



REPORT

**Foundation Investigation
Ramsayville Road Overpass Replacement
Site No. 3-265/1 (EBL) and 3-265/2 (WBL)
Highway 417
Ottawa, Ontario
GWP No. 4145-10-00**

Submitted to:

WSP Canada Group Limited

300 - 2611 Queensview Drive
Ottawa, Ontario
K2B 8K2

Submitted by:

Golder Associates Ltd.

1931 Robertson Road Ottawa, Ontario, K2H 5B7 Canada

Geocres Number: 31G5-284

Latitude: 45.373832 Longitude: -75.565307

1662565-1130

August 2018

Distribution List

3 copies - Ministry of Transportation, Kingston

2 copies - WSP Canada Group Limited

1 copy - Ministry of Transportation, Downsview

1 e-copy - Golder

Table of Contents

PART A – FOUNDATION INVESTIGATION

1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION AND GEOLOGY	1
2.1 General.....	1
2.2 Regional Geology.....	1
3.0 INVESTIGATION PROCEDURES	2
3.1 Current Investigation (2017).....	2
3.2 Previous Investigation (1968).....	4
4.0 DESCRIPTION OF SUBSURFACE CONDITIONS	5
4.1 Site Stratigraphy.....	5
4.2 Topsoil and Fill Material	5
4.3 Alluvium.....	6
4.4 Silty Clay to Clayey Silt	6
4.5 Silty Sand to Sandy Silt (Glacial Till).....	7
4.6 Bedrock	8
4.7 Groundwater Conditions	9
5.0 CLOSURE	10

DRAWINGS

Drawing 1 - Ramsayville Creek Overpass, Site 3-265/2, Borehole Locations and Soil Strata

Drawing 2 - Ramsayville Creek Overpass, Site 3-265/1, Borehole Locations and Soil Strata

APPENDICES

APPENDIX A

Borehole and Drillhole Records, Current Investigation

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes 17-1301 to 17-1312

Bedrock Core Photographs, Figures A1 to A14

APPENDIX B

Laboratory Test Results, Current Investigation

Figure B1 – Grain Size Distribution Test Results – Silt and Clay (FILL)

Figure B2 – Grain Size Distribution Test Results – Silty Sand (ALLUVIUM)

Figure B3 – Plasticity Chart – Silty Clay to Clay (WEATHERED CRUST)

Figure B4a to B4c – Plasticity Chart – Silty Clay to Clay

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

Figures B6 to B11 – Consolidation Test Results

Figure B12 – Plasticity Chart – Silty Sand to Sandy Silt (TILL)

Figure B13 – Grain Size Distribution Test Results – Silty Sand to Sandy Silt (TILL)

Figure B14 – Summary of Laboratory Compressive Strength Testing – Unconfined Compression Tests

Figure B15 – Summary of Engineering Properties

APPENDIX C

Borehole Record and Laboratory Test Results

(Previous Investigation, GEOCRETS No. 31G05-071)

Records of Previous Boreholes BH 1 to BH 10

Laboratory Test Results

APPENDIX D

Basic Chemical Analysis – Eurofins Report Number 1710192

APPENDIX E

Results of MASW Testing

APPENDIX H

Site Photographs

PART A

Foundation Investigation Report
Proposed Ramsayville Road Replacement
Site No. 3-265/1 and 3-265/2
Highway 417
Ottawa, Ontario
GWP 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 provide foundation design recommendations of the proposed replacement of the Ramsayville Road Overpass, Sites No. 3-265/1 and 3-265/2 located on Highway 417 East Bound Lane (EBL) and West Bound Lane (WBL), respectively in Ottawa, Ontario (G.W.P. 4145-10-00 and W.P. 4145-10-01). The replacement of the existing 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 Ramsayville Road Overpass is contained in Table 17.8.3 of WSP's Technical Proposal for this assignment. 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 Ramsayville Road Overpass is located approximately 2.0 km south of Hunt Club Road in Ottawa, Ontario. At this location, Highway 417 is a divided highway with two travel lanes in each direction separated by a green area with an approximate width of 70 m.

The existing EBL bridge was constructed in 1970 and the existing WBL bridge was constructed in 1973. The bridges are five-span, 93.9 m long (18.0 m, 18.3 m, 21.3 m, 18.3 m, and 18.0 m), reinforced concrete slab on pre-stressed girder structures. The overall structure width is 11.0 m in the EBL and 12.6 m in the WBL. The structure is supported by four piers and conventional spill-through abutments. The bridge abutments are supported on "perched" foundations on vertical steel piles end bearing on bedrock. The front row of piles are battered in line with Highway 417. The pier foundations are supported on battered steel piles end bearing on bedrock.

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

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.

bedrock². 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 shale 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 bedrock of Carlsbad Formation.

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada. 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.

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigation (2017)

The subsurface investigation for the bridge replacement was carried out between May 7 and June 10, 2017. During that time, twelve boreholes (17-1301 to 17-1312, inclusive) were advanced within the median at the proposed locations of the piers and abutments. The borehole locations are shown on Drawings 1 and 2.

The boreholes were advanced using 108 mm inside diameter (200 mm outside diameter) continuous flight hollow stem augers on track mounted drill rigs, supplied and operated by Forage Grenville Drilling of Grenville, Québec. The boreholes were advanced to depths ranging from about 13.4 to 56.0 m below the existing ground surface.

Samples of the overburden were obtained at 0.8 m to 4.5 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure. In-situ vane testing (using an MTO “N”-sized vane) was carried out within the cohesive deposits, where possible. Boreholes 17-1301A, 17-1306A, and 17-1312B were advanced adjacent to 17-1301, 17-1306, and 17-1312, respectively, to retrieve relatively undisturbed 73 millimetre diameter thin-walled Shelby tube samples of the clay using a fixed piston sampler.

Upon reaching refusal to casing advancement in Boreholes 17-1302, 17-1303, 17-1305 and 17-1308 to 17-1311, the boreholes were advanced into the bedrock surface to depths of 3 to 3.4 m using rotary diamond drilling techniques while retrieving NQ sized core. A water truck was on site to supply the drill rigs with water for advancing the casing in the overburden and for the coring the bedrock. Traffic control required to allow the water truck and support vehicles to park adjacent to the site was supplied by Beacon Lite Ltd. of Ottawa, Ontario.

Monitoring wells were installed in Boreholes 17-1305, 17-1310, and 17-1311 to monitor the groundwater level at the site. The monitoring wells consisted of 31 and 50 mm outside diameter PVC tubing with a 1.5 to 3.0 m long screen. The groundwater levels was measured in the monitoring wells on June 16, 2017.

The remainder of the boreholes were backfilled with bentonite mixed with soil cuttings. The site conditions were restored following completion of the field work.

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.

The field work was supervised on a full time basis by members of Golder's staff who located the boreholes in the field, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers, and transported to Golder's laboratory in Ottawa for further examination and to Golder's laboratories in Ottawa and Mississauga for testing. Index and classification tests consisting of water content determinations, Atterberg Limit tests, and grain size distribution analyses were carried out on selected soil samples at the Golder Ottawa laboratory. Unconfined compressive strength tests were carried out on selected rock core samples in the Golder Mississauga laboratory. Consolidation tests were performed on selected Shelby tube samples from Boreholes 17-1301A, 17-1305, 17-1307, 17-1311, and 17-1312B at Golder's Mississauga laboratory. The laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate.

Eight soil samples from Boreholes 17-1302, 17-1303, 17-1304, 17-1305, 17-1308, 17-1309, 17-1310, and 17-1311 were submitted to Eurofins Environment Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack).

In addition to the borehole investigation, shear wave velocity profiling at the site was completed using the Multichannel Analysis of Surface Waves (MASW) technique and was conducted on May 9, 2017, by personnel from the Golder Associates' Mississauga and Ottawa offices. A series of 24 low frequency (4.5 Hz) geophones were laid out at 3 m intervals. A 9.9 kg sledge hammer and 45 kg weight drop were used as the seismic source. The source locations were offset at distances of 5, 10, and 15 m off the end and collinear with the geophone array.

The borehole elevation were surveyed by Golder using a Trimble R8 GPS unit. The borehole locations, including MTM NAD83 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.

Borehole Number	Borehole Location	MTM NAD83 Zone 9 Northing (m)	MTM NAD83 Zone 9 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
17-1301	EBL West Approach Embankment	5026398.4	377872.0	78.2	13.4
17-1301A	EBL West Approach Embankment	5026398.4	377872.0	78.2	5.9
17-1302	EBL West Abutment	5026398.8	377896.0	74.6	54.3
17-1303	EBL West Pier	5026388.9	377932.9	71.3	51.5
17-1304	EBL East Pier	5026379.0	377968.8	72.5	48.7
17-1305	EBL East Abutment	5026374.0	377994.5	76.6	56.1

Borehole Number	Borehole Location	MTM NAD83 Zone 9 Northing (m)	MTM NAD83 Zone 9 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
17-1306	EBL East Approach Embankment	5026368.5	378017.3	77.3	13.4
17-1306A	EBL East Approach Embankment	5026369.6	378017.2	77.1	6.1
17-1307	WBL East Approach Embankment	5026409.0	378035.5	77.7	13.4
17-1308	WBL East Abutment	5026420.5	378004.0	71.3	50.8
17-1309	WBL East Pier	5026421.8	377984.1	69.6	48.4
17-1310	WBL West Pier	5026428.4	377933.4	71.6	51.4
17-1311	WBL West Abutment	5026435.9	377914.0	75.3	54.6
17-1312	WBL West Approach Embankment	5026443.2	377899.3	77.5	14.3
17-1312B	WBL West Approach Embankment	5026443.2	377899.3	77.5	10.4

3.2 Previous Investigation (1968)

A previous investigation was carried out in 1968 by the MTO (then the Department of Highways, Ontario) for the design of the existing bridge. The results of that investigation are contained in the report titled *“Foundation Investigation Report for Eastbound Lane and West Bound Lane, Structures at the Crossing of Ramsay Creek and Proposed Hwy. #417, District No. 9 (Ottawa), W.J. 68-F-54 – W.P. 34-66-10-11”* dated September 26, 1968 (GEOCREs No. 31G05-071).

As part of the current assignment, this previously collected subsurface information pertinent to the site was reviewed and compiled.

Ten boreholes, each with an adjacent Dynamic Cone Penetration Test (DCPT), were put down at the site as part of the original investigation along the then-proposed bridge alignment. 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 and DCPTs 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 1968 investigation.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The Record of Borehole sheet from the current investigation is presented 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 B13 in Appendix B. The results of basic chemical analysis completed on select soil samples are provided in Appendix D. The borehole locations and the interpreted stratigraphic profile projected along the Ramsayville Road Overpass WBL and EBL are shown on Drawings 1 and 2, respectively. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile are inferred from observations of drilling progress and noncontinuous- 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 test results and report are presented in Appendix E 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 extending down to depths of about 0.4 to 2.0 metres (Elevations of about 69.2 to 76.7 m) over a deposit of alluvium extending down to a depth of about 1.8 m (Elevation of about 67.8 m). The fill and alluvium are underlain by a thick deposit of sensitive silty clay extending down to depths of about 33.8 to 42.1 m (Elevations of about 33.5 to 36.2 m) overlying a thin glacial till mantle extending to depths of about 45.0 to 53.0 m (Elevations of about 23.3 to 24.6 m) and shale bedrock. Shale bedrock was indicated to be present at depths ranging from 45 to 53 m (Elevations of about 23.3 to 24.6 m). The groundwater levels were encountered at depths ranging from about 3.0 m below the ground surface to 7.0 m above the ground surface (Elevations ranging from about 70.4 to 79.5 m).

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

4.2 Topsoil and Fill Material

Topsoil was encountered at the ground surface at Boreholes 17-1301, 17-1302, 17-1303, and 17-1309 to 17-1312. The topsoil ranges in thickness from about 100 to 300 millimetres.

A layer of fill exists at the ground surface, or below the topsoil where encountered, in Boreholes 17-1301, 17-1303 to 17-1308, and 17-1312 and extends to depths ranging from about 0.4 to 2.0 m below ground surface. The fill material generally consists of silty sand to silty clay to clayey silt with varying amounts of gravel. The fill also contains organic matter.

SPT 'N' values measured in the fill material generally range from about 4 to 12 blows per 0.3 m of penetration indicating the state of compactness is loose to compact.

The results of grain size distribution testing carried out on three samples of the fill are shown on the record of borehole logs and provided on Figure B1. The measured water content of the fill ranges from approximately 22 to 33 percent.

4.3 Alluvium

A deposit of alluvium was encountered below the topsoil in Borehole 17-1309 and consists of a mixture of silty clay, clayey silt and silty sand. The alluvium deposit extends down to a depth of about 1.8 m below the existing ground surface.

One SPT 'N' value of 8 blows per 0.3 m of penetration was measured in the alluvium, indicating the state of compactness is loose.

The results of grain size distribution testing carried out on one sample of the alluvium are shown on the record of borehole logs and provided in Figure B2. The measured water content on one sample of the alluvium deposit is approximately 24 percent.

4.4 Silty Clay to Clayey Silt

An extensive deposit of silty clay to clayey silt was encountered in the boreholes at this site. The deposit was proven to be about 32 m to 42 m in thickness, with the base of the deposit observed at depths of approximately 33.8 to 42.1 m below the existing ground surface (i.e. Elevation ranging from about 33.5 to 36.2 m). Much of the silty clay to clay deposit contained black organic mottling. Some silty sand layers were also noted.

The upper portion of the silty clay to clay deposit has been weathered to a grey-brown crust at all of the borehole locations except 17-1309. The weathered crust extends to depths ranging from about 1.4 to 4.3 m below the existing ground surface (i.e., Elevations ranging from 67.6 to 74.4 m).

SPT 'N' values measured in the weathered silty clay crust ranged from 2 to 12 blows per 0.3 m of penetration. In situ shear vane testing carried out within this deposit measured undrained shear strengths ranging from about 57 to greater than 96 kPa, indicating that the deposit has a stiff to very stiff consistency. In situ remold strengths from two shear vane tests were about 27 kPa, indicating a silty clay of medium sensitivity. A summary of the undrained shear strengths is shown in Figure B15.

The results of Atterberg limit testing on 10 samples of the weathered silty clay deposit gave plasticity index values ranging from about 32 and 58 percent and liquid limit values ranging from about 52 and 85 percent, indicating a deposit of high plasticity. The results of the Atterberg limit testing are provided on Figure B3 and Figure B15. The measured water content on 16 samples of the weathered silty clay deposit ranges from approximately 24 to 60 percent. The silty clay to clay below the depth of weathering is grey in colour. At depth, the grey silty clay to clay grades to clayey silt to silty clay. The grey silty clay to clayey silt, where fully penetrated, extends to depths ranging from about 33.8 to 42.1 m below the existing ground surface (Elevations ranging from about 33.5 to 36.2 m).

SPT 'N' values measured in the silty clay deposit ranged from "weight of rods" 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 to greater than 96 kPa, generally increasing with depth. Lower values of 19 and 22 kPa were measured at Boreholes 17-1301 and 17-1312, both at the western limit of the investigation, with the remainder of the boreholes showing values ranging from 26 to greater than 96 kPa. The results of the in situ testing indicate a soft to very stiff consistency. In situ remold strengths carried out within the unweathered silty clay gave remold shear strengths ranging from 2 to 27 kPa, indicating a medium sensitivity to quick silty clay. A summary of the undrained shear strengths is shown in Figure B15. The results of Atterberg limit testing on 37 samples of the silty clay deposit gave plasticity index values ranging from about 7 and 60 percent and liquid limit values ranging from about 23 and 85 percent, indicating a clay of low to high plasticity. One sample of the clayey

silt was found to be non-plastic. The results of the Atterberg limit testing are provided on Figure B4 and Figure B15. The measured water content on 71 samples of the weathered silty clay deposit ranges from approximately 24 to 94 percent.

The results of grain size distribution testing carried out on five samples of the silty clay to clay are shown on the record of borehole logs and provided on Figure B5. The results of the laboratory oedometer consolidation tests indicate vertical coefficient of consolidation values (c_v) which range from about 2×10^{-5} cm²/s to 3×10^{-2} cm²/s for loads less than 125 kPa, and ranges from 9×10^{-6} cm²/s to 1×10^{-3} cm²/s for loads greater than 125 kPa. The values of the coefficient of consolidation (C_v) for the silty clay to clay were calculated using the Taylor method (root-time method). It should be noted that the oedometer consolidation tests were carried out using a relatively low load increment ratio ('LIR' – which is the ratio of the magnitude of each load increment to the magnitude of the previous total load), which assists with defining the preconsolidation pressure for a sensitive and structured clay, such as present at this site, but can yield unrepresentative c_v values.

Laboratory oedometer consolidation testing was carried out on six samples of silty clay to clay selected from Boreholes 17-1301A, 17-1305, 17-1307, 17-1311, 17-1312B. The results of that testing are provided on Figures B6 to B11 and are summarized in the table below.

Borehole/ Sample Number	Sample Depth/ Elevation (m)	Unit Weight (kN/m ³)	$\sigma_{P'}$ (kPa)	$\sigma_{vo'}^{(1)}$ (kPa)	$\sigma_{P'} - \sigma_{vo'}$ (kPa)	Cc	Cr	e_o	OCR
17-1301A / 1	5.6 / 72.6	15.0	86 - 89	57	29 – 32	1.45	0.026	2.28	1.51 – 1.56
17-1305 / 8	7.9 / 68.7	15.2	188 - 200	60	128 – 140	2.66	0.019	2.11	3.13 – 3.33
17-1305 / 11	15.4 / 61.2	15.3	220 - 235	100	110 – 135	3.32	0.022	2.13	2.20 – 2.35
17-1307 / 7	6.4 / 71.3	15.1	140 - 146	51	89 – 95	1.75	0.024	2.16	2.75 – 2.86
17-1311 / 6	7.0 / 68.3	15.2	167 - 175	65	102 – 110	2.70	0.021	2.23	2.57 – 2.69
17-1312B / 1	10.1 / 67.4	14.5	182 – 185	80	102 – 105	4.03	0.013	2.52	2.28 – 2.31

Notes:

- $\sigma_{P'}$ - Apparent preconsolidation pressure
- $\sigma_{vo'}$ - Computed existing vertical effective stress
- Cc - Compression index
- Cr - Recompression index
- e_o - Initial void ratio
- OCR - Overconsolidation ratio
- ⁽¹⁾ - Based on typical range of grey clay unit weights of 16.25 to 17.25 kN/m³

4.5 Silty Sand to Sandy Silt (Glacial Till)

A deposit of glacial till was encountered below the silty clay to clayey silt in Boreholes 17-1302 to 17-1305, and 17-1308 to 17-1311. The glacial till deposit generally consists of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt. The glacial till extends to depths ranging from about 45.0 to 53.0 m below the existing ground surface (i.e., Elevations ranging from about 23.3 to 24.6 m).

SPT 'N' values measured in the glacial till deposit ranges from 1 to greater than 50 blows per 0.3 m of penetration, but more generally ranging from 12 to 30 blows per 0.3 m of penetration, indicating the state of compactness is compact to dense. The higher blow counts could possibly reflect the presence of cobbles, boulders or the bedrock surface rather than the state of packing of the soil matrix.

The results of Atterberg limit testing on five samples of the glacial till deposit gave plasticity index values of about 3 percent and liquid limit values of about 15 percent, indicating a silt of low plasticity. Three of the samples of the glacial till were found to be non-plastic. The results of the Atterberg limit testing are provided on Figure B12 and Figure B15. The measured water content on 19 samples of the glacial till deposit ranges from approximately 5 to 19 percent.

The results of grain size distribution testing carried out on nine samples of the glacial till are shown on the borehole logs and provided on Figure B13.

4.6 Bedrock

Refusal to sampler advancement was encountered in Borehole 17-1304 at a depth of about 48.7 m below the existing ground surface (Elevation 23.8 m).

Bedrock was encountered beneath the glacial till in Boreholes 17-1302, 17-1303, 17-1305, and 17-1308 to 17-1311 at depths ranging from about 45.0 m to 53.0 m below the existing ground surface (i.e., Elevations ranging from about 23.3 to 24.6 m). The bedrock was cored between about 3.0 and 4.0 m using a NQ drill bit and rods.

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

Borehole Number	Borehole Location with respect to Bridge Structure	Existing Ground Surface Elevation (m)	Depth to Bedrock/Refusal (m)	Bedrock Surface/Refusal Elevation (m)
17-1302	EBL West Abutment	74.6	51.3	23.3
17-1303	EBL West Pier	71.3	47.5	23.8
17-1304	EBL East Pier	72.5	48.7 ¹	23.8 ¹
17-1305	EBL East Abutment	76.6	53.0	23.6
17-1308	WBL East Abutment	71.3	47.4	23.9
17-1309	WBL East Pier	69.6	45.0	24.6
17-1310	WBL West Pier	71.6	47.9	23.7
17-1311	WBL West Abutment	75.3	51.2	24.1

Note 1: Refusal to sampler advancement.

Based on the bedrock surface elevations obtained where bedrock was proven, it is likely that the refusal to sampler advancement was encountered at the surface of the bedrock in Borehole 17-1304.

The bedrock encountered in these boreholes consist of weathered to fresh, thinly to medium bedded, grey, fine grained, porous shale. The Rock Quality Designation (RQD) values measured on recovered bedrock core samples ranged from about 0 to 100 percent, but more generally between 40 to 90 percent indicating a poor to excellent quality rock.

Results of unconfined compressive strength testing carried out on four bedrock core samples are presented in Figure B14. The results range from about 39 to 86 MPa and indicate a medium strong to strong bedrock.

4.7 Groundwater Conditions

Monitoring wells were installed in Boreholes 17-1305, 17-1310, and 17-1311 to monitor the groundwater level at the site. The water levels were measured in the monitoring wells on June 16, 2017 and 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
17-1305A	76.6	Glacial Till	3.0	73.6	June 16, 2017
17-1305B	76.6	Weathered Crust / Grey Silty Clay	0.5	76.1	June 16, 2017
17-1310	71.6	Silty Clay	1.2	70.4	June 16, 2017
17-1311	75.3	Glacial Till	1.7	73.6	June 16, 2017

Artesian conditions were encountered at Boreholes 17-1303, 17-1304, 17-1308, and 17-1309 during the drilling operations. The water level elevations and depth of casing at the time of artesian conditions are listed in the following table.

Borehole	Ground Surface Elevation (m)	Depth of Casing (m)	Water Level Above Ground Surface (m)	Water Level Elevation (m)	Date
17-1303	71.3	47.5	2.4	73.7	May 19, 2017
17-1304	72.5	46.5	1.0	73.5	May 23, 2017
17-1308	71.3	48.5	1.9	73.2	June 5, 2017
17-1309	69.6	45.0	3.2	72.8	June 8, 2017

These combined groundwater level data indicate an apparent upward hydraulic gradient.

It is expected that these water levels will be subject to fluctuations both seasonally and as a result of precipitation events.

5.0 CLOSURE

This report was prepared by Mr. Alex Meacoe, P.Eng., and 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 Designated MTO Foundations Contact, conducted an independent quality control review of this report.

Golder Associates Ltd



Alex Meacoe, P.Eng.
Geotechnical Engineer




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




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



WAM/MSS/FJH/mvrd

[https://golderassociates.sharepoint.com/sites/11263g/shared documents/01_foundations/6 - reports/1130 ramsayville road/final/1662565-1130-001-r-rev0-ramsayville road bridge-august 2018 fir.docx](https://golderassociates.sharepoint.com/sites/11263g/shared%20documents/01_foundations/6_reports/1130_ramsayville_road/final/1662565-1130-001-r-rev0-ramsayville_road_bridge-august_2018_fir.docx)

Golder and the G logo are trademarks of Golder Associates Corporation

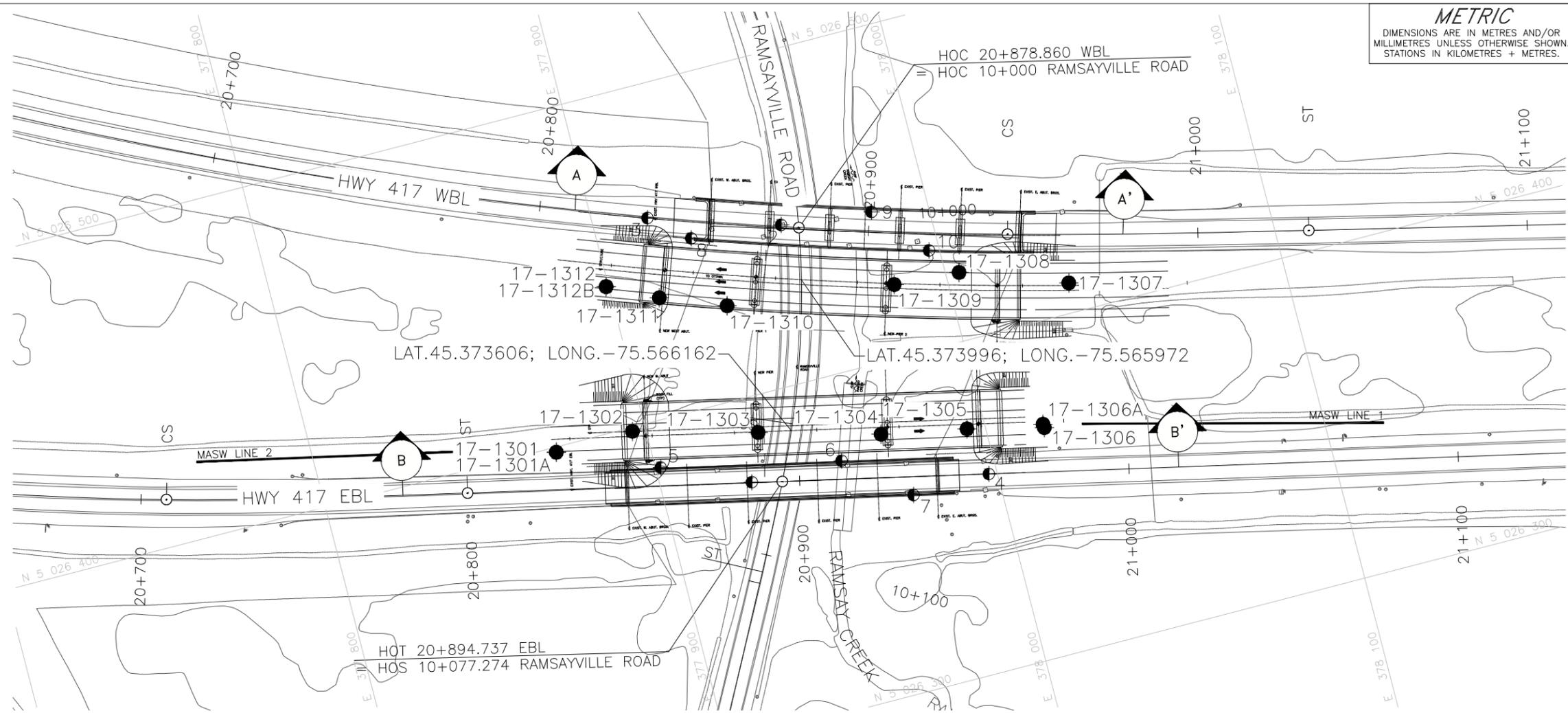
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. WP No.4145-10-00



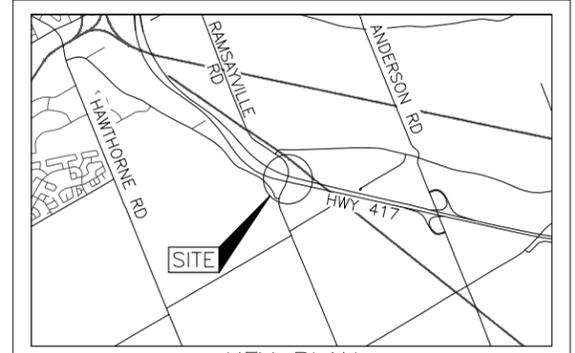
RAMSAYVILLE ROAD OVERPASS (EBL)
HIGHWAY 417
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



LAT.45.373606; LONG.-75.566162 LAT.45.373996; LONG.-75.565972

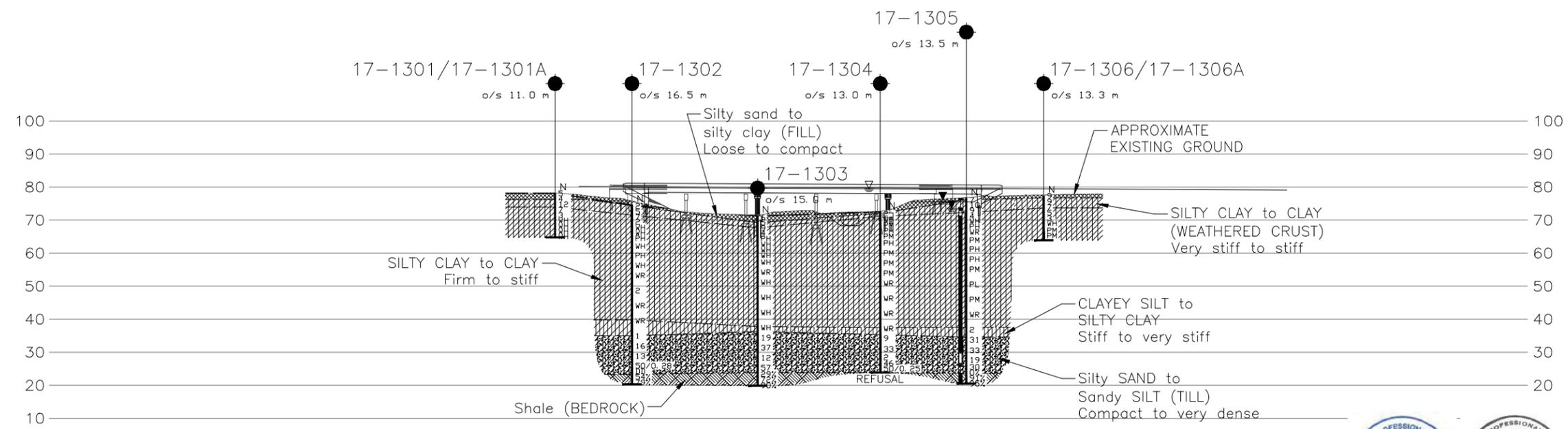
PLAN
SCALE
15 0 15 30 m



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (Geocres No. 31G5-71)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on JUN. 16, 2017
- ≡ WL upon completion of drilling



CROSS-SECTION B-B'

SCALE
15 0 15 30 m

BOREHOLE CO-ORDINATES (MTM ZONE 9)

No.	ELEVATION	NORTHING	EASTING
17-1301	78.2	5026398.4	377872.0
17-1301A	78.2	5026398.4	377872.0
17-1302	74.6	5026398.8	377896.0
17-1303	71.3	5026388.9	377932.9
17-1304	72.5	5026379.0	377968.8
17-1305	76.6	5026374.0	377994.5
17-1306	77.3	5026368.5	378017.3
17-1306A	77.1	5026369.6	378017.2
17-1307	77.7	5026409.0	378035.5
17-1308	71.3	5026420.5	378004.0
17-1309	69.6	5026421.8	377984.1
17-1310	71.6	5026428.4	377933.4
17-1311	75.3	5026435.9	377914.0
17-1312	77.5	5026443.2	377899.3
17-1312B	77.5	5026424.2	377899.3

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 A-A' shown on Drawing 1.

REFERENCE

Base plans provided in digital format by WSP, drawing file nos. XA1-NAD 83.dwg and XB1-NAD 83 (CSRS).dwg, received APR. 19, 2017 and RAMSAY-CREEK_GA_EBL.dwg received SEPT. 19, 2017.



NO.	DATE	BY	REVISION

Geocres No. 31G5-284

HWY. 417	PROJECT NO. 1662565	DIST. EASTERN
SUBM'D. SAT	CHKD. SAT	DATE: 8/18/2017
SITE: 3-265/1	APPD. FJH	DWG. 2

FILE NAME: N:\Area\SPR\1662565_100_Hwy417Ramp&Overpass\1662565-005-BG-0001.dwg
 PLOT DATE: August 8, 2017

APPENDIX A

Borehole and Drillhole Records, Current Investigation

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes 17-1301 to 17-1312

Bedrock Core Photographs, Figures A1 to A14

LIST OF SYMBOLS

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

I.	GENERAL	(a)	Index Properties (continued)
π	3.1416	w	water content
$\ln x$,	natural logarithm of x	w_l or LL	liquid limit
\log_{10}	x or log x, logarithm of x to base 10	w_p or PL	plastic limit
g	acceleration due to gravity	I_p or PI	plasticity index = $(w_l - w_p)$
t	time	w_s	shrinkage limit
FoS	factor of safety	I_L	liquidity index = $(w - w_p) / I_p$
		I_C	consistency index = $(w_l - w) / I_p$
		e_{max}	void ratio in loosest state
		e_{min}	void ratio in densest state
		I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)
II.	STRESS AND STRAIN	(b)	Hydraulic Properties
γ	shear strain	h	hydraulic head or potential
Δ	change in, e.g. in stress: $\Delta \sigma$	q	rate of flow
ε	linear strain	v	velocity of flow
ε_v	volumetric strain	i	hydraulic gradient
η	coefficient of viscosity	k	hydraulic conductivity (coefficient of permeability)
ν	Poisson's ratio	j	seepage force per unit volume
	total stress	(c)	Consolidation (one-dimensional)
σ'	effective stress ($\sigma' = \sigma - u$)	C	compression index (normally consolidated range)
σ'_{vo}	initial effective overburden stress	C_r	recompression index (over-consolidated range)
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, minor)	C_s	swelling index
σ_{oct}	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3) / 3$	C_α	secondary compression index
τ	shear stress	m_v	coefficient of volume change
u	porewater pressure	c_v	coefficient of consolidation (vertical direction)
E	modulus of deformation	c_h	coefficient of consolidation (horizontal direction)
G	shear modulus of deformation	T_v	time factor (vertical direction)
K	bulk modulus of compressibility	U	degree of consolidation
III.	SOIL PROPERTIES	σ'_p	pre-consolidation stress
(a)	Index Properties	OCR	over-consolidation ratio = σ'_p / σ'_{vo}
$\rho(\gamma)$	bulk density (bulk unit weight)*	(d)	Shear Strength
$\rho_d(\gamma_d)$	dry density (dry unit weight)	τ_p, τ_r	peak and residual shear strength
$\rho_w(\gamma_w)$	density (unit weight) of water	ϕ'	effective angle of internal friction
$\rho_s(\gamma_s)$	density (unit weight) of solid particles	δ	angle of interface friction
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)	μ	coefficient of friction = $\tan \delta$
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)	c'	effective cohesion
e	void ratio	C_u, S_u	undrained shear strength ($\phi = 0$ analysis)
n	porosity	p	mean total stress $(\sigma_1 + \sigma_3) / 2$
S	degree of saturation	p'	mean effective stress $(\sigma'_1 + \sigma'_3) / 2$
		q	$(\sigma_1 - \sigma_3) / 2$ or $(\sigma'_1 - \sigma'_3) / 2$
		q_u	compressive strength $(\sigma_1 - \sigma_3)$
		S_t	sensitivity
* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)		Notes: 1	$\tau = c' + \sigma' \tan \phi'$
		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, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Compactness	N
Condition	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	Cu, Su	psf
	kPa	
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.

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

<u>Description</u>	<u>Bedding Plane Spacing</u>
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

<u>Description</u>	<u>Spacing</u>
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

<u>Term</u>	<u>Size*</u>
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° 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	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1301	SHEET 1 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026398.4; E 377872.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.567063)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8, 2017</u>	CHECKED BY <u>WAM</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)					
							20	40	60	80	100	25	50	75			
78.2	GROUND SURFACE																
0.0	(SM) Silty sand (TOPSOIL) Dark brown Moist																
0.2	(SM) Silty sand, contains rootlets (FILL) Loose Grey to grey-brown Moist		1	SS	5											c	
77.3	(CL/ML/SM) Silty clay to clayey silt and silty sand (FILL) Loose Grey-brown Wet		2	SS	4											0 17 19 64	
0.9																	
76.2	(CL/CI) SILTY CLAY, contains organic matter (WEATHERED CRUST) Dark brown Moist		3	SS	12												
2.0																	
75.9	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown moist		4	SS	7												
2.3																	
			5	SS	3												
73.9	(CI/CH) SILTY CLAY to CLAY Soft to firm Grey with black organic mottling Wet		6	SS	WH												
4.3																	
			7	SS	WH												
			8	SS	WH												
			9	SS	WH												

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1301	SHEET 2 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026398.4; E 377872.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.567063)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---					20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	25 50 75					
67.9 10.4	(Cl/CH) SILTY CLAY to CLAY Firm to stiff Grey with black organic mottling Wet	[Hatched Box]	10	SS	WH			+								
						67			+							
						66			+							
			11	SS	WH								○			
64.8 13.4	END OF BOREHOLE					65	×	+								

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1301A	SHEET 1 OF 1	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026398.4; E 377872.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.567063)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 11, 2017</u>	CHECKED BY <u>WAM</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						GR SA SI CL
78.2	GROUND SURFACE																	
0.0	(SM) Silty sand (TOPSOIL) Dark brown Moist						78											
0.2	(SM) Silty sand, rootlets (FILL) Loose Grey to grey-brown Moist																	
77.3	(CL/ML/SM) Silty clay to clayey silt and silty sand (FILL) Loose Grey-brown Wet						77											
0.9																		
76.2	(CL/CI) SILTY CLAY, contains organic matter (WEATHERED CRUST) Dark brown Moist						76											
2.0																		
75.9	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown moist						75											
2.3																		
73.9	(CI/CH) SILTY CLAY Soft to firm Grey with black organic mottling Wet						74											
4.3																		
72.3	END OF BOREHOLE						73											
5.9	Note(s): 1. Soil stratigraphy is inferred from Record of Borehole 17-1301		1	TP	PH													

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1302** SHEET 1 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026398.8; E 377896.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.566757) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 8, 2017 **CHECKED BY** WAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
						20	40	60	80	100							
74.6	GROUND SURFACE																
0.0	(SM) Silty sand (TOPSOIL) Dark brown Moist		1	SS	2												
0.2	(CI/CH) SILTY CLAY to CLAY, some sand, contains rootlets (Weathered Crust) Grey-brown Moist		2	SS	5												
73.8	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		3	SS	7												
0.8	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		4	SS	5												
71.5	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Wet		5	SS	2												
3.1	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Wet		6	TP	PH												
70			7	SS	WH											0 0 23 77	
66.7	(CI/CH) SILTY CLAY to CLAY Stiff Grey Wet		8	SS	WH												
7.9	(CI/CH) SILTY CLAY to CLAY Stiff Grey Wet		9	TP	PH												
			10	TP	PH												

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1302	SHEET 2 OF 7	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026398.8; E 377896.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.566757)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
--- CONTINUED FROM PREVIOUS PAGE ---						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L					
						20 40 60 80 100 20 40 60 80 100					25 50 75					
	(CI/CH) SILTY CLAY to CLAY Stiff Grey Wet															
			11	SS	WH											
			12	TP	PH											
			13	SS	WH											

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1302** SHEET 5 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026398.8; E 377896.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.566757) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 8, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						SHEAR STRENGTH kPa	
										○ UNCONFINED	+ FIELD VANE							
										● QUICK TRIAXIAL	× REMOULDED	WATER CONTENT (%)						
										20	40	60	80	100	25	50	75	
	--- CONTINUED FROM PREVIOUS PAGE ---																	
	(SM) Silty SAND, trace to some clay and gravel, contains silty sand layers, cobbles and boulders (TILL) Compact Grey Wet	19	SS	16														8 54 31 7
28.6 46.0	(SM/ML) Silty SAND to Sandy Silt, contains cobbles and boulders (TILL) Very dense Brown Wet	20	SS	13														
		21	SS	50/0.28														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1302	SHEET 6 OF 7	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026398.8; E 377896.0 MTM ZONE 9 (LAT. 45.373718; LONG. -75.566757)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8, 2017</u>	CHECKED BY <u>WAM</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	--- CONTINUED FROM PREVIOUS PAGE ---																
23.3	(SM/ML) Silty SAND to Sandy Silt, contains cobbles and boulders (TILL) Very dense Brown Wet		22	NQ	DD		24										
51.3	Shale (BEDROCK) Bedrock cored from depths 51.3 m to 54.3 m For bedrock coring details refer to Record of Drillhole 17-1302		1	RC	REC 100%		23										RQD = 54%
			2	RC	REC 100%		22										
20.3	END OF BOREHOLE						21										
54.3																	

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1303** SHEET 1 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026388.9; E 377932.9 MTM ZONE 9 (LAT. 45.373625; LONG. -75.566288) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 16, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	25	50	75	GR	SA	SI	CL	
71.3	GROUND SURFACE																						
0.0	(SM) Silty sand (TOPSOIL)																						
71.1	Dark brown																						
0.2	Moist																						
	(CL/CI) Sandy silty clay, trace gravel (FILL)		1	SS	6																		
	Grey-brown																						
	Moist																						
69.2			2	SS	5																		
	(CI/CH) SILTY CLAY to CLAY, contains sand seams (WEATHERED CRUST)																						
	Stiff to very stiff																						
	Grey-brown																						
	Moist																						
67.7			3	SS	9																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			4	SS	4																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			5	TP	PH																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			6	SS	-																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			7	TP	PH																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			8	SS	WH																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						
67.7			9	SS	WH																		
	(CI/CH) SILTY CLAY to CLAY																						
	Firm to stiff																						
	Grey																						
	Wet																						

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1303** SHEET 3 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026388.9; E 377932.9 MTM ZONE 9 (LAT. 45.373625; LONG. -75.566288) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 16, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)		
						20	40	60	80	100	20	40	60	80	100	25	50	75	
	--- CONTINUED FROM PREVIOUS PAGE ---																		
50.3	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey Wet		13	SS	WH														
21.0	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black organic mottling Wet																		
			14	SS	WH														
			15	SS	WH														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1303** SHEET 4 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026388.9; E 377932.9 MTM ZONE 9 (LAT. 45.373625; LONG. -75.566288) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 16, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	25
	--- CONTINUED FROM PREVIOUS PAGE ---																	
37.8	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black organic mottling Wet																	
33.5	(ML-CI/CH) CLAYEY SILT to SILTY CLAY, trace sand Stiff Grey Wet		16	SS	WH													
36.3	(SM) Silty SAND, some gravel, contains cobbles and boulders (TILL) Compact Dark grey Wet																	
35.1																		
34.1	(SM-ML/SP) Silty SAND to SAND and SILT, some gravel, contains organic matter, cobbles and boulders (TILL) Compact to very dense Grey Wet		17	SS	19													
37.2																		
			18	SS	37													

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1303** **SHEET 5 OF 7** **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026388.9; E 377932.9 MTM ZONE 9 (LAT. 45.373625; LONG. -75.566288) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 16, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)				
						20	40	60	80	100	20	40	60	80	100	25	50	75			
	--- CONTINUED FROM PREVIOUS PAGE ---																				
	(SM-MI/SP) Silty SAND to SAND and SILT, some gravel, contains organic matter, cobbles and boulders (TILL) Compact to very dense Grey Wet																				
			19	SS	12																
			20	SS	57																
23.8	Shale (BEDROCK)																				
47.5	Bedrock cored from depths 47.5 m to 51.5 m For bedrock coring details refer to Record of Drillhole 17-1303		1	RC	REC 98%															RQD = 29%	
			2	RC	REC 100%																RQD = 72%
			3	RC																	RQD = 90%

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1303	SHEET 6 OF 7	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026388.9; E 377932.9 MTM ZONE 9 (LAT. 45.373625; LONG. -75.566288)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 16, 2017</u>	CHECKED BY <u>WAM</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	--- CONTINUED FROM PREVIOUS PAGE ---																
	Shale (BEDROCK) Bedrock cored from depths 47.5 m to 51.5 m For bedrock coring details refer to Record of Drillhole 17-1303		3	RC	REC 100%		21										RQD = 90%
19.9 51.5	END OF BOREHOLE NOTES: 1. Water level at 2.4 m above ground surface (Elev. 73.7), measured on May 19, 2017						20										

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1304** SHEET 2 OF 5 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026379.0; E 377968.8 MTM ZONE 9 (LAT. 45.373533; LONG. -75.565830) ORIGINATED BY PAH
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring COMPILED BY ZS
 DATUM Geodetic DATE May 16, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)		
						20	40	60	80	100	20	40	60	80	100	25	50	75	
	--- CONTINUED FROM PREVIOUS PAGE ---																		
	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black mottling Wet																		
			9	SS	PM														
			10	SS	PM														
			11	SS	PM														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1304	SHEET 3 OF 5	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026379.0; E 377968.8 MTM ZONE 9 (LAT. 45.373533; LONG. -75.565830)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 16, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
	--- CONTINUED FROM PREVIOUS PAGE ---					20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED	20 40 60 80 100	25 50 75						
52	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black mottling Wet																	
51			12	SS	WR													
50									+									
49																		
48																		
47																		
46					13	SS	WR							-----	○			
45									+									
44																		
43																		

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1304** SHEET 5 OF 5 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026379.0; E 377968.8 MTM ZONE 9 (LAT. 45.373533; LONG. -75.565830) **ORIGINATED BY** PAH
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash boring **COMPILED BY** ZS
DATUM Geodetic **DATE** May 16, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)			
						20	40	60	80	100	20	40	60	80	100	25	50	75		
	--- CONTINUED FROM PREVIOUS PAGE ---																			
	(ML-SM) Sandy SILT, some gravel to Gravelly Silty SAND, contains cobbles, boulders and clayey silt seams (TILL) Very loose to dense Grey Wet		17	SS	33															
27.1 45.5	(SM-SP/GP) Gravelly Silty SAND to SAND and GRAVEL, some silt, contains clayey silt seams, cobbles and boulders (TILL) Dense Wet		18	SS	2															
24.0	Weathered Shale (BEDROCK)		20	SS	50/0.25															
48.7	END OF BOREHOLE SAMPLER REFUSAL																			
	NOTES: 1. Water level at 1.0 m above ground surface (Elev. 73.5), measured on May 23, 2017																			

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1305** SHEET 5 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026374.0; E 377994.5 MTM ZONE 9 (LAT. 45.373485; LONG. -75.565503) ORIGINATED BY PAH
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 8, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40
	--- CONTINUED FROM PREVIOUS PAGE ---																	
34.5 42.1	(ML/CI/CH) CLAYEY SILT and SILTY CLAY Very loose Grey Wet																	
	(SM/GM) Silty SAND and GRAVEL, contains cobbles and boulders (TILL) Dense Grey Wet	18	SS	31														
31.0 45.6	(ML/SP) Sandy SILT to SAND and SILT, trace to some clay and gravel, contains clayey silt seams, cobbles and boulders (TILL) Dense Grey Wet	19	SS	33								OH						9 41 39 11
		20	SS	19														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1305** SHEET 6 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026374.0; E 377994.5 MTM ZONE 9 (LAT. 45.373485; LONG. -75.565503) **ORIGINATED BY** PAH
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 8, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)					
						20	40	60	80	100	20	40	60	80	100	25	50	75	GR	SA	SI	CL
	--- CONTINUED FROM PREVIOUS PAGE ---																					
25.1 51.5	(ML/SP) Sandy SILT to SAND and SILT, trace to some clay and gravel, contains clayey silt seams, cobbles and boulders (TILL) Dense Grey Wet		21	SS	30							o										
23.6 53.0	Shale (BEDROCK) Bedrock cored from depths 53.0 m to 56.1 m For bedrock coring details refer to Record of Drillhole 17-1305		1	RC	REC 88%																	RQD = 0%
			2	RC	REC 100%																	RQD = 91%
			3	RC	REC 100%																	RQD = 95%
20.5 56.1	END OF BOREHOLE NOTES: 1. Water level in deep well at a depth of 3.0 m below ground surface (Elev. 73.6), measured on June 16, 2017. 2. Water level in shallow well at a depth of 0.5 m below ground surface (Elev. 76.1), measured on June 16, 2017.																					

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1306	SHEET 2 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026368.5; E 378017.3 MTM ZONE 9 (LAT. 45.373433; LONG. -75.565213)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 8-7, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
	--- CONTINUED FROM PREVIOUS PAGE ---															
	(CI/CH) SILTY CLAY to CLAY Firm Grey with black mottling Wet															
			10	SS	PM											
			11	SS	PM											0 0 21 79
63.9																
13.4	END OF BOREHOLE															

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING02_DATA\GINT1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1307	SHEET 1 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026409.0; E 378035.5 MTM ZONE 9 (LAT. 45.373796; LONG. -75.564975)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 23-24, 2017</u>	CHECKED BY <u>WAM</u>	

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100						
77.7 0.0	GROUND SURFACE (CL-ML,SM) Mixture of Silty clay, clayey silt and silty sand, trace gravel, contains organic matter (FILL) Brown		1	GRAB	-												
76.6 1.1	(Cl/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff to stiff Grey-brown Moist		2	SS	12												
			3	SS	10												
			4	SS	5												
			5	SS	3												
73.4 4.3	(Cl/CH) SILTY CLAY to CLAY Firm Grey with black mottling Wet		6	SS	WH												
			7	TP	PH												
			8	.61	PM												
			9	SS	PM												

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1307	SHEET 2 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026409.0; E 378035.5 MTM ZONE 9 (LAT. 45.373796; LONG. -75.564975)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 23-24, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
--- CONTINUED FROM PREVIOUS PAGE ---						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L					
						20	40	60	80	100	25	50	75			
64.3	(CI/CH) SILTY CLAY to CLAY Firm Grey with black mottling Wet					X	+									
67			10	SS	PM			+								
66									+							
65			11	SS	PM									○		
64.3	END OF BOREHOLE															
13.4																

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1308** SHEET 1 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026420.5; E 378004.0 MTM ZONE 9 (LAT. 45.373902; LONG. -75.565374) **ORIGINATED BY** PAH
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 25-June 5, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	25	50	75	GR	SA	SI	CL	
71.3	GROUND SURFACE																						
0.0	(CI/CH) Silty clay to clay, some sand and gravel (FILL) Grey-brown Moist		1	GRAB	-																		
70.4																							
0.9	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST) Very stiff Grey-brown Moist		2	SS	5																		
			3	SS	6																		
69.0																							
2.3	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey with black organic mottling Wet		4	SS	WH																		
			5	TP	PH																		
			6	SS	PM																		
			7	SS	PM																		
			8	TP	PH																		
			9	SS	PM																		

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1308** SHEET 5 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026420.5; E 378004.0 MTM ZONE 9 (LAT. 45.373902; LONG. -75.565374) ORIGINATED BY PAH
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 25-June 5, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)				
						20	40	60	80	100	20	40	60	80	100	25	50	75			
	--- CONTINUED FROM PREVIOUS PAGE ---																				
	(ML/SP) Sandy SILT to SAND and SILT, some gravel, trace to some clay, contains silty sand seams, cobbles and boulders (TILL) Compact to dense Grey Wet		18	SS	21																18 41 33 8
			19	SS	20																
23.9 47.4	Shale (BEDROCK) Bedrock cored from depths 47.4 m to 50.8 m For bedrock coring details refer to Record of Drillhole 17-1308		20	SS	65/0.31																
			1	RC	REC 97%																RQD = 84%
			2	RC	REC 100%																RQD = 100%

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1308	SHEET 6 OF 7	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026420.5; E 378004.0 MTM ZONE 9 (LAT. 45.373902; LONG. -75.565374)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 25-June 5, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W			W _L	25
20.5 50.8	END OF BOREHOLE NOTES: 1. Water level at 1.9 m above ground surface (Elev. 73.2), measured on June 5, 2017		3	RC	REC 100%													RQD = 100%

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT: 1662565-1130

RECORD OF DRILLHOLE: 17-1308

SHEET 7 OF 7

LOCATION: N 5026420.5 ;E 378004.0

DRILLING DATE: May 25-June 5, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Grenville Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY											FEATURES								
						RECOVERY			R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec				WEATHERING INDEX							
						TOTAL CORE %	SOLID CORE %	FLUSH RETURN				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁰	10 ¹		10 ²	W1	W2	W3	W4	W5	W6	
						80	80	80	80	80	80	80	80	80	80	80		80	80	80	80	80	80	80	
		BEDROCK SURFACE		23.87																					
48		Shale (BEDROCK), with limestone interbeds Fresh Thinly to medium bedded Black Fine grained Porous		47.40	1	100																			
49	Rotary Drill NQ Core				2	100																			
50					3	100																			
51		END OF DRILLHOLE		20.47 50.80																					

GTA-RCK 031 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ_GAL-MISS.GDT_8/9/18_ZS

DEPTH SCALE

1 : 50



LOGGED: PAH

CHECKED: WAM

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1309	SHEET 2 OF 6	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026421.8; E 377984.1 MTM ZONE 9 (LAT. 45.373917; LONG. -75.565629)</u>	ORIGINATED BY <u>PAH</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>June 5-6, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L	GR
	--- CONTINUED FROM PREVIOUS PAGE ---																	
	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black organic mottling Wet																	
			9	TP	PH		59											
							58											
			10	SS	PM		57											
							56											
			11	SS	PM		54											
							53											
							52											
			12	SS	PM		51											
							50											

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1309** SHEET 5 OF 6 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026421.8; E 377984.1 MTM ZONE 9 (LAT. 45.373917; LONG. -75.565629) ORIGINATED BY PAH
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE June 5-6, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)		
						20	40	60	80	100	20	40	60	80	100	25	50	75	
	--- CONTINUED FROM PREVIOUS PAGE ---																		
	(ML/SP) Sandy SILT to SILT and SAND, some gravel, contains cobbles and boulders (TILL) Very Loose Grey Wet		18	SS	3							o							18 37 37 8
26.8 42.8	(SM) Gravelly Silty SAND, contains cobbles and boulders (TILL) Compact Grey Wet		19	SS	27							o							
24.7 45.0	Shale (BEDROCK) Bedrock cored from depths 45.0 m to 48.4 m For bedrock coring detail refer to Record of Drillhole 17-1309		1	RC	REC 89%														RQD = 57%
			2	RC	REC 87%														RQD = 61%
			3	RC	REC 100%														RQD = 100%
21.3 48.4	END OF BOREHOLE NOTES: 1. Water level at 3.2 m above ground surface (Elev. 72.8 m), measured on June 8, 2017																		

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1310** **SHEET 1 OF 7** **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026428.4; E 377933.4 MTM ZONE 9 (LAT. 45.373981; LONG. -75.566276) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 23-25, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100			W _p	W	W _L	GR
71.6	GROUND SURFACE																
0.0	(SM) Silty sand (TOPSOIL) Dark brown Moist																
71.3																	
0.3	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST) Stiff to very stiff Grey-brown Moist	1	SS	5													
		2	SS	12													
		3	SS	7													
68.6																	
3.1	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey with black organic mottling Wet	4	SS	2													
		5	TP	PH													
		6	SS	WH													0 0 21 79
		7	SS	PH													
		8	SS	PH													

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1310** SHEET 2 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026428.4; E 377933.4 MTM ZONE 9 (LAT. 45.373981; LONG. -75.566276) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 23-25, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40
	--- CONTINUED FROM PREVIOUS PAGE ---																	
	(CI/CH) SILTY CLAY to CLAY Firm to stiff Grey with black organic mottling Wet																	
		9	SS	WH														
		10	TP	PH														
		11	SS	WH														
		12	SS	WH														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1310	SHEET 6 OF 7	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026428.4; E 377933.4 MTM ZONE 9 (LAT. 45.373981; LONG. -75.566276)</u>	ORIGINATED BY <u>DG</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>May 23-25, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W		
20.2	51.4	--- CONTINUED FROM PREVIOUS PAGE ---	3	RC	REC 100%	21										
		Shale (BEDROCK)														
		Bedrock cored from depths 47.9 m to 51.4 m														
		For bedrock coring details refer to Record of Drillhole 17-1310														RQD = 76%
		END OF BOREHOLE														
		NOTES:														
		1. Water level in well at a depth of 1.2 m below ground surface (Elev. 70.4 m), measured on June 16, 2017														
		2. NP = Non-plastic														

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1311** SHEET 1 OF 7 **METRIC**
W.P. 4145-10-00 **LOCATION** N 5026435.9; E 377914.0 MTM ZONE 9 (LAT. 45.374050; LONG. -75.566521) **ORIGINATED BY** DG
DIST Eastern **HWY** 417 **BOREHOLE TYPE** Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core **COMPILED BY** ZS
DATUM Geodetic **DATE** May 31, 2017 **CHECKED BY** WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	25	50	75	GR	SA	SI	CL	
75.3	GROUND SURFACE																						
0.0	(SM) Silty sand (TOPSOIL)																						
75.1	Dark brown																						
0.2	Moist																						
	(CI/CH) SILTY CLAY to CLAY (WEATHERED CRUST)																						
	Stiff to very stiff																						
	Grey-brown																						
	Moist																						
			1	SS		6																	
			2	SS		6																	
			3	SS		5																	
			4	SS		3																	
71.6	(CI/CH) SILTY CLAY to CLAY																						
3.6	Stiff																						
	Grey with black organic mottling																						
	Wet																						
			5	SS		WH																	
			6	TP		PH																	
			7	SS		WH																	

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1311** SHEET 2 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026435.9; E 377914.0 MTM ZONE 9 (LAT. 45.374050; LONG. -75.566521) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 31, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)					
						20	40	60	80	100	W _p	W	W _L		GR	SA	SI	CL
	--- CONTINUED FROM PREVIOUS PAGE ---																	
	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black organic mottling Wet																	
			8	TO	PH													
			9	SS	WH													
			10	TO	PH													

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

 +³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1311** SHEET 3 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026435.9; E 377914.0 MTM ZONE 9 (LAT. 45.374050; LONG. -75.566521) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 31, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
	--- CONTINUED FROM PREVIOUS PAGE ---															
	(CI/CH) SILTY CLAY to CLAY Stiff Grey with black organic mottling Wet					55										
			11	SS	WH	54										
						53				+						
						52				+						
						51										
						50										
			12	SS	WH	49										
						48				>96+						
						47				+						
						46										

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1311** SHEET 6 OF 7 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026435.9; E 377914.0 MTM ZONE 9 (LAT. 45.374050; LONG. -75.566521) ORIGINATED BY DG
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Wash Boring/Rotary Drill, NQ Core COMPILED BY ZS
 DATUM Geodetic DATE May 31, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	WATER CONTENT (%)
24.0	(SM/GM) Silty SAND and GRAVEL, trace to some clay, contains cobbles and boulders (TILL) Compact to very dense Dark grey Wet																	
51.2	Shale (BEDROCK) Bedrock cored from depths 51.2 m to 54.6 m For bedrock coring details refer to Record of Drillhole 17-1311		1	RC	REC 100%													RQD = 45%
			2	RC	REC 100%													RQD = 72%
			3	RC	REC 100%													RQD = 46%
20.7	END OF BOREHOLE																	
54.6	NOTES: 1. Water level in well at a depth of 1.7 m below ground surface (Elev. 73.6), measured on June 16, 2017																	

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1312** SHEET 2 OF 2 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026443.2; E 377899.3 MTM ZONE 9 (LAT. 45.374117; LONG. -75.566709) ORIGINATED BY SN
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY ZS
 DATUM Geodetic DATE June 7-8, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
	--- CONTINUED FROM PREVIOUS PAGE ---															
	(CI/CH) SILTY CLAY to CLAY Soft to firm Grey with black organic mottling Wet															
			10	SS	WH											
			11	SS	WH											
			12	SS	WH											
63.2 14.3	END OF BOREHOLE															

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

PROJECT 1662565-1130 **RECORD OF BOREHOLE No 17-1312B** SHEET 1 OF 2 **METRIC**
 W.P. 4145-10-00 LOCATION N 5026443.2; E 377899.3 MTM ZONE 9 (LAT. 45.374117; LONG. -75.566709) ORIGINATED BY SN
 DIST Eastern HWY 417 BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem) COMPILED BY ZS
 DATUM Geodetic DATE June 8, 2017 CHECKED BY WAM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)							
						20	40	60	80	100	20	40	60	80	100	25	50	75		GR	SA	SI	CL	
77.5	GROUND SURFACE																							
0.0	(SM) Silty sand (TOPSOIL)																							
0.1	Moist																							
	(CL/CI) Sandy silty clay, trace to some gravel, contains rootlets (FILL)																							
76.6	Brown																							
	Moist																							
76.6	(CI/CH) SILTY CLAY to CLAY, trace sand (WEATHERED CRUST)																							
0.9	Very stiff to stiff																							
	Grey-brown																							
	Moist																							
74.5	(CI/CH) SILTY CLAY to CLAY, trace sand																							
3.1	Soft to firm																							
	Grey-brown																							
	Wet																							
73.0	(CI/CH) SILTY CLAY to CLAY																							
4.6	Firm to stiff																							
	Grey with black organic mottling																							
	Wet																							
67.8																								
9.8																								

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417\REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

Continued Next Page

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

PROJECT <u>1662565-1130</u>	RECORD OF BOREHOLE No 17-1312B	SHEET 2 OF 2	METRIC
W.P. <u>4145-10-00</u>	LOCATION <u>N 5026443.2; E 377899.3 MTM ZONE 9 (LAT. 45.374117; LONG. -75.566709)</u>	ORIGINATED BY <u>SN</u>	
DIST <u>Eastern</u> HWY <u>417</u>	BOREHOLE TYPE <u>Power Auger, 200 mm Diam. (Hollow Stem)</u>	COMPILED BY <u>ZS</u>	
DATUM <u>Geodetic</u>	DATE <u>June 8, 2017</u>	CHECKED BY <u>WAM</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _p	W			W _L	25	50	75	GR
67.2 10.4	--- CONTINUED FROM PREVIOUS PAGE --- (CI/CH) SILTY CLAY to CLAY Soft to firm Grey with black organic mottling Wet END OF BOREHOLE NOTES: 1. For soil stratigraphy refer to Record of Borehole 17-1312.	▨	1	SH	-																

GTA-MTO 001 N:\ACTIVE\SPATIAL_IMMTO\HWY417REHAB&WIDENING\02_DATA\GINT\1662565.GPJ GAL-GTA.GDT 8/9/18 ZS

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

BH 17-1302 (Wet)
Cored Length of 51.26 to 54.31 metres
Core Box 1 and 2 of 2

51.26 m Top of Bedrock



54.31 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A1

BH 17-1302 (Dry)
Cored Length of 51.26 to 54.31 metres
Core Box 1 and 2 of 2

51.26 m Top of Bedrock



54.31 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565/1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A2

BH 17-1303 (Wet)
Cored Length of 47.47 to 51.45 metres
Core Box 1 and 2 of 2

47.47 m Top of Bedrock



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A3

BH 17-1303 (Dry)
Cored Length of 47.47 to 51.45 metres
Core Box 1 and 2 of 2

47.47 m Top of Bedrock



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A4

BH 17-1305 (Wet)
Cored Length of 52.96 to 56.12 metres
Core Box 1 and 2 of 2

52.96 m Top of Bedrock



56.12 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A5

BH 17-1305 (Dry)
Cored Length of 52.96 to 56.12 metres
Core Box 1 and 2 of 2

52.96 m Top of Bedrock



56.12 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A6

BH 17-1308 (Wet)
Cored Length of 47.40 to 50.80 metres
Core Box 1 of 1

47.40 m Top of Bedrock



50.80 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A7

BH 17-1308 (Dry)
Cored Length of 47.40 to 50.80 metres
Core Box 1 of 1

47.40 m Top of Bedrock



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A8

BH 17-1309 (Wet)
Cored Length of 44.96 to 48.36 metres
Core Box 1 of 1

44.96 m Top of Bedrock



48.36 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A9

BH 17-1309 (Dry)
Cored Length of 44.96 to 48.36 metres
Core Box 1 of 1

44.96 m Top of Bedrock



48.36 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A10

BH 17-1310 (Wet)
Cored Length of 47.83 to 51.44 metres
Core Box 1 and 2 of 2

47.83 m Top of Bedrock



51.44 m EOH



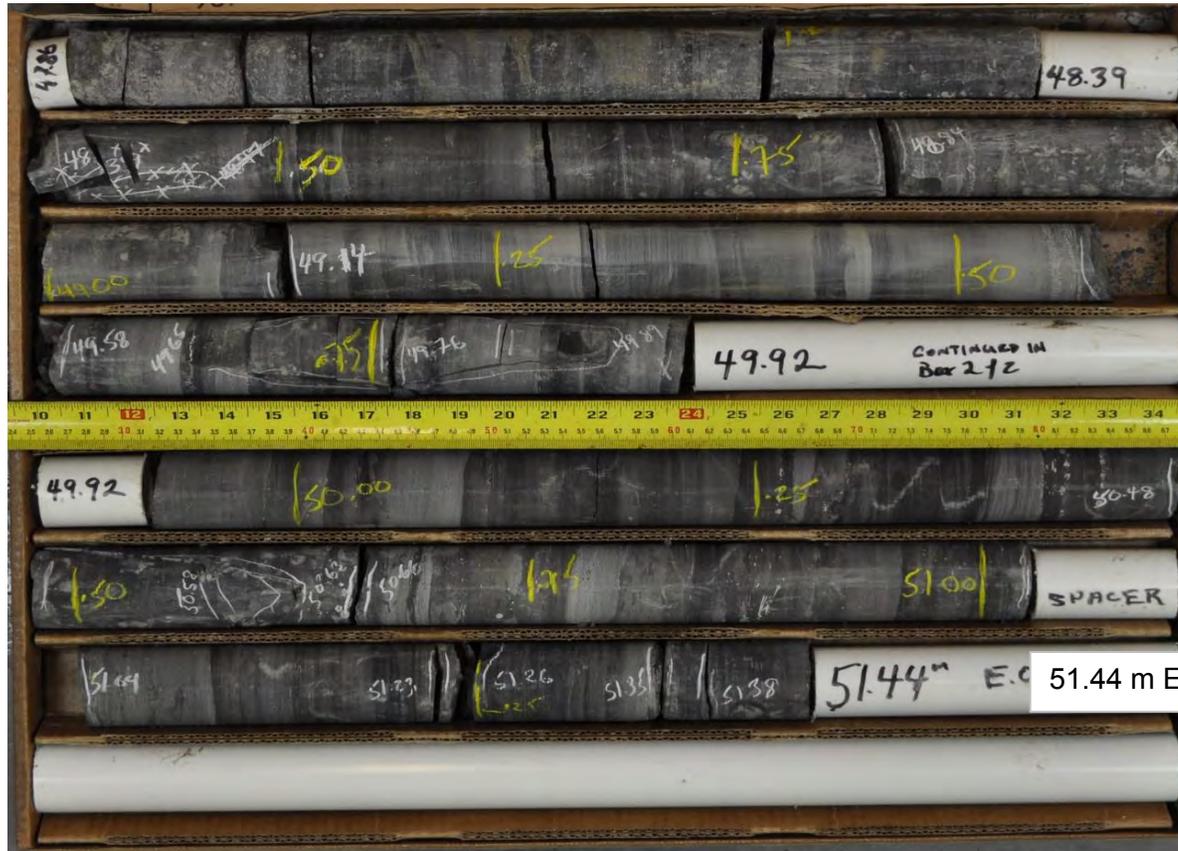
Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A11

BH 17-1310 (Dry)
Cored Length of 47.83 to 51.44 metres
Core Box 1 and 2 of 2

47.83 m Top of Bedrock



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A12

BH 17-1311 (Wet)
Cored Length of 51.22 to 54.61 metres
Core Box 1 of 1

51.22 m Top of Bedrock



54.61 m EOH



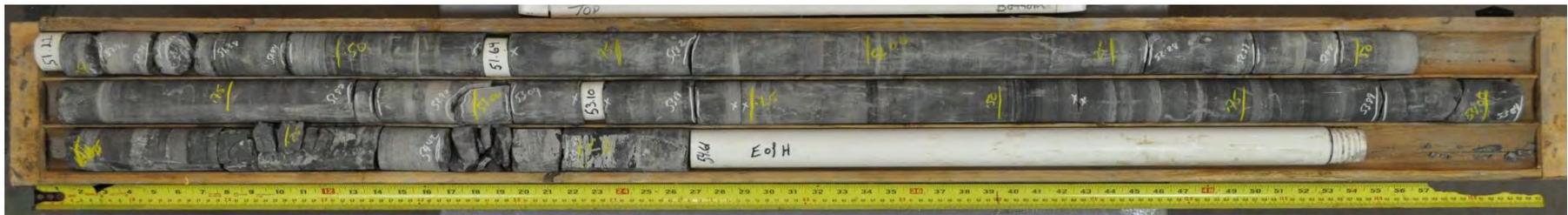
Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A13

BH 17-1311 (Dry)
Cored Length of 51.22 to 54.61 metres
Core Box 1 of 1

51.22 m Top of Bedrock



54.61 m EOH



Geotechnical Investigation
Ramsayville Road Overpass
Ottawa, Ontario

Project No.	1662565 / 1130
Drawn:	KS
Date:	2017-09-01
Checked:	WAM
Review:	MSS

Figure A14

APPENDIX B

Laboratory Test Results, Current Investigation

Figure B1 – Grain Size Distribution Test Results – Silt and Clay (FILL)

Figure B2 – Grain Size Distribution Test Results – Silty Sand (ALLUVIUM)

Figure B3 – Plasticity Chart – Silty Clay to Clay (WEATHERED CRUST)

Figure B4a to B4c – Plasticity Chart – Silty Clay to Clay

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

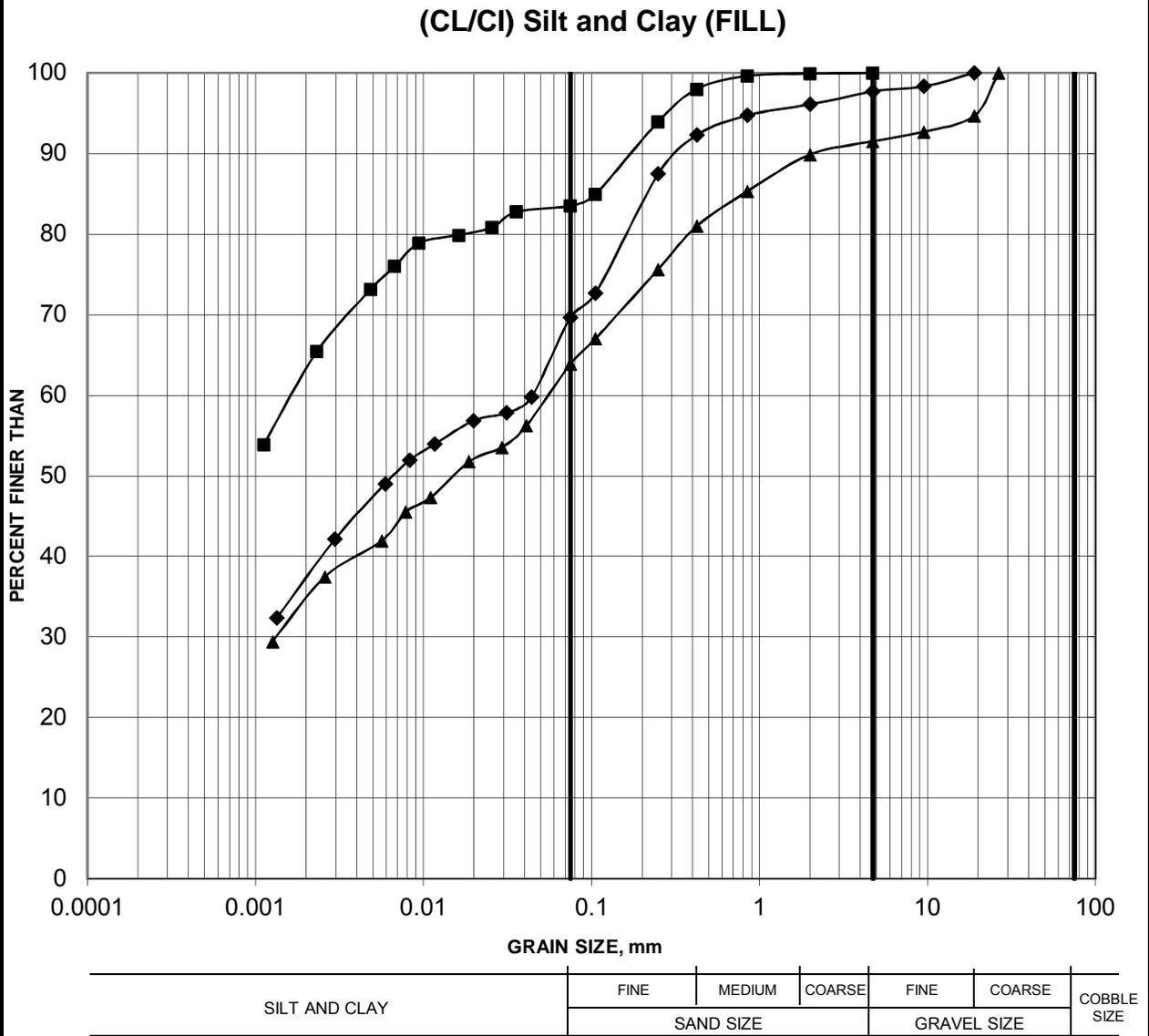
Figures B6 to B11 – Consolidation Test Results

Figure B12 – Plasticity Chart – Silty Sand to Sandy Silt (TILL)

Figure B13 – Grain Size Distribution Test Results – Silty Sand to Sandy Silt (TILL)

Figure B14 – Summary of Laboratory Compressive Strength Testing – Unconfined Compression Tests

Figure B15 – Summary of Engineering Properties

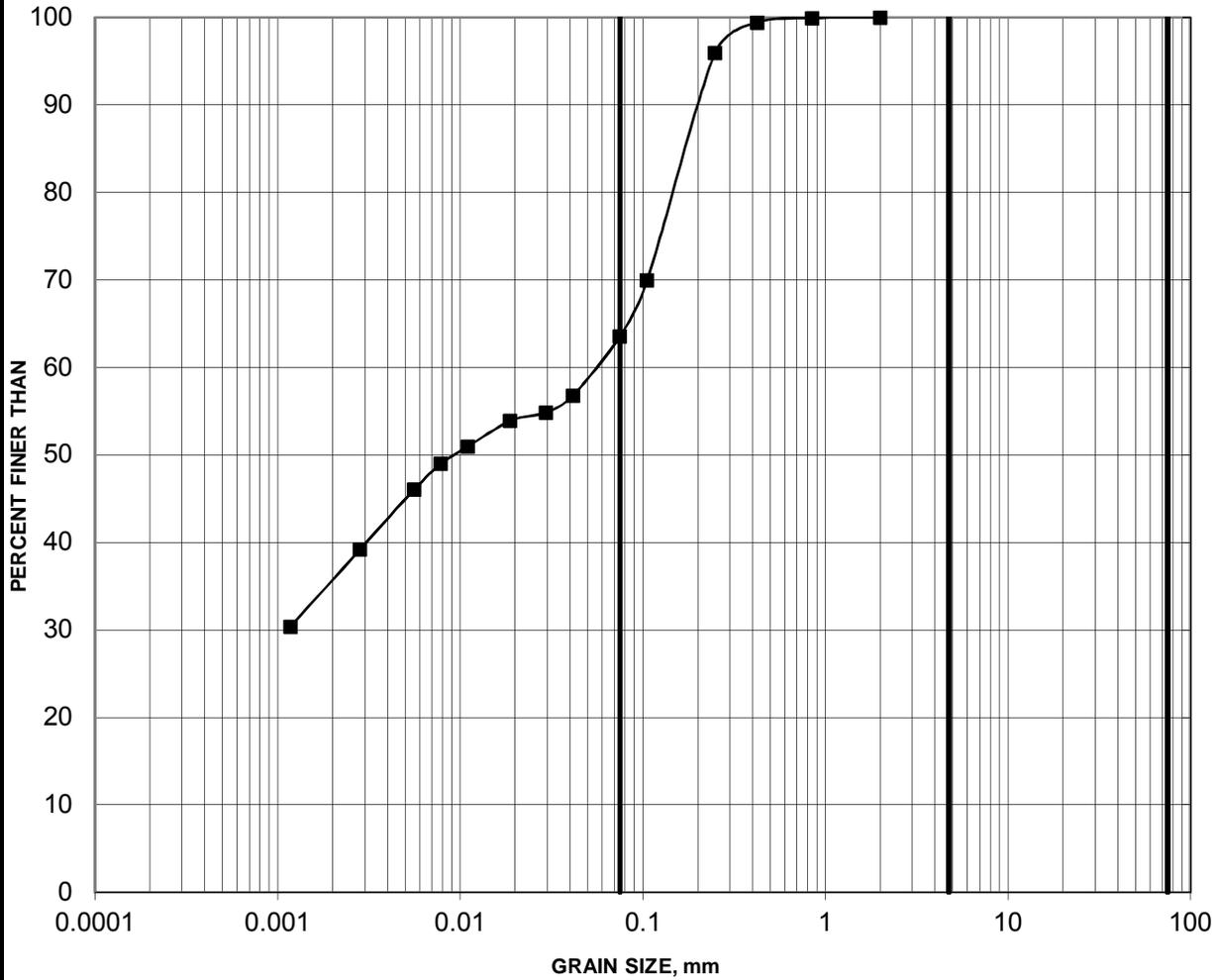


Borehole	Sample	Depth (m)
17-1301	2B	0.91-1.37
17-1303	2	0.76-1.37
17-1312	1	0.09-0.70

GRAIN SIZE DISTRIBUTION

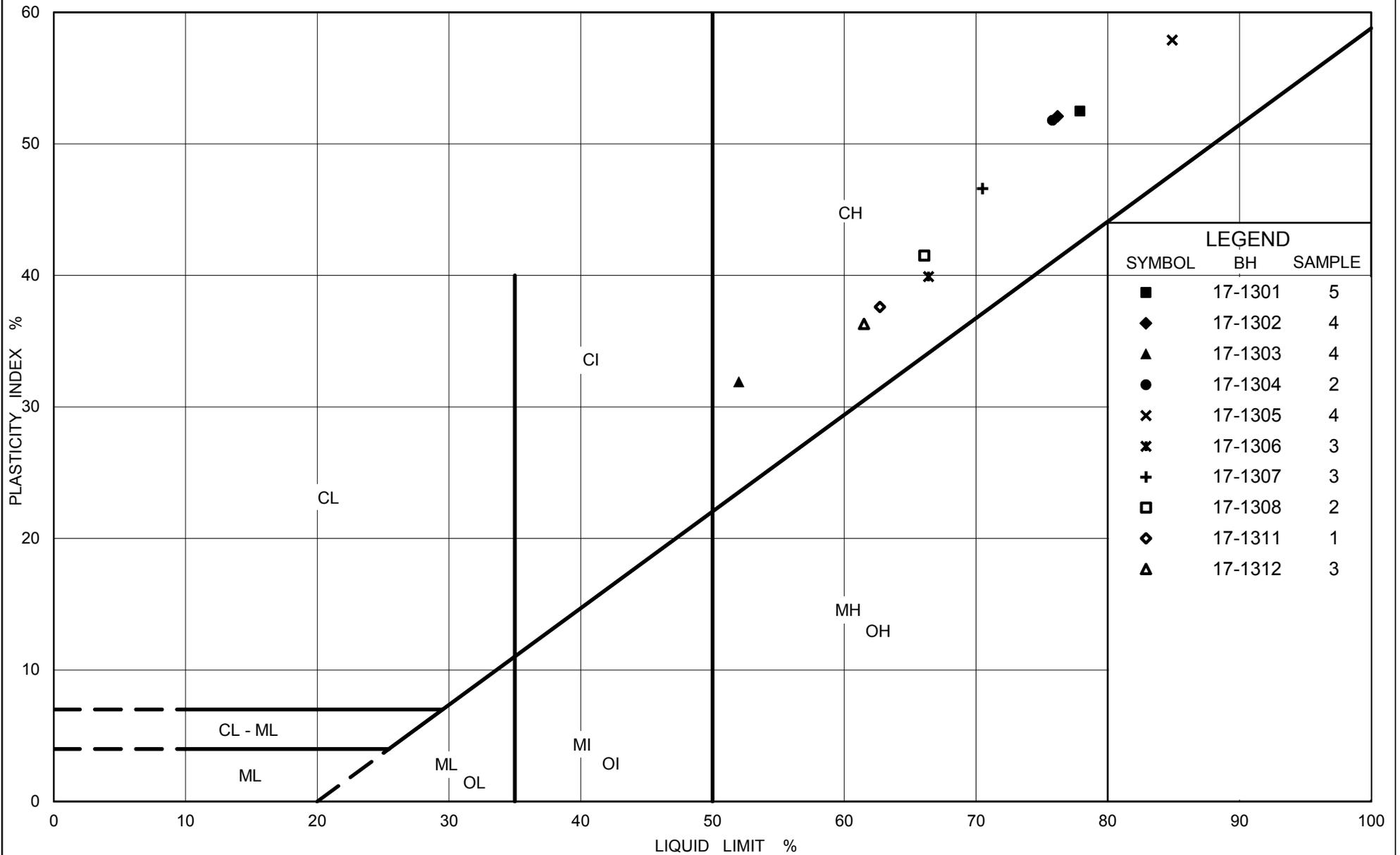
FIGURE B2

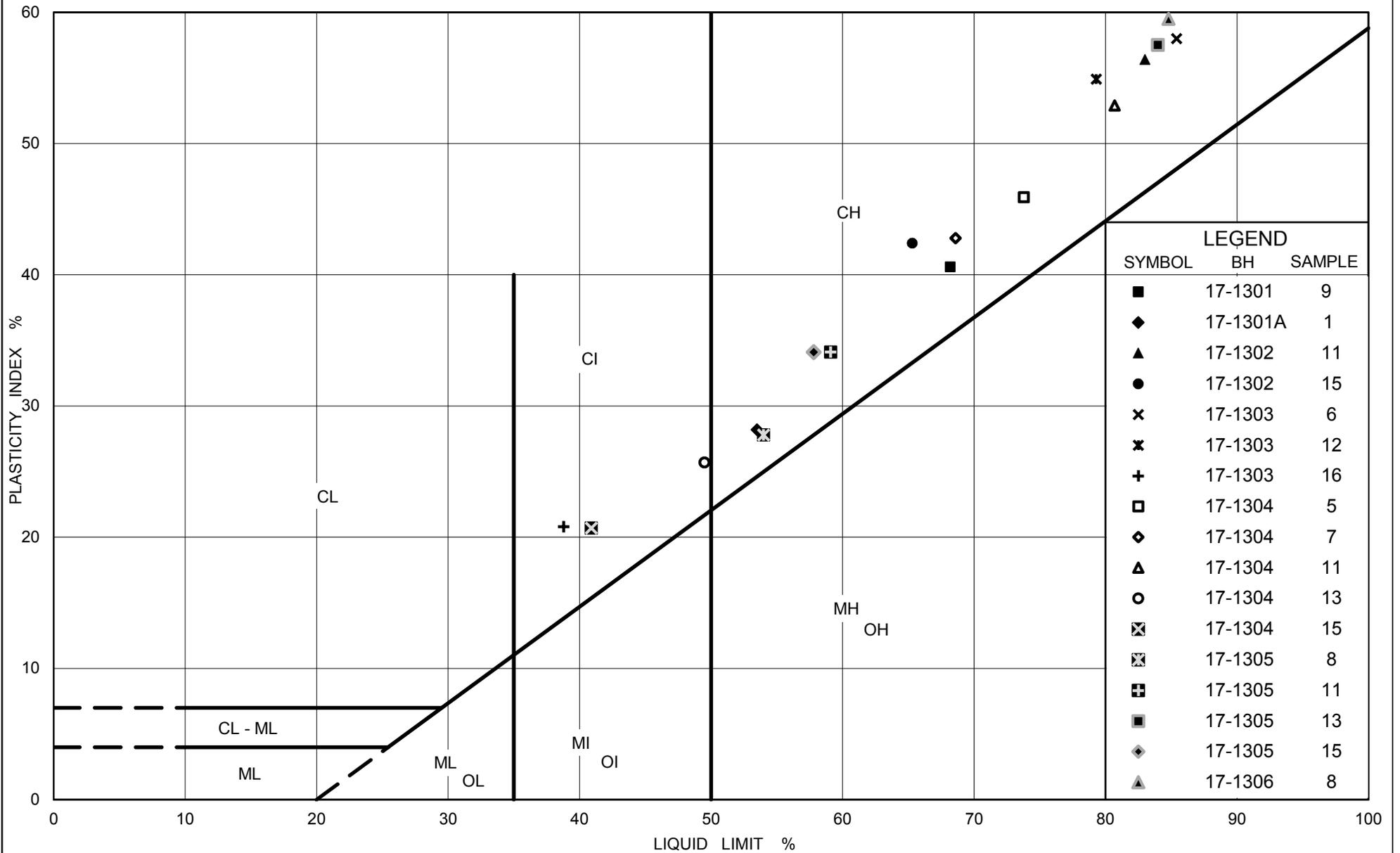
(SM) Silty Sand (ALLUVIUM)

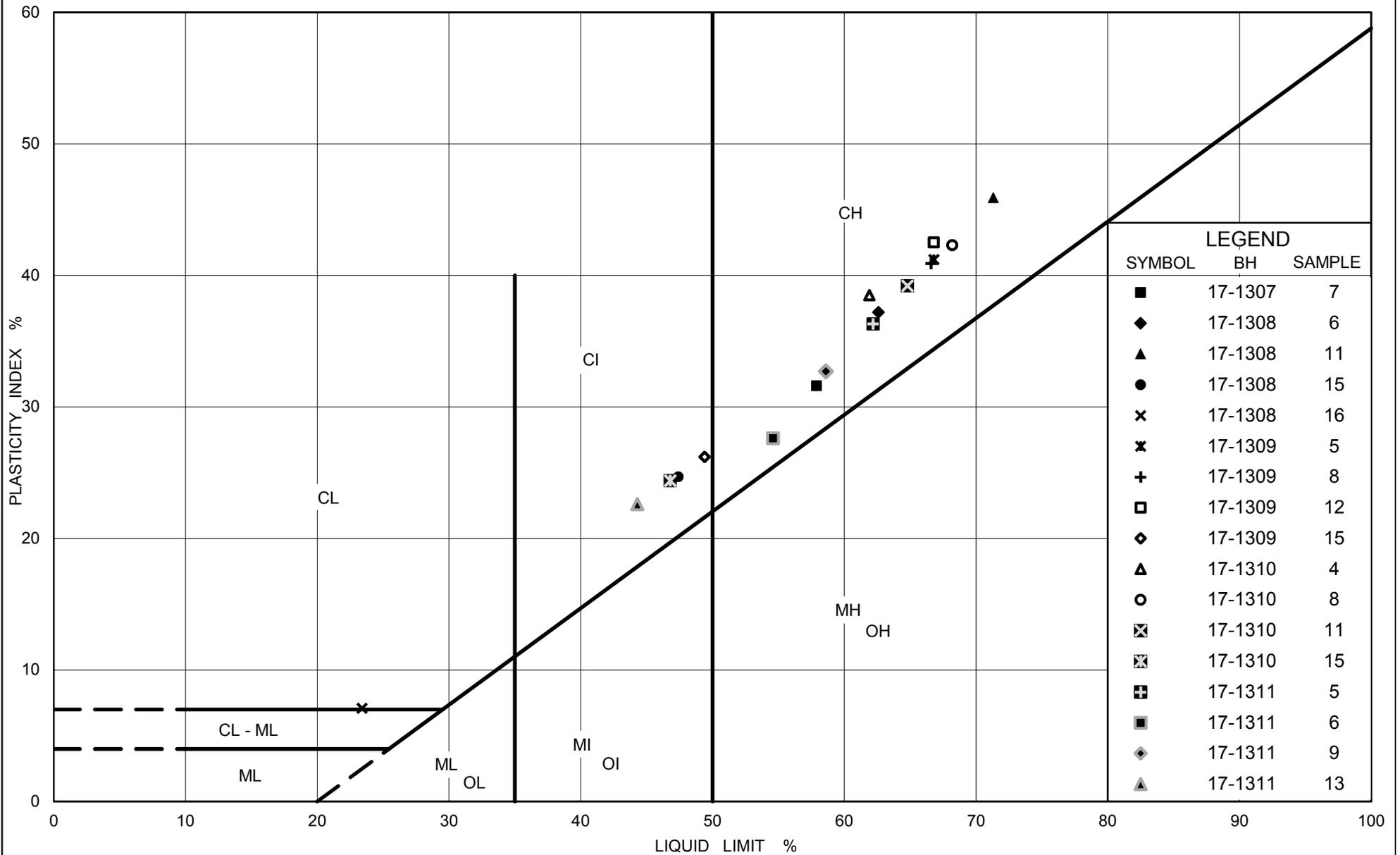


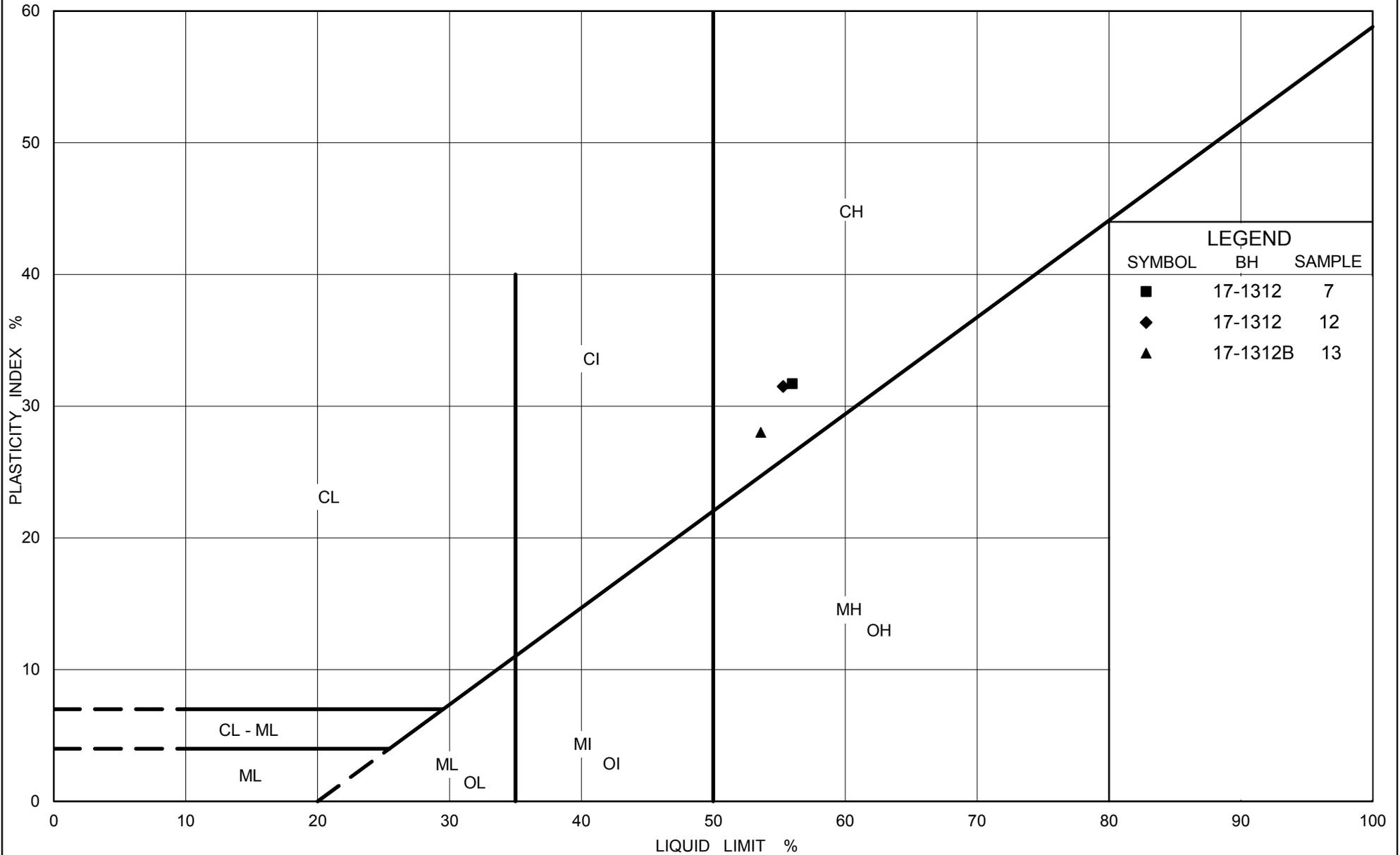
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
—■— 17-1309	2	0.76-1.37



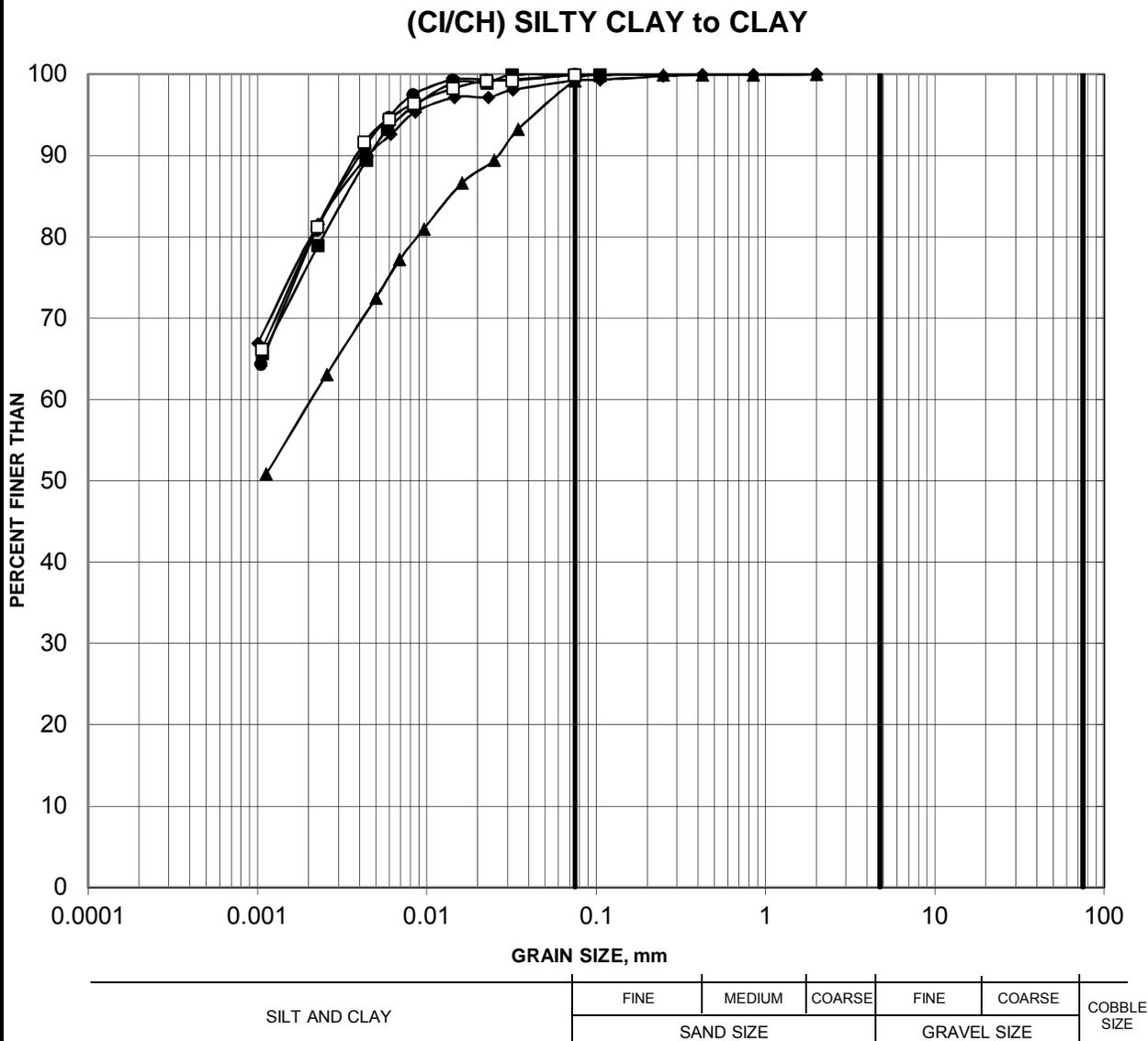




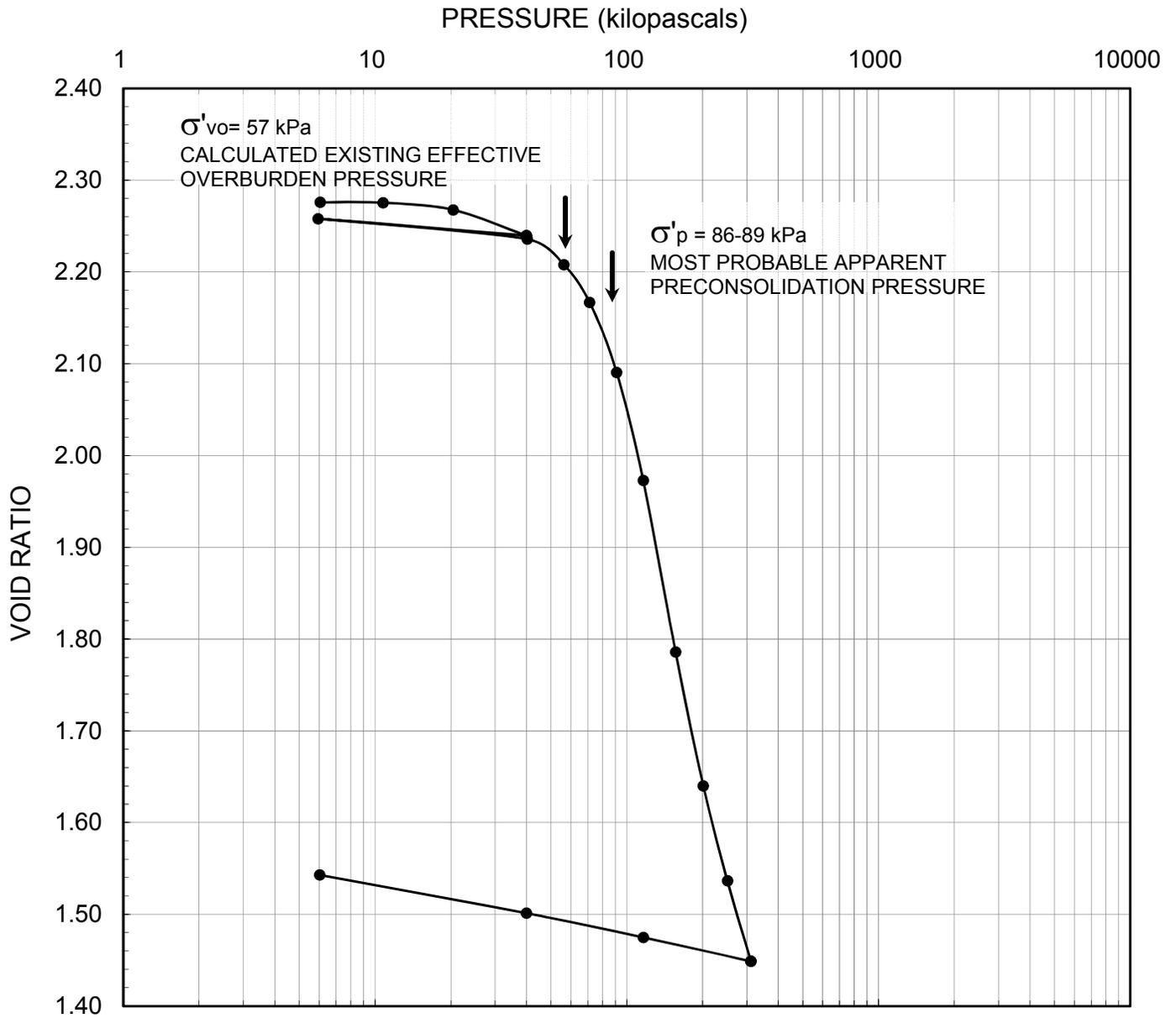


GRAIN SIZE DISTRIBUTION

FIGURE B5



Borehole	Sample	Depth (m)
—■—	17-1302	7
—◆—	17-1303	8
—▲—	17-1304	14
—●—	17-1306	11
—□—	17-1310	6



LEGEND

Borehole: 17-1301A	$w_i = 83\%$	$S_o = 100\%$	$\gamma = 15 \text{ kN/m}^3$
Sample: 1	$w_f = 55\%$	$e_o = 2.28$	$G_s = 2.75$
Depth (m): 5.8	$w_l = 54\%$	$C_c = 1.45$	
Elevation (m): 72.6	$w_p = 25\%$	$C_r = 0.026$	



GOLDER

SCALE	AS SHOWN
DATE	09/15/17
CADD	N/A
ENTERED	MI

TITLE

CONSOLIDATION TEST RESULTS

FILE No. Consolidation summary

CHECK	CNM
-------	-----

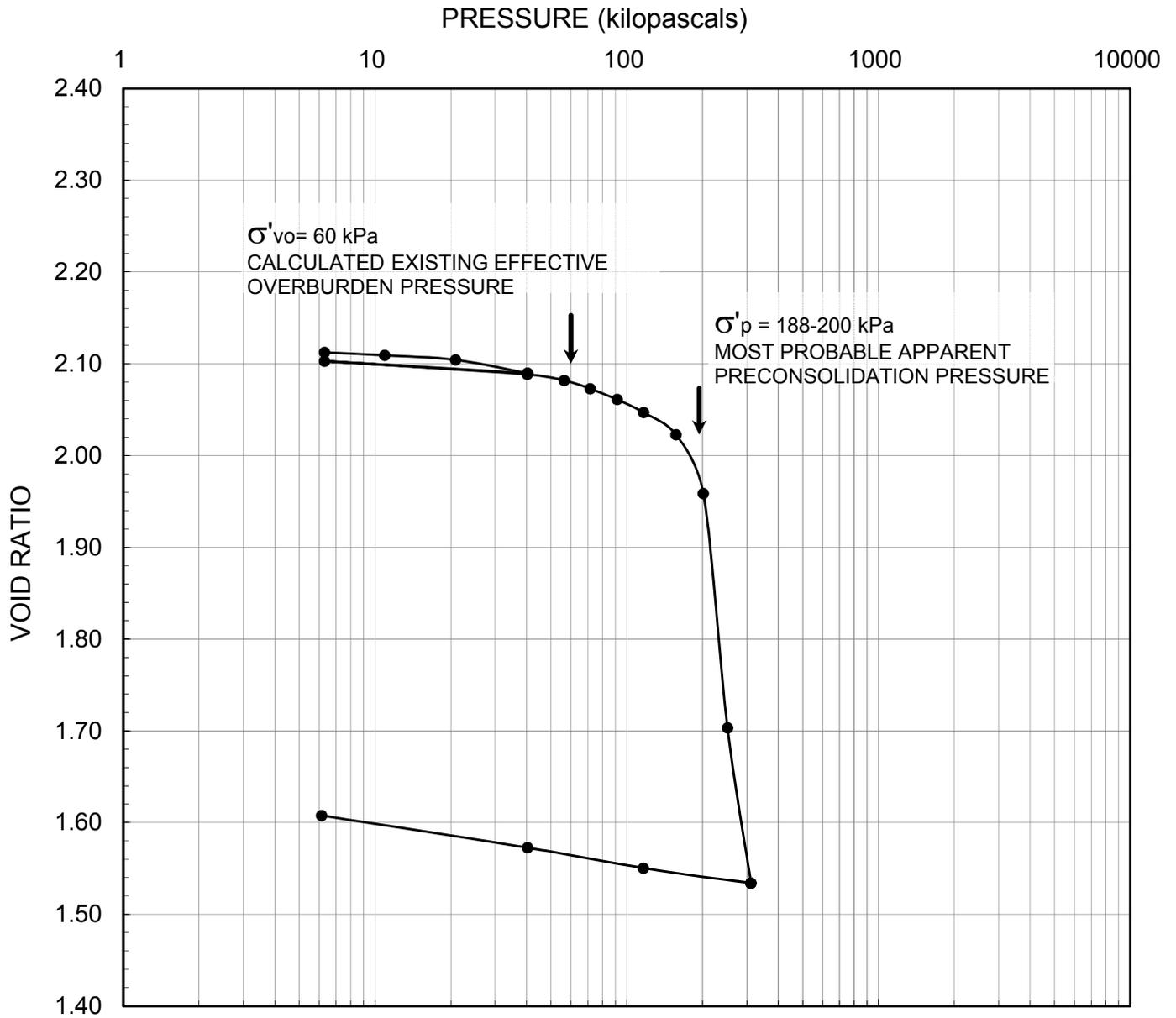
PROJECT No. 1662565 /1130

REV. 1

REVIEW	WAM
--------	-----

FIGURE

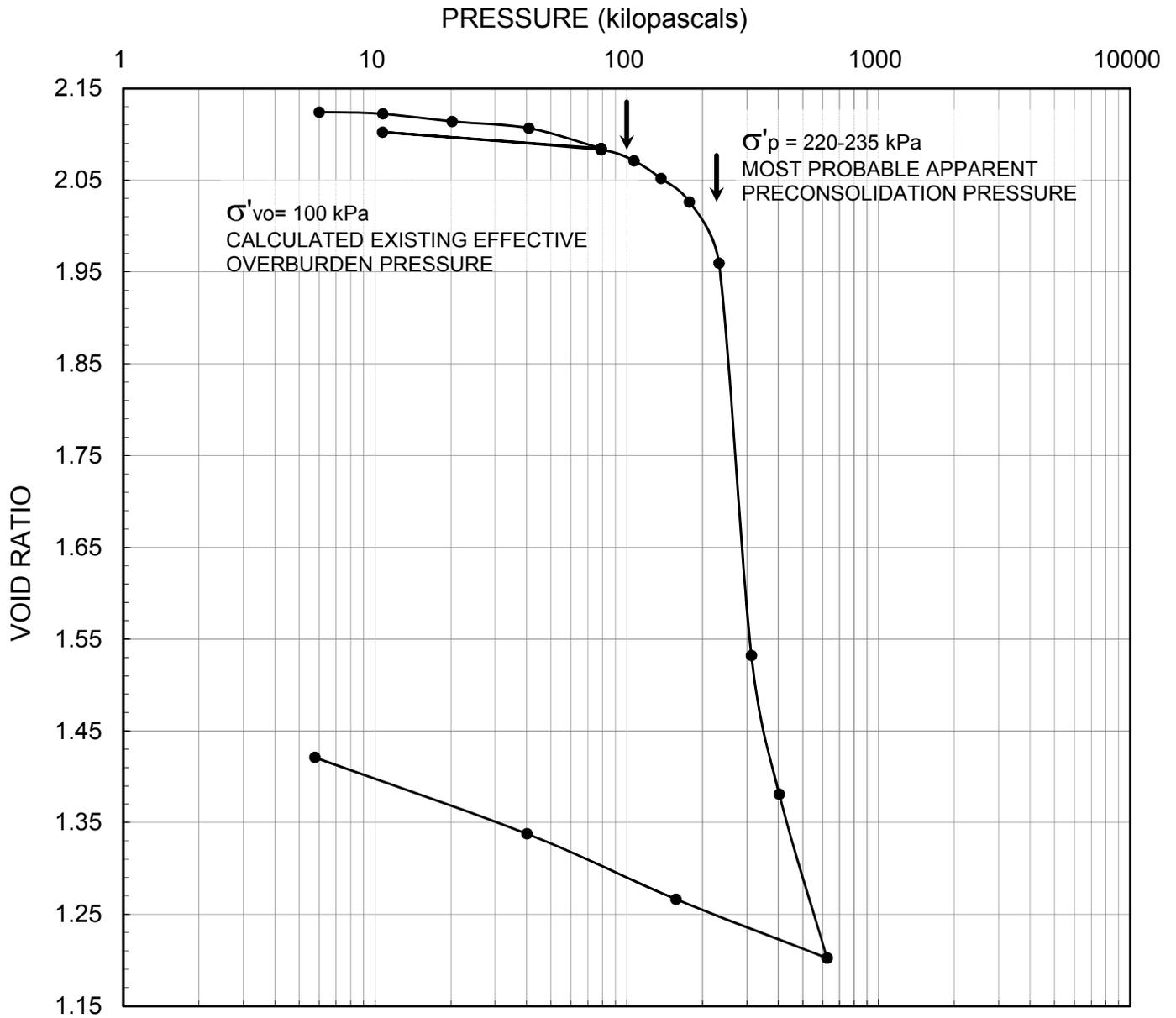
B6



LEGEND

Borehole: 17-1305	w _i = 78%	S _o = 100%	γ = 15.2 kN/m ³
Sample: 8	w _f = 62%	e _o = 2.11	G _s = 2.71
Depth (m): 8.1	w _l = 54%	C _c = 2.66	
Elevation (m): 68.7	w _p = 26%	C _r = 0.019	

	SCALE AS SHOWN	CONSOLIDATION TEST RESULTS
	DATE 09/15/17	
	CADD N/A	
	ENTERED MI	
FILE No. Consolidation summary	CHECK CNM	FIGURE B7
PROJECT No. 1662565 /1130 REV. 1	REVIEW WAM	



LEGEND

Borehole: 17-1305	$w_i = 76\%$	$S_o = 99\%$	$\gamma = 15.3 \text{ kN/m}^3$
Sample: 11	$w_f = 54\%$	$e_o = 2.13$	$G_s = 2.77$
Depth (m): 15.6	$w_l = 59\%$	$C_c = 3.32$	
Elevation (m): 61.2	$w_p = 25\%$	$C_r = 0.022$	



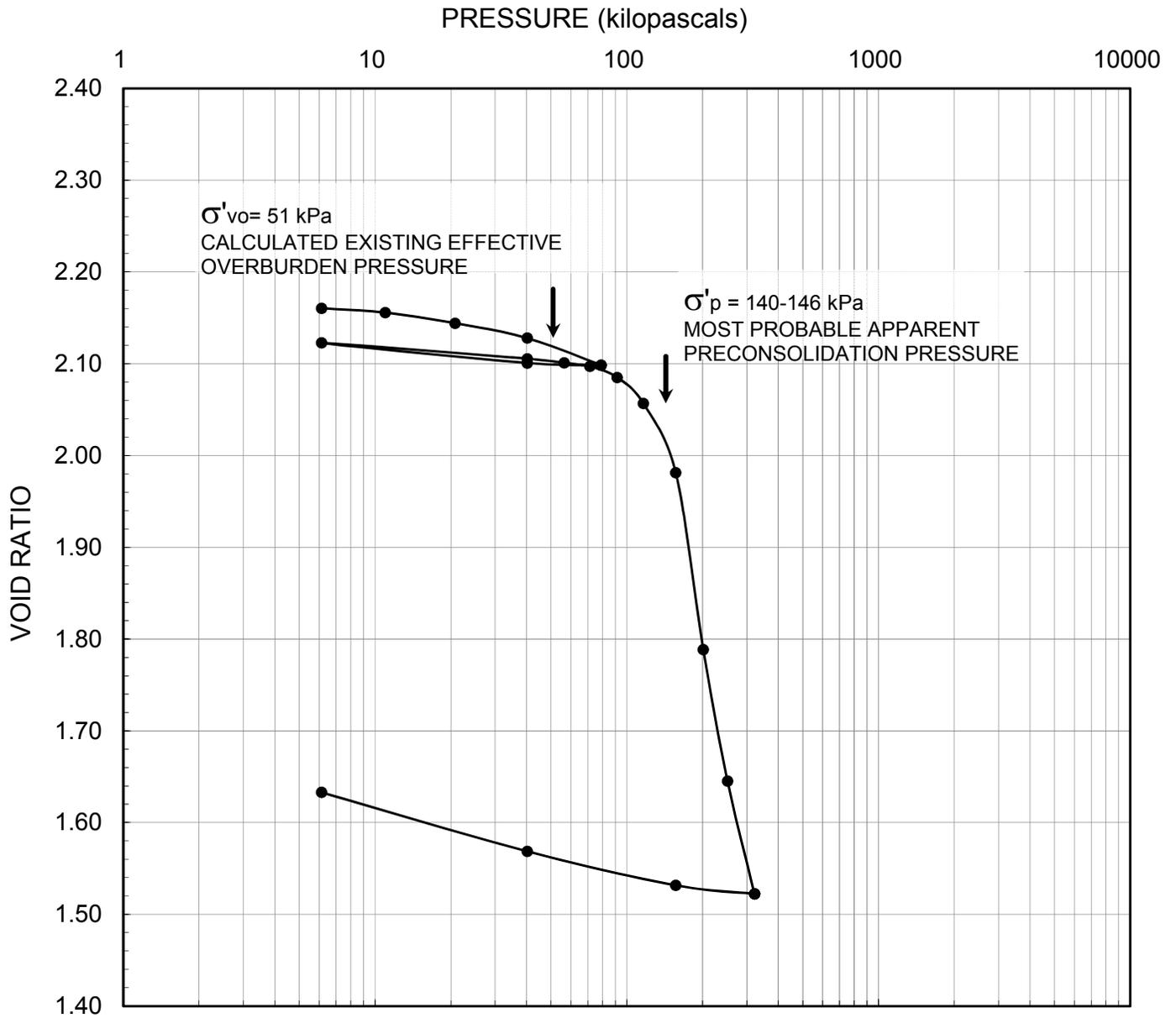
SCALE	AS SHOWN
DATE	09/15/17
CADD	N/A
ENTERED	MI

TITLE
CONSOLIDATION TEST RESULTS

FILE No.	Consolidation summary
PROJECT No.	1662565 /1130

CHECK	CNM
REVIEW	WAM

FIGURE **B8**



LEGEND

Borehole: 17-1307	w _i = 80%	S _o = 100%	γ = 15.1 kN/m ³
Sample: 7	w _f = 59%	e _o = 2.16	G _s = 2.70
Depth (m): 6.5	w _l = 58%	C _c = 1.75	
Elevation (m): 71.3	w _p = 26%	C _r = 0.024	



GOLDER

SCALE	AS SHOWN
DATE	09/15/17
CADD	N/A
ENTERED	MI

TITLE

CONSOLIDATION TEST RESULTS

FILE No. Consolidation summary

CHECK	CNM
-------	-----

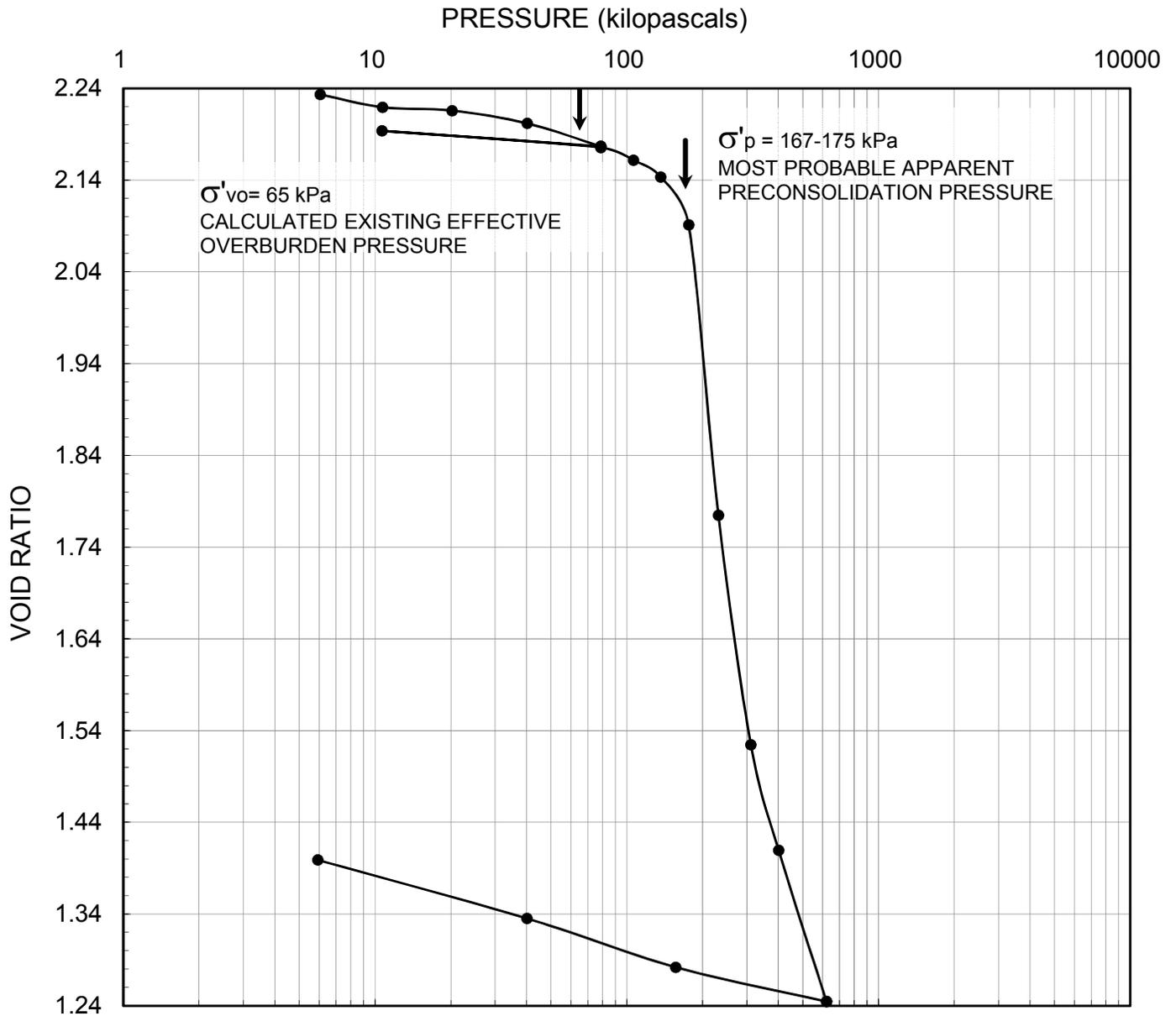
PROJECT No. 1662565 /1130

REV. 1

REVIEW	WAM
--------	-----

FIGURE

B9



LEGEND

Borehole: 17-1311	$w_i = 80\%$	$S_o = 100\%$	$\gamma = 15.2 \text{ kN/m}^3$
Sample: 6	$w_f = 53\%$	$e_o = 2.23$	$G_s = 2.77$
Depth (m): 7.1	$w_l = 55\%$	$C_c = 2.70$	
Elevation (m): 68.3	$w_p = 27\%$	$C_r = 0.021$	



GOLDER

SCALE	AS SHOWN
DATE	09/15/17
CADD	N/A
ENTERED	MI

TITLE

CONSOLIDATION TEST RESULTS

FILE No. Consolidation summary

CHECK	CNM
-------	-----

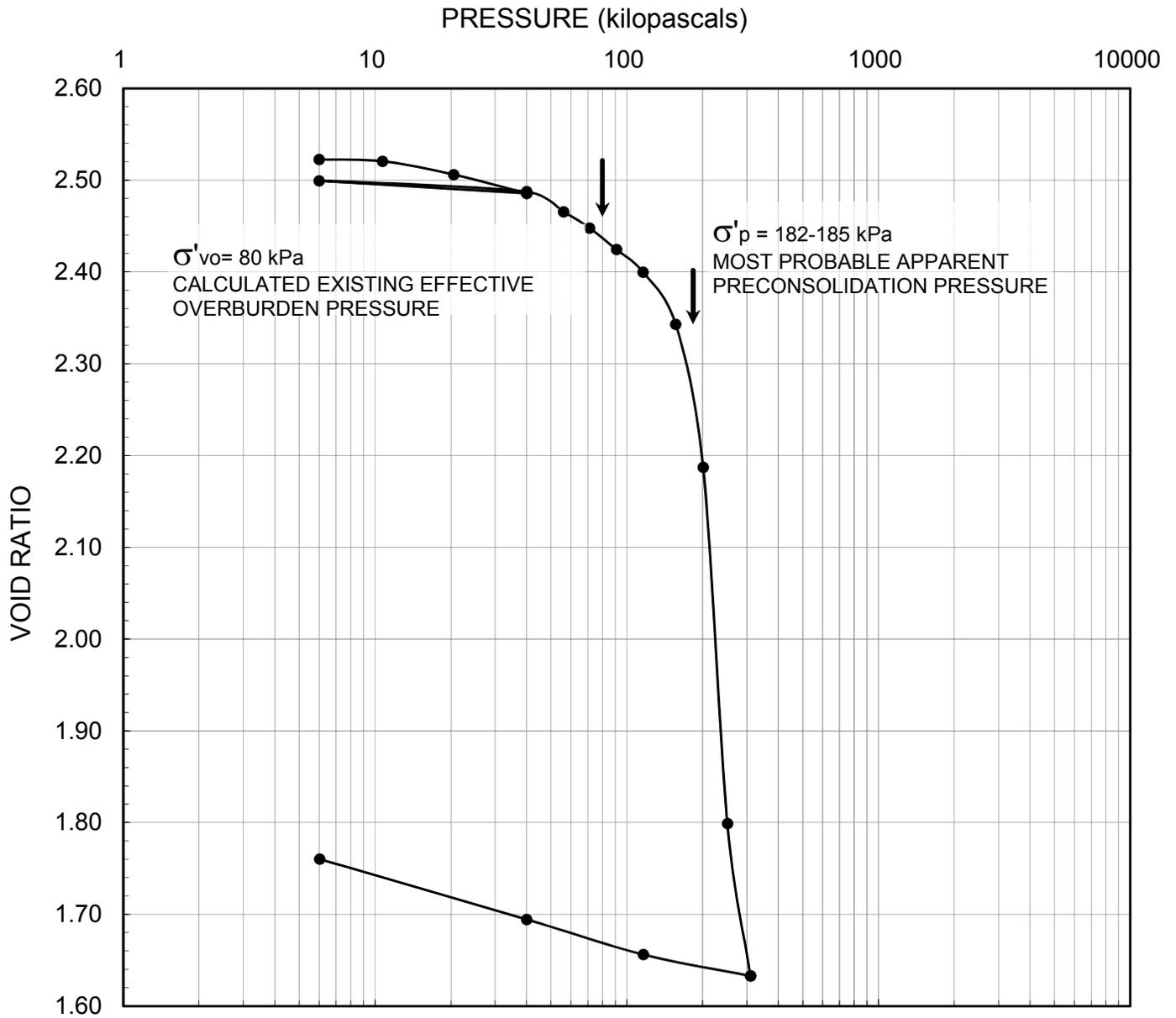
PROJECT No. 1662565 /1130

REV. 1

REVIEW	WAM
--------	-----

FIGURE

B10



LEGEND

Borehole: 17-1312B	$w_i = 90\%$	$S_o = 98\%$	$\gamma = 14.5 \text{ kN/m}^3$
Sample: 1	$w_f = 64\%$	$e_o = 2.52$	$G_s = 2.75$
Depth (m): 10.3	$w_l = 54\%$	$C_c = 4.03$	
Elevation (m): 64.5	$w_p = 26\%$	$C_r = 0.013$	



GOLDER

SCALE	AS SHOWN
DATE	09/15/17
CADD	N/A
ENTERED	MI

TITLE

CONSOLIDATION TEST RESULTS

FILE No. Consolidation summary

CHECK	CNM
-------	-----

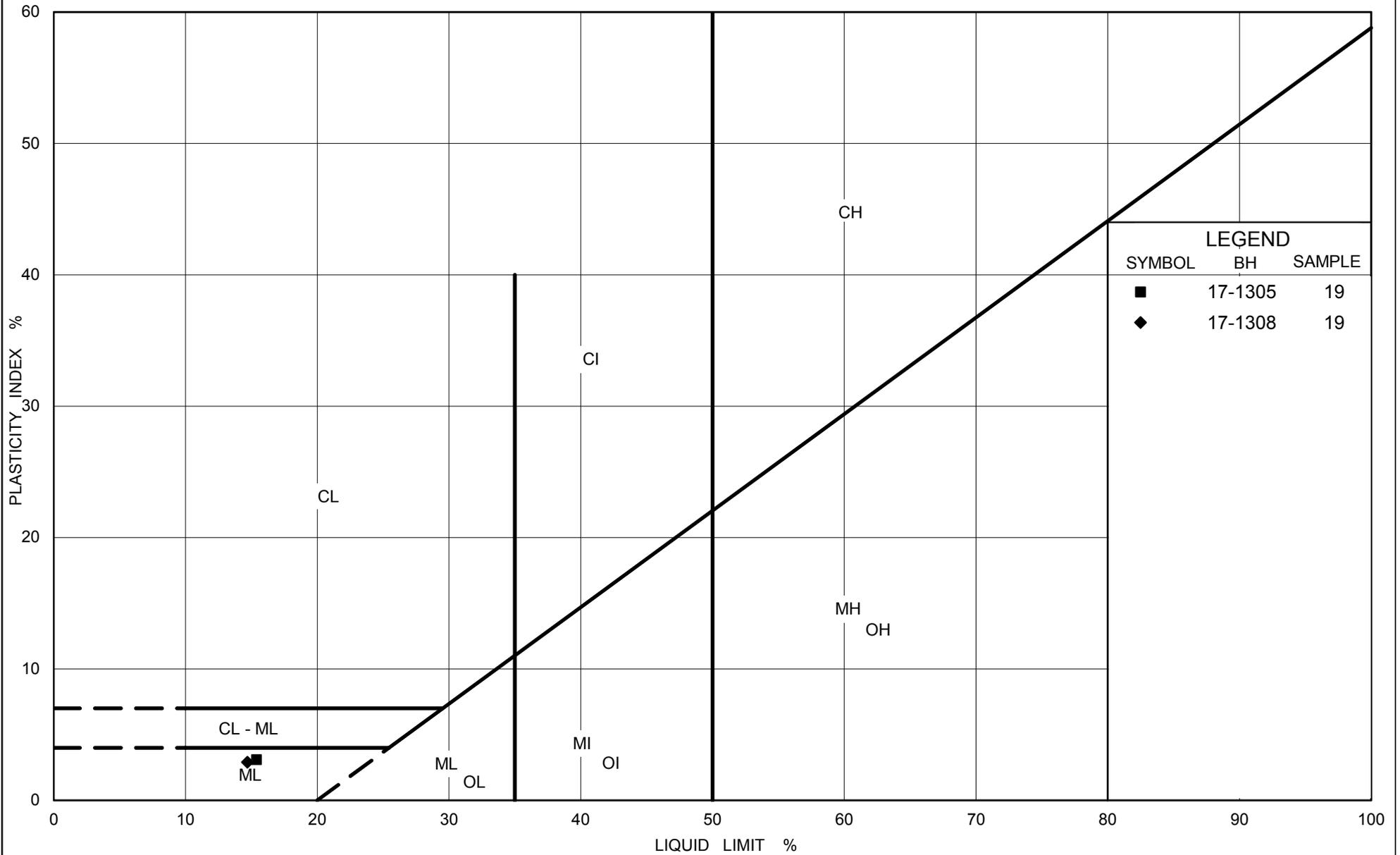
PROJECT No. 1662565 /1130

REV. 1

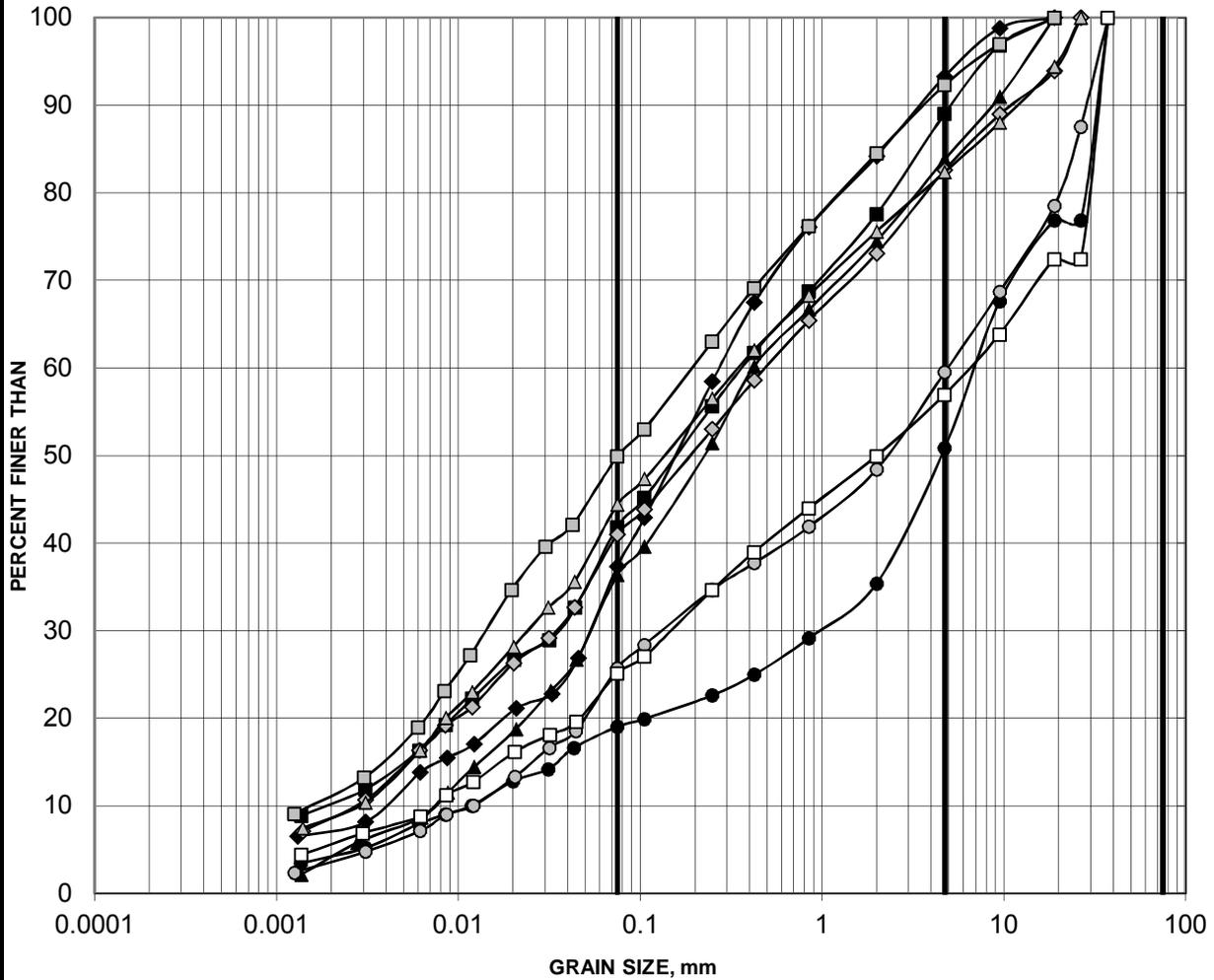
REVIEW	WAM
--------	-----

FIGURE

B11



(SM-ML) SILTY SAND to Sandy SILT (TILL)

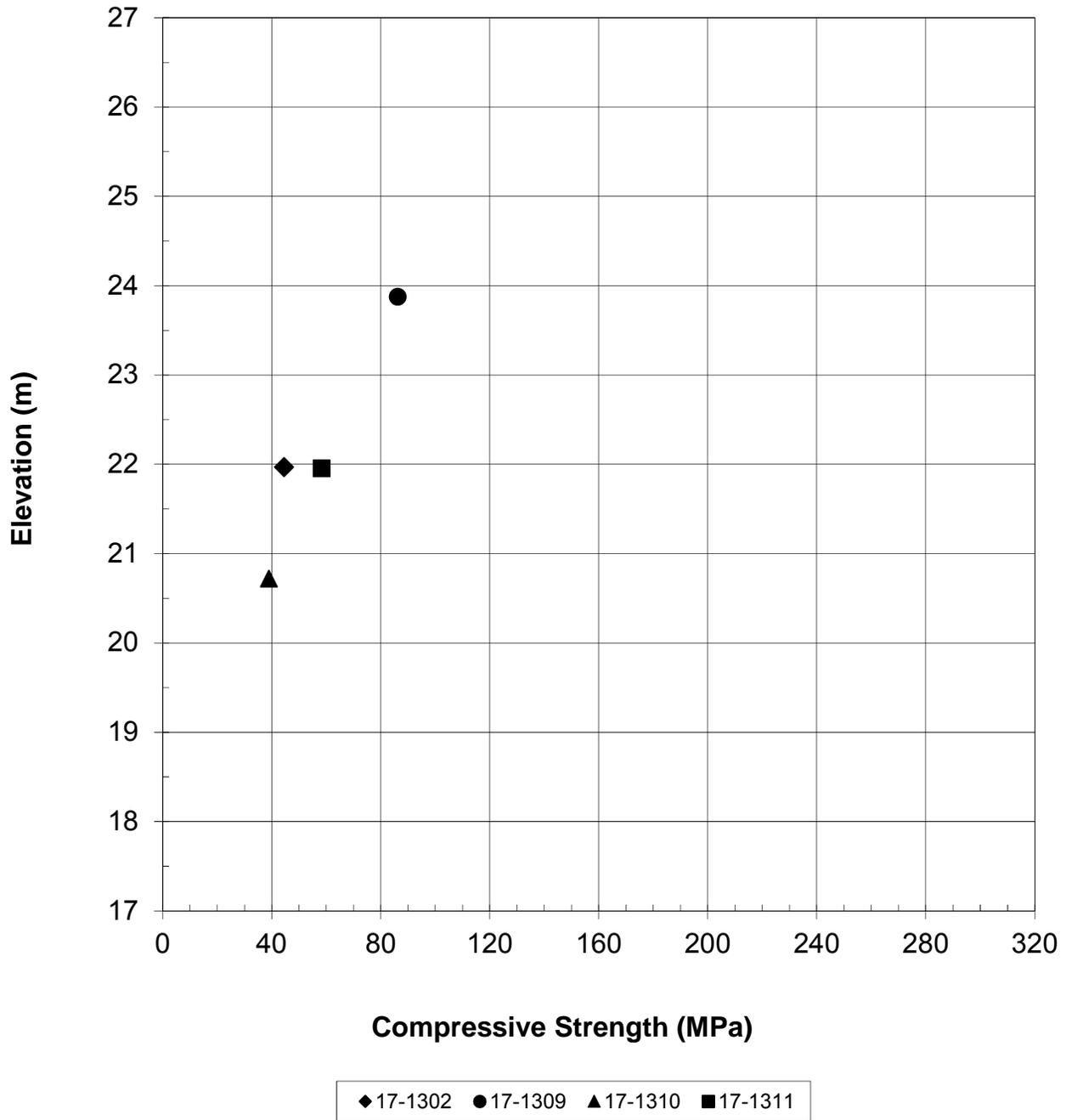


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

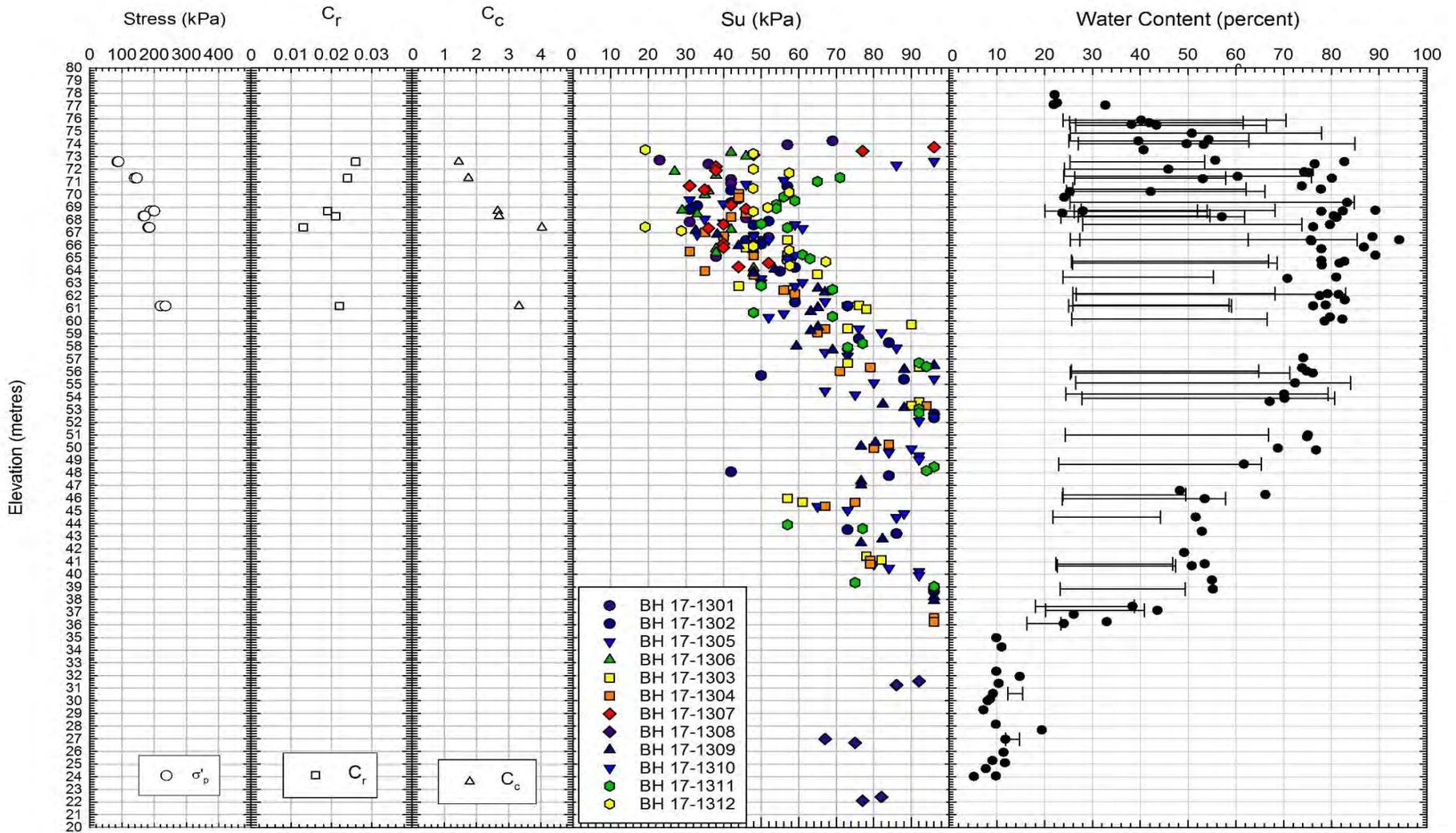
Borehole	Sample	Depth (m)
■	17-1302	18
◆	17-1302	19
▲	17-1303	20
●	17-1304	20
□	17-1305	19
◇	17-1308	18
△	17-1309	18
○	17-1310	20
◻	17-1311	17

**SUMMARY OF LABORATORY COMPRESSIVE STRENGTH
UNCONFINED COMPRESSION TESTS**

FIGURE B14



SUMMARY OF ENGINEERING PROPERTIES



RAMSAYVILLE ROAD OVERPASS
SITE NOS. 3-265/1 AND 3-265/2
HIGHWAY 417, OTTAWA, ONTARIO

Project No.	1662565 / 1130
Drawn:	WAM
Date:	03/05/2018
Checked:	MSS
Review:	FJH

Figure B15

APPENDIX C

**Borehole Record and Laboratory Test Results
(Previous Investigation, GEOCREG No. 31G05-071)
Records of Previous Boreholes BH 1 to BH 10
Laboratory Test Results**

RECORD OF BOREHOLE NO. 1

MATERIALS & TESTING DIVISION

JOB 68-F-54

LOCATION Hwy. 117, Sta. 220 + 40 EBL ☐

ORIGINATED BY PBS

W.P. 34-66-01

BORING DATE June 26 - July 3, 1968

COMPILED BY PBS

DATUM Geodetic

BOREHOLE TYPE Diamond Drill, NX - BX Casing, AXT Core

CHECKED BY *[Signature]*

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY PCF	Art. Head REMARKS
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	20	40	60		
227.2	Ground Level															
222.2	Clayey silt. Firm. Brown to grey.		1	TP	PM	220										Art. Head 240.7
5.0			2	TP	PM											REMARKS
			3	TP	PM											
			4	TP	PM											
			5	TP	PM											
			6	TP	PM											
			7	TP	PM											
			8	TP	PM											
	Sensitive clay occasional inclusions of organic matter.		9	TP	PM											
			10	TP	PM											
			11	TP	PM											
			12	TP	PM											
	Firm to stiff.		13	TP	PM											
			14	TP	PM											
			15	TP	PM											
	Grey with occasional black mottling															
119.2																
108.0	Clayey silt with sand and some gravel (Glacial Till)		16	SS	17											
	Layers of silt and sand up to 2' thick (Compact to dense)		17	SS	26											
	Very stiff to hard. Grey		18	SS	22											
			19	SS	18											
77.2			20	SS	62											
152.0	Sound calcareous sand grey.			AXT	60%											5 53 32 10
70.2																Art. pressure encountered
157.0	End of Borehole						20									
							15									
							10									

Axial strain at failure

13
10
64

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 68-F-54

W.P. 34-66-01

DATUM Geodetic

RECORD OF BOREHOLE NO. 2

LOCATION Hwy. 417 Sta. 221 + 30 WBL

BORING DATE July 4-9, 1968

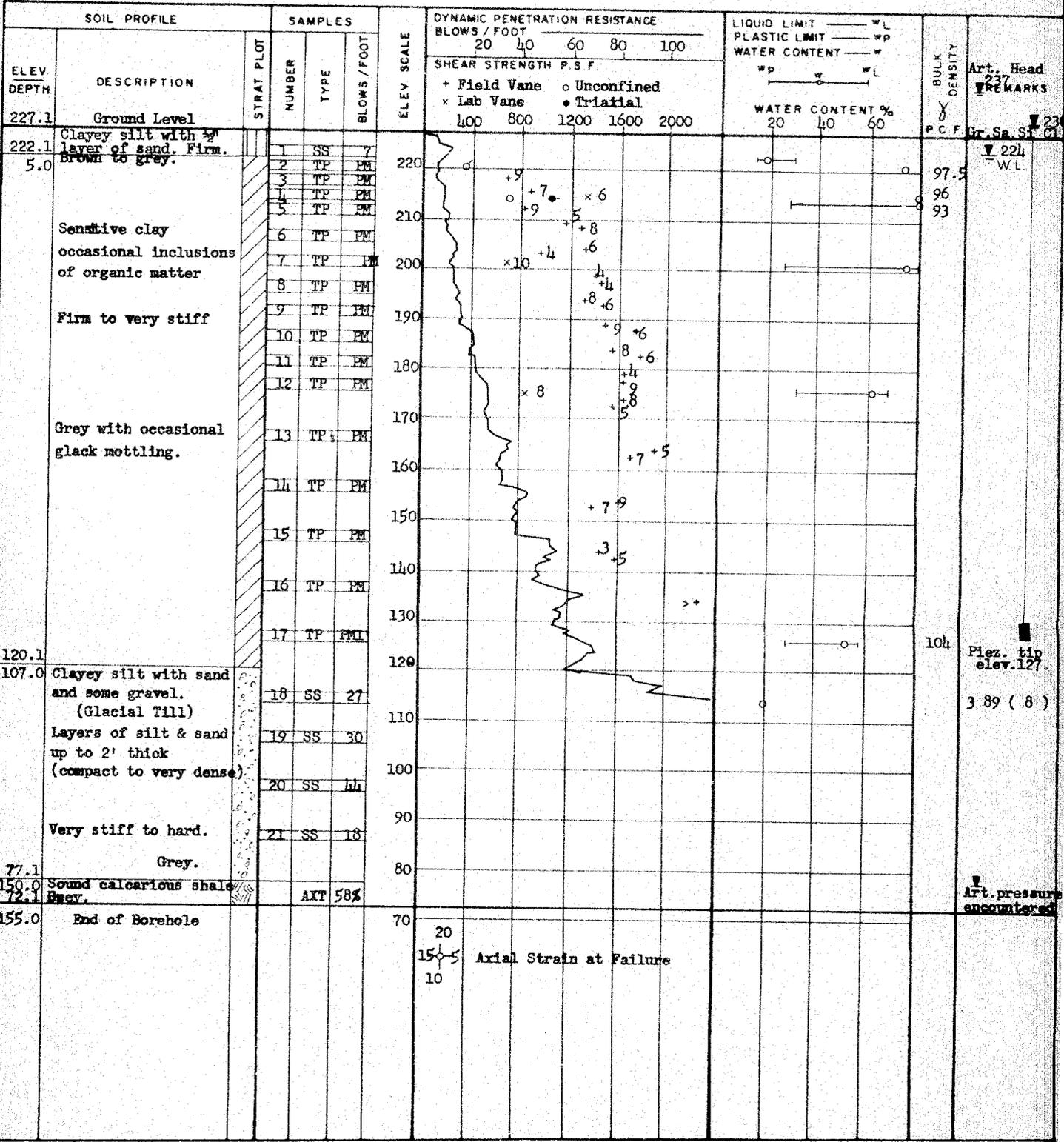
BOREHOLE TYPE Diamond Drill, NX, BX Casing, AXT Core

FOUNDATION SECTION

ORIGINATED BY BEL

COMPILED BY FS

CHECKED BY [Signature]



Axial Strain at Failure

Art. pressure encountered

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION
RECORD OF BOREHOLE NO. 3
 FOUNDATION SECTION

JOB 68-F-54 LOCATION Hwy. 417 Sta. 219 + 95 WBL ORIGINATED BY FBS
 W.P. 34-66-01 BORING DATE July 10-11, 1968 COMPILED BY FBS
 DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX Casing CHECKED BY [Signature]

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY pcf	REMARKS		
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	WL	W				
250.8	Ground Level						400	800	1200	1600	2000							
	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.		1	SS	17													
			2	SS	22													
			3	SS	9													
			4	TP	PM													
			5	TP	PM													
			6	TP	PM													
			7	TP	PM													
			8	TP	PM													
			9	TP	PM													
			10	TP	PM													
			11	TP	PM													
			12	TP	PM													
			13	TP	PM													
			14	TP	PM													
			15	TP	PM													
			16	TP	PM													
			17	TP	PM													
124.0																		
126.8	Clayey silt with sand & some gravel. (Glacial till)		18	SS	30													
104.3	Layers of silt & sand up to 2' thick (dense)																	
	Very stiff to hard. Grey.		19	SS	16													
116.5	End of Borehole																	

Gr. Sa. S1. C1

245

W=87.1%

106 12 2 56 30

RECORD OF BOREHOLE NO. 4

JOB 68-F-54 LOCATION Hwy. 417 Sta. 222 + 75 EBL ORIGINATED BY BHL
 W.P. 34-66-01 BORING DATE July 15-17, 1968 COMPILED BY PBS
 DATUM Geodetic BOREHOLE TYPE Diamond Drill, NX Casing CHECKED BY [Signature]

SOIL PROFILE		SAMPLES		ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w	BULK DENSITY PCF	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER TYPE						SHEAR STRENGTH P.S.F. + Field Vane • Triaxial x Lab Vane o Unconfined	WATER CONTENT % 20 40 60
249.6	Ground Level									
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling	[Strat Plot Hatched Area]	1 SS 18	240						
			2 SS 15							
			3 SS 11							
			4 TP PM							
			5 TP PM							
			6 TP PM						102	
			7 TP PM							
			8 TP PM							
			9 TP PM							
			10 TP PM						98.5	
			11 TP PM							
			12 TP PM							
			13 TP PM							
			14 TP PM							
			15 TP PM							
124.6					16 TP PM	140				
125.0			Clayey silt with sand		17 SS	130				
119.6	& some Grey (Gl. till)		18 SS 27							
130.0	Very stiff.		19 SS							
	End of Borehole									

20
15
10
Axial Strain at failure

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & TESTING DIVISION

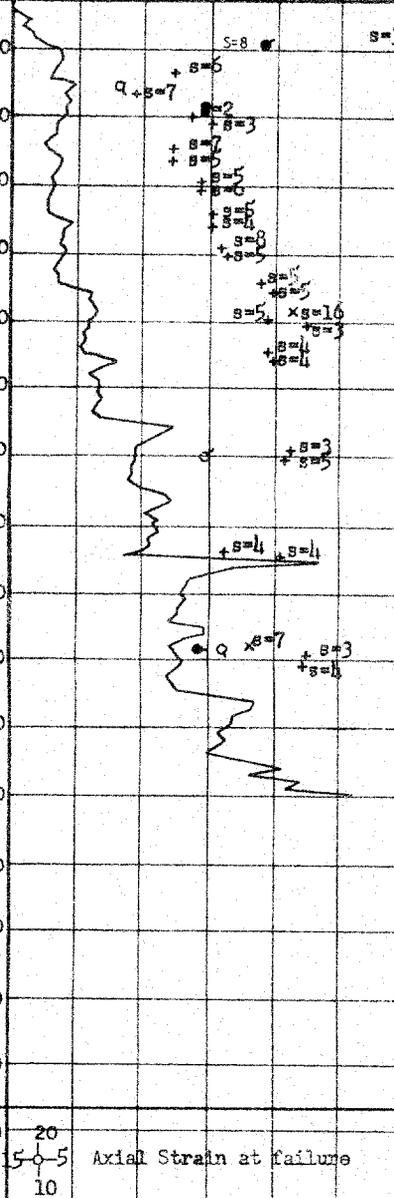
RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 219 + 50 @ Hwy. 417 EBL o/s 18' Lt. ORIGINATED BY WH
 W.P. 34-66-01 BORING DATE Aug. 7-15, 1968 COMPILED BY WH
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY [Signature]

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT PLASTIC LIMIT WATER CONTENT			BULK DENSITY P.C.F.	REMARKS	
			NUMBER	TYPE	BLOWS / FOOT		20	40	80	100	w _L	w _p	w			
237.8	Ground Level															
0-0	Clayey silt Stiff		1	SS	0											
3-0	Sensitive clay occasional inclusions of organic matter. Firm to very stiff Grey with occasional black mottling		2	TW	PM											
			3	TW	PM											
			4	TW	PM											
			5	TW	PM											
			6	TW	PM											
			7	TW	PM											
			8	TW	PM											
			9	TW	PM											
			10	TW	PM											
			11	TW	PM											
			12	TW	PM											
			12A	TW	PM											
			13	TW	PM											
		14	TW	PM												
		15	TW	PM												
		16	TW	PM												
		17	TW	PM												
119.8			18	SS	18											
118.0	Clayey silt with sand & some gravel. (Glacial till)		19	SS	21										24 43 23 10	
	Layers of silt & sand up to 2' thick (compact to very dense).		20A	SS	31											
	Very stiff to hard.		21	SS	23										34 42 21 3	
	Grey.		22	SS	100/6"											
79.0			23	AC	866											
158.8	Sound calcareous shale		24	AC	890											
73.5	Gray		24	AC	972										Art. pressure encountered	
164.3	End of Borehole															

SHEAR STRENGTH P.S.F.
 + Field Vane o Unconfined
 x Lab Vane • Triaxial



15-5 Axial Strain at failure
 10

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

JOB 68-F-54

LOCATION Sta. 221 + 30 @ Hwy. 417 EBL o/s 18' Lt.

ORIGINATED BY WH

W.P. 34-66-01

BORING DATE August 16 - 21, 1968

COMPILED BY MH

DATUM Geodetic

BOREHOLE TYPE Diamond Drill - Washboring

CHECKED BY [Signature]

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	Art. Head REMARKS	
			NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	WL	W			
228.3	Ground Level																
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.	[Strat. Plot Hatched]	1	CS													
			2	TW	PM												
			3	SS	1 1/8"												
			4	TW	PM												
			5	SS	2 7/8"												
			6	TW	PM												
			7	SS	1"												
			8	TW	PM												
			9	SS	1"												
			10	TW	PM												
			11	SS	2 1/8"												
			12	TW	PM												
			13	SS	3"												
			14	TW	PM												
			15	SS	3"												
			16	TW	PM												
			17	SS	4"												
			18	TW	PM												
118.3	Clayey silt with sand and some gravel (Glacial till) Layers of silt & sand up to 2' thick (compact to dense). Very stiff to hard. Grey.	[Strat. Plot Dotted]	19	SS	1 1/2"												
110.0			20	SS	-												
			21A	SS	2 5/8"												
79.6			22	SS	100/5"												
			Hammer bouncing														
148.7	End of Borehole Probable Bedrock					20 15-5 10	Axial strain at failure								Art. pressure encountered		

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 68-F-54 LOCATION Sta. 222 + 00 @ Hwy. 417 EBL o/s 18' Et. ORIGINATED BY WH
 W.P. 24-66-01 BORING DATE August 12 - 19, 1968 COMPILED BY WH
 DATUM Geodetic BOREHOLE TYPE Diamond Drill - Washboring CHECKED BY JK

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES		BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w			BULK DENSITY γ _p P.C.F.	REMARKS	
			NUMBER	TYPE			20	40	60	80	100	20	40			60
243.0	Ground Level															
0.0	Sensitive clay Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling.	[Strat. Plot]	1	CS		240										
			2	SS												
			3	PM												
			4	3"TW	PM											
			5	TW	PM											
			6	3"TW	PM											
			7	3"TW	PM											
			8	SS	1/18"											
			9	3"TW	PM											
			10	SS	1											
			11	3"TW	PM											
			12	SS	1											
			13	3"TW	PM											
			14	SS	2											
			15	3"TW	PM											
			16	SS	2											
			17	TW	PM											
			18	SS	3											
			19	TW	PM											
			20	SS	4											
120.0			21	TW	PM											
123.0	Clayey silt with sand & some gravel (Glacial till) Occ. layers of silt & sand up to 1' thick (compact to dense) Stiff to hard. Grey.	[Strat. Plot]	22	SS	18	120										
			23	SS	9	110										
			24	SS	17	100										
			25	SS	20	90										
			26	SS	45	80										
76.1			27	AXT RC	91 1/2 Rec	70										
166.9 70 ft	Sound calcareous shale grey															
172.6	End of Borehole						15 5 10								Axial strain at failure	

Gr. Sa. Si. Cl
0 2 29 69
237.
97.5
94.5
95
107
111
3 13 69 15
piez. tip.
el. 207.

JOB 68-F-54 LOCATION Sta. 222 + 20 @ Hwy. 417 WBL o/s 18' Lt. ORIGINATED BY WH
 W.P. 34-66-01 BORING DATE Aug. 21-23, 1968 COMPILED BY WH
 DATUM Geodetic BOREHOLE TYPE Diamond Drill, Washboring CHECKED BY LR

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY γ _{pcf}	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	20	40	60	80	100	W _p			W _L	W
228.5	Ground Level															
0.0	Clayey Silt some Sand		1	CS												
223.5	stiff Brown to Grey		2	TW	PM											
5.0	Sensitive clay. Occasional inclusions of organic matter. Firm to very stiff. Grey with occasional black mottling		3	SS	2											
				4	TW	PM										
				5	SS	17/9										
				6	TW	PM										
				7	SS	1										
				8	TW	PM										
				9	SS	2										
				10	TW	PM										
				11	SS	6										
				11A	SS	5										
				12	TW	PM										0 11 40 49
				13	SS	4										
				14	TW	PM										
				15	TW	TW										107
117.5				16	SS	-										
111.0	Clayey silt with sand & some gravel (Glacial till)		16A	SS	15										14 39 26 21	
104.5	Very stiff. Grey.		17	SS	20											
124.0	End of Borehole															
							20	15	5	10	Axial strain at failure					

RECORD OF BOREHOLE NO. 10

MATERIALS & TESTING DIVISION

JOB 68-F-54

LOCATION Sta. 222 + 80 @ Hwy. 417 EBL o/s 18' Rt.

ORIGINATED BY WH

W. P. 34-66-01

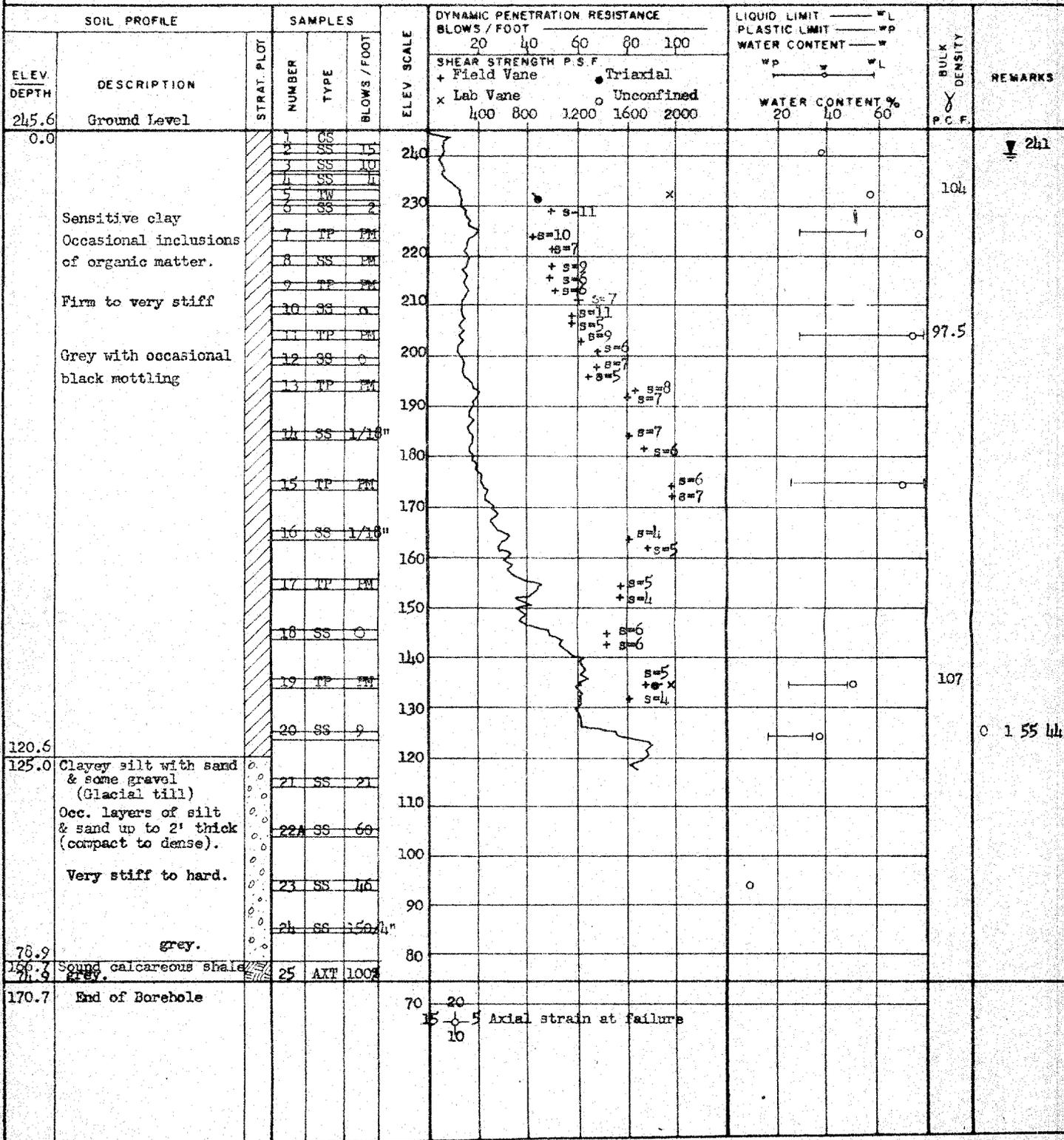
BORING DATE Aug. 15-22, 1968

COMPILED BY WH

DATUM Geodetic

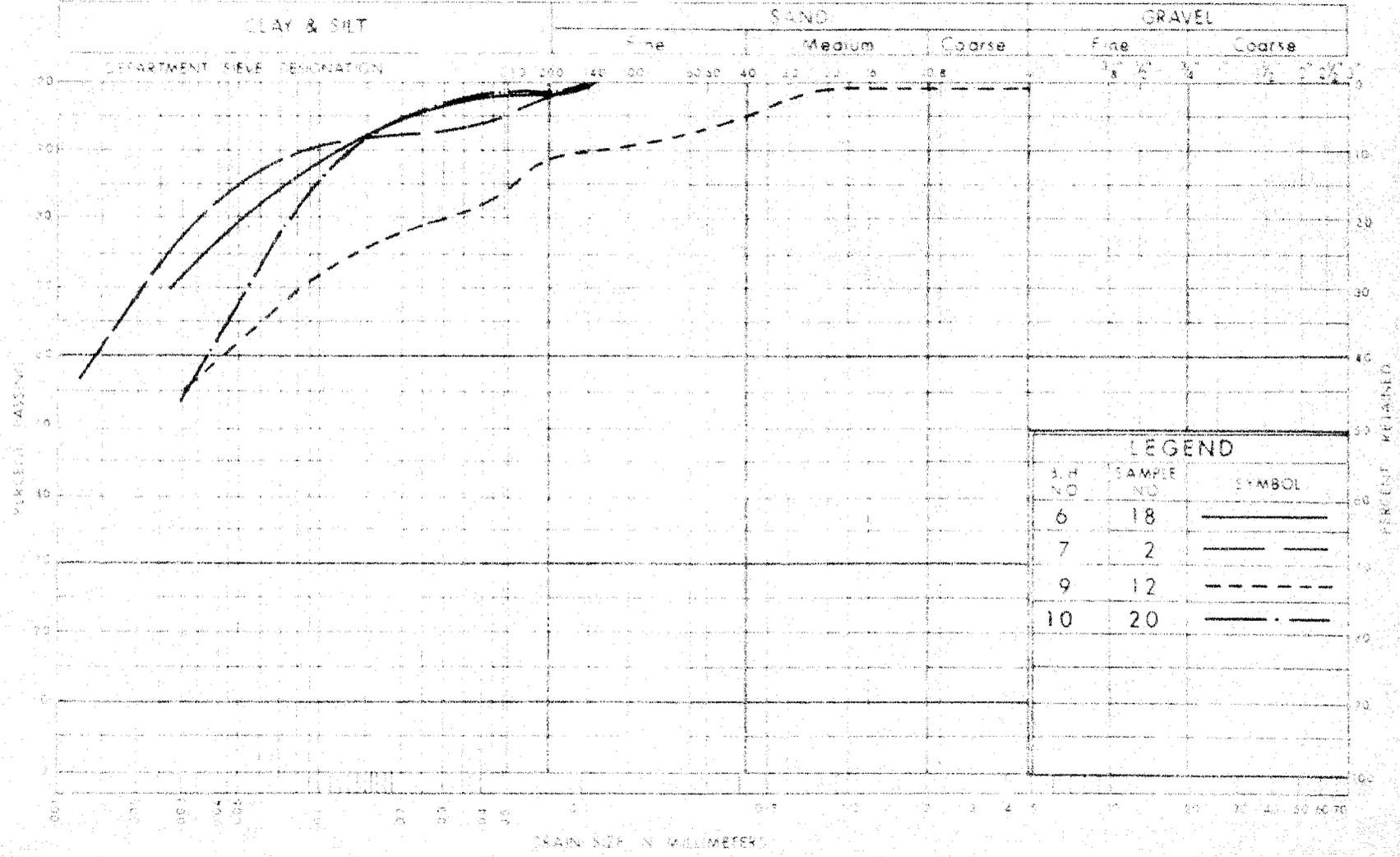
BOREHOLE TYPE Diamond Drill, Washboring

CHECKED BY *HL*



DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

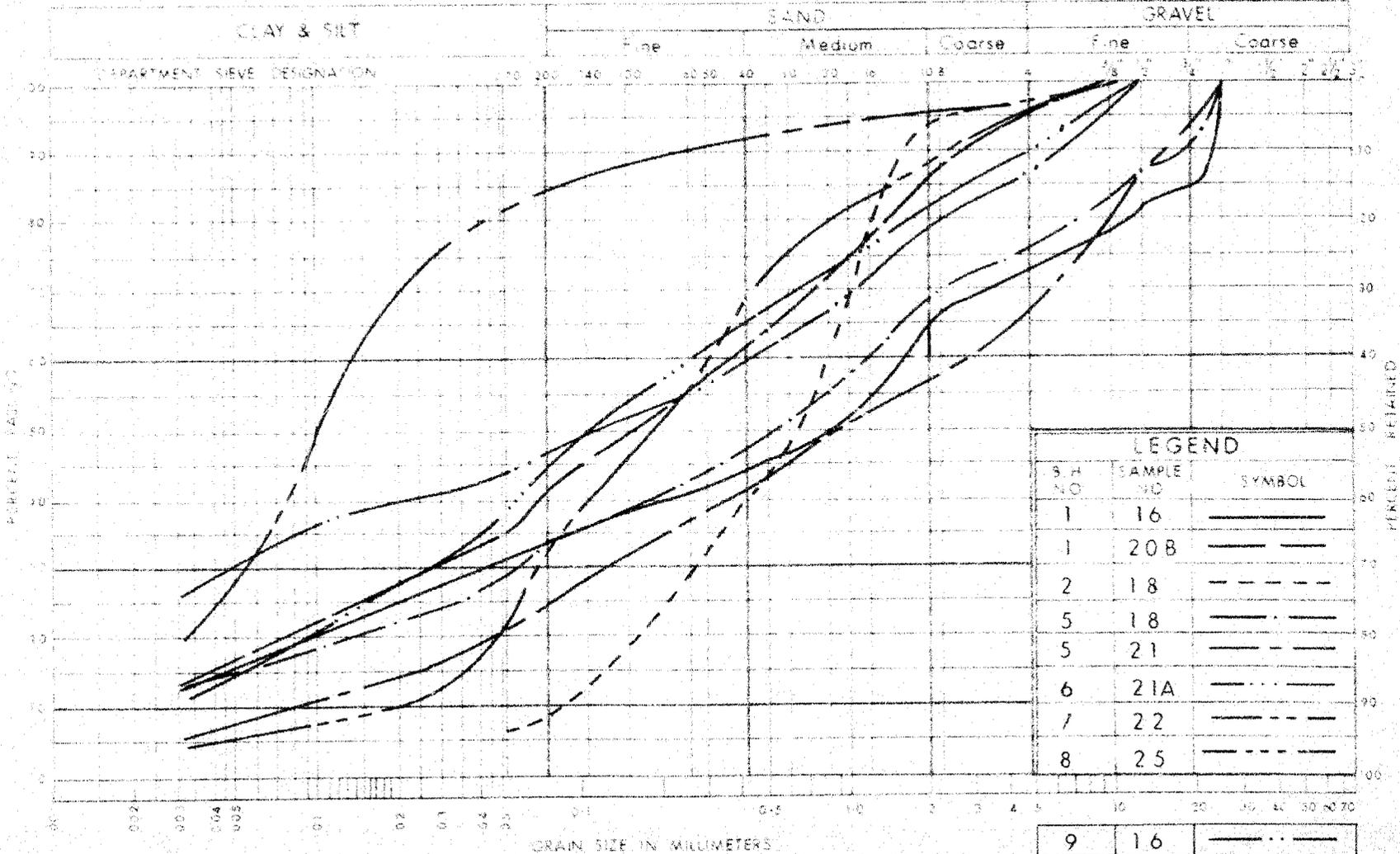
GRAIN SIZE DISTRIBUTION
SENSITIVE CLAY

W.P. No. 34-66-01
JOB No. 68-F-54

FIG. 3

DEFECTS IN NEGATIVE DUE TO
 CONDITION OF ORIGINAL DOCUMENT

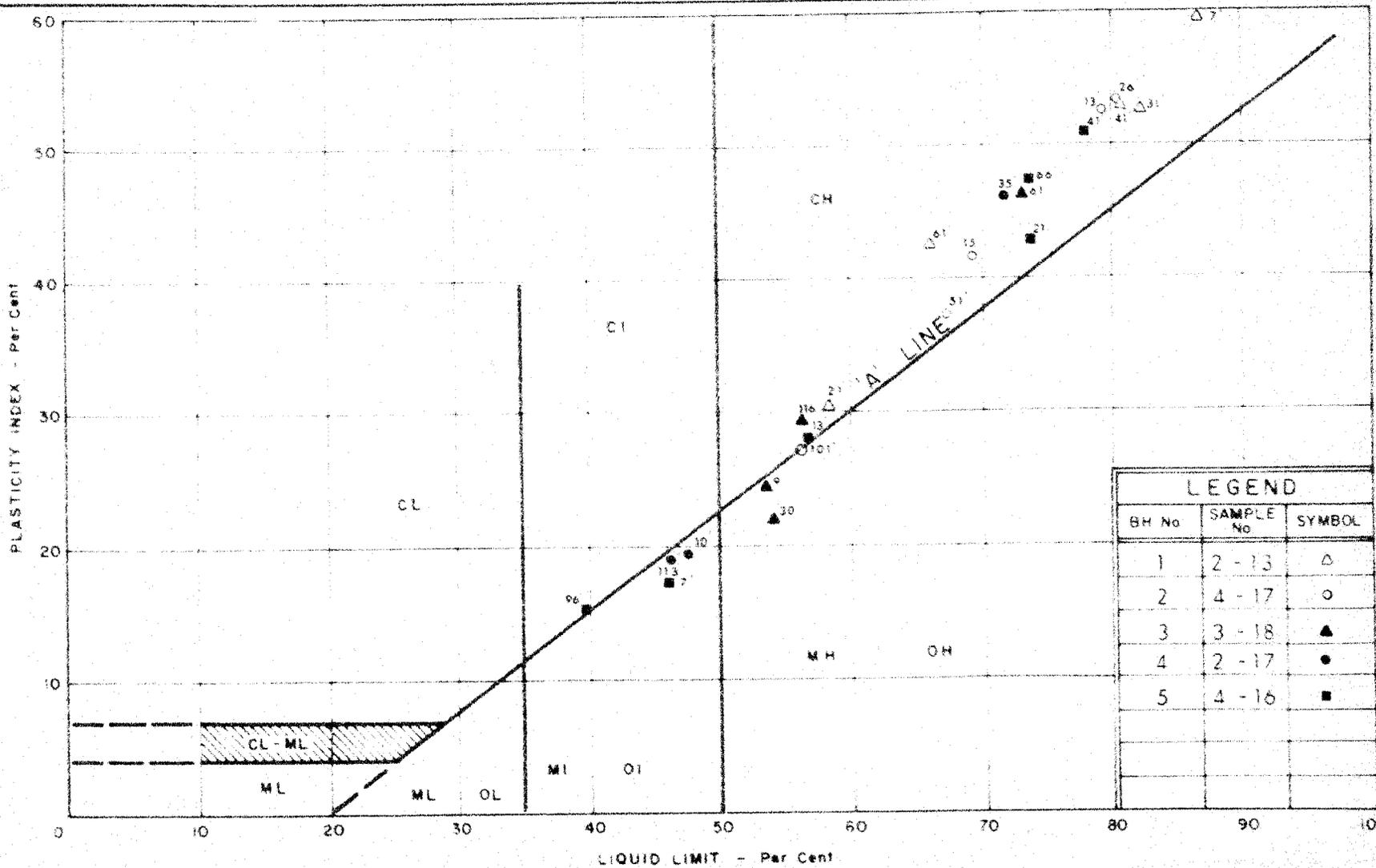
UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
 CLAYEY SILT
 WITH SAND & SOME GRAVEL
 (GLACIAL TILL)

WP No. 34 - 66 - 01
 JOB No. 68 - F - 54
 FIG. 4

DEFECTS IN NEGATIVE DUE TO
 CONDITION OF ORIGINAL DOCUMENT



LEGEND		
BH No	SAMPLE No	SYMBOL
1	2 - 13	△
2	4 - 17	○
3	3 - 18	▲
4	2 - 17	●
5	4 - 16	■

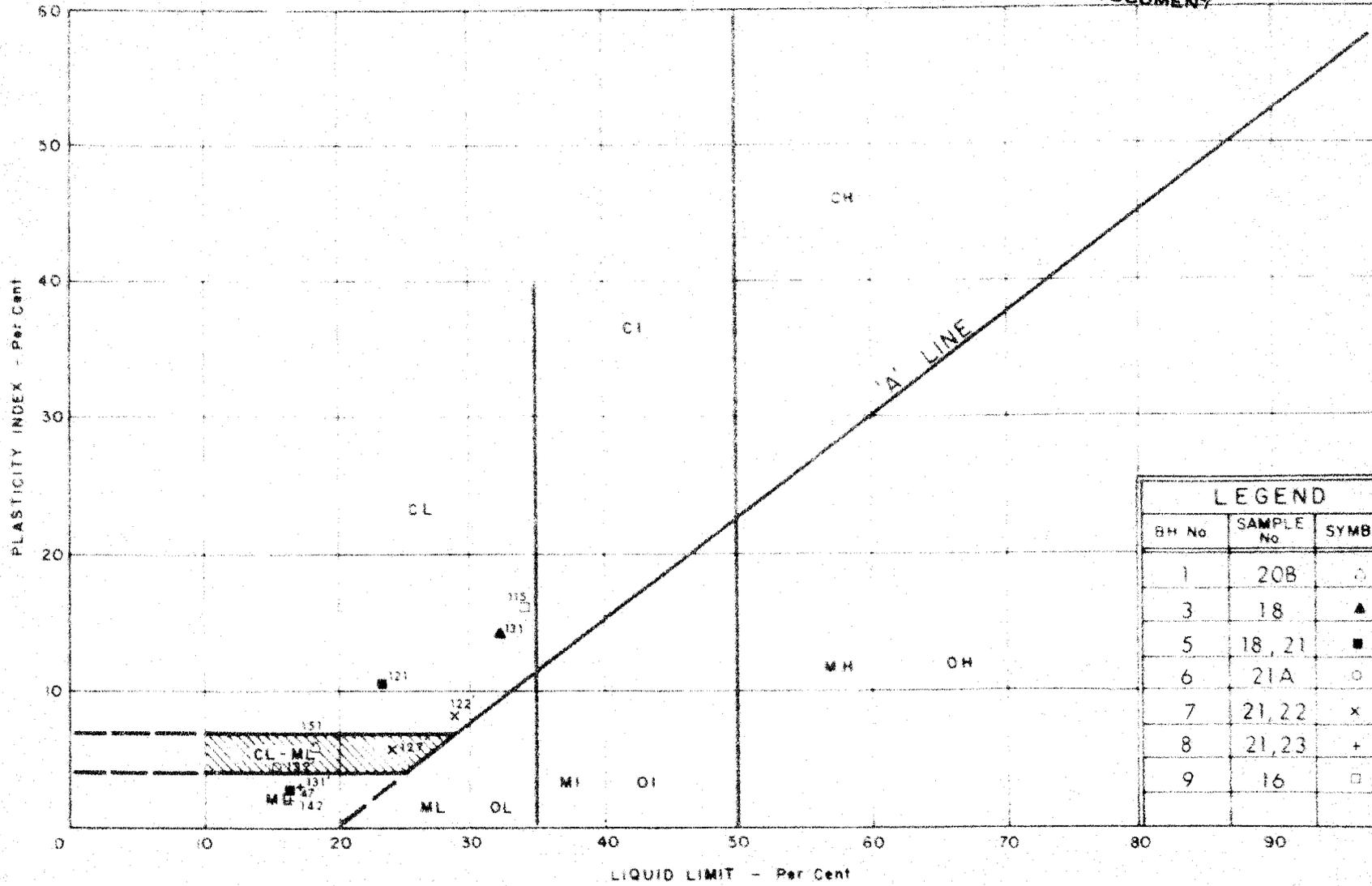


DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING
 DIVISION

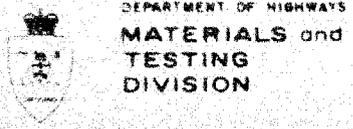
PLASTICITY CHART
 SENSITIVE CLAY

WP No. 34-66-01
 JOB No. 68 - F - 54
 FIG. No. 5

DEFECTS IN NEGATIVE DUE TO
 CONDITION OF ORIGINAL DOCUMENT



LEGEND		
BH No	SAMPLE No	SYMBOL
1	20B	○
3	18	▲
5	18, 21	■
6	21A	○
7	21, 22	x
8	21, 23	+
9	16	□



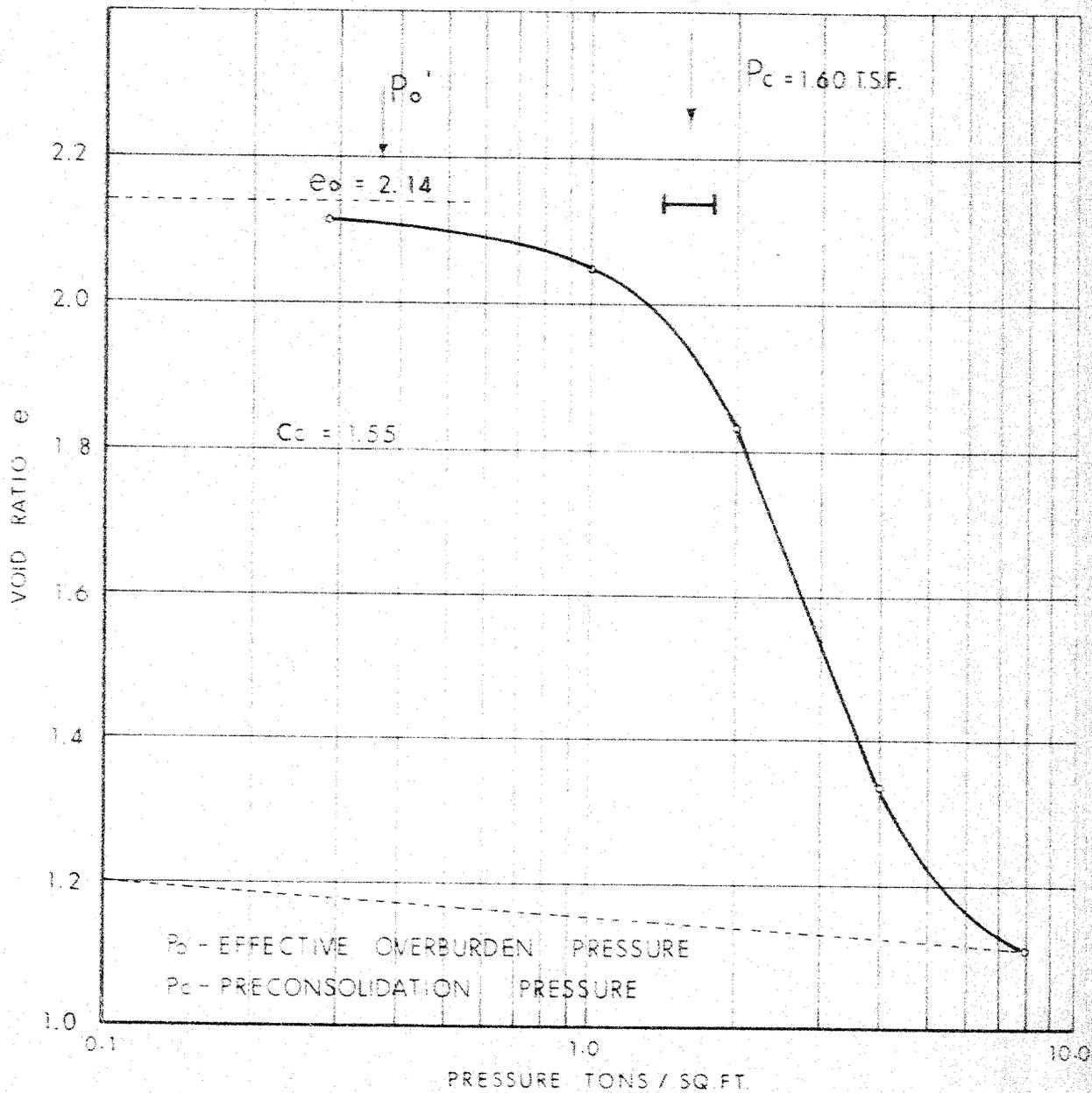
PLASTICITY CHART
 CLAYEY SILT
 WITH SAND, SOME GRAVEL
 (GLACIAL TILL)

WP No. 34-66-01
 JOB No. 68-F-54
 FIG. No. 7

VOID RATIO vs PRESSURE

$W_L = 79.0$
 $W_p = 26.9$
 $W = 78.7$
 $C_c = 1.55$

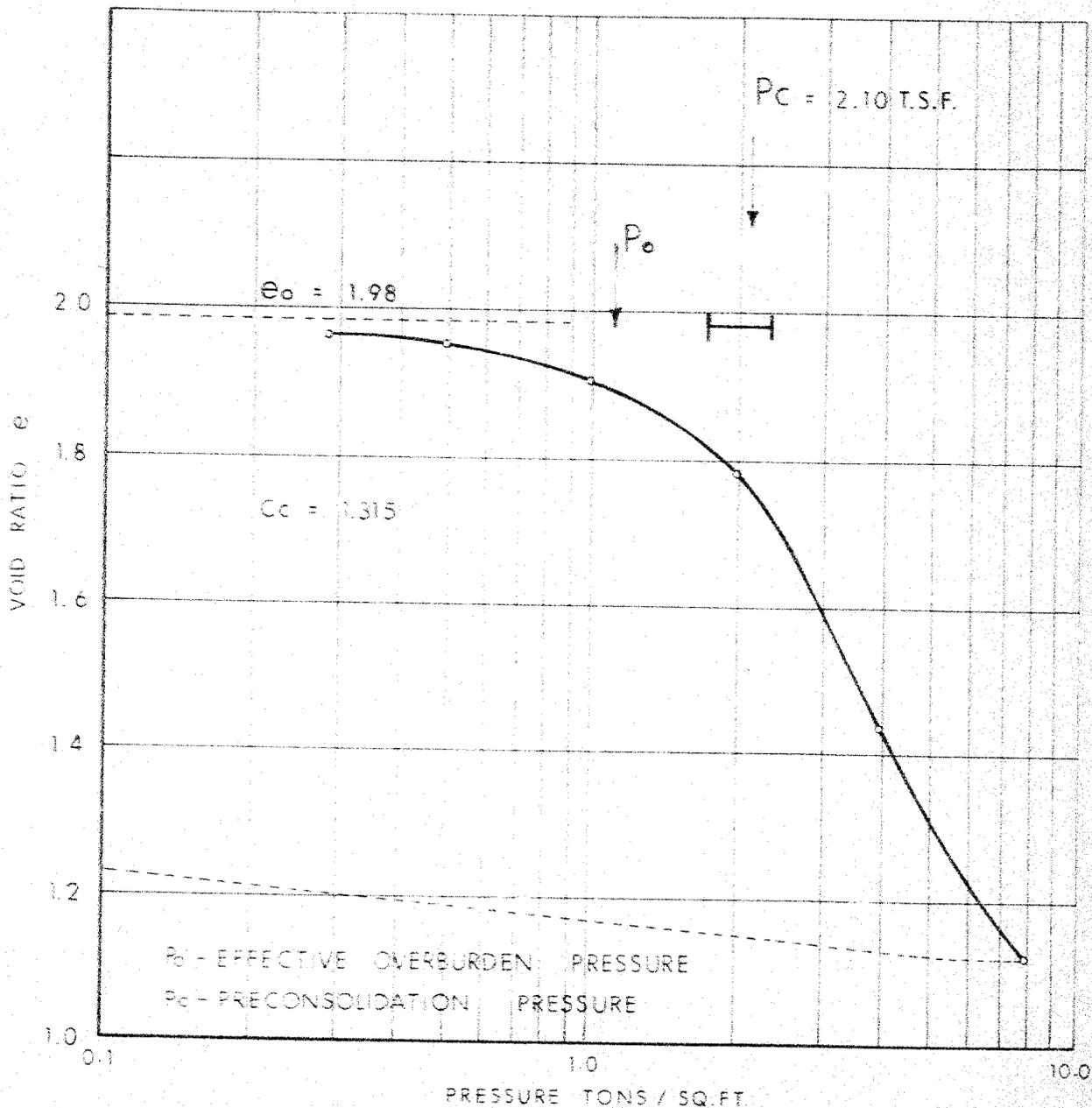
BORE HOLE 2
 SAMPLE 4
 DEPTH 12'-11"
 ELEV. 214.0



VOID RATIO vs PRESSURE

$W_L = 67.4$
 $W_p = 30.2$
 $W = 61.2$
 $C_c = 1.315$

BORE HOLE 2
 SAMPLE 12
 DEPTH 51'
 ELEV. 176.0



APPENDIX D

Basic Chemical Analysis – Eurofins Report Number 1710192

Certificate of Analysis

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: 1710192
 Date Submitted: 2017-06-22
 Date Reported: 2017-06-28
 Project: 1662565/1130
 COC #: 819239

Group	Analyte	MRL	Units	Guideline	1300006 Soil 2017-05-08 17-1302 sa3 5-7	1300007 Soil 2017-05-15 17-1303 sa11 45-47	1300008 Soil 2017-05-16 17-1304 sa3 5-7	1300009 Soil 2017-05-09 17-1305 sa14 84.5-86.5
Agri. - Soil	pH	2.0			7.5	8.5	8.2	8.7
	SO4	0.01	%		0.01	0.02	0.01	0.03
General Chemistry	Cl	0.002	%		0.041	0.392	0.034	0.294
	Electrical Conductivity	0.05	mS/cm		1.20	5.60	0.74	4.31
	Resistivity	1	ohm-cm		833	179	1350	232

Group	Analyte	MRL	Units	Guideline	1300010 Soil 2017-05-23 17-1310 sa3 7.5-9.5	1300011 Soil 2017-05-25 17-1308 sa3 5-7	1300012 Soil 2017-06-07 17-1309 sa11 50-52	1300013 Soil 2017-06-05 17-1311 sa15 130-132
Agri. - Soil	pH	2.0			7.6	7.0	8.4	9.0
	SO4	0.01	%		0.03	0.03	0.03	0.04
General Chemistry	Cl	0.002	%		0.060	0.058	0.468	0.055
	Electrical Conductivity	0.05	mS/cm		1.74	1.41	5.82	1.38
	Resistivity	1	ohm-cm		575	709	172	725

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

APPENDIX E

Results of MASW Testing

DATE May 24, 2017**PROJECT No.** 1662565**TO** Susan Trickey
Golder Associates Ltd.**FROM** Stephane Sol, Christopher Phillips**EMAIL** ssol@golder.com; cphillips@golder.com**CHBDC SEISMIC SITE CLASS TESTING RESULTS
RAMSAYVILLE RD AND HWY 417
OTTAWA, ONTARIO**

This technical memorandum presents the results of two Multichannel Analysis of Surface Waves (MASW) test performed for the Canadian Highway Bridge Design Code (CHBDC 2014) Seismic Site Classification for a bridge investigation (Figure1). The tests are located on each side of the Ramsayville Rd at the intersection with the HWY417 in Ottawa. The geophysical testing was performed by Golder Associates Ltd. (Golder) personnel on April 27, 2017.



Figure 1: MASW Location Site Map (MASW Line in red)

Golder Associates Ltd.6925 Century Avenue, Suite #100, Mississauga, Ontario, Canada L5N 7K2
Tel: +1 (905) 567 4444 Fax: +1 (905) 567 6561 www.golder.com**Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America**

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

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 April 27, 2017, by personnel from the Golder Mississauga and Ottawa offices. For the MASW line, a series of 24 low frequency (4.5 Hz) geophones were laid out at 3 metre intervals. Both active and passive readings were recorded along the MASW line. 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 metres from and collinear to the geophone array. An example of active seismic records collected at each line are shown in Figures 2 and 3, below.

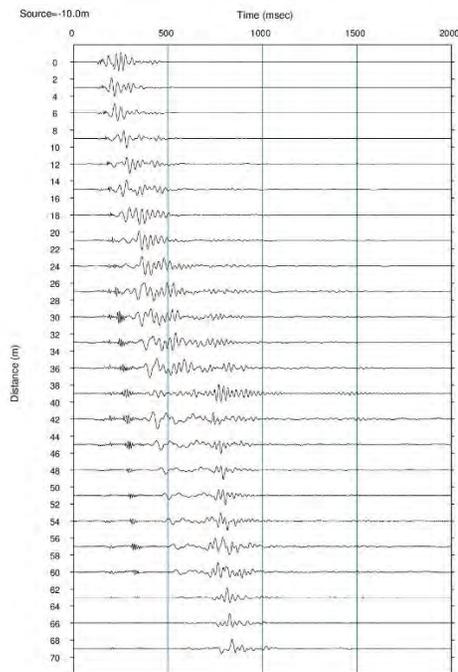


Figure 2: Typical seismic record collected at the site of MASW Line 1.

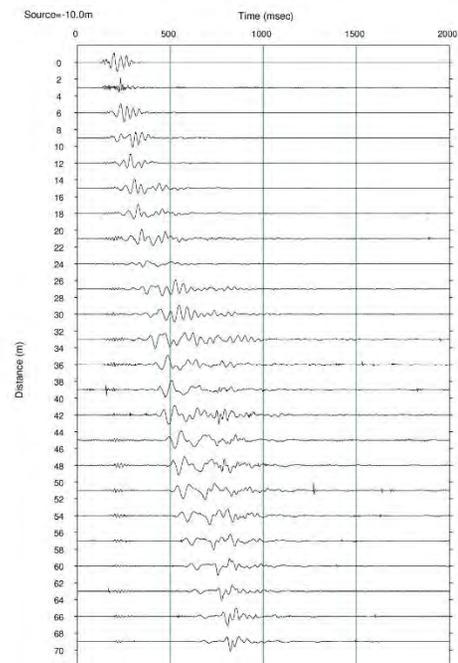


Figure 3: Typical seismic record collected at the site of MASW Line 2.

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 (r^2) 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) Combining the best active record and all the passive readings into one dispersion curve; and
- 7) 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 Figures 4 and 5 for Line 1 and Figures 6 and 7 for Line 2. The dispersion curves from the active and passive data sets were combined to increase the analyzable frequency range. 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 (5-21 Hz). The Line 1 passive survey was able to resolve the dispersion trend at lower frequency (as low as 1.5 Hz) and provided a better resolve dispersion curve from 1.5 to 21 Hz. The active survey of Line 2 provided a dispersion curve with a suitable frequency range (4-20 Hz). The Line 1 passive survey was able to resolve the dispersion trend at lower frequency (as low as 1.5 Hz) and provided a better resolve dispersion curve from 1.5 to 20 Hz. At both lines the minimum measured surface wave frequency with sufficient signal-to-noise ratio to accurately measure phase velocity was approximately 1.5 Hz.

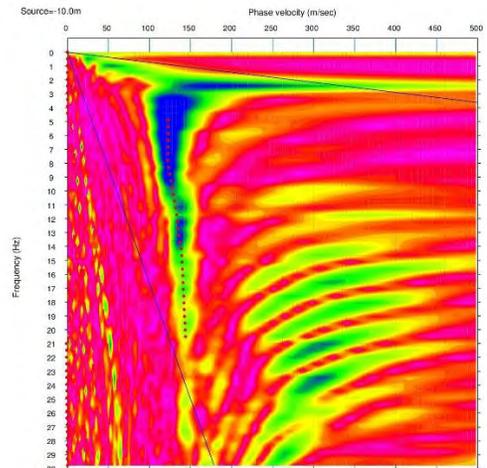


Figure 4: Active MASW Dispersion Curve Picks (red dots) along MASW Line 1

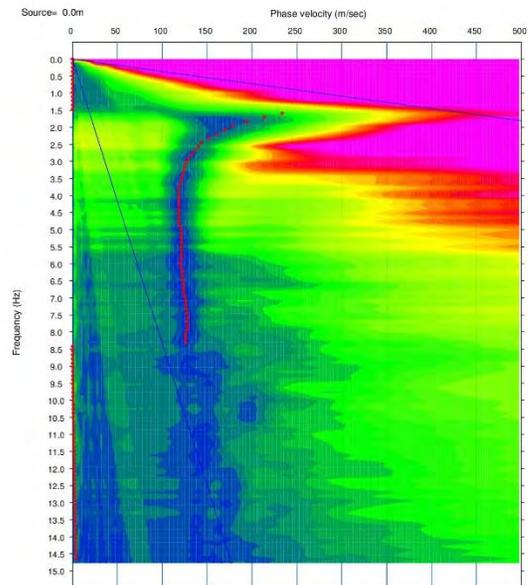


Figure 5: Passive MASW Dispersion Curve Picks (red dots) along MASW Line 1

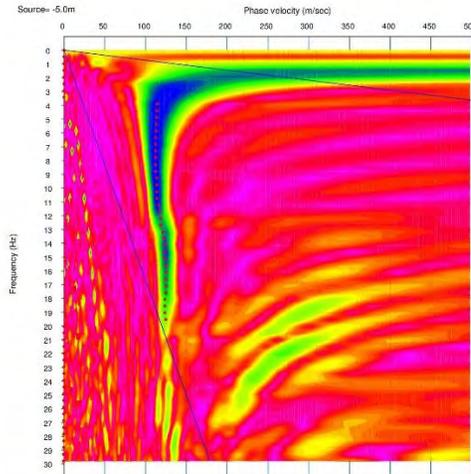


Figure 6: Active MASW Dispersion Curve Picks (red dots) along MASW Line 2

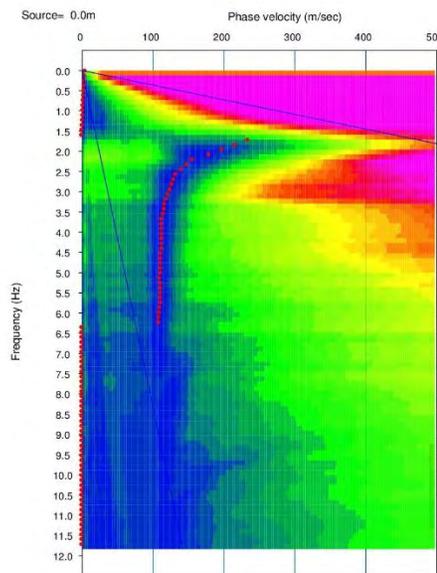


Figure 7: Passive MASW Dispersion Curve Picks (red dots) along MASW Line 2

Results

The MASW test results are presented in Figures 8 and 9, 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 weight-drop located at 10 metres from the last geophone. The results along MASW Line 1 have been calculated using weight-drop located at 5 metres from the last geophone. The field collected dispersion curves are compared with the model generated dispersion curves on Figures 10 and 11 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 2% along both lines.

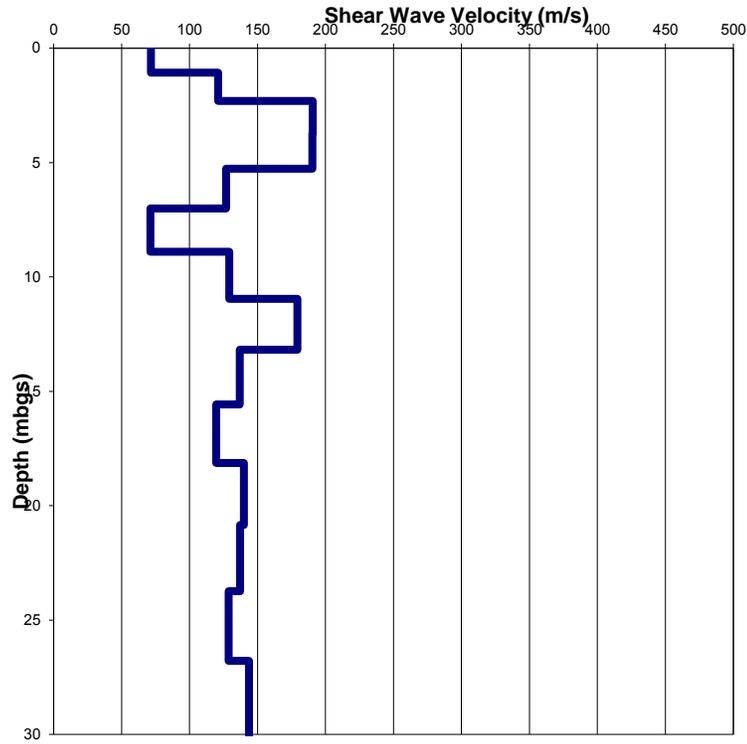


Figure 8: MASW Modelled Shear-Wave Velocity Depth profile along MASW Line 1

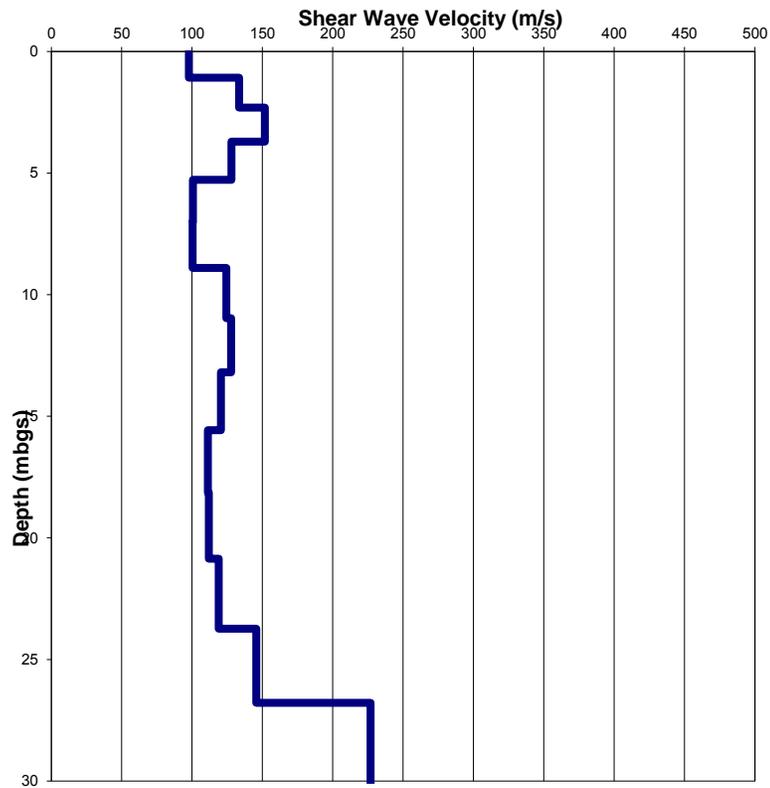


Figure 9: MASW Modelled Shear-Wave Velocity Depth profile along MASW Line 2

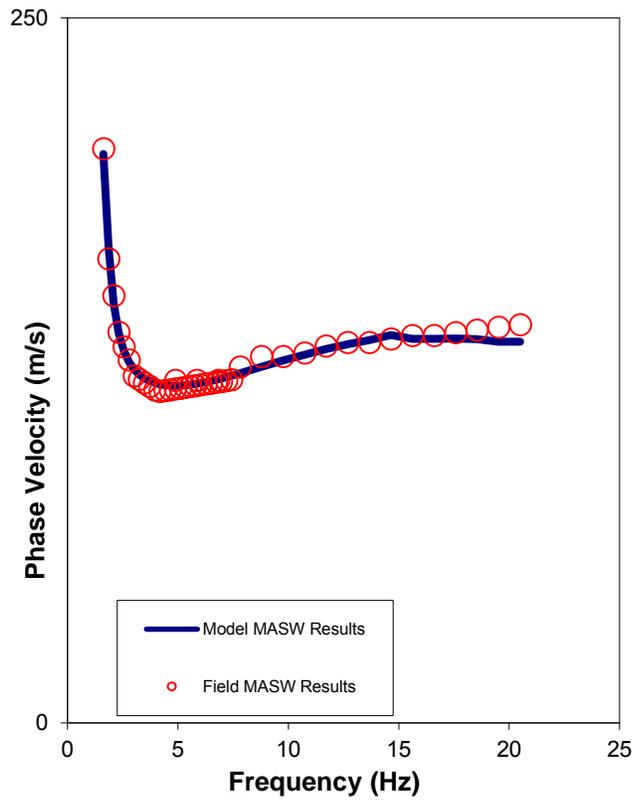


Figure 10: Comparison of Field (red dots) vs. Modelled Data (blue line) along MASW Line 1

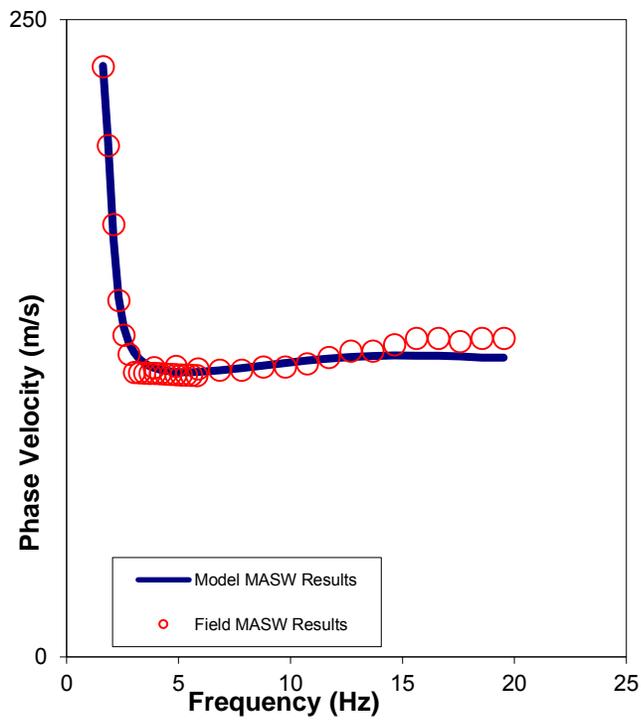


Figure 11: Comparison of Field (red dots) vs. Modelled Data (blue line) along MASW Line 2

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 was found to be 128 m/s (Table 1). The average shear-wave velocity along MASW Line 2 was found to be 126 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	71	0.014988
1.07	2.31	1.24	121	0.010220
2.31	3.71	1.40	191	0.007350
3.71	5.27	1.57	190	0.008226
5.27	7.01	1.73	127	0.013642
7.01	8.90	1.90	71	0.026645
8.90	10.96	2.06	129	0.015960
10.96	13.19	2.23	179	0.012411
13.19	15.58	2.39	137	0.017462
15.58	18.13	2.55	120	0.021358
18.13	20.85	2.72	140	0.019438
20.85	23.74	2.88	137	0.021031
23.74	26.79	3.05	129	0.023695
26.79	30.00	3.21	144	0.022365
Vs Average to 30 mbgs (m/s)			128	

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	98	0.010964
1.07	2.31	1.24	133	0.009272
2.31	3.71	1.40	152	0.009236
3.71	5.27	1.57	128	0.012238
5.27	7.01	1.73	101	0.017199
7.01	8.90	1.90	100	0.018887
8.90	10.96	2.06	124	0.016563
10.96	13.19	2.23	128	0.017435
13.19	15.58	2.39	121	0.019818
15.58	18.13	2.55	111	0.022950
18.13	20.85	2.72	112	0.024295
20.85	23.74	2.88	119	0.024259
23.74	26.79	3.05	146	0.020946
26.79	30.00	3.21	227	0.014175
Vs Average to 30 mbgs (m/s)			126	

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/09_field work/geophysics/ramsayville masw/report/tech memo_1662565 mto ramsayville.docx](https://golderassociates.sharepoint.com/sites/11263g/shared%20documents/09_field%20work/geophysics/ramsayville%20masw/report/tech%20memo_1662565%20to%20ramsayville.docx)

APPENDIX H

Site Photographs



Photograph 1: West of Site 3-265/1 (EBL), looking north (October 10, 2016).



Photograph 2: South of north abutment of Site 3-265/2 (WBL), looking north west (October 10, 2016).

CLIENT
WSP CANADA GROUP LIMITED

CONSULTANT



YYYY-MM-DD	2018/02/07
PREPARED	WAM
DESIGN	--
REVIEW	MSS
APPROVED	FJH

PROJECT
RAMSAYVILLE ROAD UNDERPASS REPLACEMENT
SITE NO. 3-265/1 (EBL) AND 3-265/2 (WBL)
HIGHWAY 417, OTTAWA, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.	Phase	Rev.
1662565	1130	1

Figure
H1

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI/A



Photograph 3: North of south abutment of Site 3-265/2 (WBL), looking south (October 10, 2016).



Photograph 4: North of south abutment of Site 3-265/1 (EBL), looking south east (October 10, 2016).

CLIENT
WSP CANADA GROUP LIMITED

CONSULTANT



YYYY-MM-DD 2018/02/07

PREPARED WAM

DESIGN --

REVIEW MSS

APPROVED FJH

PROJECT
RAMSAYVILLE ROAD UNDERPASS REPLACEMENT
SITE NO. 3-265/1 (EBL) AND 3-265/2 (WBL)
HIGHWAY 417, OTTAWA, ONTARIO

TITLE
SELECTED SITE PHOTOGRAPHS

PROJECT No.
1662565

Phase
1130

Rev.
1

Figure
H2

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI/A



golder.com