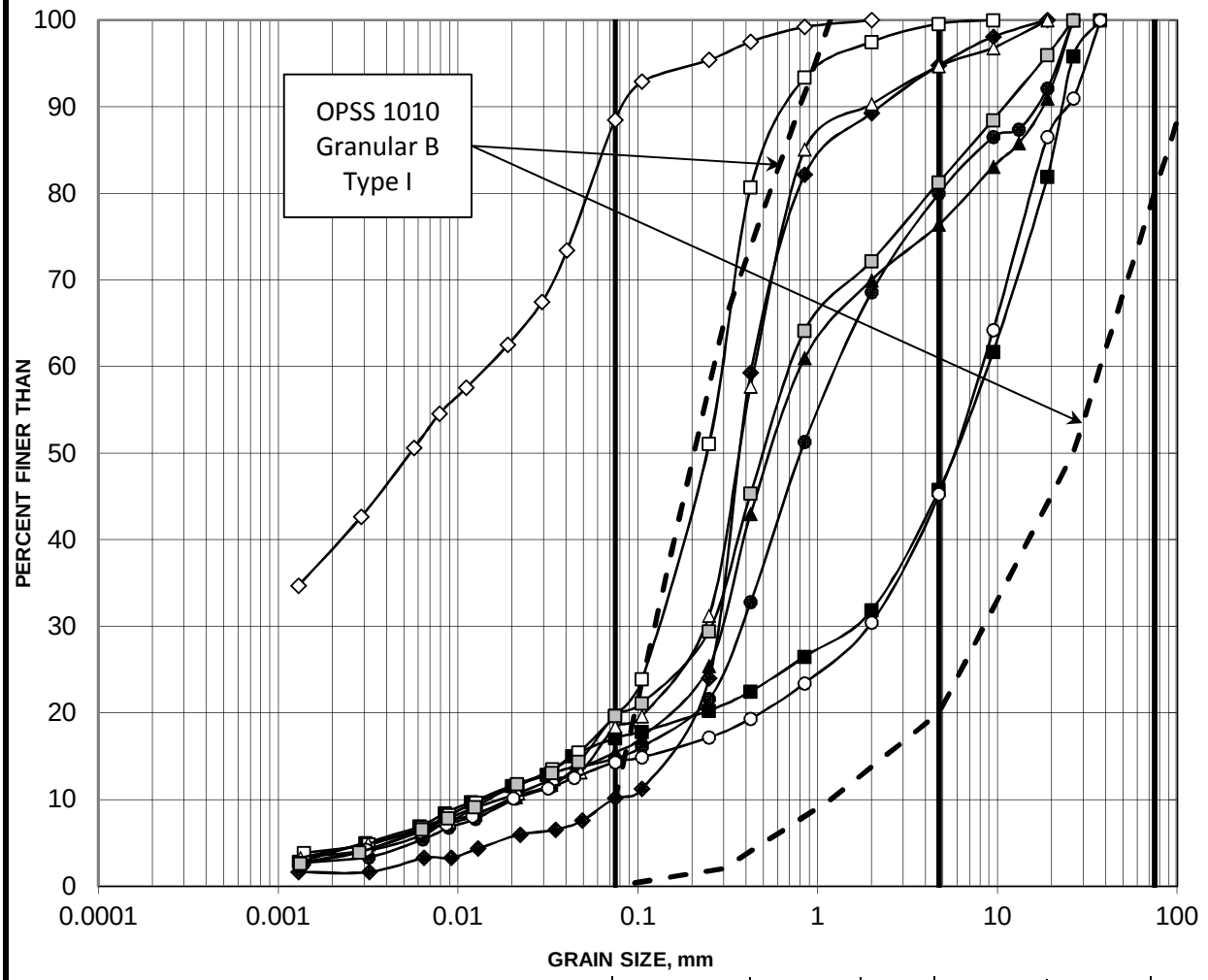
Golder Associates

Created by: CNM
Checked by: MI

GRAIN SIZE DISTRIBUTION

FIGURE B1b

FILL



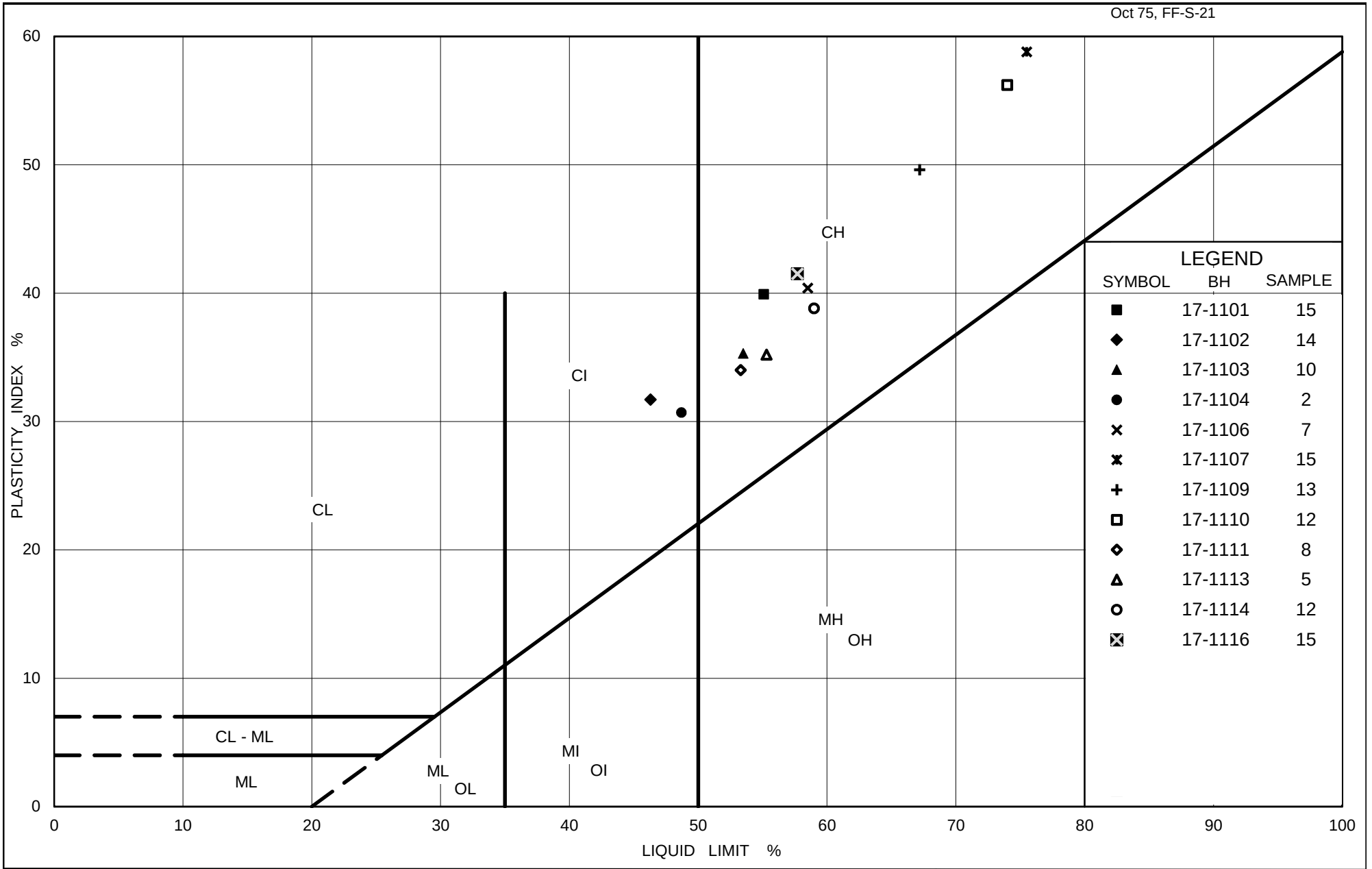
Borehole	Sample	Depth (m)
17-1109	3	1.52-2.13
17-1110	7	4.57-5.18
17-1111	2	1.52-2.13
17-1114	4	1.83-2.44
17-1114	8	4.27-4.88
17-1114	10	5.49-6.10
17-1115	8	5.33-5.94
17-1116	4	2.29-2.90
17-1116	10	6.86-7.47

Project: 1662565 /1110

Golder Associates

Created by: CNM

Checked by: MI



Ministry of Transportation

Ontario

PLASTICITY CHART
WEATHERED SILTY CLAY to CLAY

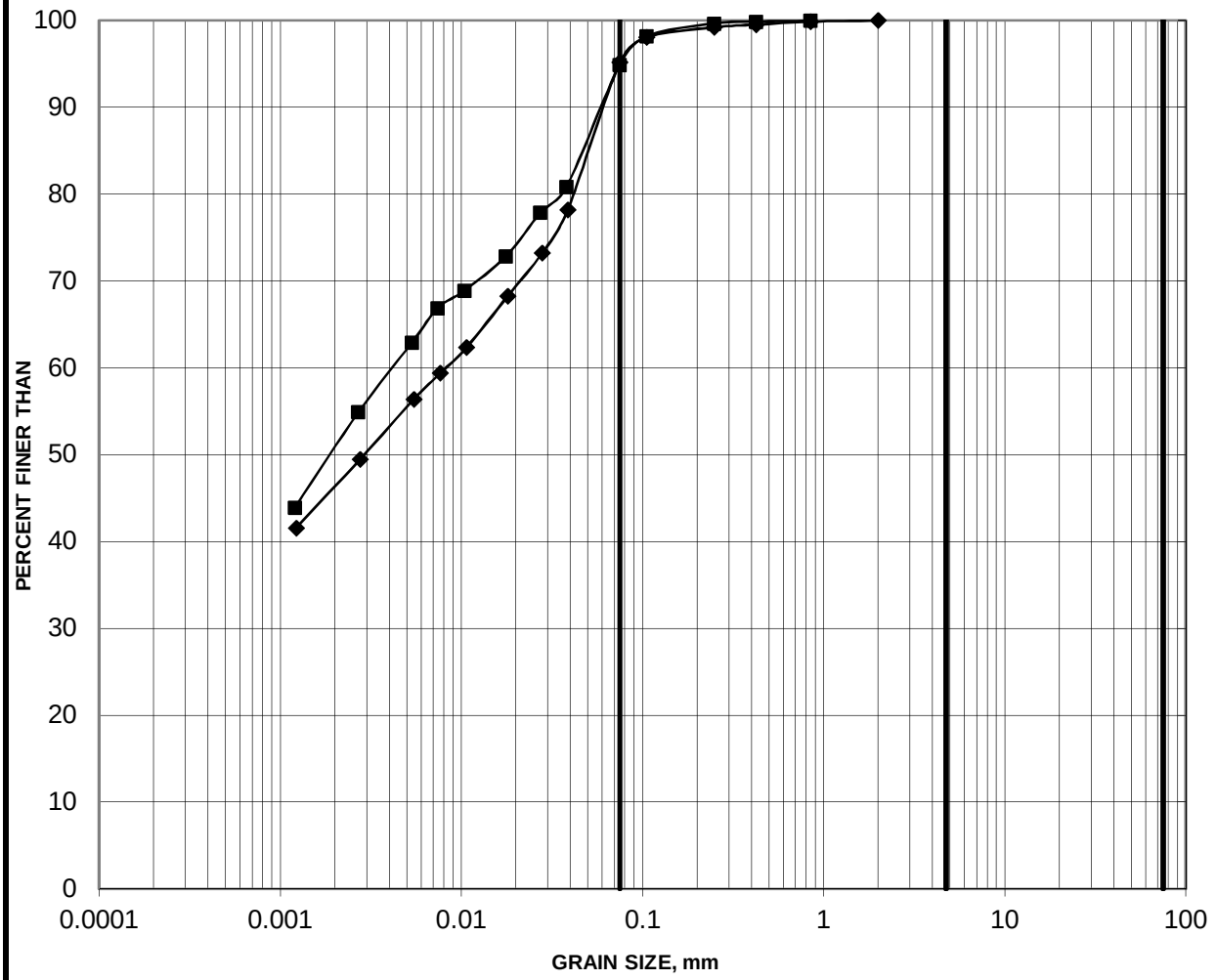
FIG No. B2

Project No. 1662565 /1110

Compiled By : CNM Checked By : AC

GRAIN SIZE DISTRIBUTION	FIGURE B3

WEATHERED SILTY CLAY to CLAY



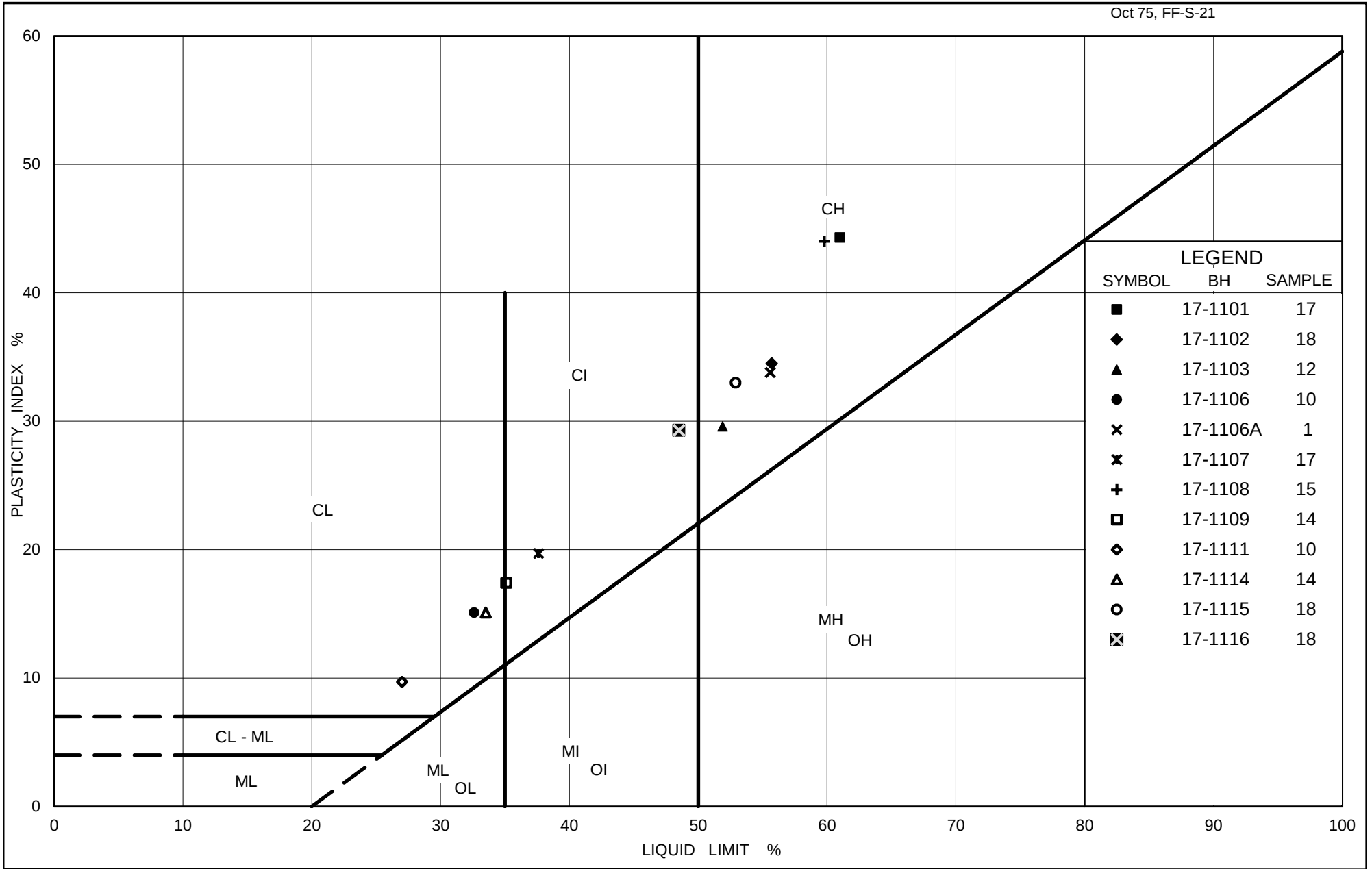
Borehole	Sample	Depth (m)
17-1108	13	10.67-11.28
17-1115	15	10.67-11.28

Project: 1662565 /1110

Golder Associates

Created by: CNM
Checked by: AC

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
UNWEATHERED SILTY CLAY to CLAY

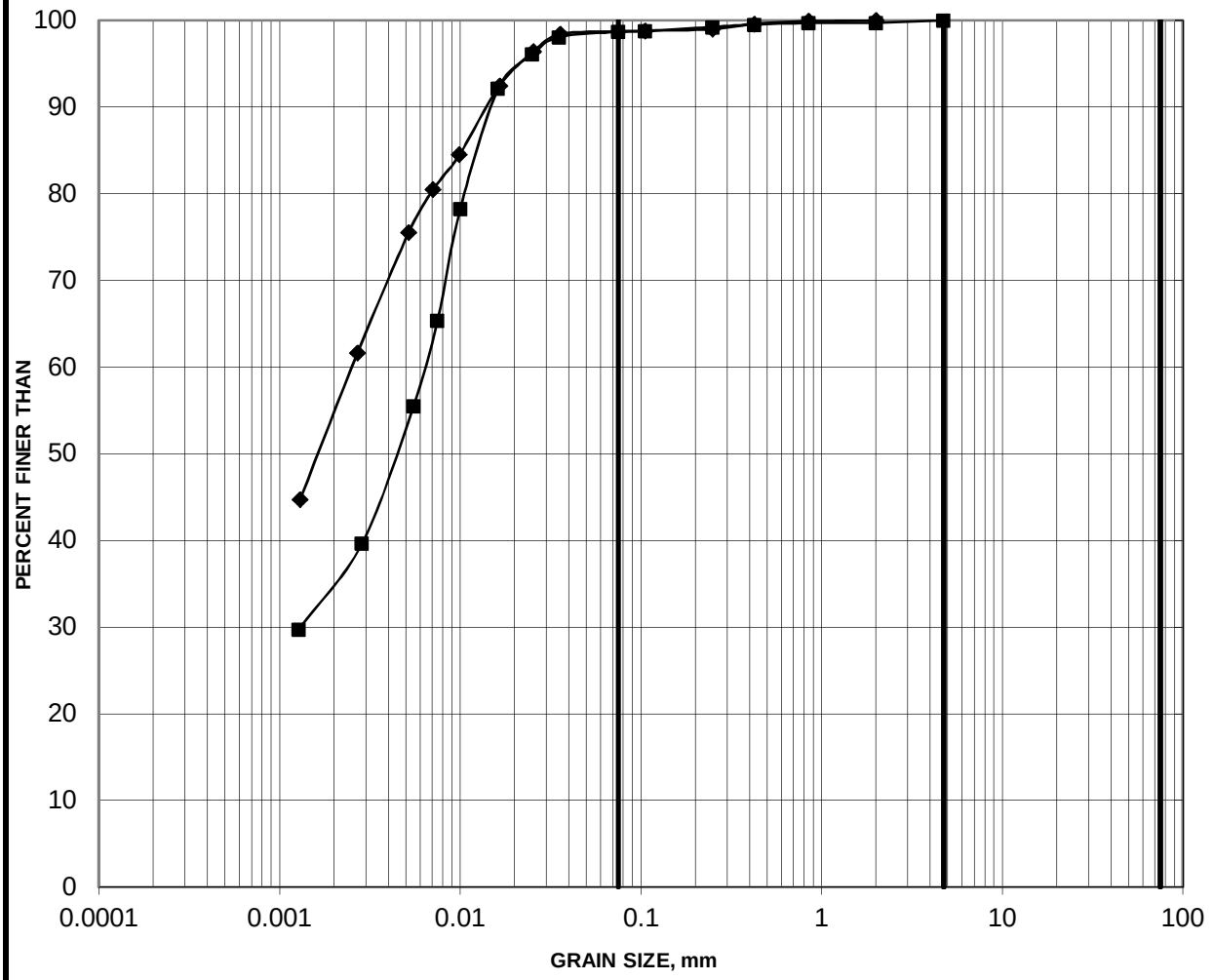
FIG No. B4

Project No. 1662565 /1110

Compiled By : CNM Checked By : AC

GRAIN SIZE DISTRIBUTION	FIGURE B5

UNWEATHERED SILTY CLAY to CLAY

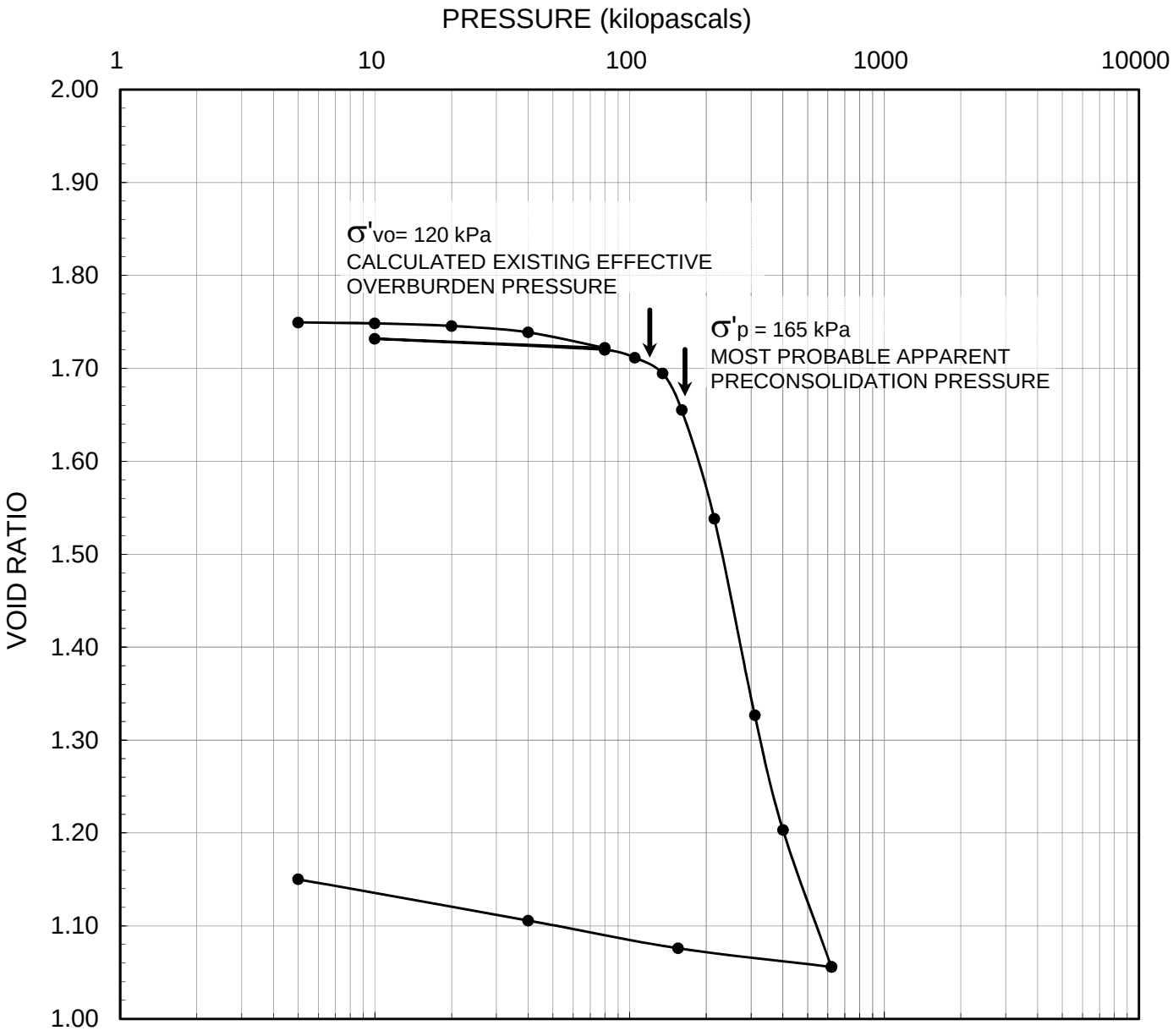


Borehole	Sample	Depth (m)
17-1102	19	15.24-15.85
17-1104	6	3.66-4.27

Project: 1662565 /1110

Golder Associates

Created by: CNM
Checked by: AC



LEGEND

Borehole:	17-1106A	w_i = 62%	S_o = 100%	γ = 16.2 kN/m³
Sample:	1	w_f = 42%	e_o = 1.75	G_s = 2.79
Depth (m):	8.1	w_l = 56%	C_c = 1.33	
Elevation (m):	62.2	w_p = 22%	C_r = 0.013	

GOLDER

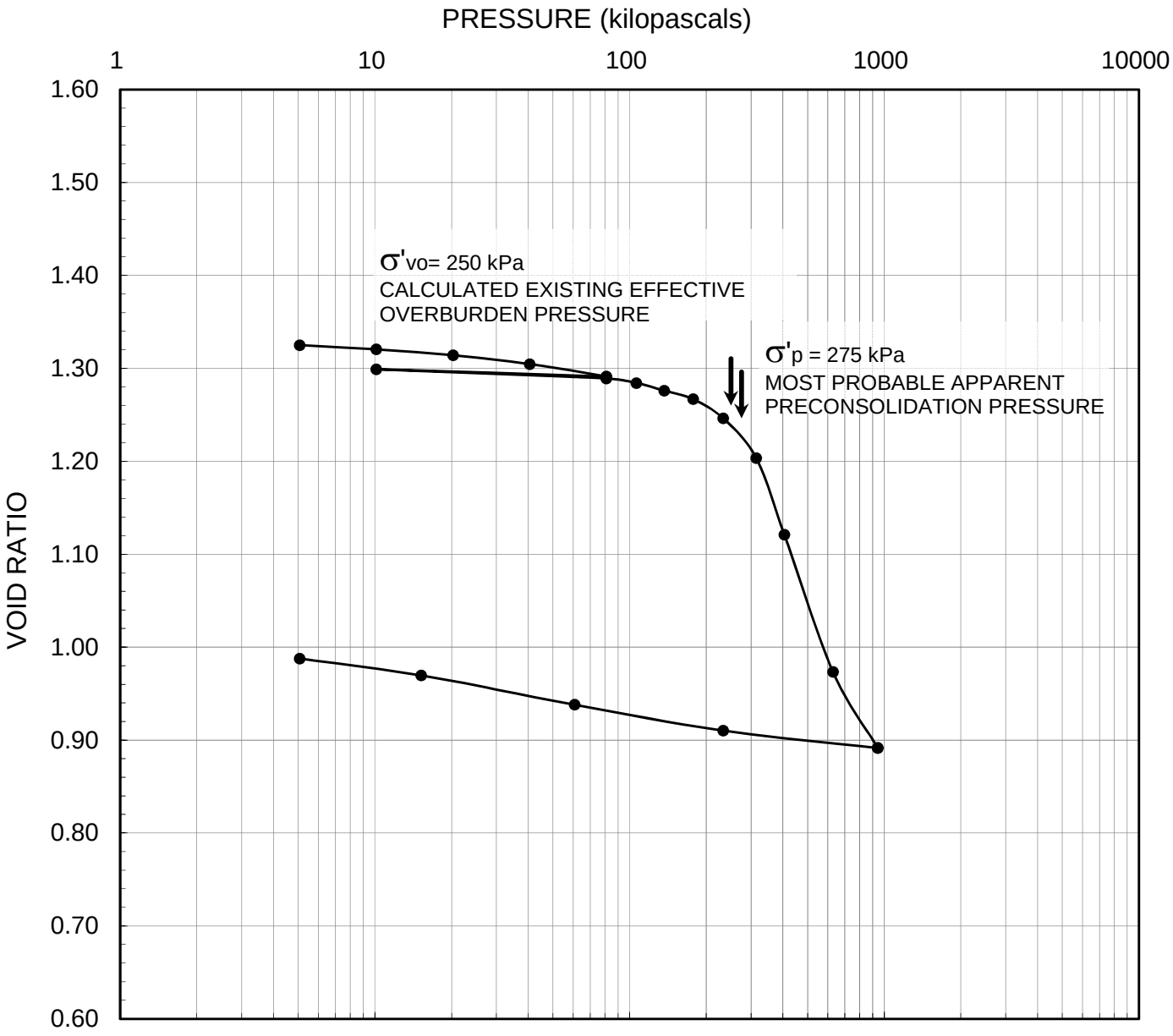
SCALE	AS SHOWN
DATE	12/20/17
CADD	N/A
ENTERED	CNM
CHECK	AC
REVIEW	SAT

TITLE

CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary		
PROJECT No.	1662565 /1110	REV.	2

FIGURE **B6**



LEGEND

Borehole:	17-1116	w_i = 46%	S_o = 97%	γ = 17.1 kN/m³
Sample:	18	w_f = 35%	e_o = 1.33	G_s = 2.78
Depth (m):	14.1	w_l = 49%	C_c = 0.76	
Elevation (m):	61.8	w_p = 19%	C_r = 0.011	

GOLDER

SCALE	AS SHOWN
DATE	12/20/17
CADD	N/A
ENTERED	CNM
CHECK	AC
REVIEW	SAT

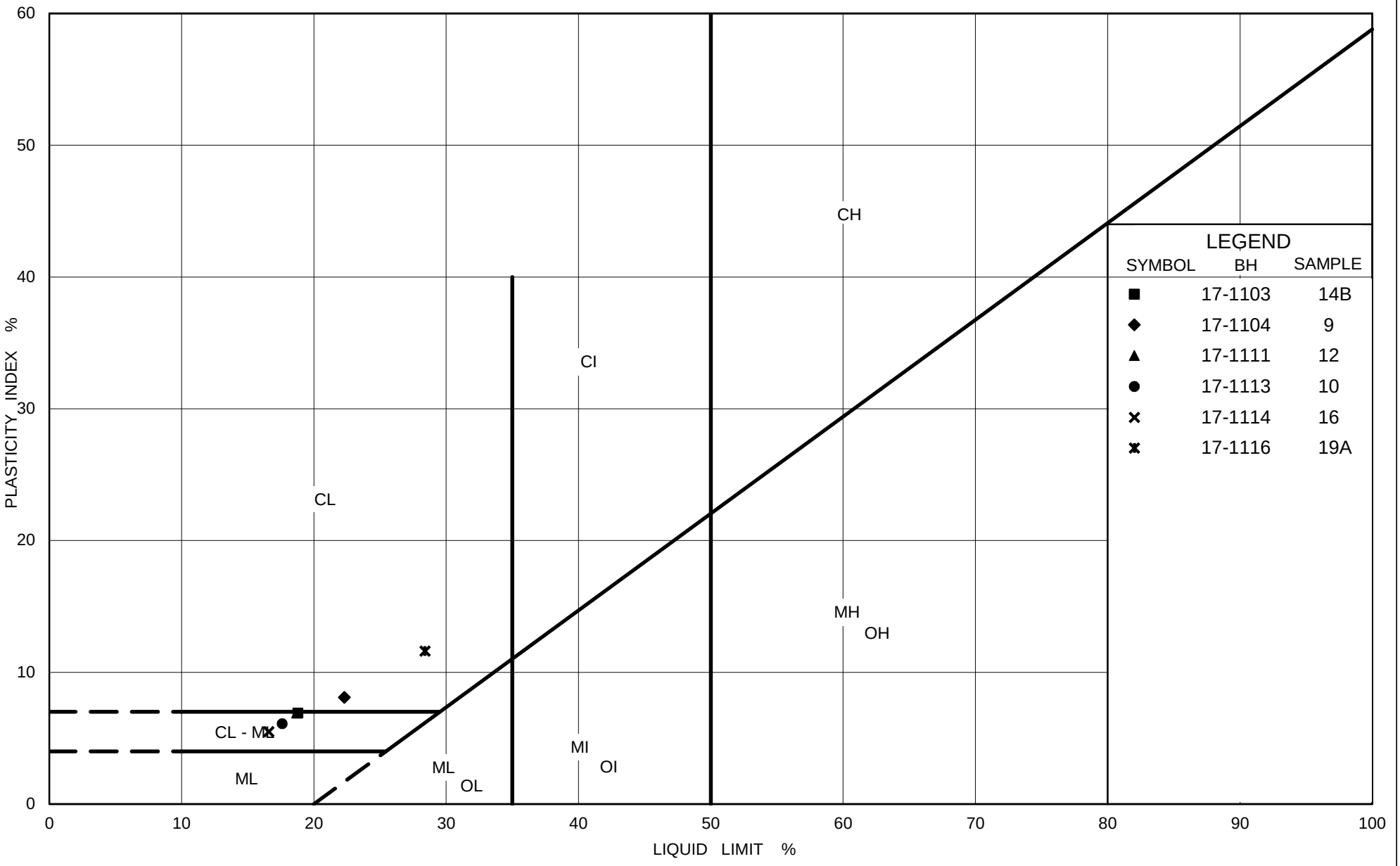
TITLE

CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary		
PROJECT No.	1662565 /1110	REV.	2

FIGURE **B7**

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART

SILT and SAND, Silty SAND, and CLAYEY SILT TILL

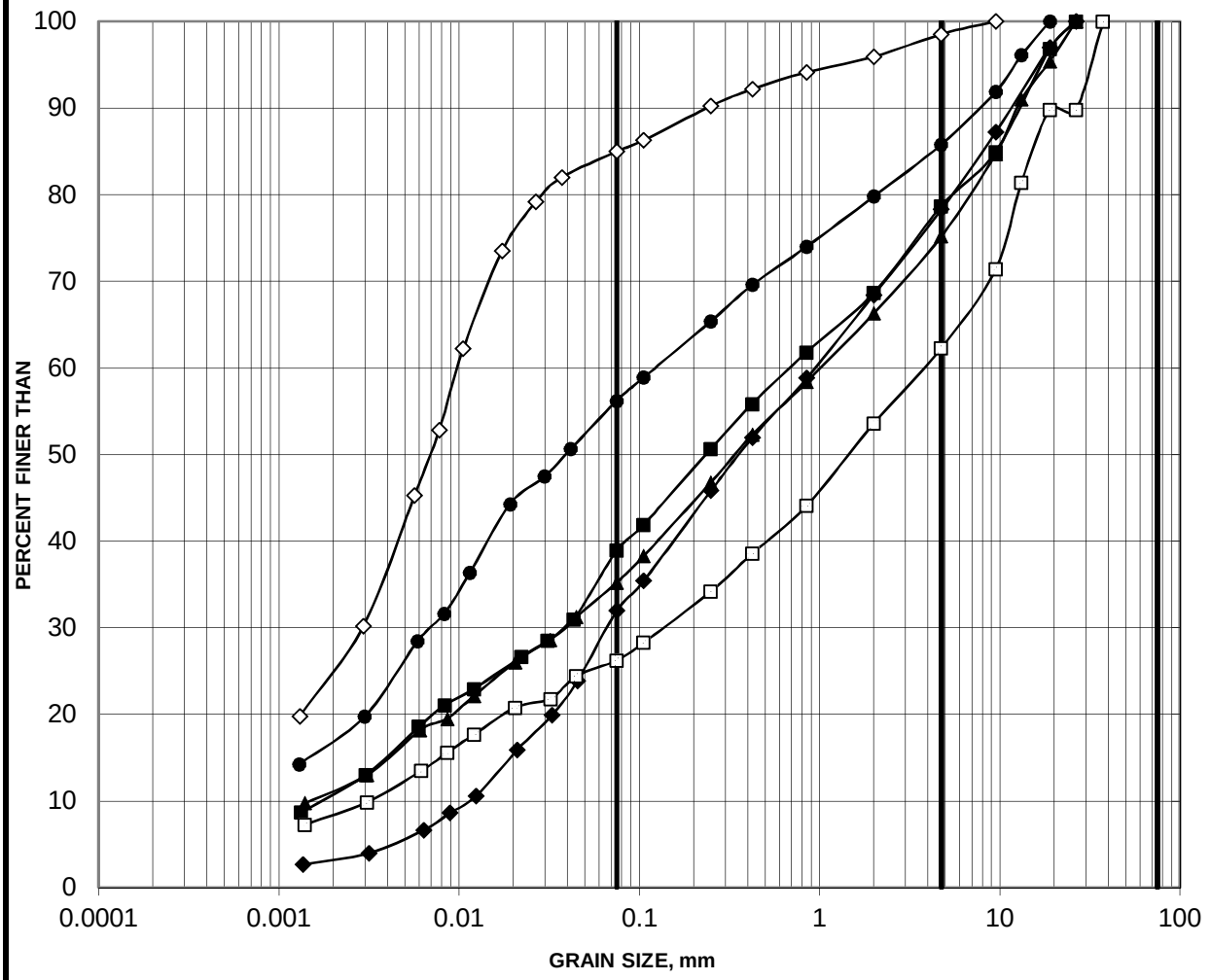
FIG No. B8

Project No. 1662565 /1110

Compiled By : CNM Checked By : MI

GRAIN SIZE DISTRIBUTION	FIGURE B9a

Silty SAND, Sandy SILT, SAND and GRAVEL, and CLAYEY SILT TILL



Borehole	Sample	Depth (m)
17-1101	20	16.76-17.37
17-1102	23	19.05-19.66
17-1103	15	11.49-12.10
17-1104	9	6.71-7.32
17-1106	11	10.67-11.10
17-1108	17A	15.24-15.54

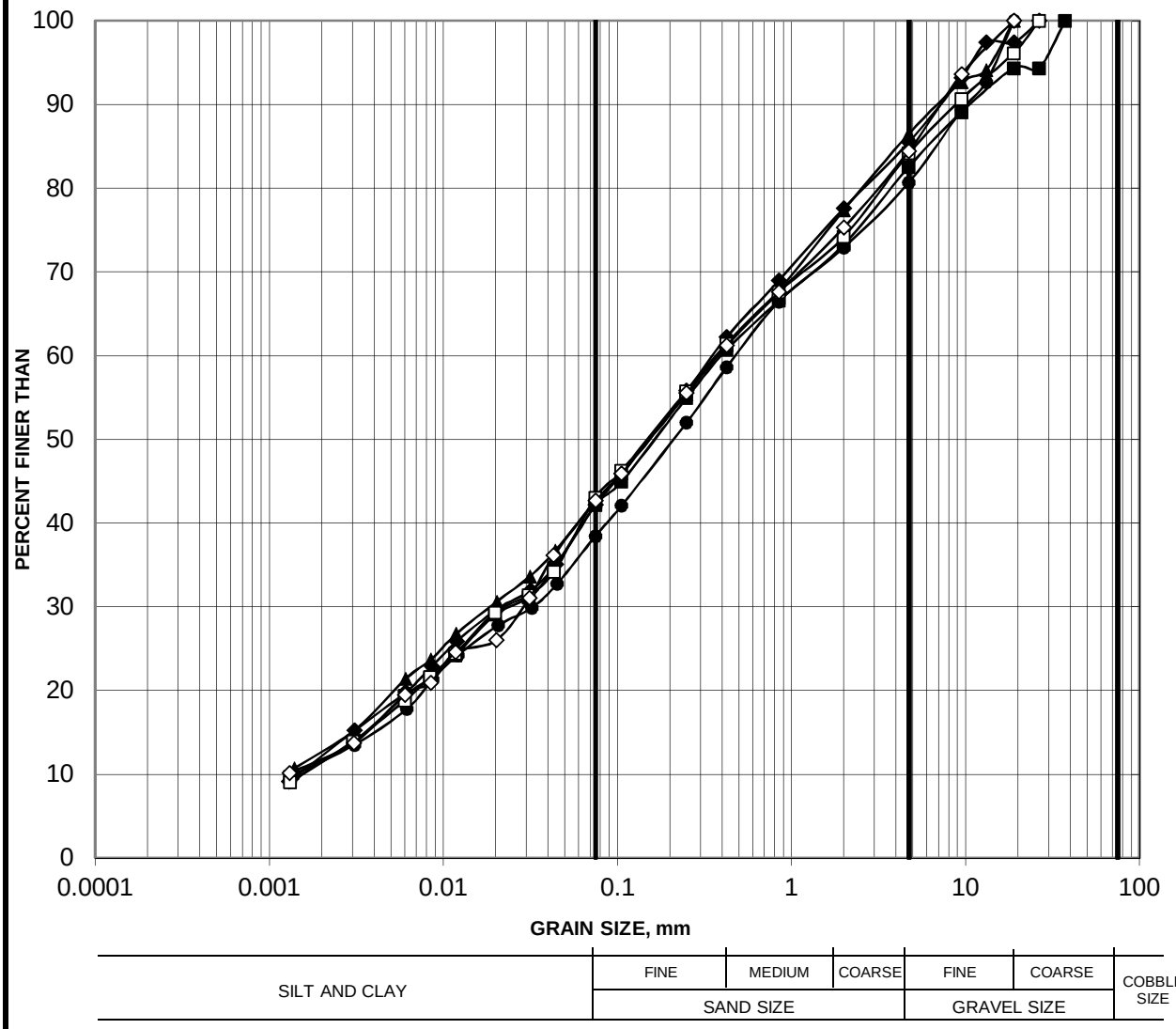
Project: 1662565 /1110

Golder Associates

Created by: CNM
Checked by: MI

GRAIN SIZE DISTRIBUTION	FIGURE B9b

SILT and SAND to Silty SAND TILL



Borehole	Sample	Depth (m)
17-1110	16	15.24-15.85
17-1111	12	9.91-10.52
17-1113	10	6.71-7.32
17-1114	16	10.36-10.97
17-1115	21	16.76-17.37
17-1116	20	16.00-16.61

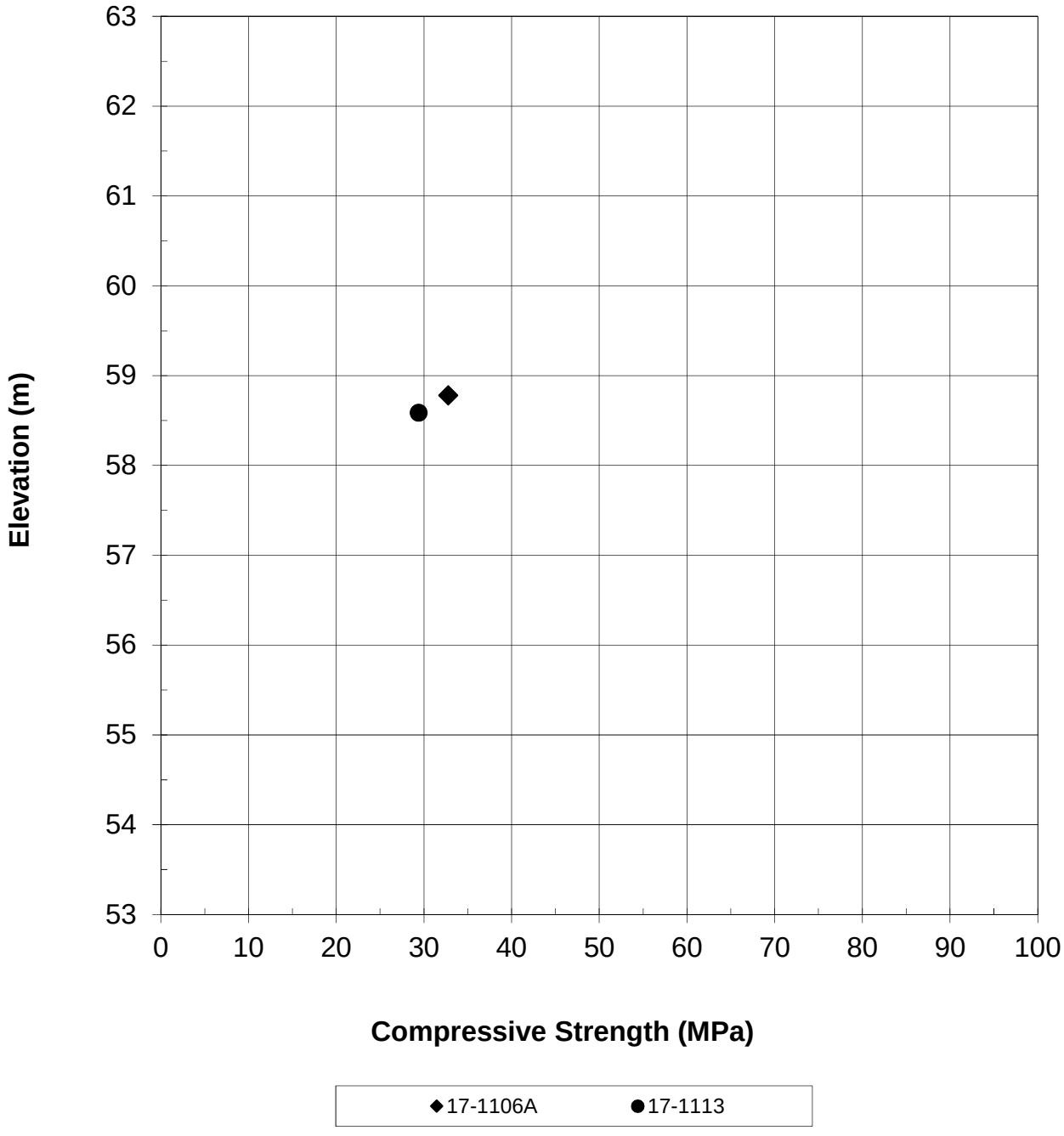
Project: 1662565 /1110

Golder Associates

Created by: CNM
Checked by: MI

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH
UNCONFINED COMPRESSION TESTS

FIGURE B10

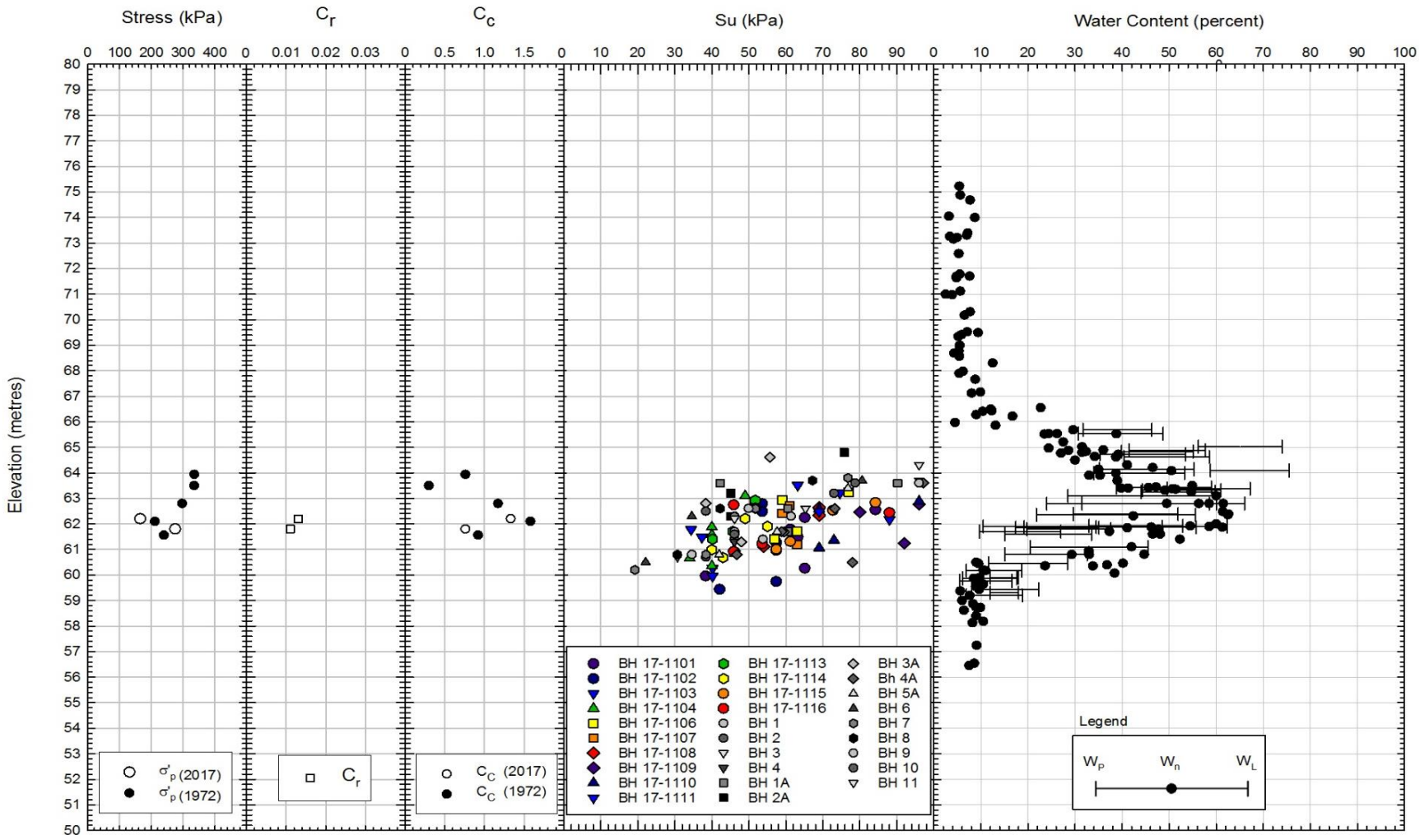


Project: 1662565 /1110

Golder Associates

Created by: CNM
Checked by: MI

SUMMARY OF ENGINEERING PROPERTIES



GOLDER

CNR OVERHEAD WIDENING

SITE NOS. 3-301/1 AND 3-301/2

HIGHWAY 417, OTTAWA, ONTARIO

Project No.	1662565 / 1110
Drawn:	WT/WAM
Date:	2018-05-03
Checked:	WT
Review:	MSS

Figure B11

APPENDIX C

Borehole Record and Laboratory Test Results (Previous Investigation, Geocres No. 31G5-79)

Records of Previous Boreholes BH1 to BH11 and BH1A to BH5A

Laboratory Test Results – Previous Investigation

FORM OD–MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,769 N; 233,682 E. ORIGINATED BY WH

W.P. 10-69-03 & 04 BORING DATE Nov. 10, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT
215.7	Ground Level				
0.0	Silty clay to clay				
	Firm to Very Stiff		1	SS	23
			2	SS	7
	Grey				
			3	TW	PM
200.7			4	TW	PM
15.0	Het.mix.of silt,sand & gravel,some clay		5	SS	2
195.2	Glac.Till. V.Loose		6	SS	4
20.5	Shale Bedrock		7	BX	100%
			8	BX	95%
	Sound Grey				
185.6			9	BX	98%
30.1	End of Borehole				

ELEV. SCALE: 210, 200, 190, 180

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

Hammer bouncing

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w

w_P w w_L

WATER CONTENT %
15 30 45

BULK DENSITY γ P.C.F.

10½

REMARKS

▼ 213.

GR. SA. SI. CL.

23 41 26 10

FORM CD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,801 N; 233,846 E. ORIGINATED BY TF

W.P. 10-69-03 & 04 BORING DATE Dec. 3, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
215.7	Ground Level					
0.0	Silty clay to clay					
	Firm to Very Stiff		1	SS	26	
			2	TW	PH	210
	Grey		3	TW	PH	
			4	TW	PH	
198.7			5	TW	PH	200
17.0	Het.mix.of silt,sand & gravel,trace of clay		6	SS	5	
192.7	Glac.Till. Grey		7	SS	5	
23.0	Shale Bedrock		8	BX	42%	
187.4	Sound Grey		9	BX	100%	190
28.3	End of Borehole					180

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w

WATER CONTENT %
15 30 45

BULK DENSITY γ P.C.F	REMARKS GR.SA.SI.CL.
	▼ 212.0 In open BH Dec.4/71
113	
113	0 2 57 41
	17 40 34 9

FORM OD–MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,999 N; 233,548 E. ORIGINATED BY JS

W.P. 30-69-03 & 04 BORING DATE Dec. 3, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F. (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB. VANE) (400 800 1200 1600 2000)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % (15 30 45)	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
216.5 Ground Level										
0.0	Silty clay to clay									215.
	Firm to Very Stiff		1	SS	25					
	Grey		2	TW	PH	210			115	0 4 48 48
			3	TW	PH					
			4	TW	PH				105	
199.5			5	TW	PH	200				
17.0	Het.mix.of silt, sand & gravel, trace of clay		6	SS	9					22 41 28 9
	Loose - Compact Grey		7	SS	12	190				
190.0										
26.5	Shale Bedrock		8	BX	38%					
	Sound Grey		9	BX	98%					
181.5										
35.0	End of Borehole					180				

FORM OD–MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 71-1112½ LOCATION Co-ords. 495,822 N; 233,562 E. ORIGINATED BY J.S.

W.P. 10-69-03 & BORING DATE Dec. 13, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F. (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB. VANE) (400 800 1200 1600 2000)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % (15 30 45)	BULK DENSITY γ P.C.F.	REMARKS GR SA SI CL
215.0	Ground Level									
0.0	Silty clay to clay. Firm to Stiff Grey		1	TW	PM	210			112	
			2	TW	PM					
			3	TW	PM					
200.0			4	TW	PM	200			114.5	
15.0	Het.mix.of silt,sand & gravel,trace of clay Glacial Till		5	SS	8					35 40 18 7
			6	SS	9					
192.2	Loose to Compact		7	SS	100/4"					
22.8	End of Borehole Probable Bedrock					190				

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,746 N; 233,826 E. ORIGINATED BY JS

W.P. 10-69-03 & 04 BORING DATE Dec. 13, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Cone Test Only CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB. VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				GR. SA. SI. CL.
215.9	Ground Level									
0.0						210				
						200				
197.5										
18.4	End of Cone Test					190				

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,692 N; 233,703 E. ORIGINATED BY JS

W.P. 10-69-03 & 04 BORING DATE Dec. 13, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

SOIL PROFILE ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. o UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE (400 800 1200 1600 2000)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w — WATER CONTENT % (15 30 45)	BULK DENSITY γ P.C.F.	REMARKS GR SA SI CL
215.6	Ground Level									
0.0	Silty clay to clay									
	Firm to Stiff		1	TW	PM	210	o + ×	o	114	
	Grey		2	TW	PM		+			
198.6			3	TW	PM	200	+ ●	o	116	0 1 71 28
17.0	Het.mix.of silt, sand & gravel, trace of clay									
193.8			4	SS	116/10"					
21.8	End of Borehole					190				
	Probable Bedrock									

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 496,028 N; 233,220 E. ORIGINATED BY JS

W.P. 10-69-03 & 04 BORING DATE Dec. 7, 1971. COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
216.6	Ground Level					
0.0	Silty clay to clay Firm to Stiff Grey		1	TW	PH	210
			2	TW	PH	
			3	TW	PH	
			4	TW	PH	
199.6			5	TW	PH	200
17.0	Het.mix. of silt, sand and gravel, trace of clay. Loose to Very Dense Grey		6	TW	PH	
			7	SS	5	
			8	SS	37	
188.1			9	SS	163	190
28.5	End of Borehole Probable Bedrock					180

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
15 30 45

BULK DENSITY γ P.C.F.

210	120
	102
200	112.5

REMARKS

GR. SA. SI. CL.

▽ 216.

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 496,108 N; 233,001 E. ORIGINATED BY JS

W.P. 10-69-03 & 04 BORING DATE Dec. 5 & 7, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w	BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB. VANE 400 800 1200 1600 2000	w_P w w_L WATER CONTENT % 15 30 45	P.C.F.	GR. SA. SI. CL.
216.7	Ground Level									▽ 215.5
0.0	Silty clay to clay									
	Firm to Stiff		1	SS	13					
			2	TW	PH	210			109	
	Grey		3	TW	PH				103	0 2 47 51
			4	TW	PH					
			5	TW	PH					
198.7						200				
18.0	Het.mix.of silt,sand and gravel,trace of clay.		6	SS	19					18 42 30 10
	Compact to Very Dense		7	SS	22	190				
	Grey		8	SS	78					
186.2										
30.5	Shale Bedrock		9	BX	95%					
180.7										
36.0	End of Borehole					180				

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 71-1112h | LOCATION Co-ords. 495,992 N; 233,072 E. | ORIGINATED BY JS

W.P. 10-69-03 & 04 | BORING DATE Dec. 10, 1971 | COMPILED BY SO

DATUM Geodetic | BOREHOLE TYPE NX Washboring | CHECKED BY

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
216.7	Ground Level					
0.0	Silty clay to clay. Firm to Very Stiff Grey		1	TW	PH	
			2	TW	PH	210
			3	TW	PH	
			4	TW	PH	
199.7			5	TW	PH	200
17.0	Het.mix.of silt,sand & gravel,trace of clay.		6	SS	3	
193.9	Glac.Till		7	SS	101/3"	
22.8	End of Borehole					
24.5	End of Cone Test					190

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY γ P.C.F.

103

REMARKS

GR-SA-SI-CL

216.2

0 5 50 45

47 20 25 8

FORM OD-MT - 126 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,907 N; 233,297 E. ORIGINATED BY JS.

W.P. 10-69-03 & 04 BORING DATE Dec. 10, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
216.0	Ground Level							
0.0	Silty clay to clay. Firm to Very Stiff Grey		1	TW	PH	210	116	▽ 215.5
			2	TW	PH			
			3	TW	PH		103	0 1 44 55
			4	TW	PH			
198.5			5	TW	PH	200	118	
17.5	Het.mix.of silt, sand & gravel, trace of clay.		6	SS	2			25 33 25 17
193.0	Glac.Till Grey		7	SS	31			
23.0	Shale Bedrock		8	BX	85%	190		
			9	BX	90%			
186.5	Sound Grey		10	BX	80%			
29.5	End of Borehole					180		

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %
15 30 45

FORM OB-MT-126 (REV. 1971)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 1A

FOUNDATION SECTION

JOB 71-11124
W.P. 10-69-03
10-69-04
DATUM Geodetic

LOCATION Co-ord's 496,188N. 233,106 E.
BORING DATE April 18, 1972
BOREHOLE TYPE Auger & RE Rock Core

ORIGINATED BY S.A.A.
COMPILED BY A.T.
CHECKED BY

ELEV. / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
216.7	Ground surface.					
	Silty clay to clay. Firm to very stiff. Grey.		1	SS	16	
			2	TW	PH	210
			3	TW	PH	
			4	TW	PH	
			5	TW	PH	200
197.7						
19.0	Het. mix. of silt, sand and gravel. Trace of clay. Loose to very dense. Grey.		6	SS	5	
			7	SS	14	190
			8	SS	23	
			9	SS	136	
181.9						
179.9	Shale bedrock.		10	RC BX	Rec. 100%	180
36.8	End of borehole.					
						170

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %

BULK DENSITY γ
P.C.F.

REMARKS
GR. SA. SI. CL.
El. 215.7

FORM OB-MT-126 (REV. 1971)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 2 A

FOUNDATION SECTION

JOB 71-11124

W.P. 10-69-03 / 10-69-04

DATUM Geodetic

LOCATION Co-ord's 495,909 N. 233,656 E.

BORING DATE April 19, 1972

BOREHOLE TYPE Auger & Re Rock Core

ORIGINATED BY S.A.A.

COMPILED BY A.T.

CHECKED BY HK

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20, 40, 60, 80, 100) / SHEAR STRENGTH P.S.F. (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB. VANE) (400, 800, 1200, 1600, 2000)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
215.8	Ground surface.									
	Silty Clay to Clay. Firm to stiff. Grey.		1	SS	12	210				▼ El. 211.8
			2	TW	PH					
			3	TW	PH					
202.8			4	TW	PH					
13.0	Het. mix. of silt, sand and gravel. Trace of clay.		5	SS	1	200				
194.8			6	SS	18					
21.0	Shale bedrock. Sound-grey.		7	RC BX	Rec. 89%	190				GR.SA.SI.CL.
26.5	End of borehole.									

FORM OB-MT-126 (REV. 1971)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
DESIGN SERVICES BRANCH

RECORD OF BOREHOLE No. 3 A

FOUNDATION SECTION

JOB 71-11124
W.P. 10-69-03 / 10-69-4
DATUM Geodetic

LOCATION Co-ord's 496,003 N. 233,610 E.
BORING DATE April 20, 1972
BOREHOLE TYPE Auger & RE Rock Core

ORIGINATED BY S.A.A.
COMPILED BY A.T.
CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE
217.0	Ground surface.					
	Silty clay to clay.		1	SS	12	
	Firm to very stiff.		2	TW	PH	210
	Grey.		3	TW	PH	
			4	TW	PH	
200.5			5	TW	PH	200
16.5	Het. mix. of silt, sand and gravel.		6	SS	6	
	Trace of clay.		7	SS	12	
189.0	Probable bedrock.					190
28.0	End of borehole.					180

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %

BULK DENSITY γ P.C.F.

REMARKS
GR SA SI CL

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE Nº 4A

JOB 71-1112½ LOCATION Co'ord's 496,069 N. 233,124 E. ORIGINATED BY S.A.A.

W.P. 10-69-03 BORING DATE June 16, 1972 COMPILED BY S.A.A.

DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (400 800 1200 1600 2000)	LIQUID LIMIT W_L — PLASTIC LIMIT W_P — WATER CONTENT W — WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS GR.SA.SI.CL.
216.6	Ground surface.									
0.0	Silty clay, with trace of sand. Firm to very stiff. Grey.		1	SS	11	210	> +			▽ Elev. 213.6 in open B.H. June 16/72
			2	TW	PM		+			
			3	TW	PM		+			
			4	TW	PM		+			
198.6			5	TW	PM	200	+			
18.0	Het. Mix. of silt, sand and gravel, trace of clay. Glacial Till. Very dense.		6	TW	PM					
			7	TW	60	190				
187.1										
29.5	Shale bedrock. Sound - grey.		8	RC BX	Rec 100%					
184.6										
32.0	End of borehole.					180				

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

DESIGN SERVICES BRANCH — FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 5A

JOB 71-1112A — LOCATION Co-ord's 495,951 N. 233,170 E. — ORIGINATED BY S.A.A.

W.P. 10-69-03 — BORING DATE June 19, 1972 — COMPILED BY S.A.A.

DATUM Geodetic — BOREHOLE TYPE Washboring - NX Casing — CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE
216.3	Ground surface.					
0.0	Silty clay, with trace of sand. Firm to very stiff. Grey.		1	SS	11	210
			2	TW	PM	
			3	TW	PM	
			4	TW	PM	200
199.3			5	TW	PM	
17.0	Het. mix. of silt, sand & gravel, trace of clay. Glacial Till Very dense.		6	TW	PM	
			7	SS	118	190
188.3	Probable Bedrock.					
28.0	End of borehole.					180

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000

LIQUID LIMIT W_L
PLASTIC LIMIT W_P
WATER CONTENT W
W_P W W_L
WATER CONTENT %

BULK DENSITY γ P.C.F.

REMARKS
GR.SA.SI.CL.
▽215.2

OFFICE REPORT ON SOIL EXPLORATION

FORM OD–MT 26 (REV. 1969)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11

FOUNDATION SECTION

JOB 71-11124 LOCATION Co-ords. 495,866 N; 233,206 E. ORIGINATED BY JS

W.P. 10-69-03 & 04 BORING DATE Dec. 13, 1971 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE NX Washboring CHECKED BY

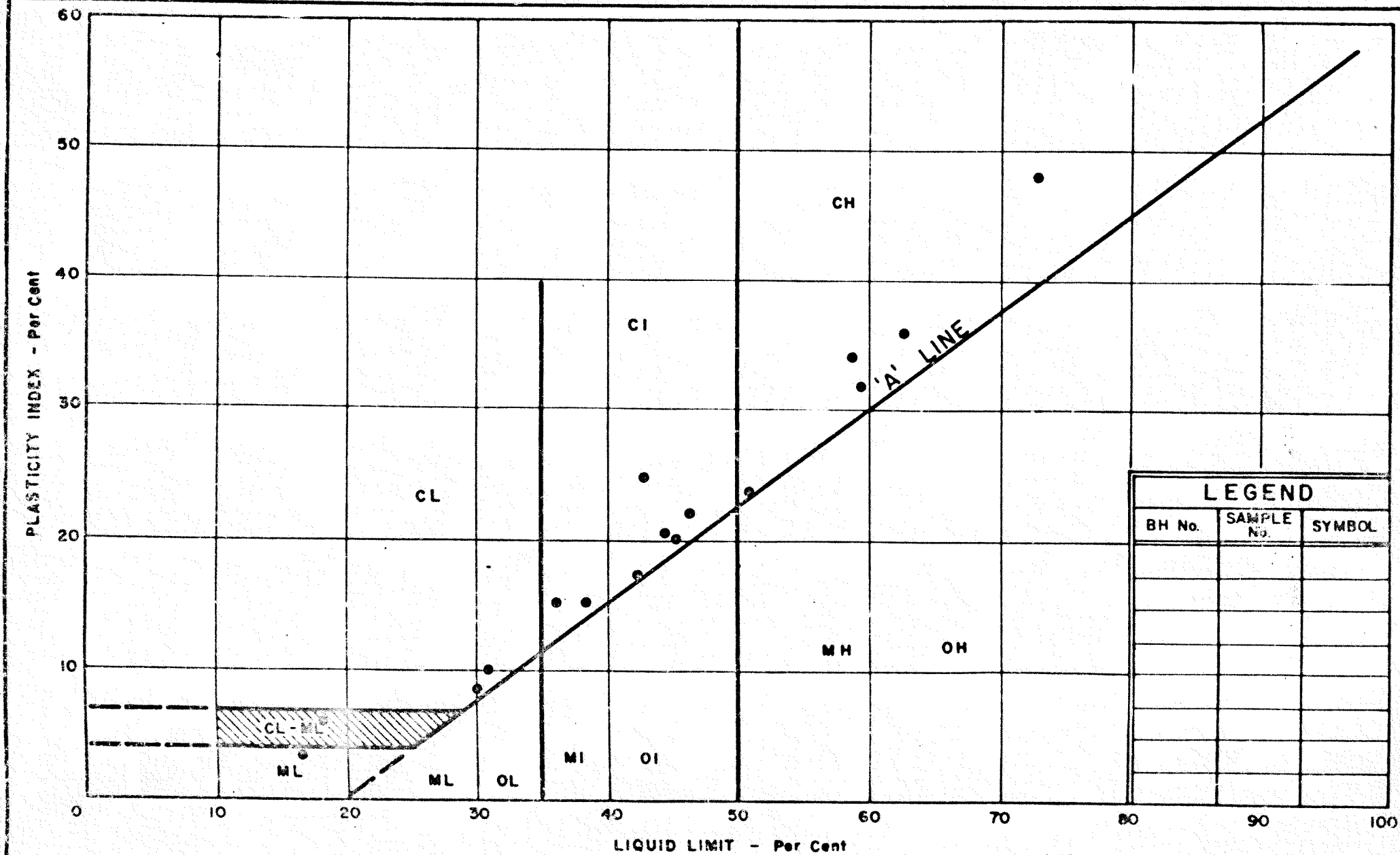
ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS GR. SA. SI. CL.
216.1	Ground Level							215. ▽
0.0	Silty clay to clay							
	Firm to Very Stiff		1	TW	PM	210	113.5	
	Grey		2	TW	PM		117	0 1 81 18
198.6			3	TW	PM	200		
17.5 / 195.6	Het.mix.of silt,sand & gravel,trace of clay		4	SS	100/5"			
20.5	End of Borehole					190		

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB. VANE
400 800 1200 1600 2000

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

FORM OB-MT-252
REVISED JU[illegible] 1966



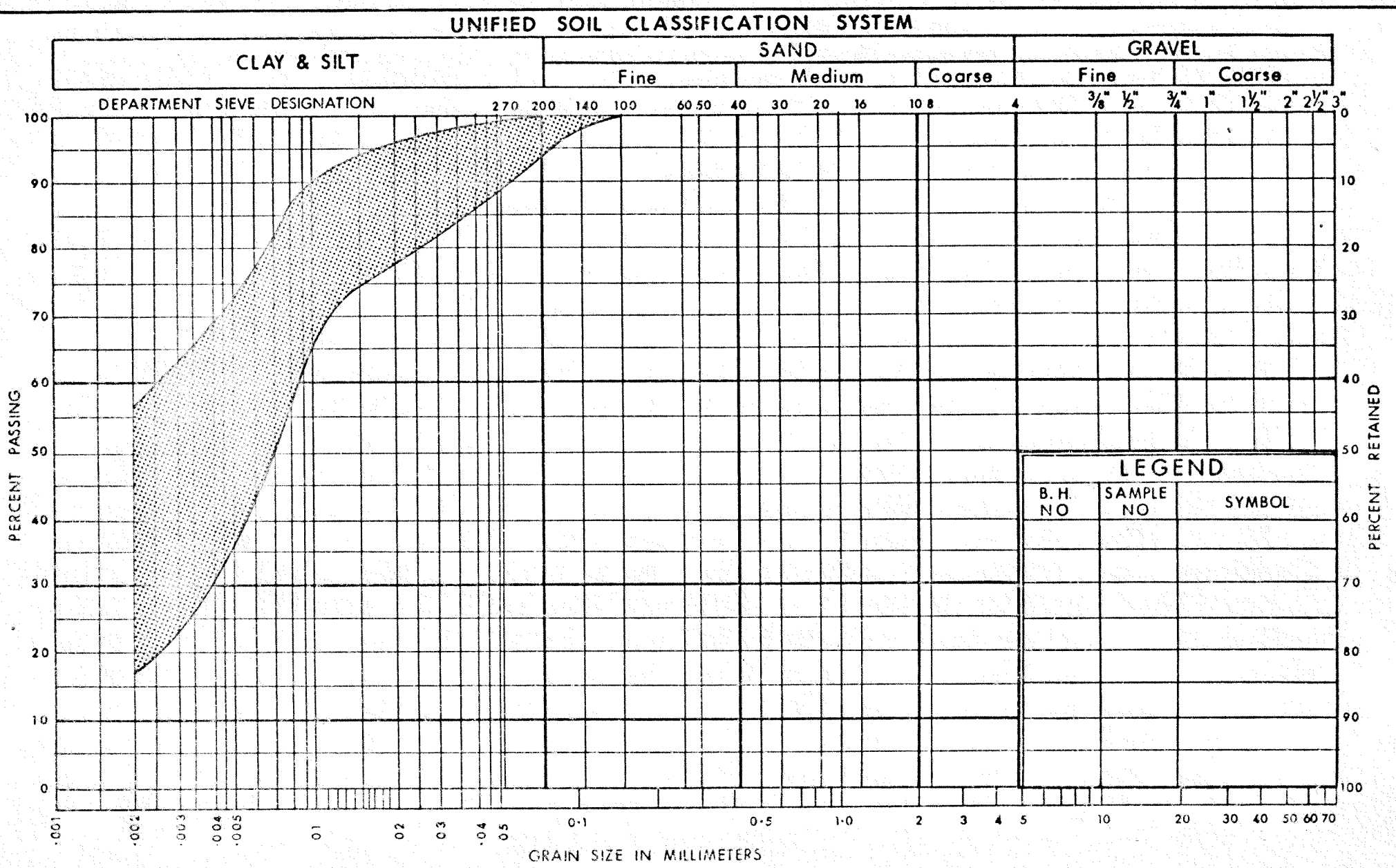
DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

SILTY CLAY TO CLAY

W.P. No. 10-69-03 & 04
JOB No. 71-11124
FIG. 1

FORM OD-MT-
REV. AUG. 1971



DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

DESIGN SERVICES BRANCH

ONTARIO

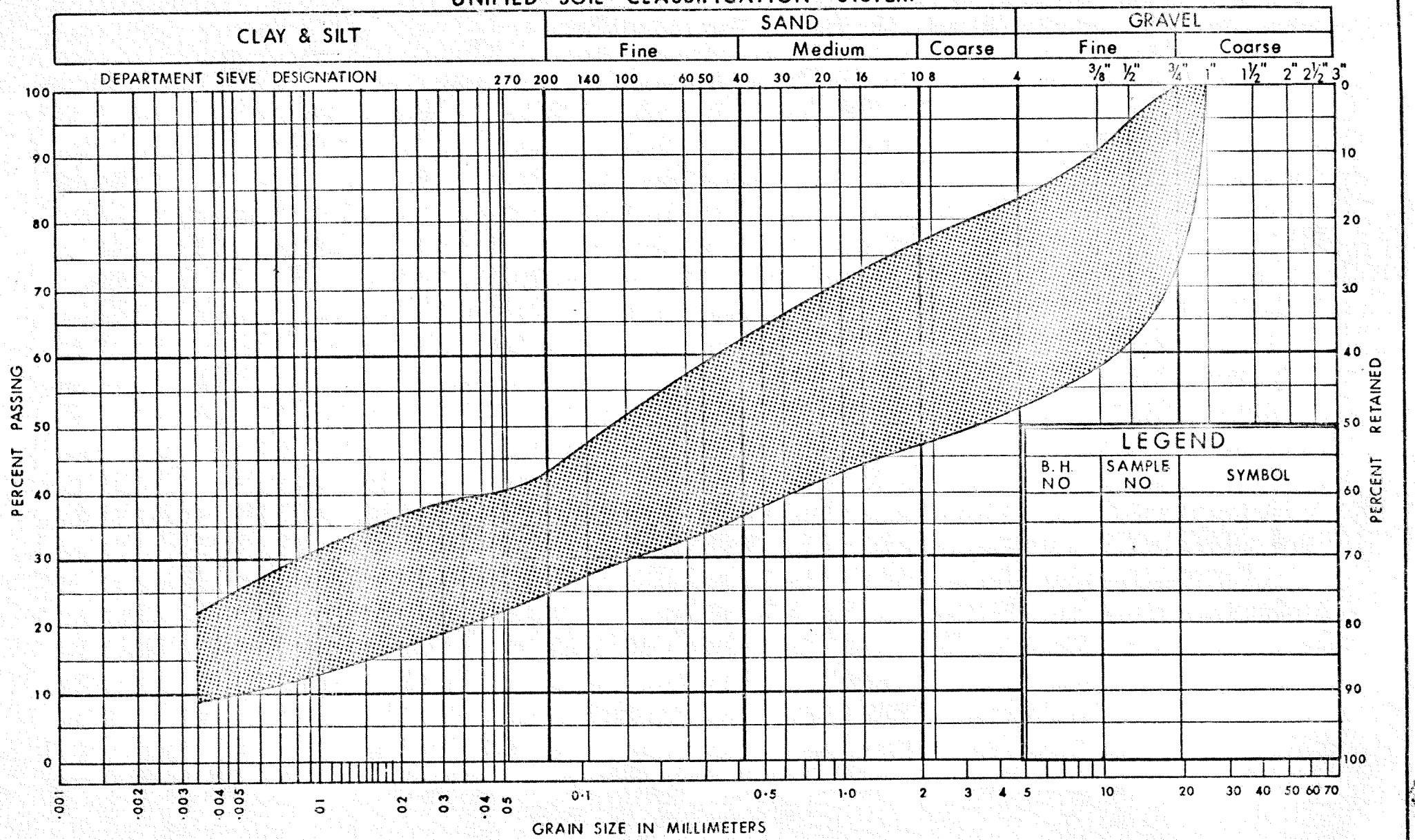
GRAIN SIZE DISTRIBUTION

SILTY CLAY TO CLAY

W.P. No.	10-69-03 & 04
JOB No.	71-11124
	FIG. 2

FORM OD-MT-
REV. AUG. 1971

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

ONTARIO

DESIGN SERVICES BRANCH

GRAIN SIZE DISTRIBUTION

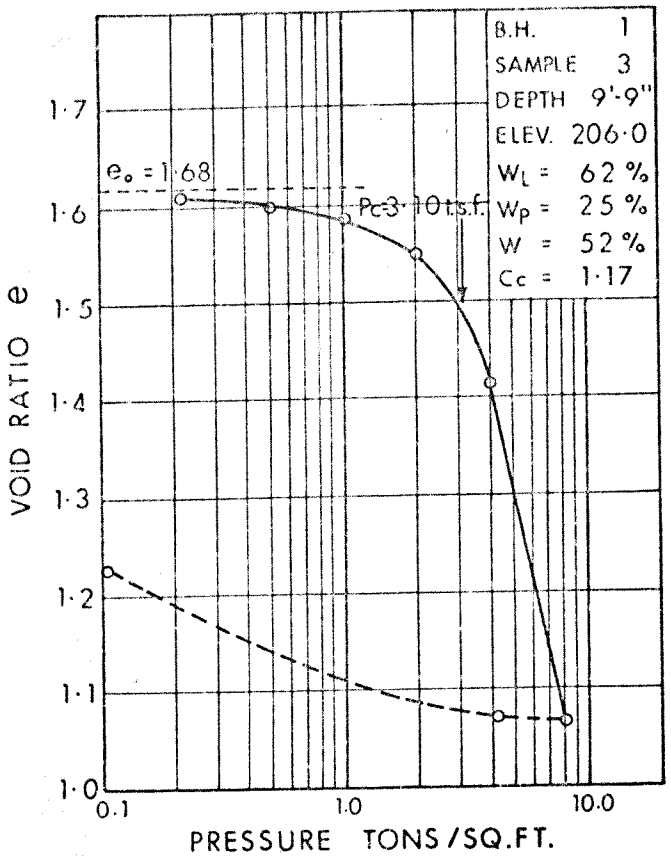
GLACIAL TILL

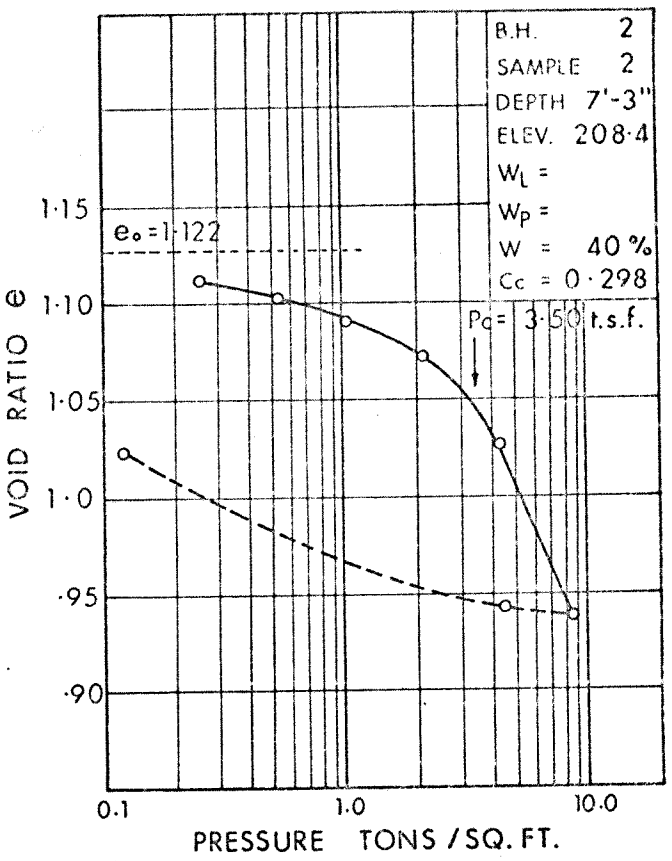
HET. MIXTURE OF SILT, SAND & GRAVEL, TRACE OF CLAY

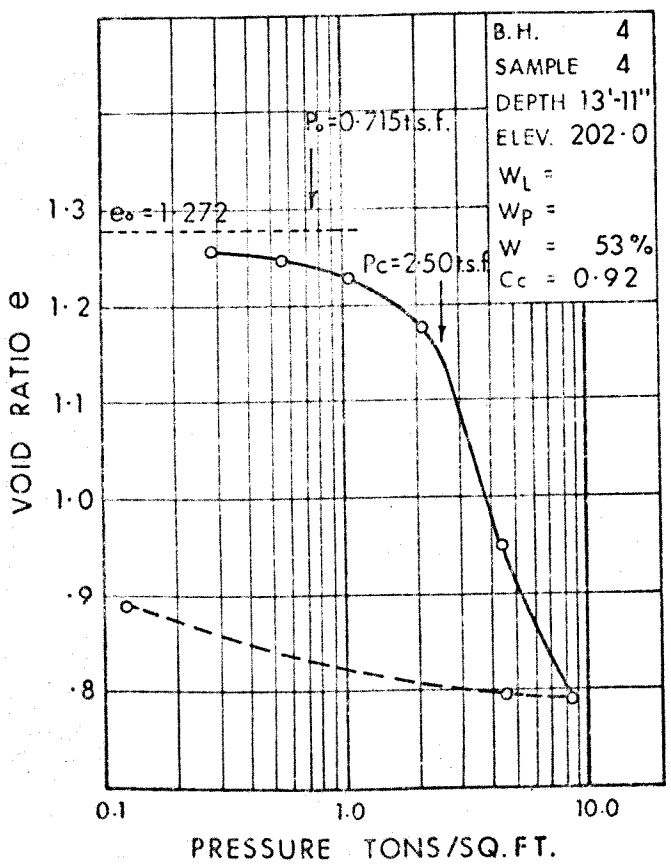
W.P. No.	10-69-03 & 04
JOB No.	71-11124
	FIG. 3

VOID RATIO – PRESSURE CURVES

JOB NO. 71-11124







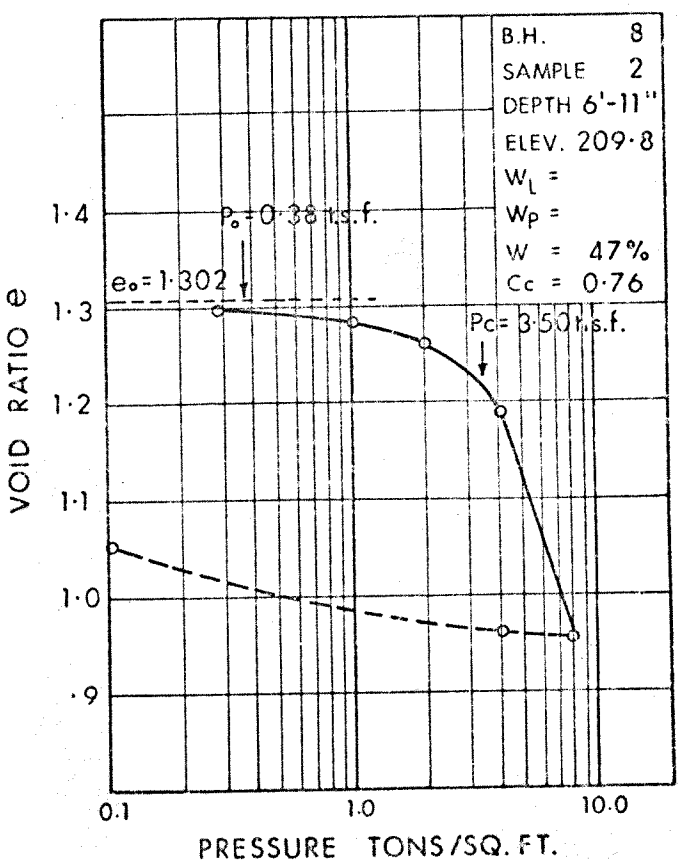
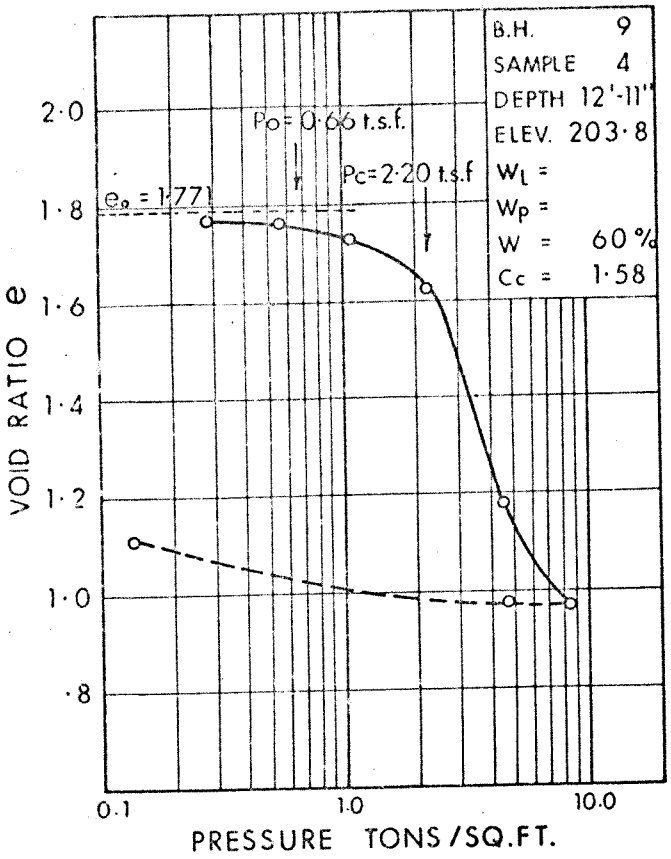
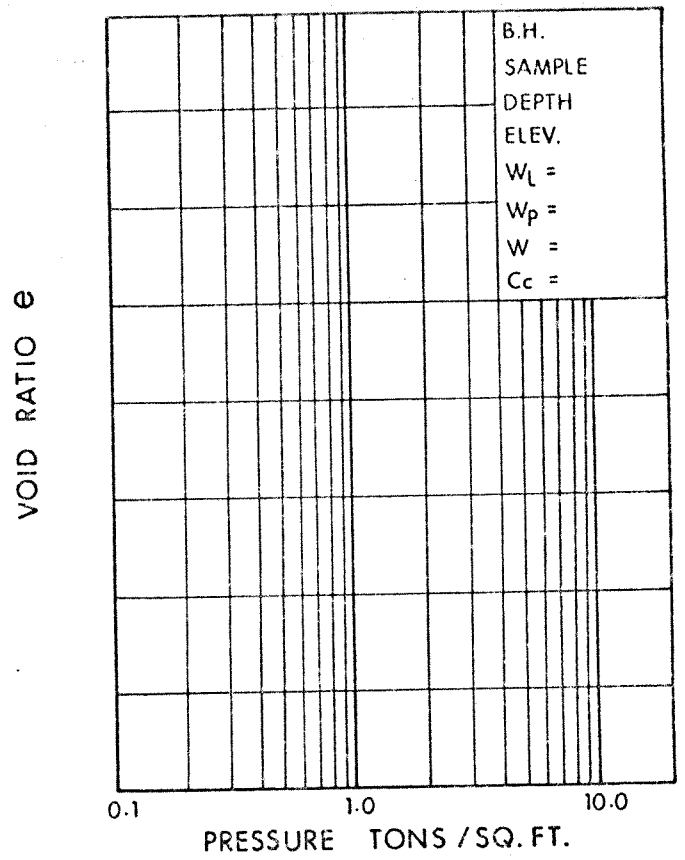


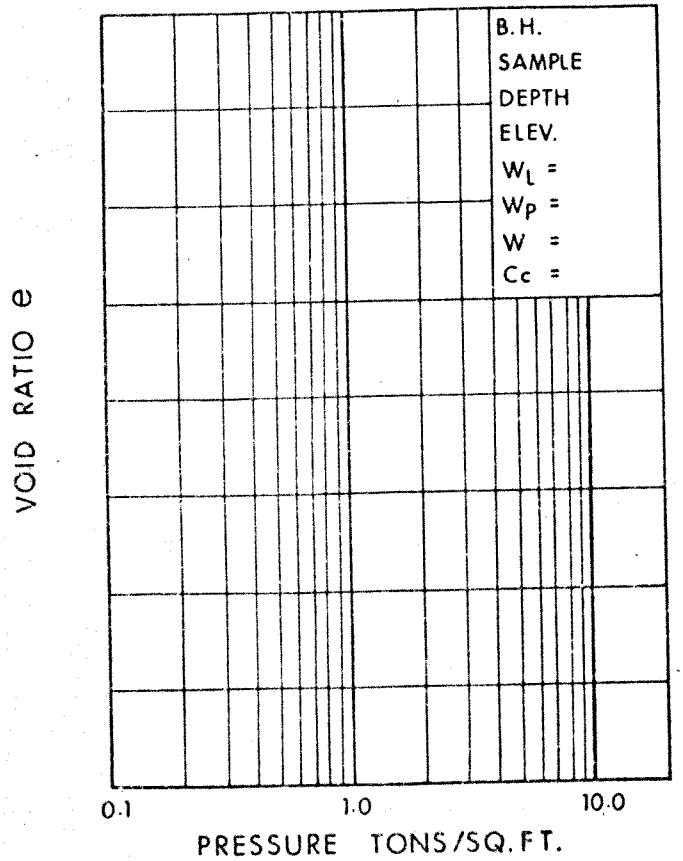
FIG. 4

VOID RATIO – PRESSURE CURVES

JOB NO. 71 - 11124







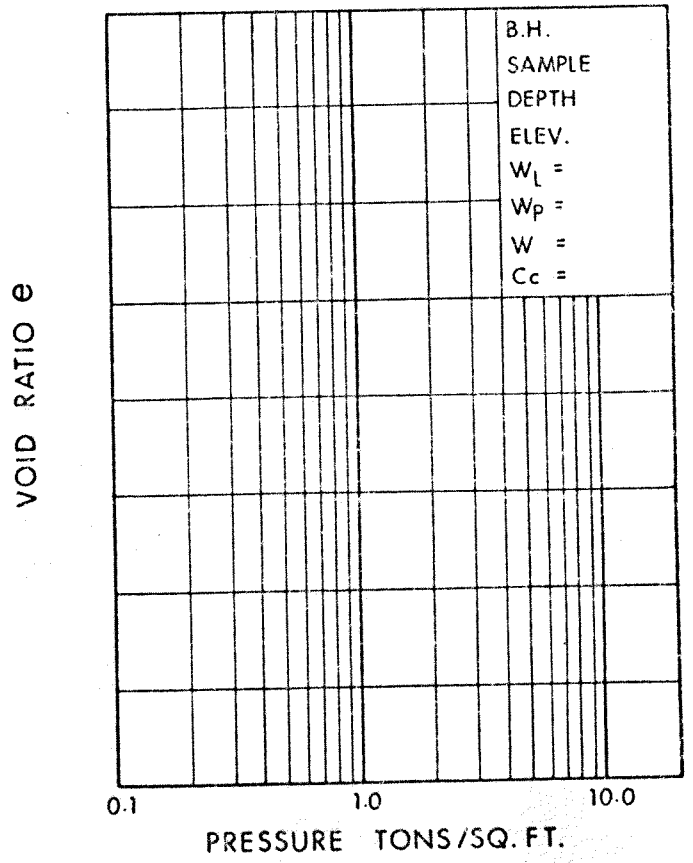


FIG. 5

APPENDIX D

Selected Site Photographs

Photograph 1: Site 3-301/1 (EBL), East side, looking North (June 14, 2017).

Photograph 2: Site 3-301/1 (EBL), CNR Tracks, looking North (June 14, 2017).

CLIENT
WSP CANADA GROUP LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2018/02/21
PREPARED	SAT
DESIGN	SAT
REVIEW	MSS
APPROVED	FJH

PROJECT
CNR OVERHEAD WIDENING
SITE NOS. 3-301/1 & 3-301/2
HIGHWAY 417, OTTAWA, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1662565	**1110**	**1**	**D1**

Photograph 3: Site 3-301/2 (WBL), East side, looking North (June 14, 2017).

Photograph 4: Site 3-301/2 (WBL), CNR Tracks, looking North (June 14, 2017).

CLIENT
WSP CANADA GROUP LIMITED

CONSULTANT
GOLDER

YYYY-MM-DD	2018/02/28
PREPARED	SAT
DESIGN	SAT
REVIEW	MSS
APPROVED	FJH

PROJECT
CNR OVERHEAD WIDENING
SITE NOS. 3-301/1 & 3-301/2
HIGHWAY 417, OTTAWA, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.	Figure
1662565	**1110**	**1**	**D2**

APPENDIX E

Basic Chemical Analysis – Eurofins Report Numbers 1713269 and 1718216

Certificate of Analysis

eurofins | Environment Testing

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Ms. Susan Trickey
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1713269
Date Submitted: 2017-07-17
Date Reported: 2017-07-24
Project: 1662565/1110
COC #: 821253

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1306727 Soil 2017-07-05 17-1102 SA 15/35-37	1306728 Soil 2017-06-26 17-1107 SA5/10-12	1306729 Soil 2017-07-04 17-1110 SA 13/37.5-39.5	1306730 Soil 2017-06-28 17-1115 SA 9/20-22
Agri. - Soil	pH	2.0				7.6	9.2	8.3	8.3
	SO4	0.01	%			<0.01	<0.01	<0.01	<0.01
General Chemistry	Cl	0.002	%			0.252	0.197	0.006	0.030
	Electrical Conductivity	0.05	mS/cm			1.65	0.43	0.49	1.00
	Resistivity	1	ohm-cm			606	2330	2040	1000

Guideline = *** = Guideline Exceedence**

All analysis completed in Ottawa, Ontario (unless otherwise indicated by ** which indicates analysis was completed in Mississauga, Ontario).
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

eurofins | Environment Testing

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Mr. Alex Meacoe
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1718216
Date Submitted: 2017-09-21
Date Reported: 2017-09-27
Project: 1662565/1110
COC #: 823662

Group	Analyte	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sampling Date / Sample I.D.			
					1321667 Soil 2017-08-21 17-1103 SA9/16-18	1321668 Soil 2017-09-08 17-1104 SA10/24-25.8	1321669 Soil 2017-08-22 17-1106 SA8/20-22	1321670 Soil 2017-08-26 17-1111 SA11/30-32
Agri. - Soil	pH	2.0			7.6	8.8	7.6	8.7
	SO4	0.01	%		<0.01	0.02	0.02	0.04
General Chemistry	Cl	0.002	%		0.032	0.006	0.219	0.008
	Electrical Conductivity	0.05	mS/cm		0.33	0.20	1.97	0.28
	Resistivity	1	ohm-cm		3030	5000	508	3570

Group	Analyte	MRL	Units	Guideline	Lab I.D. / Sample Matrix / Sample Type / Sampling Date / Sample I.D.	
					1321671 Soil 2017-08-27 17-11113 SA6/10-12	1321672 Soil 2017-08-21 17-1114 SA 17/36-38
Agri. - Soil	pH	2.0			8.1	8.6
	SO4	0.01	%		<0.01	0.04
General Chemistry	Cl	0.002	%		0.015	0.008
	Electrical Conductivity	0.05	mS/cm		0.38	0.29
	Resistivity	1	ohm-cm		2630	3450

Guideline = *** = Guideline Exceedence**

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MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX F

Results of MASW and VSP Testing

TECHNICAL MEMORANDUM

DATE December 19, 2017 **PROJECT No.** 1662565/1110

TO Susan Trickey
Golder Associates Ltd.

FROM Stephane Sol, Christopher Phillips **EMAIL** ssol@golder.com;cphillips@golder.com

CHBDC SEISMIC SITE CLASS TESTING RESULTS
CNR OVERHEAD AND HWY 417, OTTAWA, ONTARIO

This technical memorandum presents the results of two Multichannel Analysis of Surface Waves (MASW) tests performed for the purpose of the Canadian Highway Bridge Design Code (CHBDC 2014) Seismic Site Classification for the widening of the CNR Overhead (Figure 1). The tests are located on each side of the CNR line at the intersection with Highway 417 in Ottawa. The geophysical testing was performed by Golder Associates Ltd. (Golder) personnel on May 25, 2017.

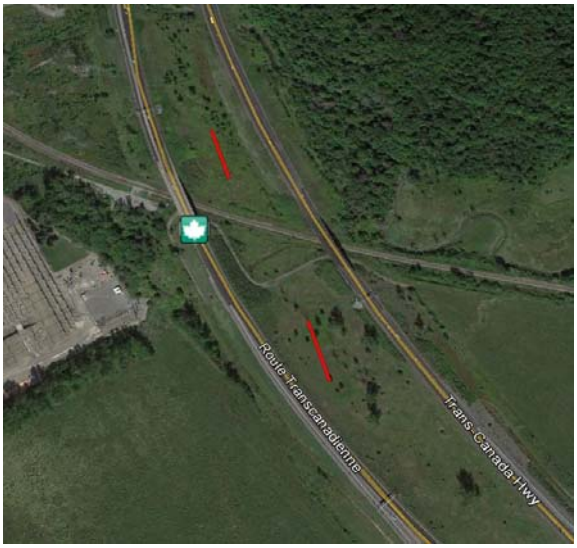

Figure 1: MASW Location Site Map (MASW Lines in red – Line 1 (North) and Line 2 (South))

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Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

Methodology

The MASW method measures variations in surface-wave velocity with increasing distance and wavelength and can be used to infer the rock/soil types, stratigraphy and soil conditions.

A typical MASW survey requires a seismic source, to generate surface waves, and a minimum of two geophone receivers, to measure the ground response at some distance from the source. Surface waves are a special type of seismic wave whose propagation is confined to the near surface medium.

The depth of penetration of a surface wave into a medium is directly proportional to its wavelength. In a non-homogeneous medium, surface waves are dispersive, i.e., each wavelength has a characteristic velocity owing to the subsurface heterogeneities within the depth interval that particular wavelength of surface wave propagates through. The relationship between surface-wave velocity and wavelength is used to obtain the shear-wave velocity and attenuation profile of the medium with increasing depth.

The seismic source used can be either active or passive, depending on the application and location of the survey. Examples of active sources include explosives, weight-drops, sledge hammer and vibrating pads. Examples of passive sources are road traffic, micro-tremors, and water-wave action (in near-shore environments).

The geophone receivers measure the wave-train associated with the surface wave travelling from a seismic source at different distances from the source.

The participation of surface waves with different wavelengths can be determined from the wave-train by transforming the wave-train results into the frequency domain. The surface-wave velocity profile with respect to wavelength (called the ‘dispersion curve’) is determined by the delay in wave propagation measured between the geophone receivers. The dispersion curve is then matched to a theoretical dispersion curve using an iterative forward-modelling procedure. The result is a shear-wave velocity profile of the tested medium with depth, which can be used to estimate the dynamic shear-modulus of the medium as a function of depth.

Field Work

The MASW field work was conducted on May 25, 2017, by personnel from the Golder Mississauga and Ottawa offices. For each MASW line, a series of 24 low frequency (4.5 Hz) geophones were laid out at 3 m intervals. Both active and passive readings were recorded along the MASW lines. For the active investigation, a seismic drop of 45 kg and a 9.9 kg sledge hammer were used as seismic sources. Active seismic records were collected with seismic sources located 5, 10, and 15 m from the end and collinear to the geophone array. An example of active seismic records collected at each line are shown in Figures 2 and 3, below.

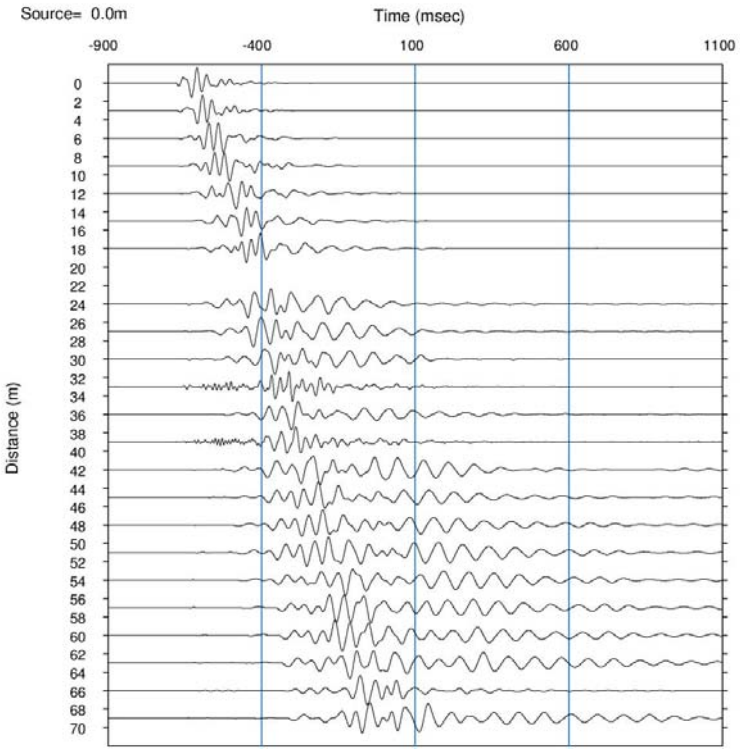


Figure 2: Typical seismic record collected at the site of MASW Line 1 (North).

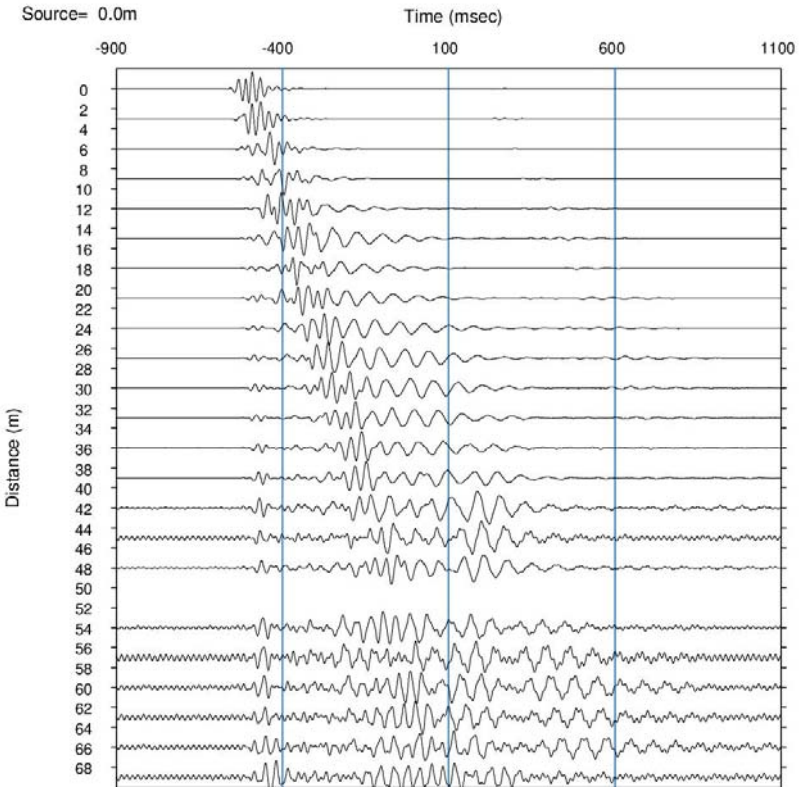


Figure 3: Typical seismic record collected at the site of MASW Line 2 (South).

Data Processing

Processing of the MASW test results consisted of the following main steps:

1) Transformation of the time domain data into the frequency domain using a Fast-Fourier Transform (FFT) for each source location;

2) Calculation of the phase for each frequency component;

3) Linear regression to calculate phase velocity for each frequency component;

4) Filtering of the calculated phase velocities based on the Pearson correlation coefficient (r2) between the data and the linear regression best fit line used to calculate phase velocity;

5) Generation of the dispersion curve by combining calculated phase velocities for each shot location of a single MASW test; and,

6) Generation of the stiffness profile, through forward iterative modelling and matching of model data to the field collected dispersion curve.

Processing of the MASW data was completed using the SeisImager/SW software package (Geometrics Inc.). The calculated phase velocities for a seismic shot point were combined and the dispersion curve generated by choosing the minimum phase velocity calculated for each frequency component as shown on Figure 4 for Line 1 and Figure 5 for Line 2. Shear wave velocity profiles were generated through inverse modelling to best fit the calculated dispersion curves. The active survey of Line 1 provided a dispersion curve with a suitable frequency range (5.8-23 Hz). The active survey of Line 2 provided a dispersion curve with a suitable frequency range (6.8-19.5 Hz). The minimum measured surface wave frequency with sufficient signal-to-noise ratio to accurately measure phase velocity was approximately 5.8 Hz at Line 1 and 6.8 Hz at Line 2.

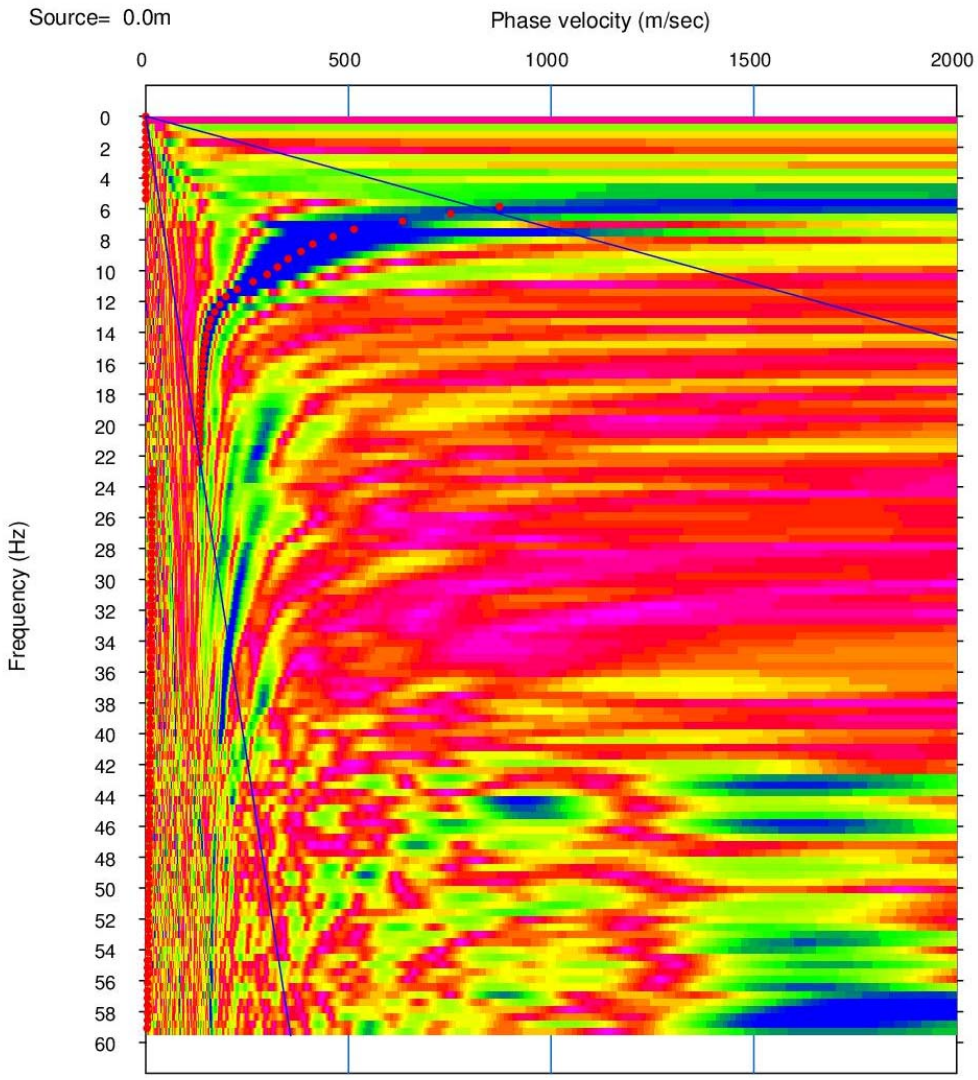


Figure 4: Active MASW Dispersion Curve Picks (red dots) along MASW Line 1

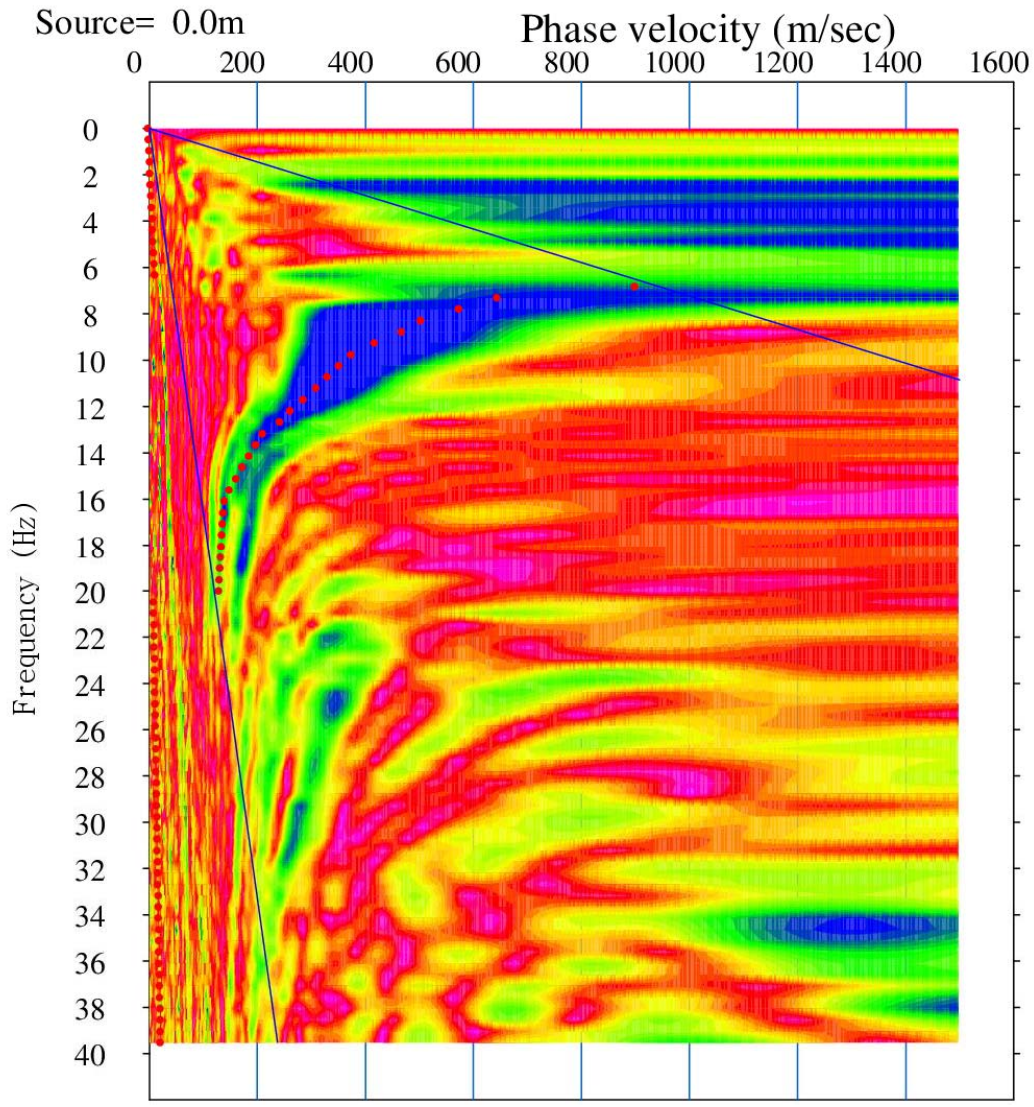


Figure 5: Active MASW Dispersion Curve Picks (red dots) along MASW Line 2

Results

The MASW test results are presented in Figures 6 and 7, which present the calculated shear wave velocity profile derived from the field testing along MASW Lines 1 and 2, respectively. The results along MASW Line 1 have been calculated using a weight-drop located 5 m from the last geophone. The results along MASW Line 2 have also been calculated using a weight-drop located 5 m from the last geophone. The field collected dispersion curves are compared with the model generated dispersion curves on Figures 8 and 9 for MASW Lines 1 and 2, respectively. There is a satisfactory correlation between the field collected and model calculated dispersion curves, with a root mean squared error of less than 4% along both lines.

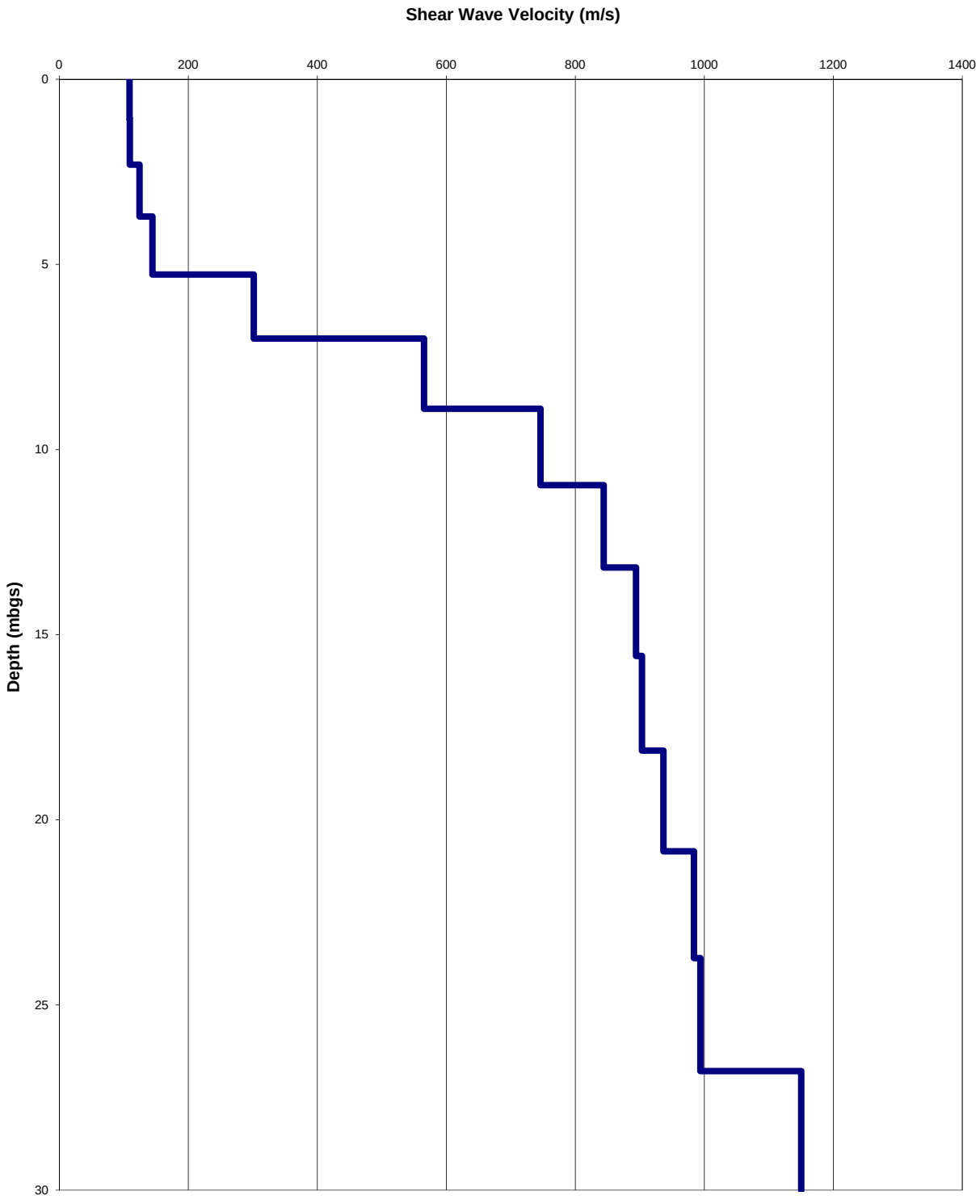


Figure 6: MASW Modelled Shear-Wave Velocity Depth profile along MASW Line 1

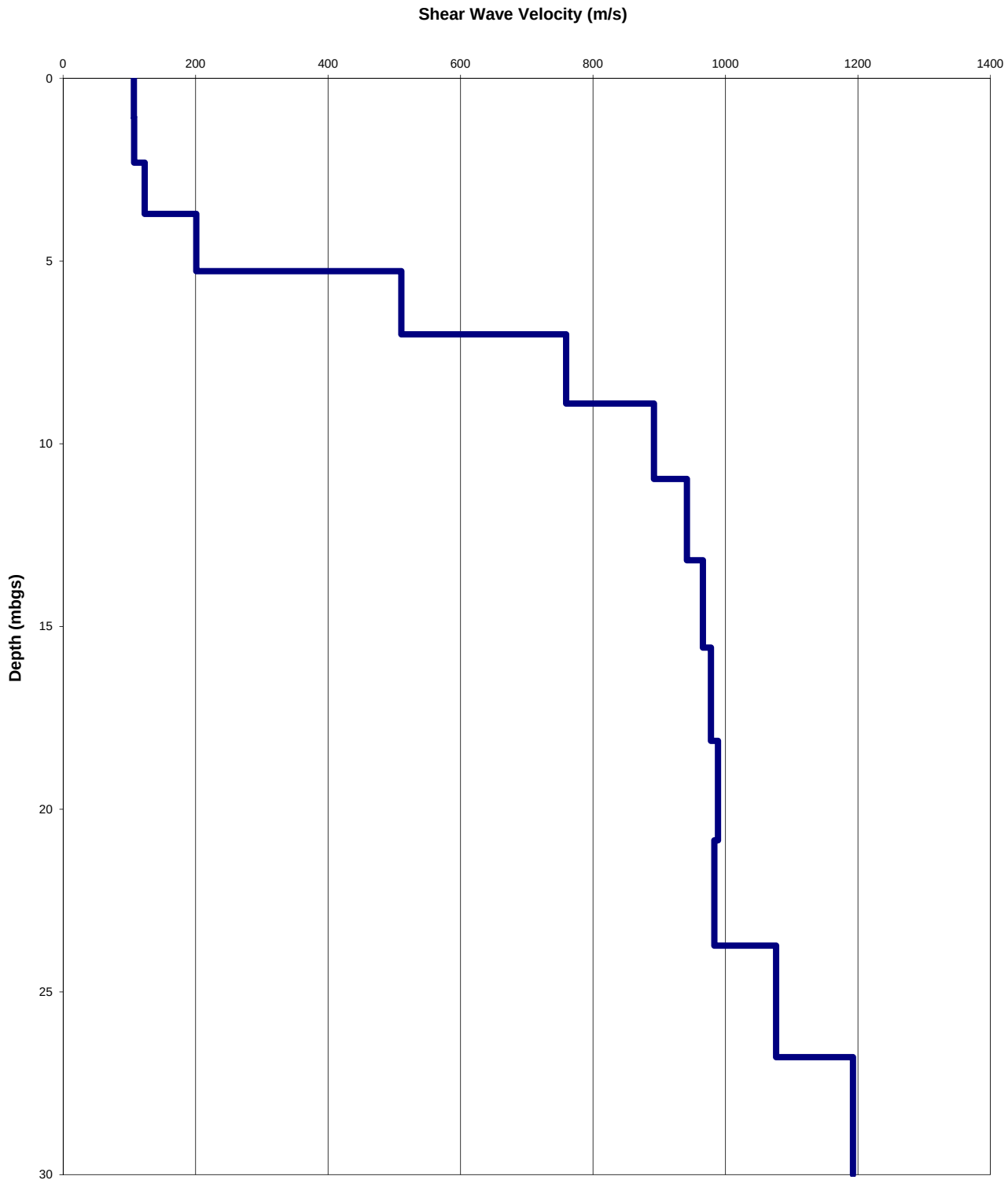


Figure 7: MASW Modelled Shear-Wave Velocity Depth profile along MASW Line 2

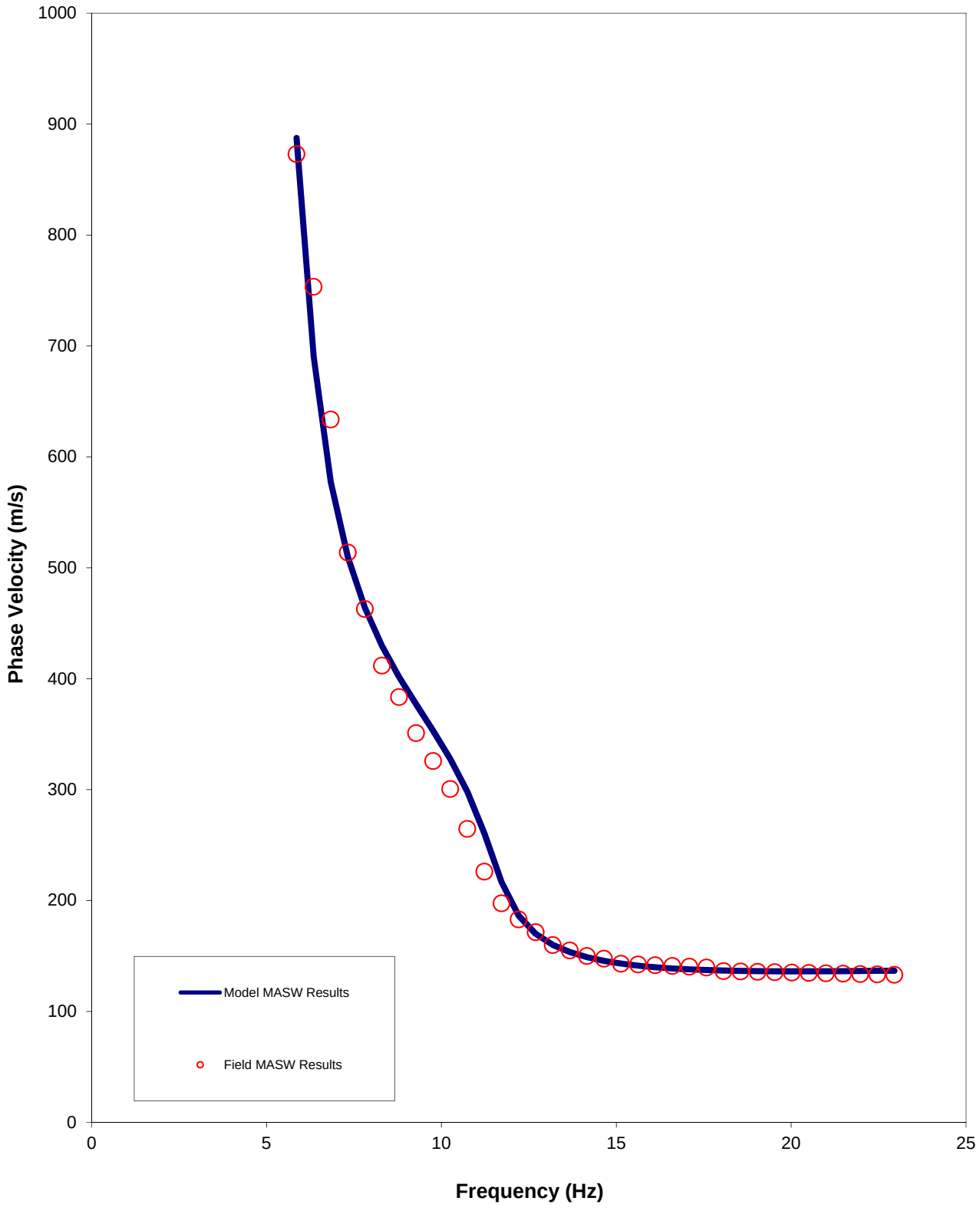


Figure 8: Comparison of Field (red dots) vs. Modelled Data (blue line) along MASW Line 1

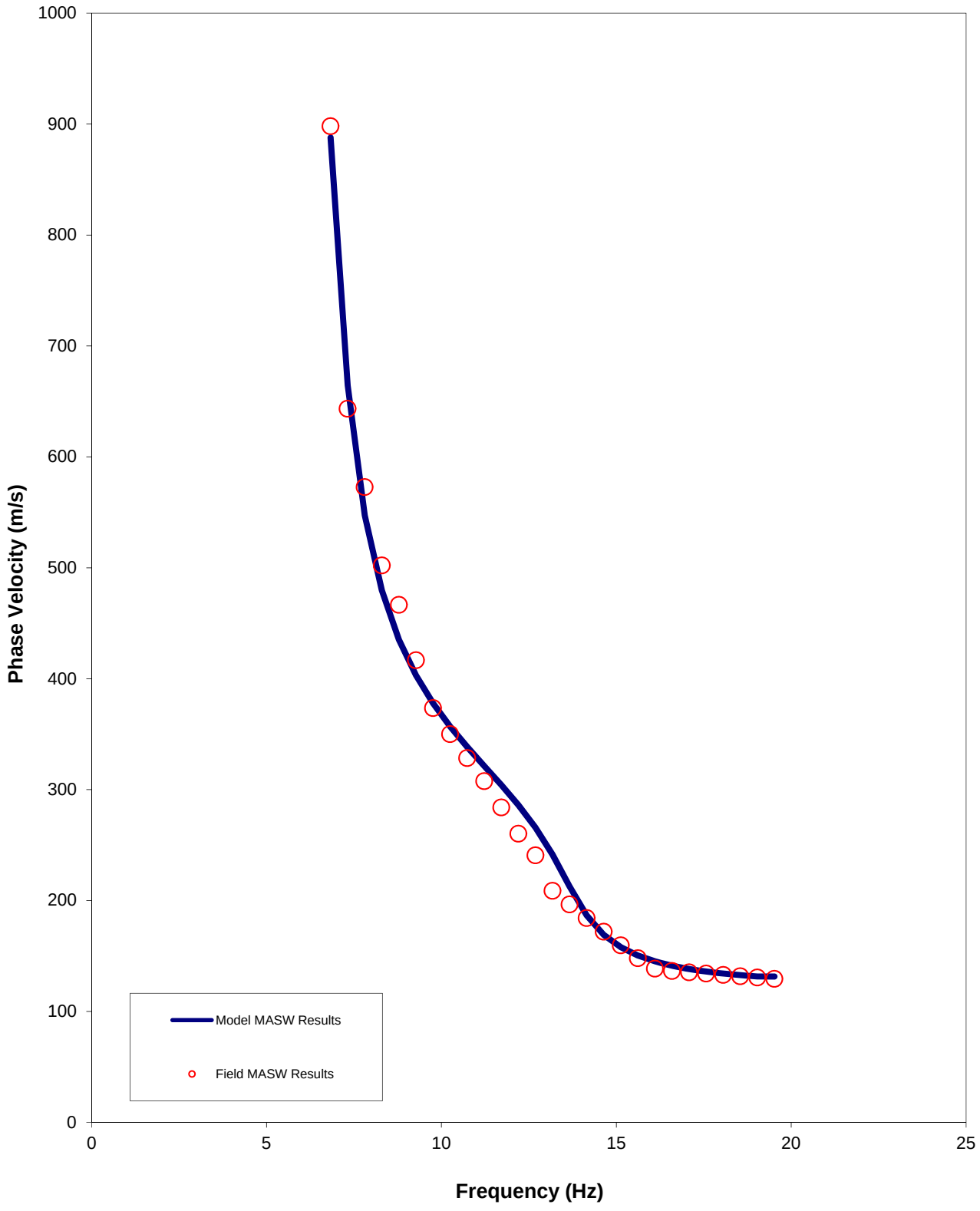


Figure 9: Comparison of Field (red dots) vs. Modelled Data (blue line) along MASW Line 2

To calculate the average shear-wave velocity as required by the CHBDC 2014, the results were modelled to 30 metres below ground surface. The average shear-wave velocity along MASW Line 1 in the north was found to be 400 m/s (Table 1). The average shear-wave velocity along MASW Line 2 in the south was found to be 444 m/s (Table 2).

Table 1: Shear-Wave Velocity Profile along MASW Line 1

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	109	0.009830
1.07	2.31	1.24	109	0.011296
2.31	3.71	1.40	124	0.011266
3.71	5.27	1.56	145	0.010832
5.27	7.01	1.74	302	0.005737
7.01	8.90	1.89	566	0.003352
8.90	10.96	2.06	746	0.002762
10.96	13.19	2.23	844	0.002636
13.19	15.58	2.39	894	0.002673
15.58	18.13	2.55	903	0.002828
18.13	20.85	2.72	937	0.002904
20.85	23.74	2.89	984	0.002931
23.74	26.79	3.05	994	0.003068
26.79	30.00	3.21	1150	0.002794
			Vs Average to 30 mbgs (m/s)	**400**

Table 2: Shear-Wave Velocity Profile along MASW Line 2

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0.00	1.07	1.07	107	0.010013
1.07	2.31	1.24	107	0.011518
2.31	3.71	1.40	123	0.011356
3.71	5.27	1.56	201	0.007781
5.27	7.01	1.74	511	0.003388
7.01	8.90	1.89	760	0.002496
8.90	10.96	2.06	892	0.002310
10.96	13.19	2.23	942	0.002362
13.19	15.58	2.39	966	0.002474
15.58	18.13	2.55	978	0.002612
18.13	20.85	2.72	989	0.002751
20.85	23.74	2.89	983	0.002933
23.74	26.79	3.05	1077	0.002832
26.79	30.00	3.21	1193	0.002695
			Vs Average to 30 mbgs (m/s)	**444**

The CHBDC 2014 requires special site specific evaluation if certain soil types are encountered on the site, so the site classification stated here should be reviewed, and modified if necessary, according to borehole stratigraphy, standard penetration resistance results, and undrained shear strength measurements, if available for this site.

Limitations

This technical memorandum is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The services performed, as described in this memo, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this memo, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this memo.

The findings and conclusions of this memo are valid only as of the date of this memo. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this memo, and to provide amendments as required.

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.

Stephane Sol, Ph.D, P. Geo
Senior Geophysicist

Christopher Phillips, M. SC., P. Geo
Senior Geophysicist, Principal

SS/CRP/jl

https://golderassociates.sharepoint.com/sites/11263g/shared documents/01_foundations/12_geophysics/cnr-phase 1110 masw/report/final_december 2017/1662565 1110 tech memo 2017dec mto cnr.docx

TECHNICAL MEMORANDUM

DATE March 06, 2018 **PROJECT No.** 1662565/1110

TO Susan Trickey
Golder Associates Ltd.

FROM Stephane Sol, Christopher Phillips **EMAIL** ssol@golder.com, cphillips@golder.com

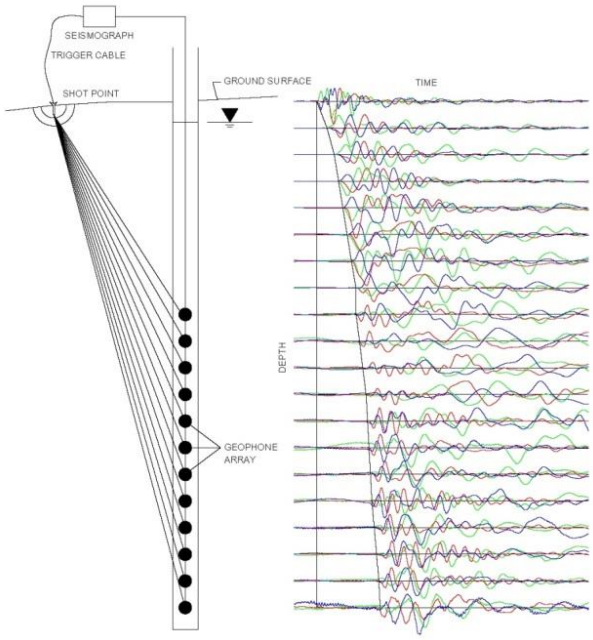
VERTICAL SEISMIC PROFILING TEST RESULTS
CNR OVERPASS ALONG HWY 17, OTTAWA, ONTARIO

This memorandum presents the results of a Vertical Seismic Profiling (VSP) testing carried out at the CNR Overpass along HWY417 in Ottawa, Ontario. VSP testing was completed in Borehole 17-1110. VSP testing was carried out on July 27, 2017. Borehole 17-1110 was drilled to an approximate depth of 21.9 m below the existing ground surface and then cased with a PVC pipe grouted in place. The overburden consisted of approximately 0.7 m of asphalt and road granular, overlying approximately 10 m of sand fill, 4.2 m of weathered and unweathered silty clay, and 1.3 m of glacial till. At Borehole 17-1110 the shale bedrock was located at approximately 16.2 mbgs to the bottom of the hole.

Methodology

For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in a nearby borehole at a known depth. The active seismic source can be either compression or shear wave. The time required for the energy to travel from the source to the receiver (geophone) provides a measurement of the average compression or shear wave seismic velocity of the medium between the source and the receiver. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the test borehole.

The high resolution results of a VSP survey are often used for earthquake engineering site classification, as per the 2014 Canadian Highway Bridge Design Code (CHBDC 2014).



Example 1: Layout and resulting time traces from a VSP survey.

Fieldwork

The fieldwork was carried out on July 27, 2017, by personnel from the Golder Mississauga and Ottawa offices.

Both compression and shear-wave seismic sources were used and both were located 2 m from the borehole. The seismic source for the compression wave test consisted of a 9.9 kg sledge hammer vertically impacted on a metal plate. The seismic source for the shear-wave test consisted of a 2.4 m long, 150 mm by 150 mm wooden beam, weighted by a vehicle and horizontally struck with a 9.9 kilogram sledge hammer on alternate ends of the beam to induce polarized shear waves. The shear source was coupled to the ground surface by parking a vehicle on top of it. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced at 1-metre intervals below the ground surface to a depth of 12 m and spaced at 0.5 metre intervals from 12 m to 21.5 m.

The seismic records collected for each source location were stacked a minimum of five times to minimize the effects of ambient background seismic noise on the collected data. The data was sampled at 0.020833 ms intervals and a total time window of 0.341 s was collected for each seismic shot.

Data Processing

Processing of the VSP test results consisted of the following main steps:

1) Combination of seismic records to present seismic traces for all depth intervals on a single plot for each seismic source and for each component;

2) Low pass filtering of data to remove spurious high frequency noise;

3) First break picking of the compression and shear wave arrivals; and,

4) Calculation of the average compression and shear wave velocity to each tested depth interval.

Processing of the VSP data was completed using the SeisImager/SW software package (Geometrics Inc.). The seismic records are presented on the following two plots and show the first break picks of the compression wave at Borehole 17-1110 (Figure 1) and shear wave arrivals at Borehole 17-1110 (Figure 2) overlaid on the seismic waveform traces recorded at the different geophone depths for each borehole. The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.

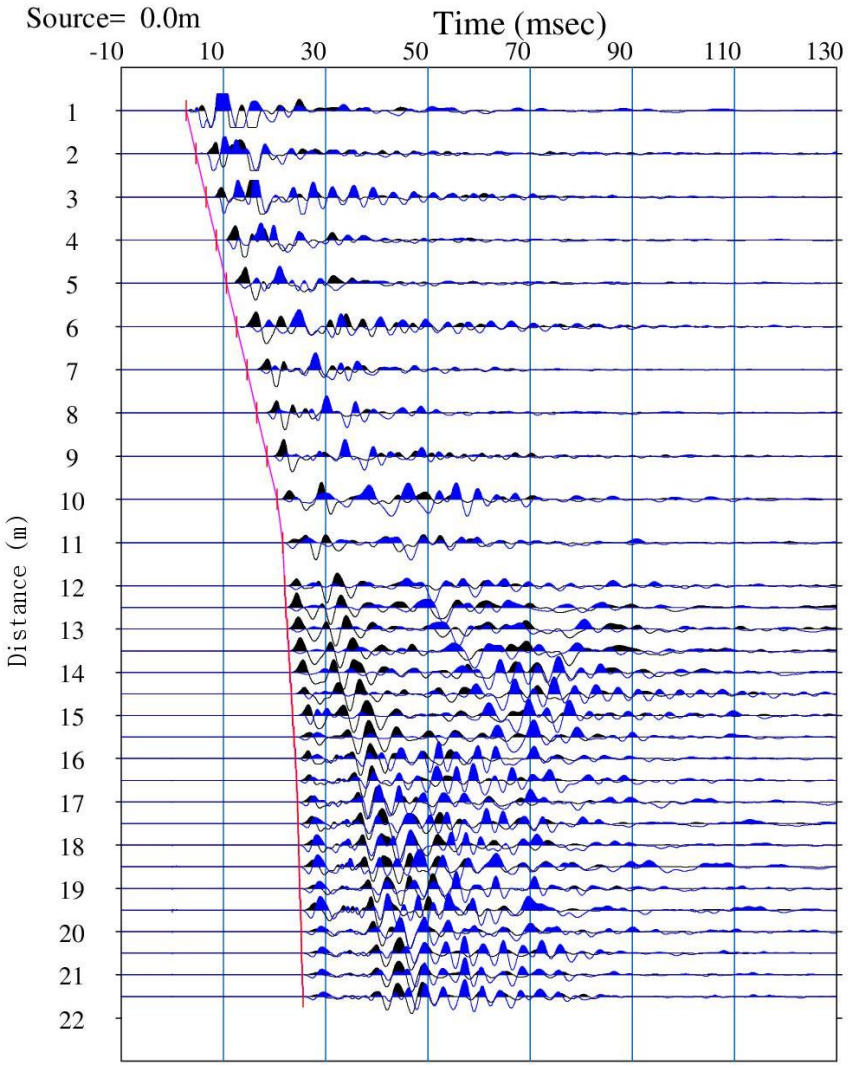


Figure 1: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 17-1110.

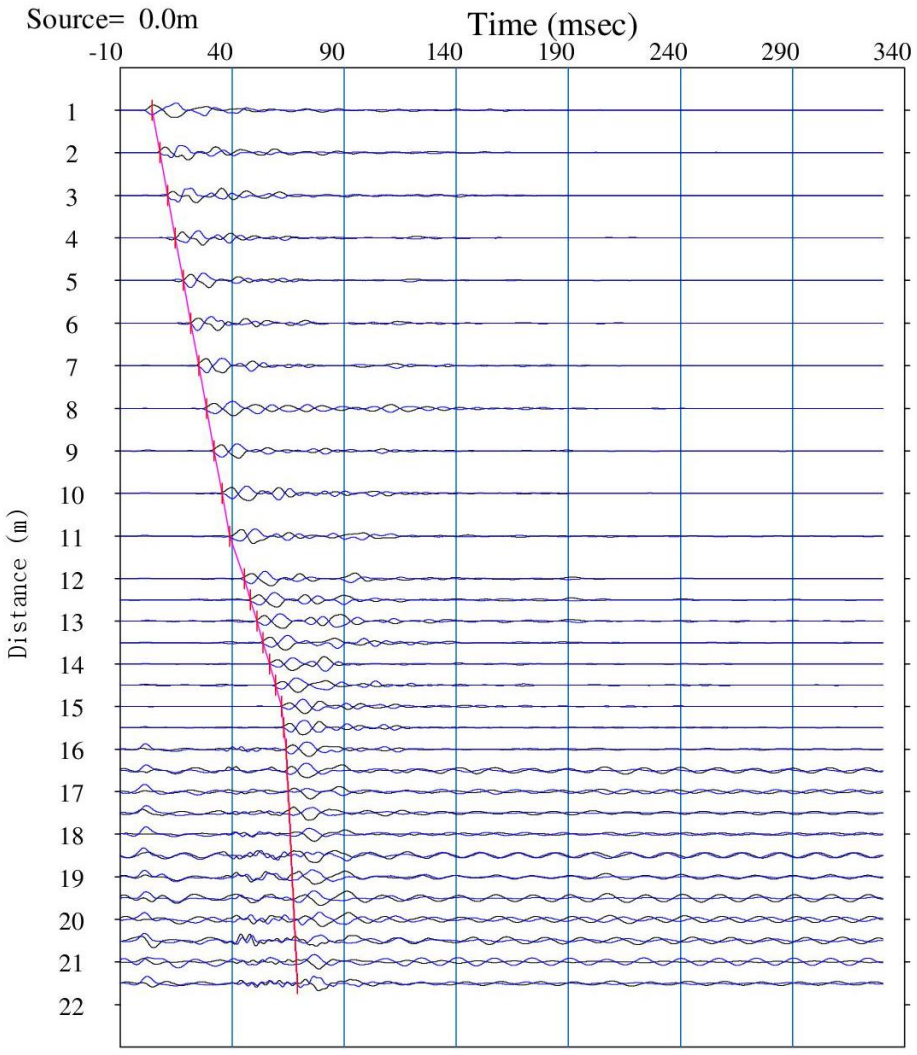


Figure 2: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of Borehole 17-1110.

Results

The VSP results at Borehole 17-1110 are summarized in Table 1. The compression and shear wave layer velocities were calculated by best fitting a theoretical travel time model to the field data. The depths presented on the table are relative to ground surface.

The estimated dynamic engineering moduli, based on the calculated wave velocities, are also presented in Table 1. The engineering moduli were calculated using an estimated bulk density of 2,140 kg/m^3 for sand fill, 1,835 kg/m^3 for the weathered silty clay, 1,750 kg/m^3 for unweathered silty clay, 2,365 kg/m^3 for glacial till and an estimated shale bedrock bulk density of 2,400 kg/m^3 based on the borehole log.

The average shear wave velocity from ground surface to a depth of 30 m (Vs30) was measured to be 393 m/s at Borehole 17-1110. The average velocity was calculated assuming that the velocity from 21.5 m to a depth of

30 m was constant with an average shear wave velocity value of 1,100 m/s which is equal to the velocity of the bedrock at the bottom of the borehole.

Limitations

This technical memorandum is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

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The findings and conclusions of this memo are valid only as of the date of this memo. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this memo, and to provide amendments as required.

Closure

We trust that these results meet your current needs. If you have any questions or require clarification, please contact the undersigned at your convenience.

GOLDER ASSOCIATES LTD.

Stephane Sol, Ph.D., P.Geo
Senior Geophysicist

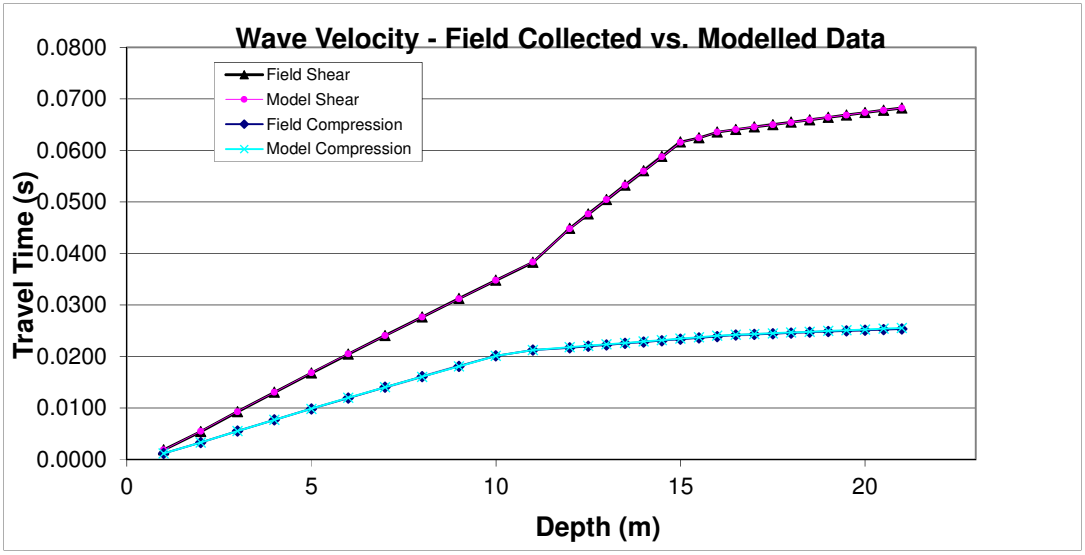
Christopher Phillips, M.Sc., P.Geo
Principal, Senior Geophysicist

SS/CRP/jl
https://golderassociates.sharepoint.com/sites/11263g/shared documents/01_foundations/12_geophysics/cnr-vsp_phase1110_bh17-1110/report/march 2018/1662565_1110 tech memo 2018mar06.docx

Attachment: Table 1 – Shear Wave Velocity Profile at Borehole 17-1110

TABLE 1
SHEAR WAVE VELOCITY PROFILE AT BOREHOLE 17-1110

Layer Depth (m)		Velocities (m/s)		Estimated Bulk Density (kg/m^3)	Dynamic Engineering Properties			
Top	Bottom	Compressional Wave	Shear Wave		Poissons Ratio	Shear Modulus (MPa)	Deformation Modulus (MPa)	Bulk Modulus (MPa)
0.0	1.0	830	530	2140	0.16	601	1390	673
1.0	2.0	475	280	2140	0.23	168	414	259
2.0	3.0	450	260	2140	0.25	145	361	240
3.0	4.0	455	265	2140	0.24	150	374	243
4.0	5.0	470	265	2140	0.27	150	381	272
5.0	6.0	470	275	2140	0.24	162	401	257
6.0	7.0	485	280	2140	0.25	168	419	280
7.0	8.0	495	280	2140	0.26	168	424	301
8.0	9.0	490	280	2140	0.26	168	422	290
9.0	10.0	490	280	2140	0.26	168	422	290
10.0	11.0	900	280	2140	0.45	168	485	1510
11.0	12.0	1800	155	1835	0.50	44	132	5887
12.0	12.5	1800	175	1835	0.50	56	168	5870
12.5	13.0	1800	180	1835	0.49	59	178	5866
13.0	13.5	1800	180	1750	0.49	57	170	5594
13.5	14.0	1800	180	1750	0.49	57	170	5594
14.0	14.5	1800	180	1750	0.49	57	170	5594
14.5	15.0	1800	180	1750	0.49	57	170	5594
15.0	15.5	1800	550	2365	0.45	715	2073	6709
15.5	16.0	1800	450	2365	0.47	479	1405	7024
16.0	16.5	2900	1000	2365	0.43	2365	6776	16736
16.5	17.0	3300	1100	2400	0.44	2904	8349	22264
17.0	17.5	3300	1100	2400	0.44	2904	8349	22264
17.5	18.0	3400	1100	2400	0.44	2904	8372	23872
18.0	18.5	3400	1050	2400	0.45	2646	7659	24216
18.5	19.0	3400	1050	2400	0.45	2646	7659	24216
19.0	19.5	3400	1050	2400	0.45	2646	7659	24216
19.5	20.0	3400	1100	2400	0.44	2904	8372	23872
20.0	20.5	3400	1100	2400	0.44	2904	8372	23872
20.5	21.0	3400	1100	2400	0.44	2904	8372	23872
21.0	21.5	3400	1100	2400	0.44	2904	8372	23872



Notes

1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.

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