PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT

for

RECONSTRUCTION OF AYR PATROL YARD
HIGHWAY 401 AND HIGHWAY 97 INTERCHANGE
NORTH DUMFRIES TOWNSHIP
MUNICIPALITY OF WATERLOO, ONTARIO
ASSIGNMENT NO. 3017-E-0002, GWP 3039-16-00
LATITUDE: 43.329863; LONGITUDE: - 80.451409

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PML Ref.: 17TF036A
Index No.: 016FIR and 017DR
GEOCRES No.: 40P8-259
December 20, 2018

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A – PRELIMINARY FOUNDATION INVESTIGATION REPORT

for

RECONSTRUCTION OF AYR PATROL YARD
HIGHWAY 401 AND HIGHWAY 97 INTERCHANGE
NORTH DUMFRIES TOWNSHIP
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PART A – PRELIMINARY FOUNDATION INVESTIGATION REPORT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A – PRELIMINARY FOUNDATION INVESTIGATION REPORT
For
Reconstruction of Ayr Patrol Yard
Highway 401 and Highway 97 Interchange, North Dumfries Township
Municipality of Waterloo, Ontario
Assignment No. 3017-E-0002, GWP 3039-16-00

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1. INTRODUCTION

Ministry of Transportation Ontario (MTO) has retained Morrison Hershfield Limited (MH) as the Prime Consultant, to provide Design Build Ready services for the development of a New Patrol Yard and access road at the northwest quadrants of the Highway 401 and Regional Road 97 Interchange, located in the Township of New Dumfries, Municipality of Waterloo, Ontario.

MH has retained Peto MacCallum Ltd. (PML) on behalf of (MTO) to provide foundation engineering services for the assignment. The foundation investigation work reported herein is part of MTO Assignment No. 3017-E-0002. The terms of reference and scope of work for the design build ready package are outlined in the Request for Proposals (RFP) Version 8.1 dated May 2016.

This report presents the factual findings obtained from the foundation investigation carried out for the proposed Reconstruction of Ayr Patrol Yard. The proposed developments included a 533 m^2 office space, 3 Bay maintenance garage, wash bay, 12-bay vehicle storage, salt and sand storage facility, 9 brine tanks containment bay, 4 bay bulk material storage, storage shed, fuel pad, and outdoor parking.

The purpose of the investigation is to assess the subsurface conditions and to provide the preliminary foundation recommendation for planning and preliminary design of the proposed Reconstruction of Ayr Patrol Yard.

2. SITE DESCRIPTION

The topography of the project area is generally flat, except for the highway embankments. The site surrounding the patrol yard is covered with trees, bushes, and grass. The area along the highway on both the north and south sides is moderately vegetated with grass, trees, and shrubs. The site is an abandoned MTO Patrol Yard which currently, contains a salt dome, asphalt surfaces with an access road from Cedar Creek Road (Highway 97) north of Highway 401.

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BARRIE, COLLINGWOOD, HAMILTON, KITCHENER, LONDON, TORONTO

The grade slopes upward towards the east with grades varying between approximate elevations of about 335 and 338, with topographic relief of in the order of approximately 3 m to 3.5 m. Adjacent land uses include industrial, commercial, and farmland.

3. FIELD INVESTIGATION PROCEDURES

The field work for this investigation was supervised on a full-time basis by members of PML's technical staff. PML staff located the boreholes in the field, arranged for the clearance of underground service locations, directed the drilling, sampling and in situ testing operations, and logged the boreholes.

The fieldwork was carried out between May 10 and 22, 2018 and the location of boreholes in the field was established by PML staff using a portable GPS device. Subsequently, Callon Dietz, London, Ontario, under PML subcontract carried out the survey of the locations and elevations of the boreholes and provided the co-ordinates for locations in MTM NAD 83 northing and easting. PML used the survey data provided by Callon Dietz for preparation of this report. All elevations reported in this report are referred to Geodetic datum and expressed in meters.

The investigation included advancing 18 boreholes numbered BH 17-1 to BH 17-18. The boreholes were drilled to depths ranging from 9.6 m to 12.6 m below the existing ground surface (El. 328.6 to El. 322.4), as required by the RFP, and were terminated in competent soil. These boreholes were advanced using hollow stem augers powered by a D50 track-mounted drill rig. The drilling equipment from two (2) different drilling contractors were used for the field investigation. The equipment used were owned and operated by Landshark Drilling, and Aardvark Drilling Inc., who are specialist drilling contractors.

The borehole locations and the ground surface elevations at the borehole locations are presented in Table 1 and on the Record of Borehole sheets attached in Appendix A.

Table 1: Summary of Boreholes

BOREHOLE NO.	BOREHOLE LOCATION	MTM NAD 83 COORDINATES		GROUND SURFACE ELEVATION (m)	SURFICIAL FILL MATERIAL	BOREHOLE DEPTH (m)
		NORTHING	EASTING			
BH17-1	Outdoor Storage	4799374.6	227562.4	335.3	Silty Sand	12.6
BH17-2	Bulk Material Storage/Storage Shed	4799275.3	227578.9	335.0	Silty Sand	12.6
BH17-3	Sand/Salt Storage	4799351.5	227600.7	335.2	Pavement Structure on Clayey Silt	12.6
BH17-4	Sand/Salt Storage	4799354.2	227636.0	335.3	Pavement Structure on Clayey Silt	12.6
BH17-5	12-Bay Vehicle Storage/3-Wash Bay	4799341.8	227711.8	335.4	Clayey Silt	12.6
BH17-6	12-Bay Vehicle Storage	4799348.3	227657.4	335.5	Pavement Structure on Clayey Silt	12.6
BH17-7	3-Bay Garage	4799382.7	227729.5	335.2	Clayey Silt	12.6
BH17-8	Fuel Pad	4799337.9	227757.1	335.6	Pavement Structure on Sandy Silt	12.6
BH17-9	West Limit of Property	4799318.7	227531.1	335.0	Clayey Silt Silty Sand	12.6
BH17-10	Sand/Salt Storage	4799316.4	227575.6	335.4	Pavement Structure on Clayey Silt	11.1
BH17-11	12-Bay Vehicle Storage	4799325.0	227645.3	335.6	Clayey Silt	9.6
BH17-12	12-Bay Vehicle Storage/3-Wash Bay	4799371.6	227705.0	335.3	Pavement Structure on Clayey Silt	9.6
BH17-13	Office Building/Staff Parking Lot	4799385.6	227752.9	335.2	Silty Sand	9.6
BH17-14	Leeching Bed/Septic Tank	4799414.0	227779.5	336.6	Silty Sand	9.6
BH17-15		4799378.9	227804.1	337.7	Clayey Silt	9.6
BH17-16	East Limit of Property	4799416.5	227904.7	338.2	Clayey Silt	9.6

Table 1: Summary of Boreholes

BOREHOLE NO.	BOREHOLE LOCATION	MTM NAD 83 COORDINATES		GROUND SURFACE ELEVATION (m)	SURFICIAL FILL MATERIAL	BOREHOLE DEPTH (m)
		NORTHING	EASTING			
BH17-17	Storm Water Pond	4799250.5	227694.2	334.8	Clayey Silt	9.6
BH17-18		4799238.8	227637.8	334.4	Clayey Silt	9.6
N.B: The thickness of pavement structure is measured to be 800 mm.						

Representative soil samples were recovered from the boreholes at 0.75 m intervals to a depth of 5.0 m, using a conventional 51 mm O.D split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586 – Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soil). The frequency of sampling was increased to 1.5 m intervals below the depth of 6.0 m. Standard penetration tests were conducted with the sampling operation to assess the strength characteristics of the substrata. The soil samples retrieved were identified in the field, placed in labelled containers and transported to the PML laboratory in Toronto, for further examination and testing. Visual examinations of soil samples and index tests consisting of water content determination, Atterberg limits and grain size distribution analyses were conducted on selected representative soil samples.

The groundwater conditions at the borehole locations were observed during the drilling by visual examination of the soil samples, sampler, and drill rods, as the samples were retrieved. Upon completion of drilling, water level measurements were taken in open boreholes. Three monitoring wells were installed in Borehole Nos. BH17-8, BH17-13 and BH17-18 to monitor groundwater level, although these were originally planned to install at Borehole Nos. BH17-3, BH17-6 and BH17-17. The revised monitoring well locations were recommended by Tom Hlavacek, P.Eng., a senior Geo-Environmental Engineer from MH during field investigation for not encountering any instant perched/groundwater in three original monitoring wells. The monitoring wells typically consisted of 50 mm outside diameter rigid PVC pipe with a 3.0 m long screen surrounded by a sand pack and sealed at selected depths using bentonite pellets within the borehole.

All the boreholes were backfilled upon completion of drilling in accordance with Ontario Regulation 903 – Wells (as amended by Ontario Regulation 372). In the case of monitoring well installations, the annular space between the borehole wall and the monitoring well pipe above the filter pack was backfilled to ground surface using bentonite pellets.

4. LABORATORY TEST PROCEDURES

Laboratory tests on representative SPT samples recovered during the fieldwork were carried out by the Canadian Council of Independent Laboratories (CCIL) certified laboratory owned by PML, located in Toronto, Ontario. The laboratory testing program included the following:

- Natural moisture content determinations (205)
- Grain size distribution analyses (77)
- Atterberg Limits Tests (10)

The laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow American Society for Testing Materials (ASTM) test procedures, with the exception of hydrometer test (LS-702). The results of the grain size distribution analyses are presented on Figures GS-1, GS-2, GS-3A, GS-3B, GS-3C, GS-3D, GS-3E, GS-4A, GS-4B, GS-4C and GS-5, and the Atterberg limits test results are presented on Figures PC-1 and PC-2 attached in Appendix A. All of the test results are summarized on the Record of Borehole Sheets.

5. SITE GEOLOGY AND SUBSURFACE CONDITIONS

5.1 Site Geology

In general, the project area is located within the physiographic region known as the Waterloo Hills of the Kame Moraines land formation. This region mainly consists of sandy hills and adjoins the Grand River Spillway system, which contains more uniform sandy and gravelly material, as outlined in The Physiography of Southern Ontario (Chapman and Putnam, 1984). The project area is mainly surrounded by farmland and commercial use.

The Quaternary Geology map published by the Ontario Ministry of Northern Development and Mines (MNDM), indicates that the surface conditions in the vicinity of the project site consist of Glaciofluvial outwash deposits: gravel and sand; includes Proglacial River and deltaic deposits. In general, the area consists of outwash sand, and sand and gravel overlying glacial tills. Undrained depressions or “kettles”, formed amongst the hill during glaciation, are now generally occupied by organic deposits and seasonally intermittent water.

Based on the Bedrock Geology map (MRD126-REV1, 2011) published by the MNDM, the site lies within the Salina Formation of the Upper Silurian rock formations. The bedrock underlying the project area consists mainly of limestone, dolostone, shale, sandstone, gypsum and salt.

5.2 Subsurface Conditions

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets in Appendix A. The locations of the boreholes and monitoring wells are shown in Reconstruction of Ayr Patrol Yard Borehole and Monitoring Well Location Plan, DWG. 1.

In general, the subsurface conditions immediately below the existing ground level consist of 800 mm of pavement structure in the paved area and 100 mm to 200 mm of topsoil in boreholes that were advanced outside the perimeter of paved area. The topsoil and pavement structure are underlain by fill comprised of silty sand and clayey silt to depths ranging from 1.4 m (El. 333.0) to 4.3 m (El. 331.3). The fill is followed by silty sand to sand throughout the project site. For classification purposes, the soils encountered at this site can be divided into four (4) distinct zones.

a) Topsoil
b) Asphalt over Sand and Gravel (Pavement Structure)
c) Sandy Silt to Silty Sand/Clayey Silt (Fill)
d) Silty Sand to Sand, trace/with gravel

5.2.1 Topsoil

Surficial topsoil was encountered in borehole locations BH17-1, BH17-2, BH17-5, BH17-7, BH17-9, BH17-11 and BH17-13 through BH17-18, advanced outside of the paved area of the abandoned MTO Patrol Yard. The thickness of the topsoil was observed to vary from 100 mm to 200 mm.

5.2.2 Asphalt over Sand and Gravel (Pavement Structure)

The pavement structure was encountered immediately below the existing paved surface of the abandoned patrol yard area in Borehole locations BH17-3, BH17-4, BH17-6, BH17-8, BH17-10, and BH17-12. The pavement structure was 800 mm in thickness and includes 120 mm to 175 mm of asphalt over sand and gravel.

The moisture content of samples tested from the pavement base vary between 4.1% and 15.0% with an average value of 8.9%.

5.2.3 Sandy Silt to Silty Sand/Clayey Silt (Fill)

The topsoil and pavement structure layers are followed by fill materials comprised of either non-cohesive sandy silt to silty sand, or cohesive clayey silt layer of thickness ranging from 0.7 m to 3.5 m and extended to El. 333.8 to El. 331.3. Both non-cohesive and cohesive fill materials were encountered in BH17-9, located at the west limit of the study area.

5.2.3.1 Sandy Silt to Silty Sand, Trace Gravel (Fill)

This non-cohesive fill material was encountered in six (6) borehole locations. The SPT N values in this fill layer ranged from 1 to 17 blows, indicating a very loose to compact of state.

The moisture content of samples tested from this fill materials varies from 2.5% to 26.2% with an average value of 14.4%. The results of the gradation (sieve and hydrometer) analysis test performed on seven (7) representative samples from the fill are provided on Figure GS-1. The test results indicate that the fill consists of 0% to 14% gravel, 33% to 86% sand, 7% to 47% silt, and 7% to 12% clay sized particles.

5.2.3.2 Clayey Silt, Trace/with Sand (Fill)

Fill consisting of clayey silt was encountered in thirteen (13) boreholes advanced. The SPT N values in this fill layer vary from as low as 1 to 20 blows, indicating a very soft to very stiff state consistency.

The moisture content of samples tested from this fill vary from 2.3% to 27.6% with an average value of 15.8%. The results of the gradation analysis test performed on seven (7) representative samples from the fill are provided on Figure GS-2. The test results indicate that this fill consists of 0% to 5% gravel, 5% to 43% sand, 41% to 74% silt and 11% to 24% clay. Atterberg limit tests performed on nine (9) representative samples from the clayey silt fill are provided on Figure PC-1. The results of Atterberg tests conducted on soil samples are summarized below Table 2.

Table 2: Summary of The Atterberg Limits Test Results on Soil Samples

BOREHOLE NO.	SAMPLE ID	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	REMARKS
BH 17-3	SS3	24	18	6	Low Plasticity
BH 17-4	SS3	22	15	7	Low Plasticity
BH 17-5	SS2	19	12	7	Low Plasticity
BH 17-6	SS3	19	15	4	Low Plasticity
BH 17-7	SS4	17	13	4	Low Plasticity
BH 17-11	SS3	26	16	10	Low Plasticity
BH 17-15	SS4	23	21	2	Low Plasticity
BH 16-17	SS2	25	17	8	Low Plasticity
BH 17-17	SS4	34	17	17	Medium Plasticity

5.2.4 Silty Sand to Sand, Trace/with Gravel

The fill layers are immediately underlain by the silty sand to sand deposit, which contains occasional gravel and silt seams with varying proportions of sand, and extends to a maximum termination depth of 12.6 m (El. 322.4) below the existing ground surface. The SPT N values in this deposit vary widely from as low as 11 blows to refusal (100 blows/30 cm of sampler penetration), indicating compact to very dense compactness state. The termination depths of boreholes range from 9.6 m to 12.6 m (El. 328.6 to El. 322.4).

The moisture content of samples tested from this deposit varies widely from 0.7% to 23.7% with an average value of 4.7%. Laboratory gradation analysis tests were performed on a total of 63 representative samples from silty sand to sand deposit, including samples from gravel and silt seams/deposits. The results of 41 representative samples of the silty sand to sand are provided on Figures GS-3A to GS-3E. The test results indicate that this deposit consists of 0% to 21% gravel, 37% to 94% sand, 3% to 40% silt, and 0% to 4% clay sized particles.

The results of the sieve analysis test performed on 19 representative samples from the gravel layers/seams are provided in Figures GS-4A to GS-4C. The test results indicate that the gravel layers/seams consist of 21% to 51% gravel, 42% to 73% sand, and 3% to 12% silt and clay sized particles.

The results of the gradation analysis test performed on three (3) representative samples from the silt seams are provided on Figure GS-5. The test results indicate that the silt seams/layers consist

of 0% to 1% gravel, 6% to 47% sand, 50% to 78% silt and 3% to 15% clay sized particles. Atterberg limit tests performed on a representative silt sample below the native sand deposit in borehole location BH17-13, are included on Figure PC-2. The results of Atterberg tests conducted on soil samples are summarized below Table 3.

Table 3: Summary of The Atterberg Limits Test Results on Soil Samples

BOREHOLE NO.	SAMPLE ID	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	REMARKS
BH 17-13	SS7	19	16	3	Low Plasticity

5.3 Groundwater

Groundwater was not encountered during the drilling or upon completion of drilling operation. However, after 17 days of completion of drilling, the water level was measured at Borehole No. BH17-13 on June 5, 2018 and found to be at El. 333.1. On June 27, 2018, the water level was measured to be at El. 332.9. As confirmed by MH, this monitoring well did not recover after purging dry. It is inferred that the groundwater initially observed was shallow perched water and the measured groundwater level was not the representative of static groundwater conditions. Refer to Table 4 for groundwater level readings following the installation of monitoring wells. The water levels may fluctuate due to the influence of precipitation and seasonal changes.

Table 4: Monitoring Well Readings

BOREHOLE NO.	WELL INSTALLATION DATE	WELL SCREEN DEPTH (m)	DATE	DEPTH (m)	ELEVATION (m)
BH 17-8	May 17, 2018	2.5 to 5.5	June 5, 2018 June 27, 2018	Dry	---
BH 17-13	May 18, 2018	3.1 to 5.8	June 5, 2018 June 27, 2018	2.1* 2.3**	333.1 332.9
BH 17-18	May 14, 2018	6.1 to 9.1	June 5, 2018 June 27, 2018	Dry	---

Note: (*) – Perched water; (**) – After purging water from the well, the water level did not recover to depths of 2.3 m and remains dry.

The information from the website of the Ministry of the Environment, Conservation and Park indicates that there is a registered well within the proposed site. The existing well was registered under Well No. 6500594 and was drilled through a thin layer of clay underlain by sand and gravel,

followed by cohesive glacial till. The water level in this well was recorded at a depth of 61.0 m below the ground surface.

5.4 Chemical Analysis

SGS Canada Inc. (SGS), accredited by the Standards Council of Canada (SCC) and the Canadian Association of Laboratory Accreditation (CALA) carried out the chemical analyses. A total of six (6) samples (one sample from each of below listed six boreholes) were tested to determine the soil corrosivity. Details of the chemical test results provided by SGS are presented in Appendix A.

A summary of the chemical test results provided by SGS Canada (SGS) are presented in Table 5.

Table 5: Soil Chemical Analysis Results

BOREHOLE	SAMPLE	DEPTH (ELEVATION) (m)	SOIL TYPE	Redox Potential (mV)	Sulphide (%)	pH	Resistivity (Ohm-cm)	Conductivity (µS/cm)	Sulphate (µg/g)	Chloride (µg/g)	Moisture Content (%)
BH 17-2	8	5.3 - 5.8 (329.7 - 329.2)	Silty Sand to Sand	245	< 0.02	9.30	15200	66	2.3	11	4.8
BH 17-3	5	3.1 - 3.6 (332.1 - 331.6)	Silty Sand to Sand	288	< 0.02	9.43	10600	94	2.9	9.9	7.2
BH 17-6	6	3.8 - 4.3 (331.7 – 331.2)	Silty Sand to Sand	299	< 0.02	9.39	19600	51	1.7	4.0	2.3
BH 17-7	8	5.3 – 5.8 (329.9 – 329.4)	Silty Sand to Sand	308	< 0.02	9.62	4170	240	8.9	91	7.8
BH 17-14	5	3.1 – 3.6 (333.5 – 333.0)	Silty Sand to Sand	303	< 0.02	9.30	16500	61	1.3	8.0	2.5
BH 17-15	5	3.1 – 3.6 (334.6 – 334.1)	Sand	290	< 0.02	9.34	16200	62	2.0	13	3.5

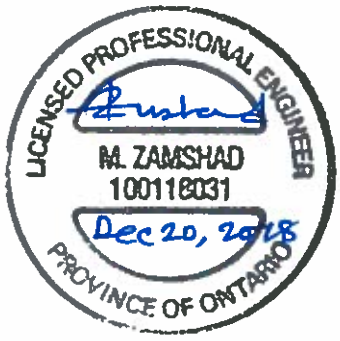
6. CLOSURE

Mr. Dylan Brice carried out the field investigations under the supervision of Mr. M. Zamshad, MEng, P.Eng. Landshark Drilling from Brantford, ON and Aardvark Drilling Inc. from Guelph, ON, supplied the drilling equipment for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML geotechnical laboratory located in Toronto, Ontario.

This report was prepared by Ms. N. Leong-Sem, EIT, and reviewed by Mr. M. Vasavithasan, M.Sc. Eng., P.Eng. and Mr. M. Zamshad, MEng, P.Eng, Senior Engineer, Geotechnical Services. Mr. R. Ng, MBA, PhD, P.Eng., Principal Consultant, conducted an independent review of the report.

Yours very truly

Peto MacCallum Ltd.



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NL/MZ/RN:nk-ap

APPENDIX A

Reconstruction of Ayr Patrol Yard Borehole and Monitoring Well Location Plan with Soil Stratigraphy (Section A-A') – DWG. 1

Reconstruction of Ayr Patrol Yard Soil Stratigraphy (Sections B_1-B_1', B_2-B_2' C_1-C_1' & C_2-C_2') – DWG. 2

Explanation of Terms Used in Report

Record of Borehole Sheets

Results of Grain Size Distribution Analyses – Figures GS-1, GS-2, GS-3A/B/C/D/E GS-4A/B/C, and GS-5

Results of Atterberg Limits Tests – Figures PC-1 and PC-2

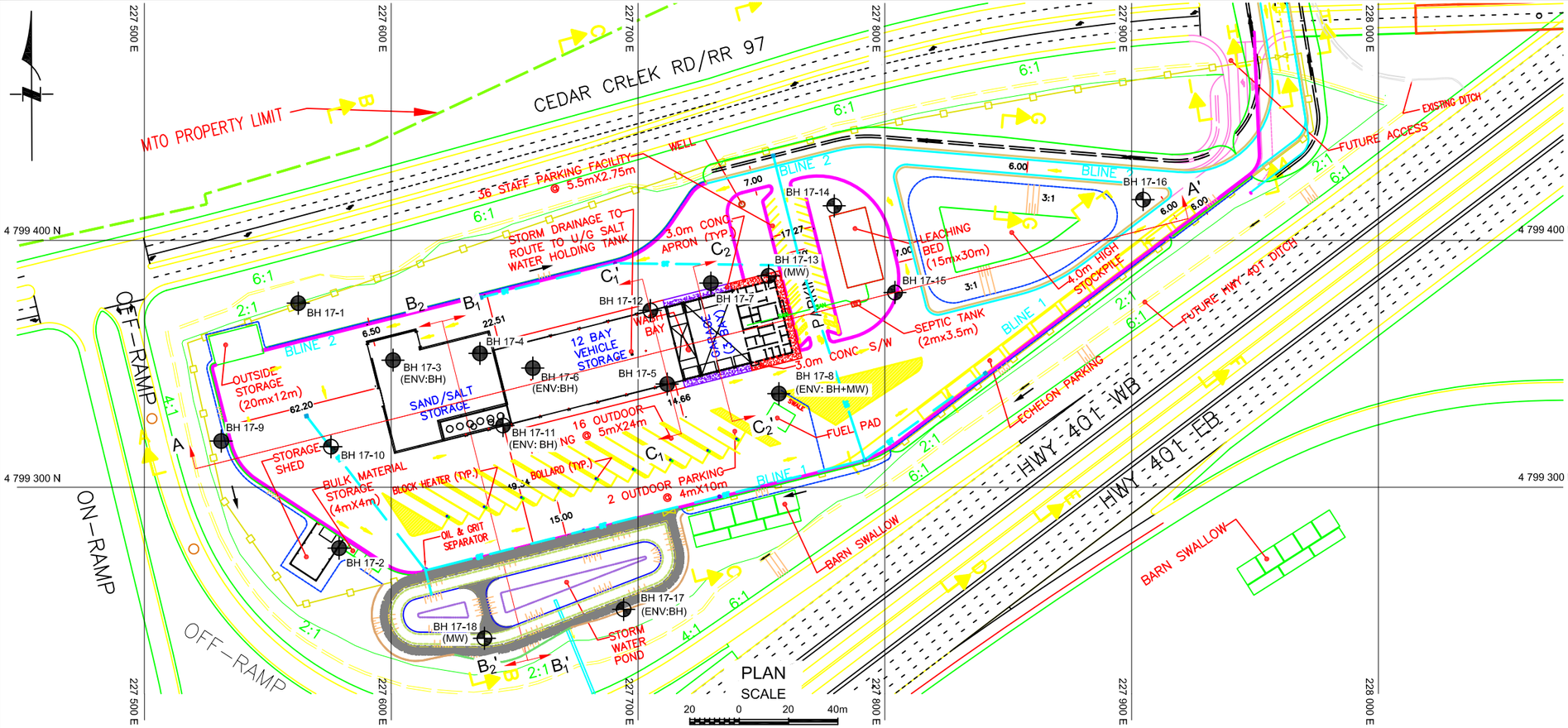
Results of Chemical Tests Provided by SGS Canada

ASGMT No. 3017-E-0002
GWP No. 3039-16-00
WP No.

RECONSTRUCTION OF AYR PATROL YARD BOREHOLE AND MONITORING WELL LOCATION PLAN WITH SOIL STRATIGRAPHY(SECTION A-A')

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



LEGEND

- Borehole (17-1 to 17-9) depth 12.6 m
- Borehole (17-10 to 17-18) depth 9.6 m to 11.1 m

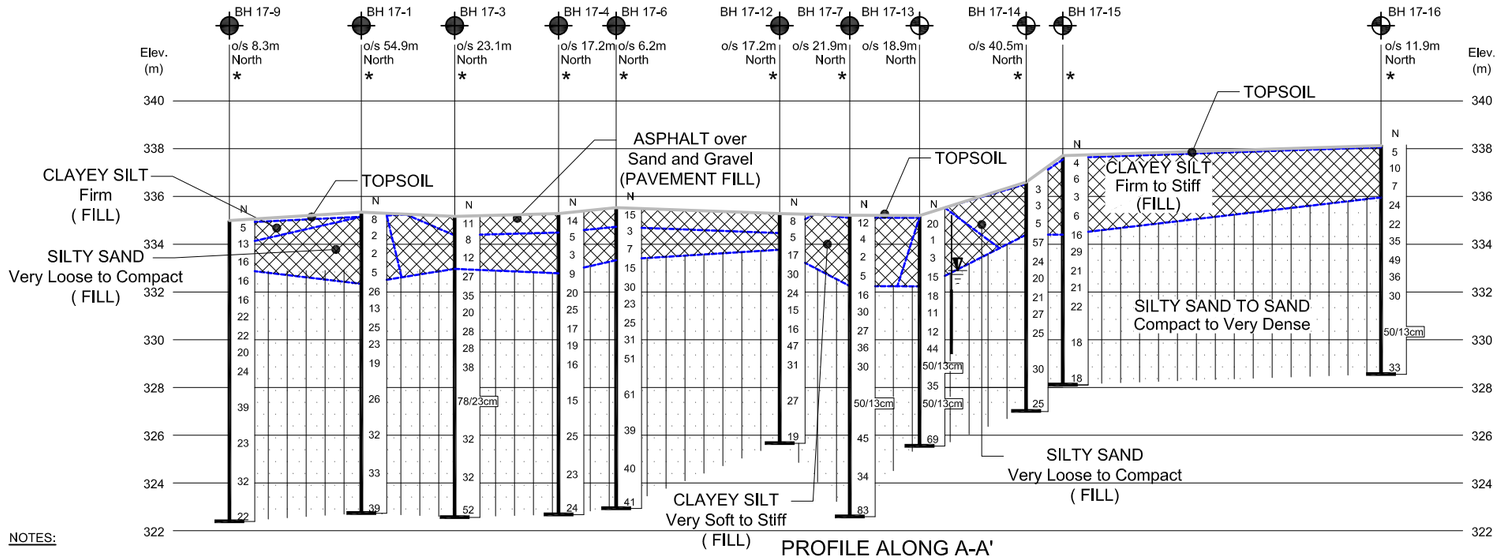
(ENV: BH)- Environmental Borehole
(ENV: BH+MW)- Environmental BH with 50 mm dia. Monitoring Well

* Groundwater was not encountered during and upon completion of augering

Piezometer

Water Level in Piezometer, June 27, 2018

BH No	ELEVATION	NORTHINGS	EASTINGS
BH 17-1	335.3	4 799 374.6	227 562.4
BH 17-2	335.0	4 799 275.3	227 578.9
BH 17-3	335.2	4 799 351.5	227 600.7
BH 17-4	335.3	4 799 354.2	227 636.0
BH 17-5	335.4	4 799 341.8	227 711.8
BH 17-6	335.5	4 799 348.3	227 657.4
BH 17-7	335.2	4 799 382.7	227 729.5
BH 17-8	335.6	4 799 337.9	227 757.1
BH 17-9	335.0	4 799 318.7	227 531.1
BH 17-10	335.4	4 799 316.4	227 575.6
BH 17-11	335.6	4 799 325.0	227 645.3
BH 17-12	335.3	4 799 371.6	227 705.0
BH 17-13	335.2	4 799 385.6	227 752.9
BH 17-14	336.6	4 799 414.0	227 779.5
BH 17-15	337.7	4 799 378.9	227 804.1
BH 17-16	338.2	4 799 416.5	227 904.7
BH 17-17	334.8	4 799 250.5	227 694.2
BH 17-18	334.4	4 799 238.8	227 637.8



PROFILE ALONG A-A'
HORIZONTAL SCALE
20 0 20 40m
VERTICAL SCALE
2.5 0 2.5 5m

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

LICENSED PROFESSIONAL ENGINEER M. ZAHUSHAD 100180137 Dec 20, 2018 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER R. M. C. NG Dec. 20, 2018 PROVINCE OF ONTARIO

REF MH Drawing:Updated Cedar Patrol yard Prelim Layout.dwg, dated Dec 11, 2018.

— NOTE —
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No. 40P8-259

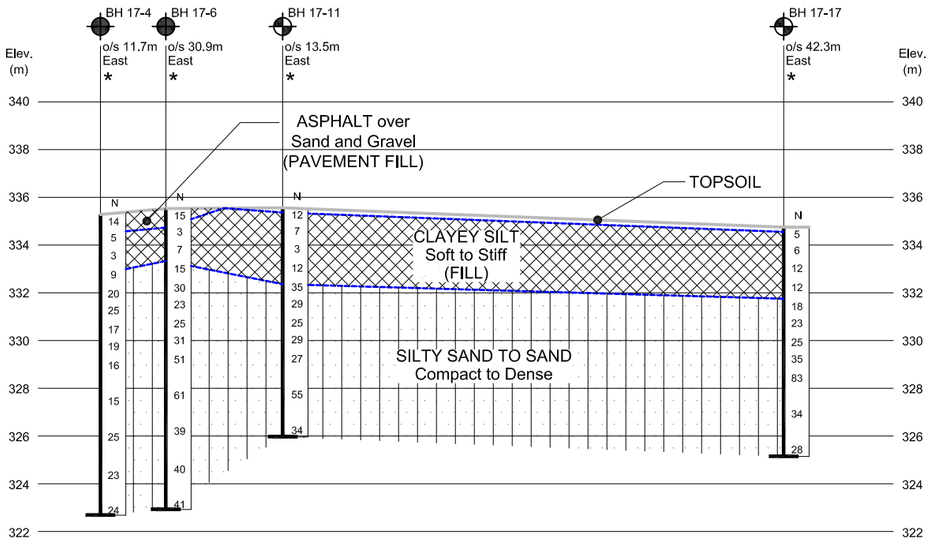
HWY No	401				DIST
SUBM'D	NL	CHECKED	MZ	DATE DEC. 20, 2018	SITE
DRAWN	NL	CHECKED	NR	APPROVED RN	DWG. 1

ASGMT No. 3017-E-0002
GWP No. 3039-16-00
WP No.

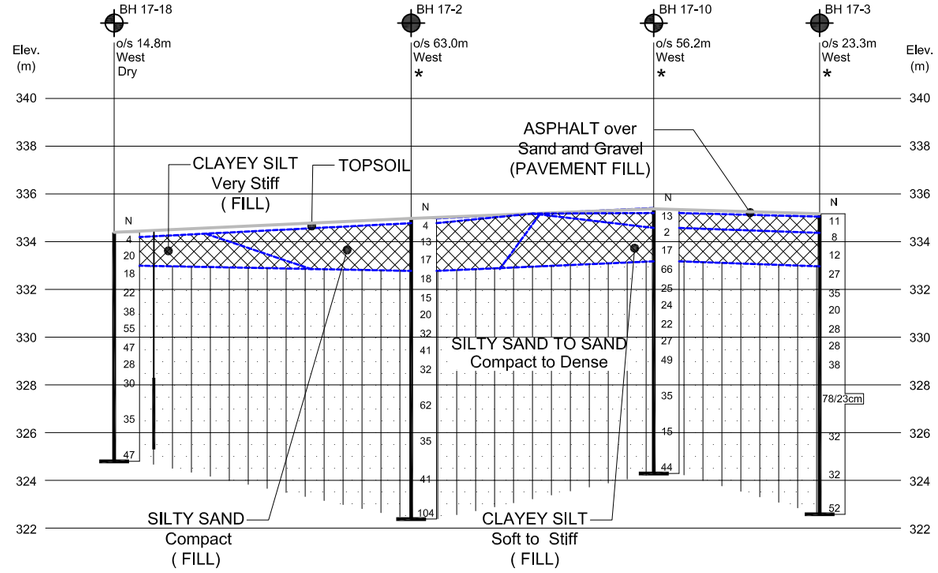
SHEET

RECONSTRUCTION OF AYR PATROL YARD
SOIL STRATIGRAPHY
(SECTIONS B_1-B_1', B_2-B_2', C_1-C_1', AND C_2-C_2')

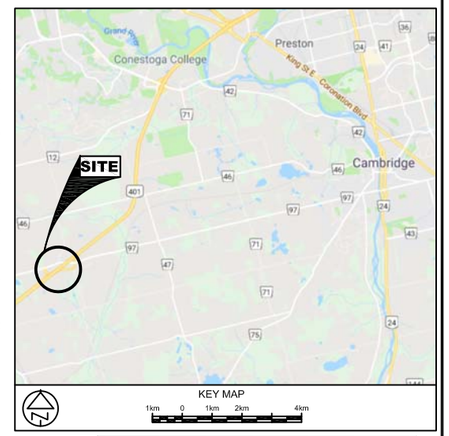
Peto MacCallum Ltd.
CONSULTING ENGINEERS

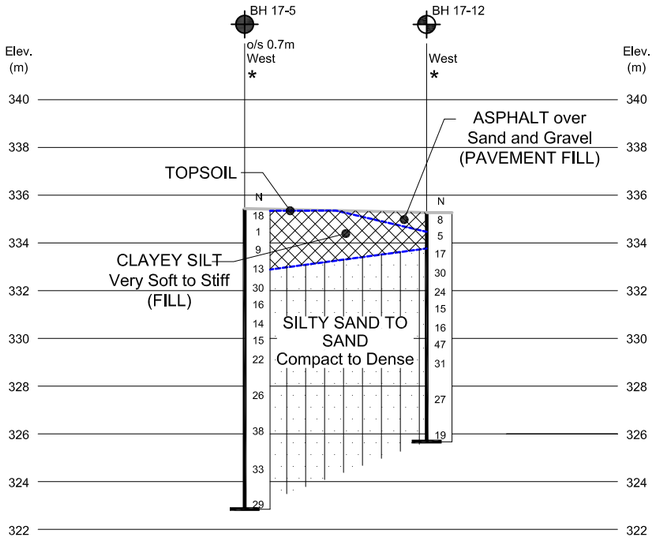


PROFILE ALONG B_1-B_1'

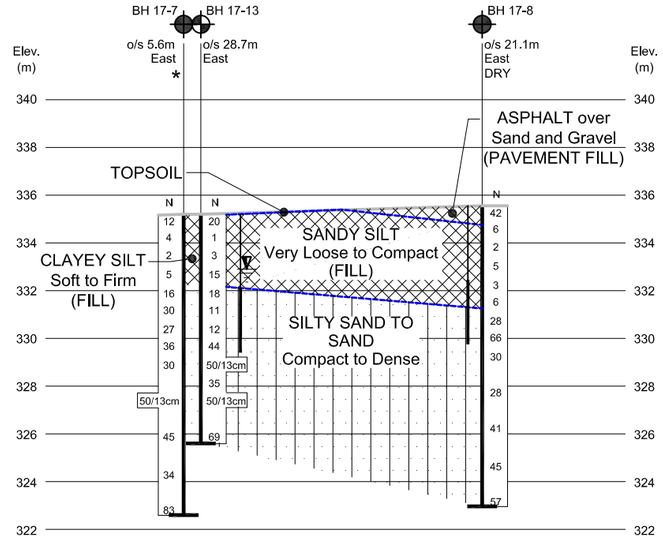


PROFILE ALONG B_2-B_2'





PROFILE ALONG C_1-C_1'



PROFILE ALONG C_2-C_2'

LEGEND

- Borehole (17-1 to 17-9) depth 12.6 m
- Borehole (17-10 to 17-18) depth 9.6 m to 11.1 m

(ENV: BH)- Environmental Borehole
(ENV: BH+MW)- Environmental BH with 50 mm dia, Monitoring Well
Groundwater was not encountered during and upon completion of augering
Piezometer
Water Level in Piezometer, June 27, 2018

BH No	ELEVATION	NORTHINGS	EASTINGS

See Drawing 1 for Borehole Details

NOTES:

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HORIZONTAL SCALE
10 0 10 20m

VERTICAL SCALE
2.5 0 2.5 5m

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

LICENSED PROFESSIONAL ENGINEER
M. ZAMSHAD
100118031
PROVINCE OF ONTARIO
Dec. 20, 2018

LICENSED PROFESSIONAL ENGINEER
R. M. C. NG
PROVINCE OF ONTARIO
Dec. 20, 2018

REF MH Drawing:Cedar Patrol yard Prelim Layout.dwg, dated Dec 11, 2018.

REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No. 40P8-259

HWY No	401				DIST
SUBM'D	NL	CHECKED	MZ	DATE DEC. 20, 2018	SITE
DRAWN	NL	CHECKED	NR	APPROVED RN	DWG. 2

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No BH17-1

1 OF 1 **METRIC**

G.W.P. 3039-16-00 LOCATION Coords: 4 799 374.6 N; 227 562.4 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.16 LATITUDE 43.330292 LONGITUDE -80.452434 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.3	GROUND SURFACE										
335.1	TOPSOIL										
0.2	SILTY SAND, trace gravel Loose to very loose, Brown, Moist		1	SS	8		335		○		
			2	SS	2				○		
			3	SS	2		334		○		1 65 27 7
	(FILL)		4	SS	5		333		○		
332.3											
3.0	SILTY SAND TO SAND, trace/some gravel Compact, Brown, Moist		5	SS	26		332		○		
			6	SS	13				○		
			7	SS	25		331				15 72 (13)
			8	SS	23		330		○		
			9	SS	19		329		○		
			10	SS	26		328		○		0 93 (7)
	Dense		11	SS	32		327				
	Sandy Silt		12	SS	33		326		○		0 47 50 3
							325				
322.7			13	SS	39		324				
12.6	End of borehole						323		○		

Notes:
1. Groundwater was not encountered during and upon completion of augering.
2. Borehole was moved by 3.0 m south of the original staked location to locate inside the fence.
3. Borehole caved-in at 11.0 m

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

RECORD OF BOREHOLE No BH17-2 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 275.3 N; 227 578.9 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.14 LATITUDE 43.329409 LONGITUDE -80.452221 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.0	GROUND SURFACE										
334.8	TOPSOIL										
0.2	SILTY SAND, trace gravel Compact, Brown, Moist		1	SS	4				○		
			2	SS	13		334		○		1 81 (18)
	(FILL)		3	SS	17				○		0 69 (31)
332.8							333				
2.2	SILTY SAND TO SAND, trace gravel Compact, Brown, Moist		4	SS	18				○		
			5	SS	15		332		○		
			6	SS	20		331		○		3 64 (33)
			7	SS	32				○		
	Dense		8	SS	41		330		○		
			9	SS	32		329		○		
	with gravel		10	SS	62		328		○		32 62 (6)
			11	SS	35		327		○		
			12	SS	41		326		○		
322.4			13	SS	104		325		○		0 60 (40)
12.6	End of borehole						324				
	Notes: 1. Groundwater was not encountered during and upon completion of augering. 2. Borehole caved-in at 6.4 m						323				

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

RECORD OF BOREHOLE No BH17-3 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 351.5 N; 227 600.7 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.15 LATITUDE 43.330096 LONGITUDE -80.451962 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.2	GROUND SURFACE										
335.0 / 0.1	120mm ASPHALT over Sand and Gravel		1	SS	11		335		○		
334.4	(PAVEMENT STRUCTURE)										
0.8	CLAYEY SILT, some sand Stiff, Brown, Moist		2	SS	8		334		○		
	(FILL)		3	SS	12				H		0 12 74 14
333.0							333				
2.2	SILTY SAND TO SAND, trace/some gravel Compact, Brown, Moist		4	SS	27				○		
			5	SS	35		332		○		0 79 (21)
			6	SS	20				○		
			7	SS	28		331		○		
	Dense to very dense		8	SS	28		330		○		6 87 (7)
			9	SS	38		329		○		
			10	SS	78/23cm		328		○		21 73 (6)
			11	SS	32		327				
			12	SS	32		326		○		
			13	SS	52		325				
322.6							324				
12.6	End of borehole						323		○		

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 9.2 m

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-4

1 OF 1 **METRIC**

G.W.P. 3039-16-00 LOCATION Coords: 4 799 354.2 N; 227 636.0 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.16 LATITUDE 43.330125 LONGITUDE -80.451528 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.3	GROUND SURFACE										
335.2 / 0.1	120mm ASPHALT over Sand and Gravel (PAVEMENT STRUCTURE)		1	SS	14		335				
334.5 / 0.8	CLAYEY SILT, with sand Firm, Brown, Moist to wet		2	SS	5						0 24 53 23
			3	SS	3		334				
332.8 / 2.5	(FILL) SILTY SAND TO SAND, trace gravel Compact, Brown, Moist		4	SS	9		333				
			5	SS	20		332				2 87 (11)
			6	SS	25						
			7	SS	17		331				
			8	SS	19		330				
			9	SS	16		329				2 94 (4)
			10	SS	15		328				
			11	SS	25		327				
			12	SS	23		326				
			13	SS	24		325				1 93 (6)
322.7 / 12.6	End of borehole						324				
	Notes: 1. Groundwater was not encountered during and upon completion of augering. 2. Borehole caved-in at 9.2 m						323				

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-5

1 OF 1

METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 341.8 N; 227 711.8 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.17 LATITUDE 43.330021 LONGITUDE -80.450591 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.4	GROUND SURFACE										
335.3 / 0.1	TOPSOIL										
	CLAYEY SILT, with sand, trace gravel Very soft to stiff, Brown, Moist to wet		1	SS	18		335		○		
			2	SS	1				○		
			3	SS	9		334		○		
	(FILL)		4	SS	13		333		○		
332.7 / 2.7	SILTY SAND TO SAND, with gravel Compact to dense, Brown, Moist		5	SS	30		332		○		35 57 (8)
			6	SS	16				○		
			7	SS	14		331		○		
			8	SS	15		330		○		
			9	SS	22		329		○		
			10	SS	26		328		○		31 64 (5)
			11	SS	38		327		○		
			12	SS	33		326		○		20 74 (6)
			13	SS	29		325		○		
322.8 / 12.6	End of borehole Notes: 1. Groundwater was not encountered during and upon completion of augering. 2. Borehole caved-in at 9.2 m						324 323				

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-6

1 OF 1 **METRIC**

G.W.P. 3039-16-00 LOCATION Coords: 4 799 348.3 N; 227 657.4 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.16 LATITUDE 43.330074 LONGITUDE -80.451262 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.5	GROUND SURFACE										
335.4 / 0.1	130mm ASPHALT over Sand and Gravel		1	SS	15		335	○	○		
334.7	(PAVEMENT STRUCTURE)										
0.8	CLAYEY SILT, with sand, trace gravel Soft to firm, Brown, Moist		2	SS	3			○	○		
	(FILL)		3	SS	7		334	○	○		5 30 54 11
333.3											
2.2	SILTY SAND TO SAND, trace/some gravel Compact, Brown, Moist		4	SS	15		333	○	○		4 85 (11)
			5	SS	30			○	○		9 85 (6)
			6	SS	23		332	○	○		
			7	SS	25		331	○	○		2 88 (10)
	Dense		8	SS	31		330	○	○		7 87 (6)
			9	SS	51			○	○		
							329				
			10	SS	61		328	○	○		14 78 (8)
	with gravel										
			11	SS	39		327	○	○		41 55 (4)
							326				
			12	SS	40		325	○	○		4 61 33 2
	Sandy Silt						324				
322.9			13	SS	41		323	○	○		0 36 61 3
12.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 8.5 m

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

RECORD OF BOREHOLE No BH17-7 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 382.7 N; 227 729.5 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.18 LATITUDE 43.330390 LONGITUDE -80.450379 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.2	GROUND SURFACE										
335.1 / 0.1	TOPSOIL										
	CLAYEY SILT, with sand Soft to firm, Brown, Moist to wet		1	SS	12		335		○		
			2	SS	4				○		
							334				
			3	SS	2				○		
							333				
	(FILL)		4	SS	5				H ○		0 29 54 17
332.2 / 3.0	SILTY SAND TO SAND, some/with gravel Compact, Brown, Moist		5	SS	16		332		○		
			6	SS	30				○		
							331				
			7	SS	27				○		15 79 (6)
	Dense to very dense		8	SS	36		330		○		
			9	SS	30		329		○		37 59 (4)
							328				
			10	SS	50/13cm				○		
							327				
			11	SS	45		326		○		31 64 (5)
							325				
			12	SS	34				○		
							324				
322.6			13	SS	83		323		○		27 67 (6)
12.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 7.0 m

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-8 1 OF 2 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 337.9 N; 227 757.1 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.17 LATITUDE 43.329990 LONGITUDE -80.450032 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.6	GROUND SURFACE										
335.4 / 0.1	120mm ASPHALT over Sand and Gravel		1	SS	42		335				
334.8	(PAVEMENT STRUCTURE)										
0.8	SANDY SILT, trace/some gravel Very loose to loose, Brown, Moist to wet		2	SS	6				○		
			3	SS	2		334		○		
			4	SS	5		333		○		
			5	SS	3		332		○		14 33 47 6
	(FILL)		6	SS	6				○		
331.3							331				
4.3	SILTY SAND TO SAND, trace gravel Compact to very dense, Brown, Moist		7	SS	28				○		5 69 (26)
			8	SS	66		330		○		
			9	SS	30				○		9 86 (5)
							329				
			10	SS	28		328		○		
	with gravel										
			11	SS	41		327		○		21 73 (6)
							326				
			12	SS	45		325		○		51 44 (5)
							324				
323.0			13	SS	57		323		○		
12.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 7.9 m

Continued Next Page

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

RECORD OF BOREHOLE No BH17-8 2 OF 2 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 337.9 N; 227 757.1 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.17 LATITUDE 43.32999 LONGITUDE -80.450032 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	GR SA SI CL
320.6								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60	kN/m³	

Monitoring Well Legend:

Bentonite seal

Filter sand

Screen

Monitoring Well Readings:

Date	Depth (m)	Elev.
June. 5/'18	Dry	---,--

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-9 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 318.7 N; 227 531.1 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.15 LATITUDE 43.329794 LONGITUDE -80.452815 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.0	GROUND SURFACE										
334.8	TOPSOIL										
0.2	CLAYEY SILT, with sand		1	SS	5						
	SILTY SAND, trace gravel Compact, Brown, Moist		2	SS	13		334		○		
	(FILL)		3	SS	16				○		7 86 (7)
332.8							333				
2.2	SAND, trace silt, trace gravel Compact to dense, Brown, Moist		4	SS	16				○		
			5	SS	16		332		○		
			6	SS	22		331		○		0 93 (7)
			7	SS	22				○		
	with gravel		8	SS	20		330		○		1 93 (6)
			9	SS	24		329		○		
			10	SS	39		328		○		28 66 (6)
			11	SS	23		327		○		
			12	SS	32		326		○		
			13	SS	22		325		○		2 93 (5)
322.4							324				
12.6	End of borehole						323				

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 10.4 m

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-10 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 316.4 N; 227 575.6 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.15 LATITUDE 43.329778 LONGITUDE -80.452267 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
335.4	GROUND SURFACE										
335.2 / 0.2	175mm ASPHALT over Sand and Gravel		1	SS	13		335		○		
334.6	(PAVEMENT STRUCTURE)										
0.8	CLAYEY SILT		2	SS	2				○		
	Soft to stiff, Brown, Moist						334				
			3	SS	17						
333.2	(FILL)										
2.2	SAND, trace/some gravel, trace silt		4	SS	66		333	Non Plastic	○		19 37 40 4
	Compact to dense, Brown, Moist to wet										
			5	SS	25		332		○		
			6	SS	24				○		
							331				
			7	SS	22						
			8	SS	27		330		○		1 93 (6)
			9	SS	49				○		
							329				
							328				
			10	SS	35				○		
							327				
			11	SS	15		326		○		6 89 (5)
							325				
324.3			12	SS	44				○		
11.1	End of borehole										

Note: 1. Groundwater was not encountered during and upon completion of augering.

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

RECORD OF BOREHOLE No BH17-11 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 325.0 N; 227 645.3 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.17 LATITUDE 43.329863 LONGITUDE -80.451409 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.6	GROUND SURFACE										
335.4	TOPSOIL										
0.2	CLAYEY SILT, with sand, trace gravel Firm to stiff, Brown, Moist		1	SS	12		335		○		
			2	SS	7						
			3	SS	3		334		⊢○⊣		1 28 49 22
			4	SS	12		333		○		
	(FILL)										
332.4											
3.2	SAND, trace/some gravel, trace silt Compact to dense, Brown, Moist		5	SS	35		332		○		
			6	SS	29				○		1 90 (9)
			7	SS	25		331		○		
			8	SS	29		330		○		0 94 (6)
			9	SS	27		329		○		
			10	SS	55		328		○		12 82 (6)
			11	SS	34		327		○		
326.0							326				
9.6	End of borehole										

Note: 1. Groundwater was not encountered during and upon completion of augering.

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

RECORD OF BOREHOLE No BH17-12 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 371.6 N; 227 705.0 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.17 LATITUDE 43.330288 LONGITUDE -80.450679 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.3	GROUND SURFACE										
335.1 / 0.1	130mm ASPHALT over Sand and Gravel (PAVEMENT STRUCTURE)		1	SS	8		335				
334.5 / 0.8	CLAYEY SILT, with sand Firm, Brown, Moist (FILL)		2	SS	5				○		
333.8 / 1.5	SAND, trace/some gravel, trace silt Compact to dense, Brown, Moist		3	SS	17		334		○		
			4	SS	30		333		○		17 75 (8)
			5	SS	24		332		○		
			6	SS	15				○		1 93 (6)
			7	SS	16		331		○		
			8	SS	47		330		○		
	with gravel		9	SS	31		329		○		29 67 (4)
			10	SS	27		328		○		
			11	SS	19		327		○		
325.7 / 9.6	End of borehole						326				7 88 (5)

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 6.1 m

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

RECORD OF BOREHOLE No BH17-13

1 OF 1

METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 385.6 N; 227 752.9 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.18 LATITUDE 43.330419 LONGITUDE -80.450091 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.2	GROUND SURFACE										
335.1 / 0.1	TOPSOIL										
	SILTY SAND, trace gravel Very loose to compact, Brown, Moist to wet		1	SS	20		335				
			2	SS	1						
							334				
			3	SS	3						
							333				
	(FILL)		4	SS	15						7 62 26 5
332.2 / 3.0	SAND, trace silt, trace gravel Compact, Brown, Wet to moist		5	SS	18		332				
			6	SS	11						
	Silt, trace sand						331				
			7	SS	12						1 6 78 15
			8	SS	44		330				
	with gravel dense to very dense		9	SS	50/13cm		329				
			10	SS	35		328				21 71 (8)
			11	SS	50/13cm		327				
325.6			12	SS	69		326				36 56 (8)
9.6	End of borehole										

Note: 1. Groundwater was not encountered during and upon completion of augering.

2. After purging water from well, water level didn't recover to depth of 2.3 m and remained dry.

Monitoring Well Readings:

Date	Depth (m)	Elev.
June. 5/'18	2.1	333.1
June. 27/'18	2.3	332.9

Bentonite seal
Filter sand
Screen

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

ONTARIO MTO 17TF036A-REVISED-DEC 19 2018.GPJ ONTARIO MTO.GDT 12/20/18

RECORD OF BOREHOLE No BH17-14 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 414.0 N; 227 779.5 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.10 LATITUDE 43.330678 LONGITUDE -80.449766 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.6	GROUND SURFACE										
336.4	TOPSOIL										
0.2	SILTY SAND, trace/with gravel Very loose to loose, Brown, Wet to moist		1	SS	3		336				
			2	SS	3				○		2 60 26 12
	(FILL)		3	SS	5		335		○		
334.4											
2.2	SILTY SAND TO SAND, with gravel Compact, Brown, Moist		4	SS	57		334		○		46 42 (12)
			5	SS	24				○		
			6	SS	20		333		○		
			7	SS	21		332		○		
	trace gravel		8	SS	27		331		○		2 90 (8)
			9	SS	25				○		
			10	SS	30		329		○		36 52 (12)
			11	SS	25		328		○		
327.0							327				
9.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 6.1 m

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

RECORD OF BOREHOLE No BH17-15 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 378.9 N; 227 804.1 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.22 LATITUDE 43.330364 LONGITUDE -80.449458 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.7	GROUND SURFACE										
337.6 / 0.1	TOPSOIL										
	CLAYEY SILT, with sand, trace gravel Firm, Brown, Moist to wet		1	SS	4		337		○		
			2	SS	6				○		
			3	SS	3		336		○		1 43 41 15
	(FILL)		4	SS	6		335		○		
334.7 / 3.0	SAND, trace silt, trace gravel Compact, Brown, Moist		5	SS	16				○		
			6	SS	29		334		○		
	with gravel		7	SS	21		333		○		34 63 (3)
			8	SS	21				○		
			9	SS	22		332		○		
			10	SS	18		331		○		4 92 (4)
			11	SS	18		330		○		
328.1 / 9.6	End of borehole						329				

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 6.1 m

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

RECORD OF BOREHOLE No BH17-16

1 OF 1

METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 416.5 N; 227 904.7 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.22 LATITUDE 43.330713 LONGITUDE -80.448223 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.2	GROUND SURFACE										
338.1 / 0.1	TOPSOIL										
	CLAYEY SILT, trace/with sand Firm to stiff, Brown, Wet to moist		1	SS	5		338		○		
			2	SS	10				○		0 5 71 24
	(FILL)		3	SS	7		337		○		
336.0 / 2.2	SAND, trace silt, trace gravel Compact to dense, Brown, Moist		4	SS	24		336		○		0 94 (6)
			5	SS	22		335		○		
			6	SS	35				○		
	with gravel		7	SS	49		334		○		24 70 (6)
			8	SS	36		333		○		
			9	SS	30		332		○		1 92 (7)
			10	SS	50/13cm		331		○		
							330				
			11	SS	33		329		○		
328.6 / 9.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 8.5 m

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/10/18

RECORD OF BOREHOLE No BH17-17 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 250.5 N; 227 694.2 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.14 LATITUDE 43.329197 LONGITUDE -80.450795 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.8	GROUND SURFACE										
334.6	TOPSOIL										
0.2	CLAYEY SILT, with sand Firm to stiff, Brown, Wet to moist		1	SS	5		334		○		
			2	SS	6				○		
			3	SS	12		333				
	(FILL)		4	SS	12		332		○⊢		
331.8											
3.0	SAND, trace silt, trace gravel Compact to dense, Brown, Moist		5	SS	18				○		
			6	SS	23		331		○		7 88 (5)
			7	SS	25		330		○		
			8	SS	35				○		4 92 (4)
			9	SS	83		329		○		
	with gravel		10	SS	34		328		○		39 57 (4)
			11	SS	28		327		○		
325.2							326				
9.6	End of borehole										

Notes: 1. Groundwater was not encountered during and upon completion of augering.
2. Borehole caved-in at 6.4 m

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

RECORD OF BOREHOLE No BH17-18 1 OF 1 METRIC

G.W.P. 3039-16-00 LOCATION Coords: 4 799 238.8 N; 227 637.8 E ORIGINATED BY K.P.

DIST Central HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.Z.

DATUM Geodetic DATE 2018.05.14 LATITUDE 43.329086 LONGITUDE -80.451489 CHECKED BY M.V.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.4	GROUND SURFACE										
334.2	TOPSOIL										
0.2	CLAYEY SILT, with sand Very stiff, Brown, Moist (FILL)		1	SS	4		334		○		
			2	SS	20				○		
333.0							333				
1.4	SAND, some/trace gravel, trace silt Compact to dense, Brown, Moist		3	SS	18				○		14 82 (4)
			4	SS	22		332		○		
			5	SS	38		331				
	with gravel		6	SS	55				○		46 48 (6)
			7	SS	47		330		○		
			8	SS	28		329		○		13 82 (5)
			9	SS	30		328		○		
			10	SS	35		327		○		8 87 (5)
			11	SS	47		326				
324.8							325		○		
9.6	End of borehole										

Monitoring Well Readings:

Date	Depth (m)	Elev.
June. 5/'18	Dry	---,--

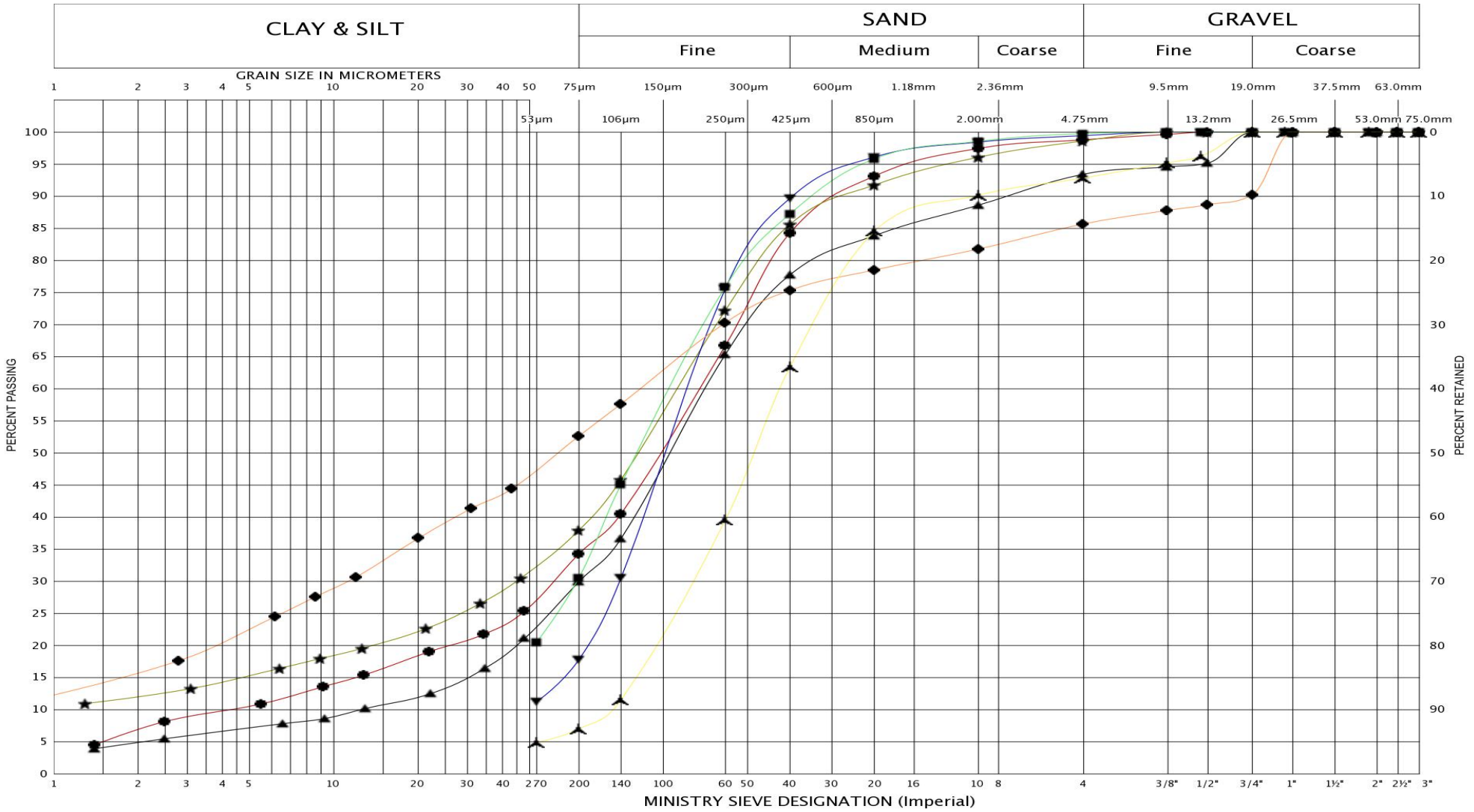
Monitoring Well Legend:

- Bentonite seal
- Filter sand
- Screen

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

ONTARIO MTO 17TF036A.GPJ ONTARIO MTO.GDT 12/7/18

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-1	17-2	17-2	17-8	17-9	17-13	17-14
	SAMPLE	3	2	3	5	3	4	2
	SYMBOL	●	▼	■	◆	⅄	▲	★

Ontario

GRAIN SIZE DISTRIBUTION

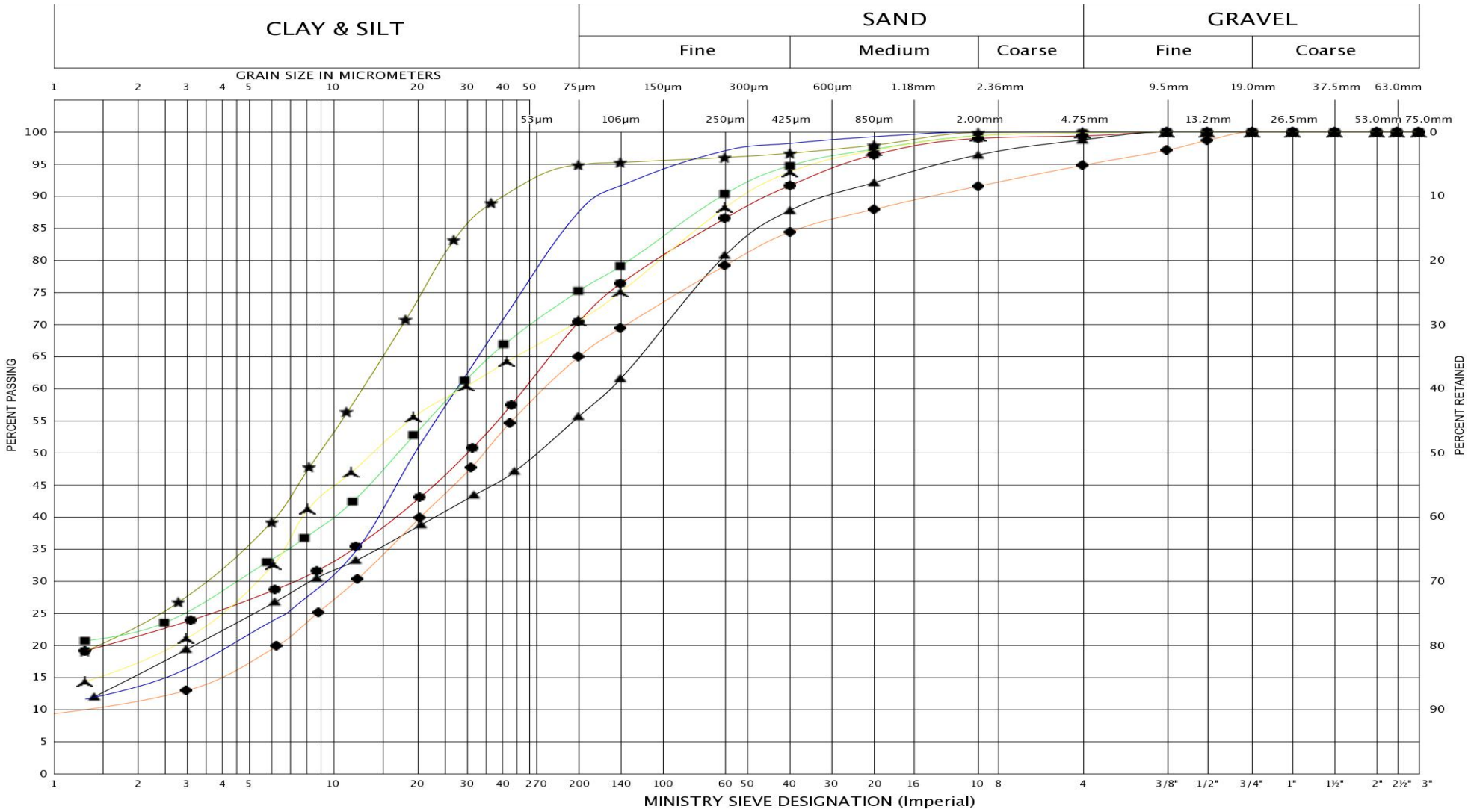
SANDY SILT TO SILTY SAND, trace gravel (FILL)

FIG No.: GS-1

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-3	17-4	17-6	17-7	17-11	17-15	17-16
	SAMPLE	3	2	3	4	3	3	2
	SYMBOL	▼	■	◆	⅄	⬢	▲	★

Ontario

GRAIN SIZE DISTRIBUTION

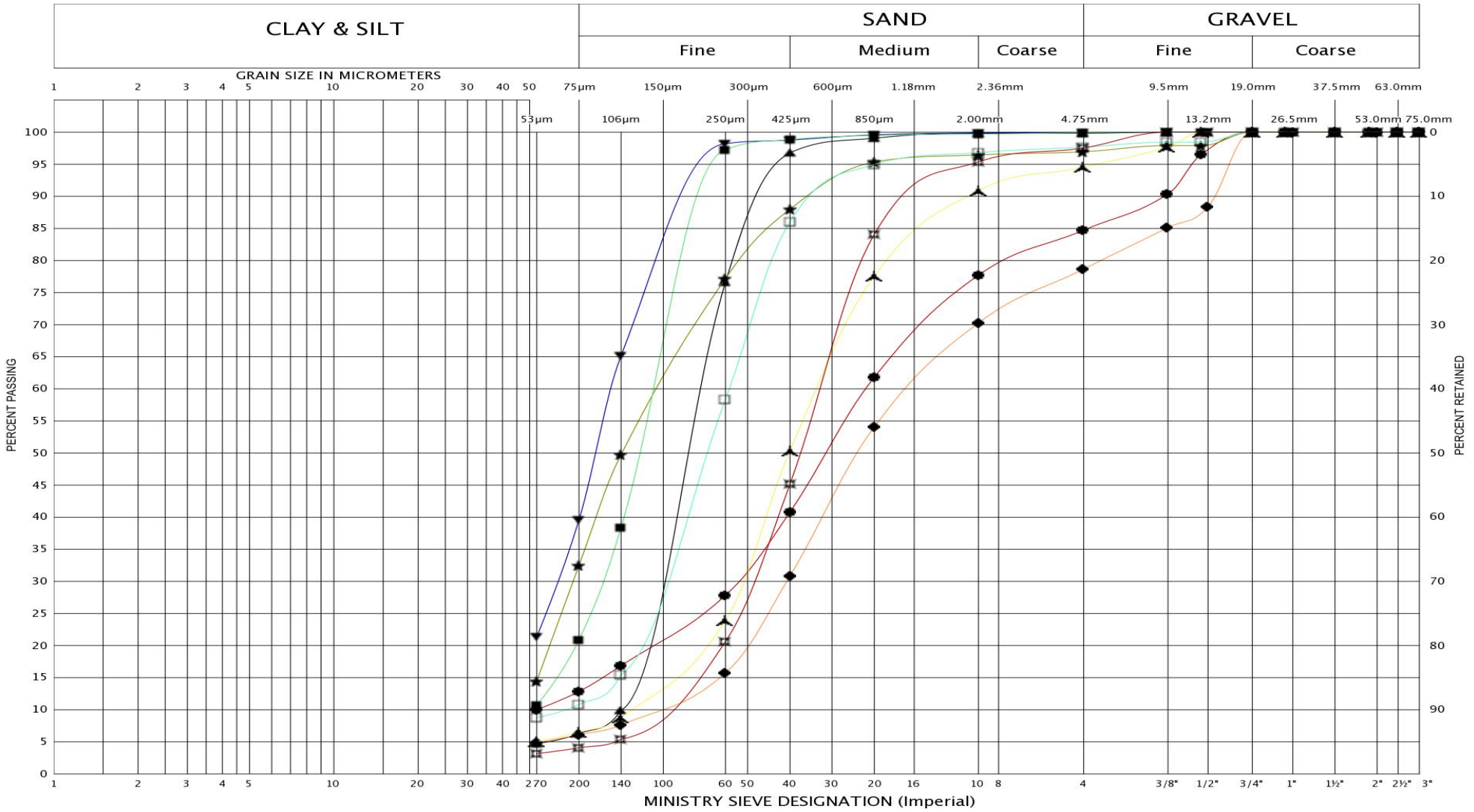
CLAYEY SILT, trace/with sand (FILL)

FIG No.: GS-2

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-1	17-1	17-2	17-2	17-3	17-3	17-3	17-4	17-4
	SAMPLE	7	10	6	13	5	8	10	5	9
	SYMBOL	●	▲	★	▼	■	⅄	◆	□	⊠

Ontario

GRAIN SIZE DISTRIBUTION

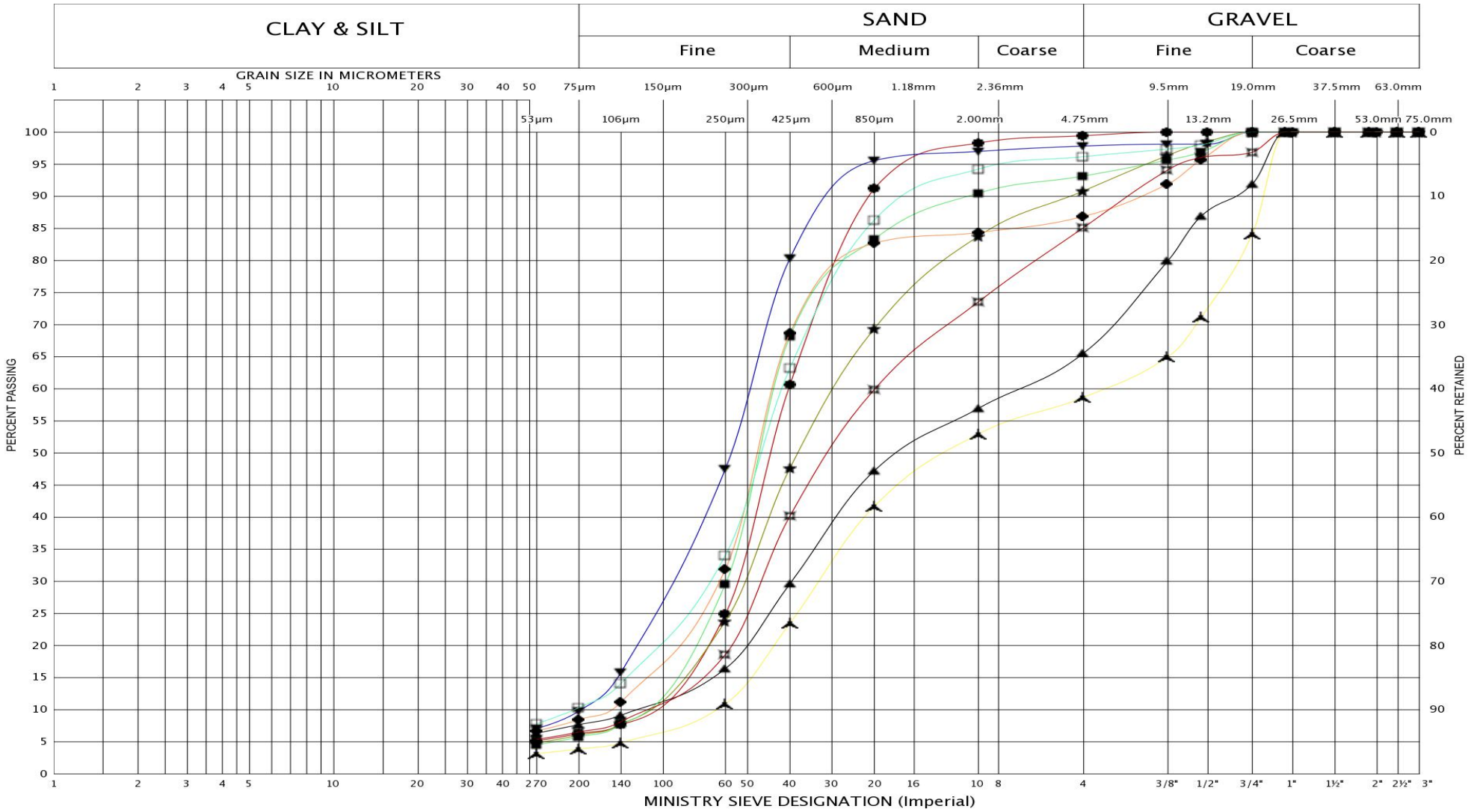
SILTY SAND to SAND, trace/some gravel

FIG No.: GS-3A

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-4	17-5	17-6	17-6	17-6	17-6	17-6	17-6	17-7
	SAMPLE	12	5	4	5	7	8	10	11	7
	SYMBOL	●	▲	□	✱	▼	■	◆	⅄	✖

Ontario

GRAIN SIZE DISTRIBUTION

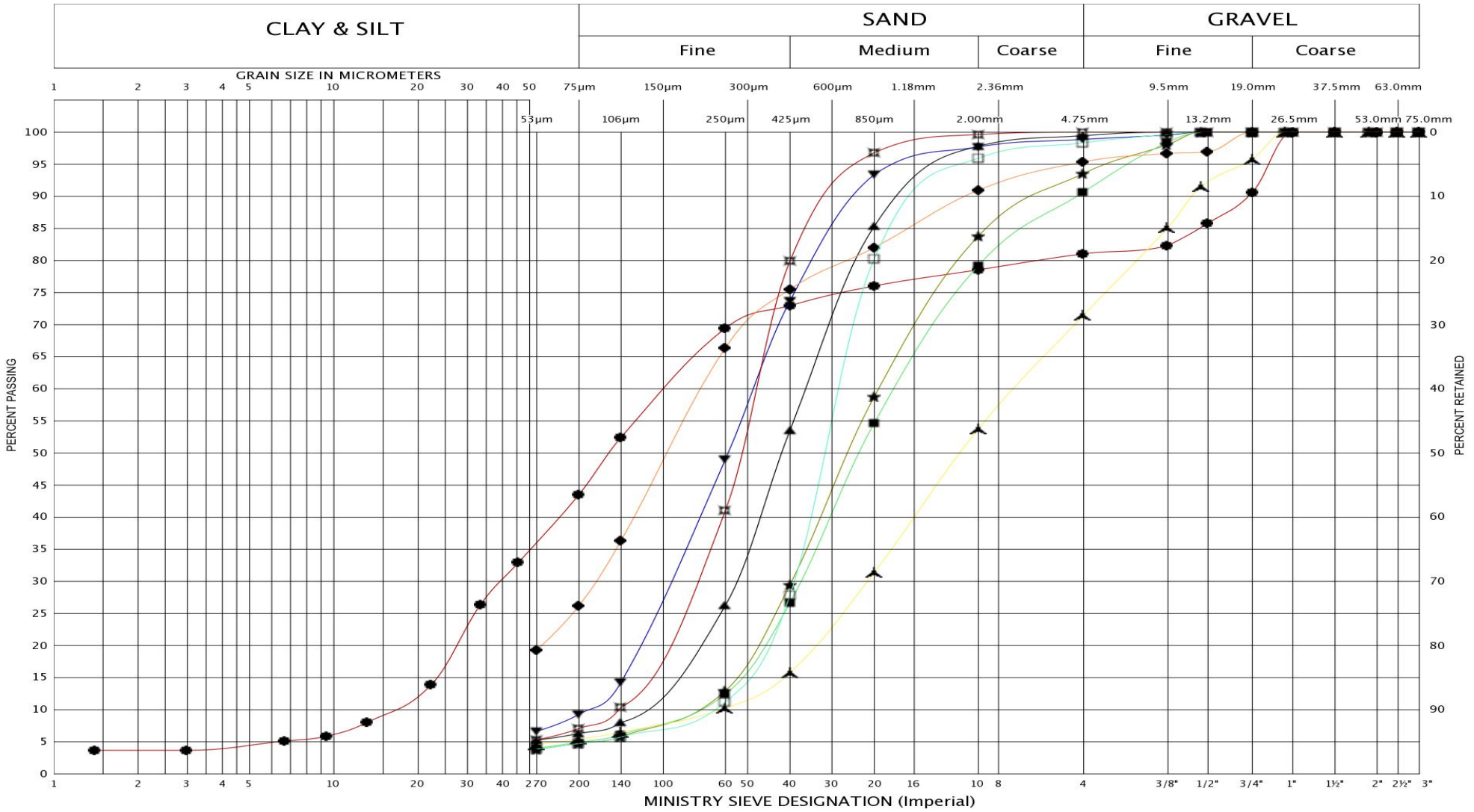
SILTY SAND to SAND, trace/some gravel

FIG No.: GS-3B

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-8	17-8	17-9	17-9	17-9	17-10	17-10	17-10	17-11
	SAMPLE	7	9	6	10	13	4	8	11	6
	SYMBOL	◆	■	✖	⅄	□	●	▲	★	▼

Ontario

GRAIN SIZE DISTRIBUTION

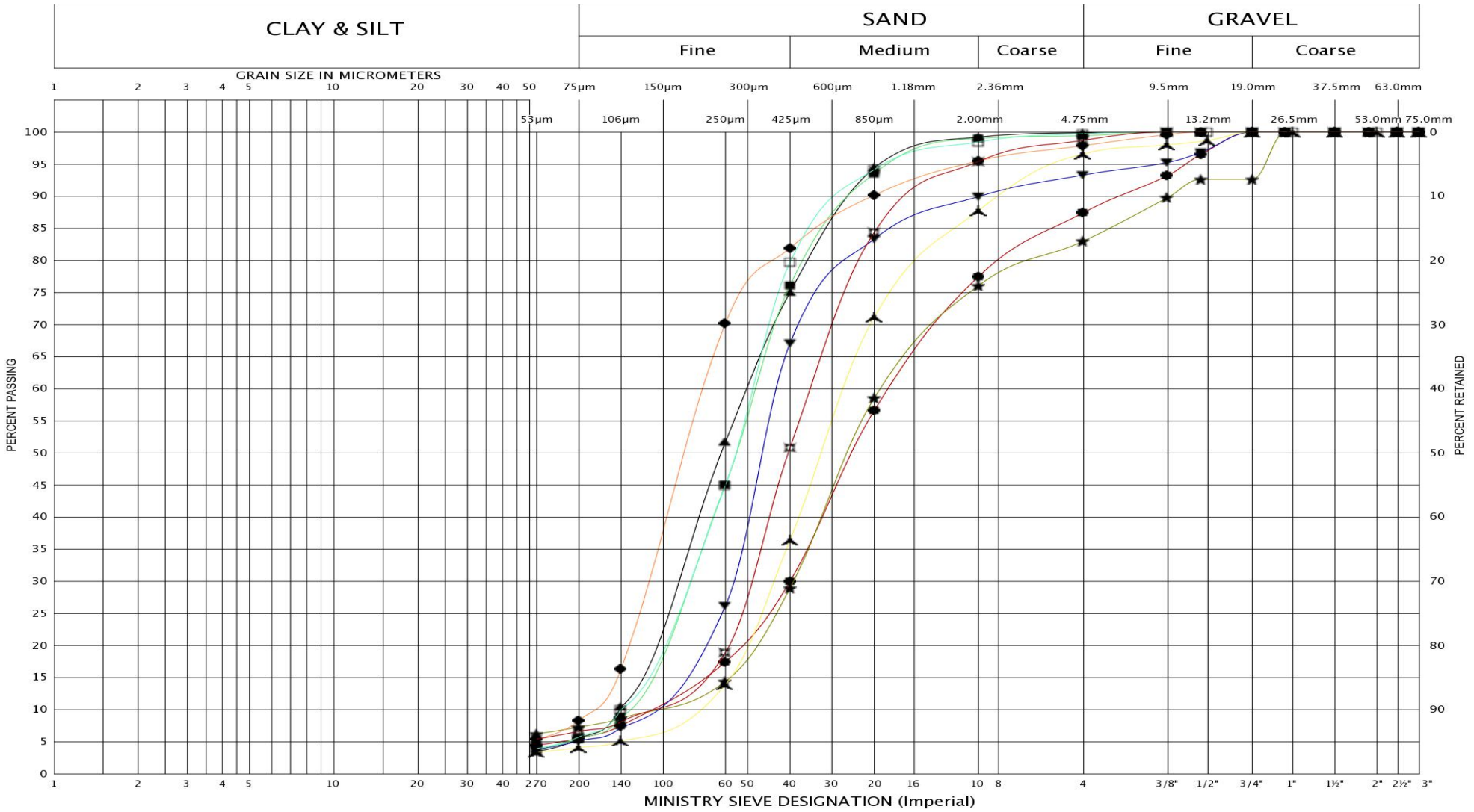
SILTY SAND to SAND, trace/some gravel

FIG No.: GS-3C

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-11	17-11	17-12	17-12	17-12	17-14	17-15	17-16	17-16
	SAMPLE	8	10	4	6	11	8	10	4	9
	SYMBOL	▲	●	★	■	▼	◆	⅄	□	⊠

Ontario

GRAIN SIZE DISTRIBUTION

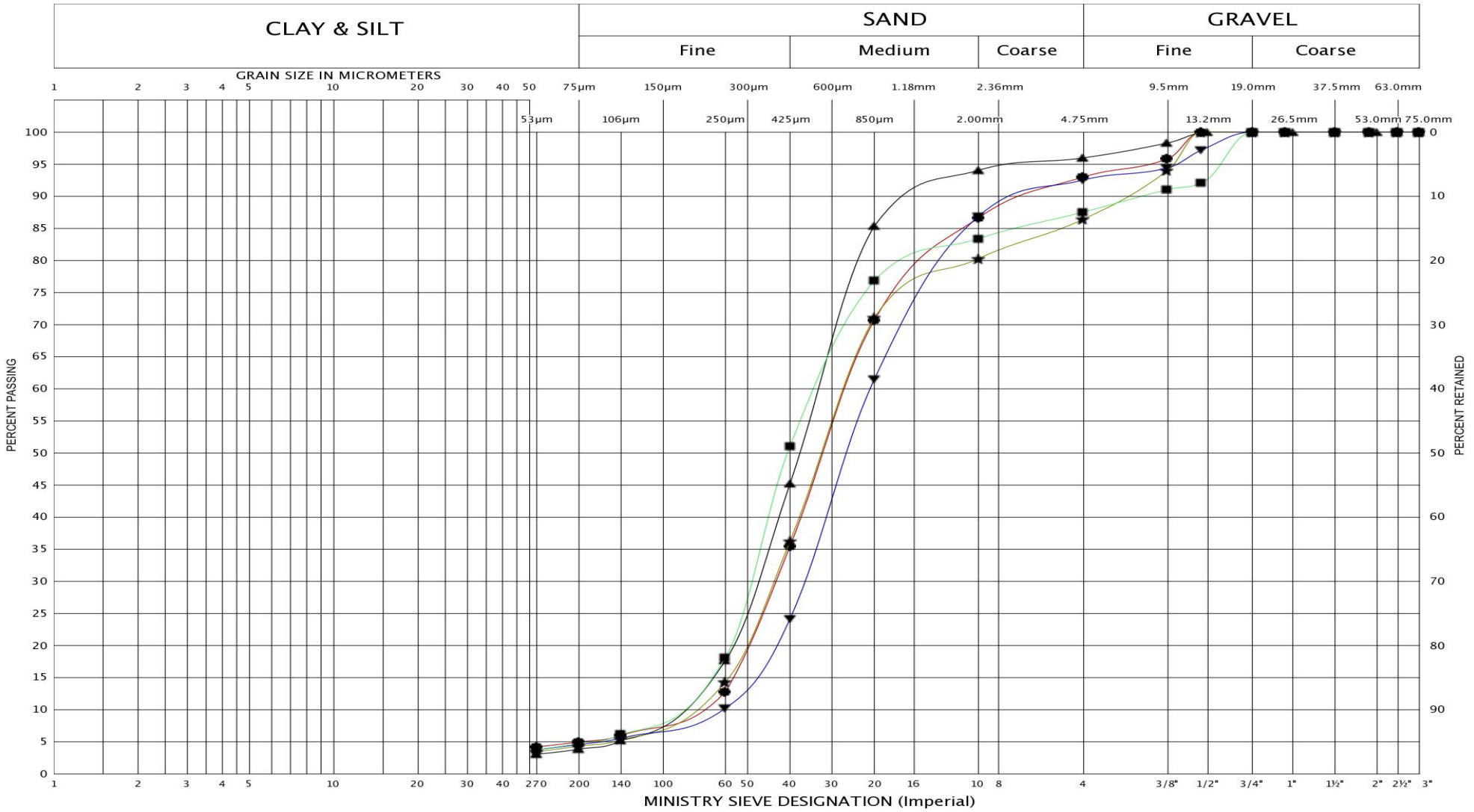
SILTY SAND to SAND, trace/some gravel

FIG No.: GS-3D

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-17	17-17	17-18	17-18	17-18
	SAMPLE	6	8	3	8	10
	SYMBOL	●	▲	✱	■	▼

Ontario

GRAIN SIZE DISTRIBUTION

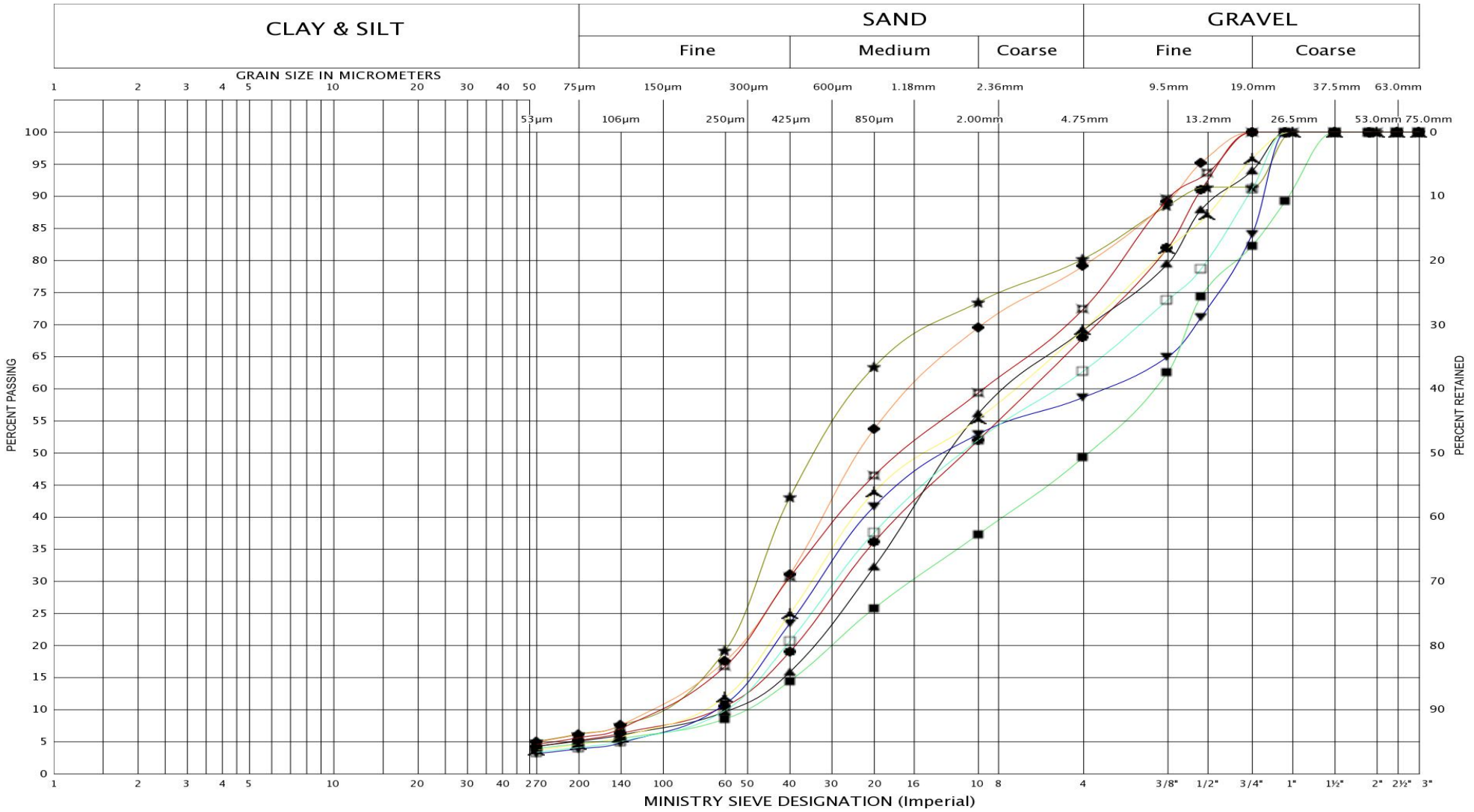
SILTY SAND to SANDY SILT, trace/some gravel

FIG No.: GS-3E

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-2	17-5	17-5	17-6	17-7	17-7	17-7	17-8	17-8
	SAMPLE	10	10	12	11	9	11	13	11	12
	SYMBOL	●	▲	★	▼	□	⅄	✖	◆	■

Ontario

GRAIN SIZE DISTRIBUTION

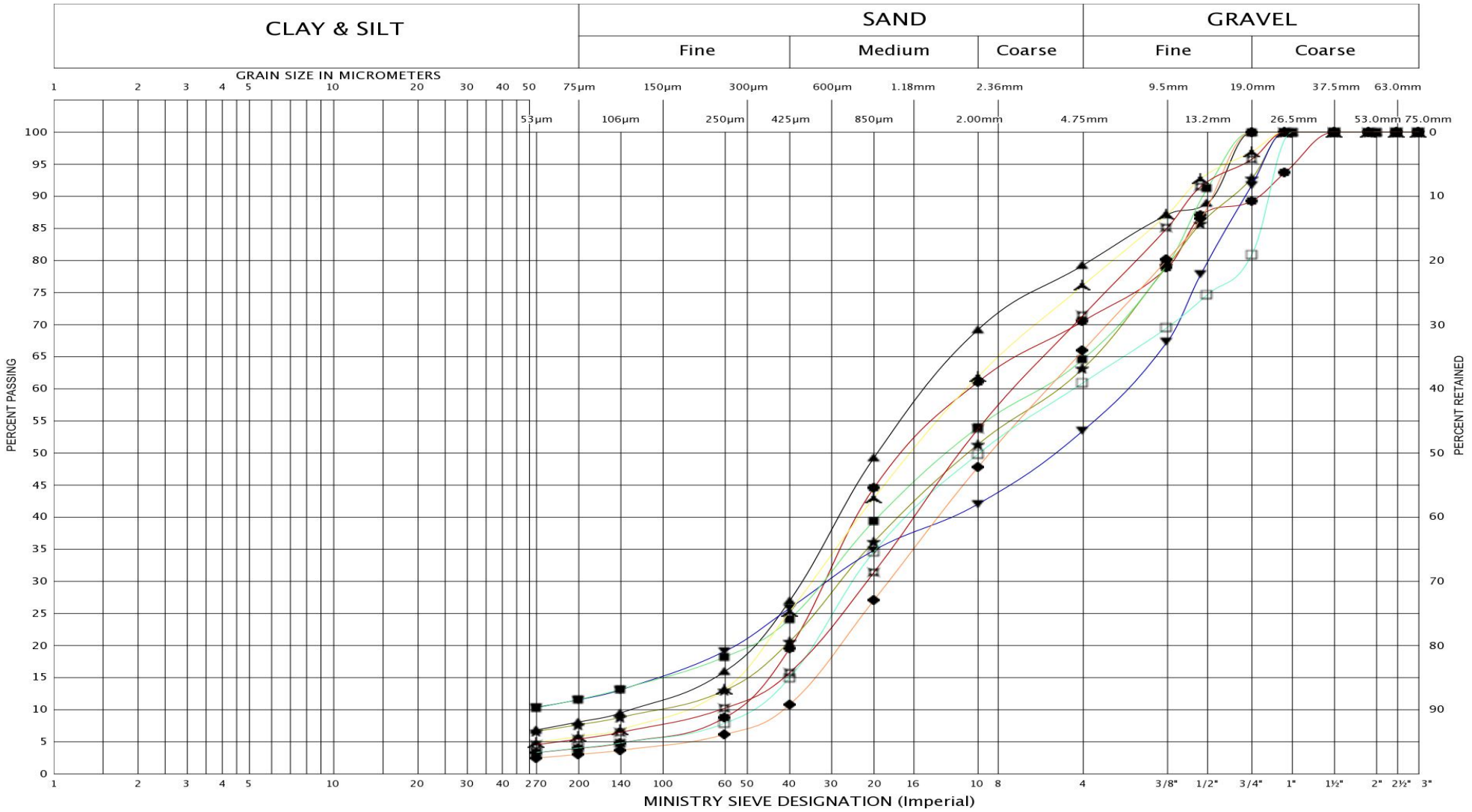
SILTY SAND to SAND, with gravel

FIG No.: GS-4A

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-9	17-12	17-13	17-13	17-14	17-14	17-15	17-16	17-17
	SAMPLE	10	9	10	12	4	10	7	7	10
	SYMBOL	✖	●	▲	★	▼	■	◆	⅄	□

Ontario

GRAIN SIZE DISTRIBUTION

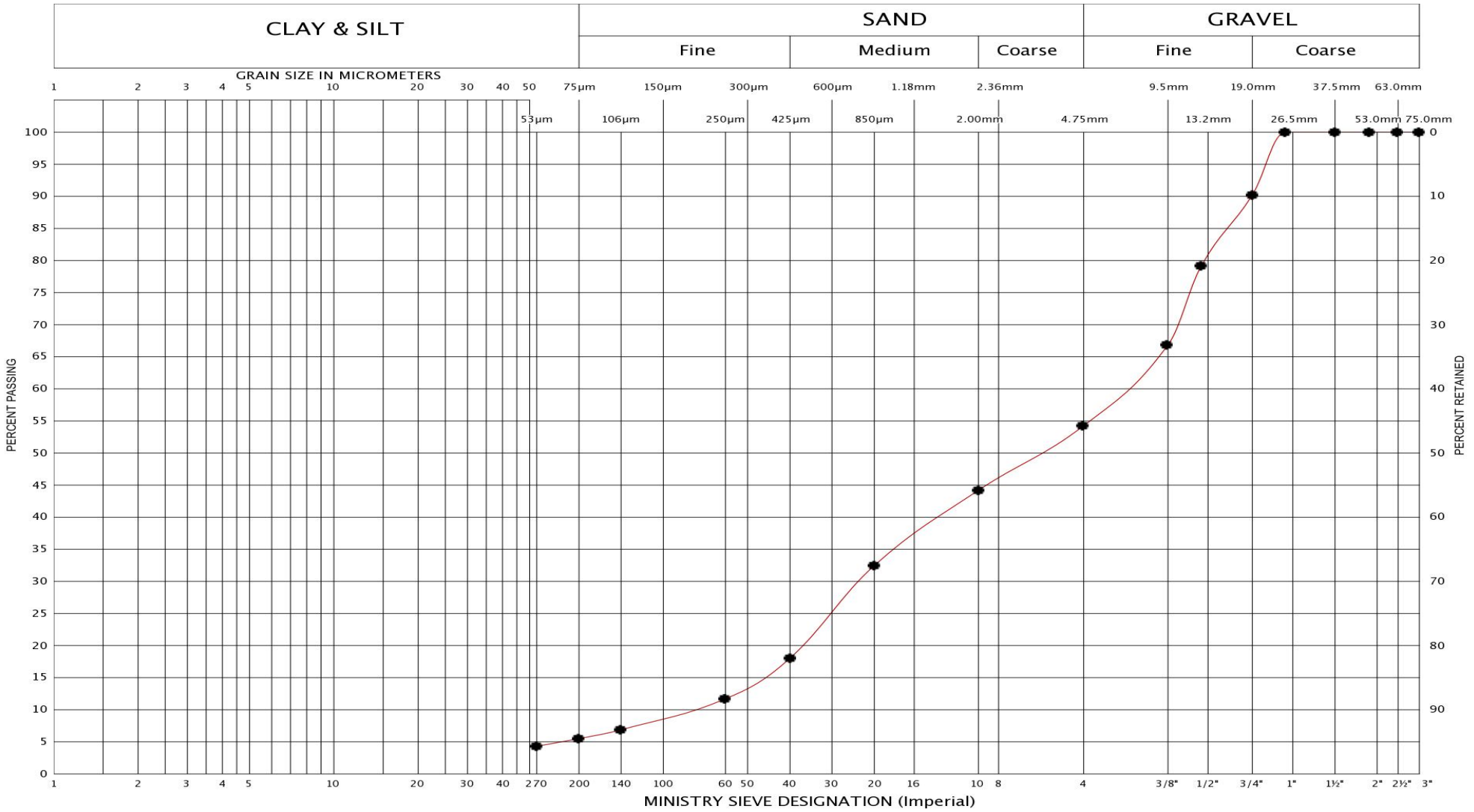
SILTY SAND to SAND, with gravel

FIG No.: GS-4B

HWY : 401/97 Interchange

GWP: 3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-18
	SAMPLE	6
	SYMBOL	●

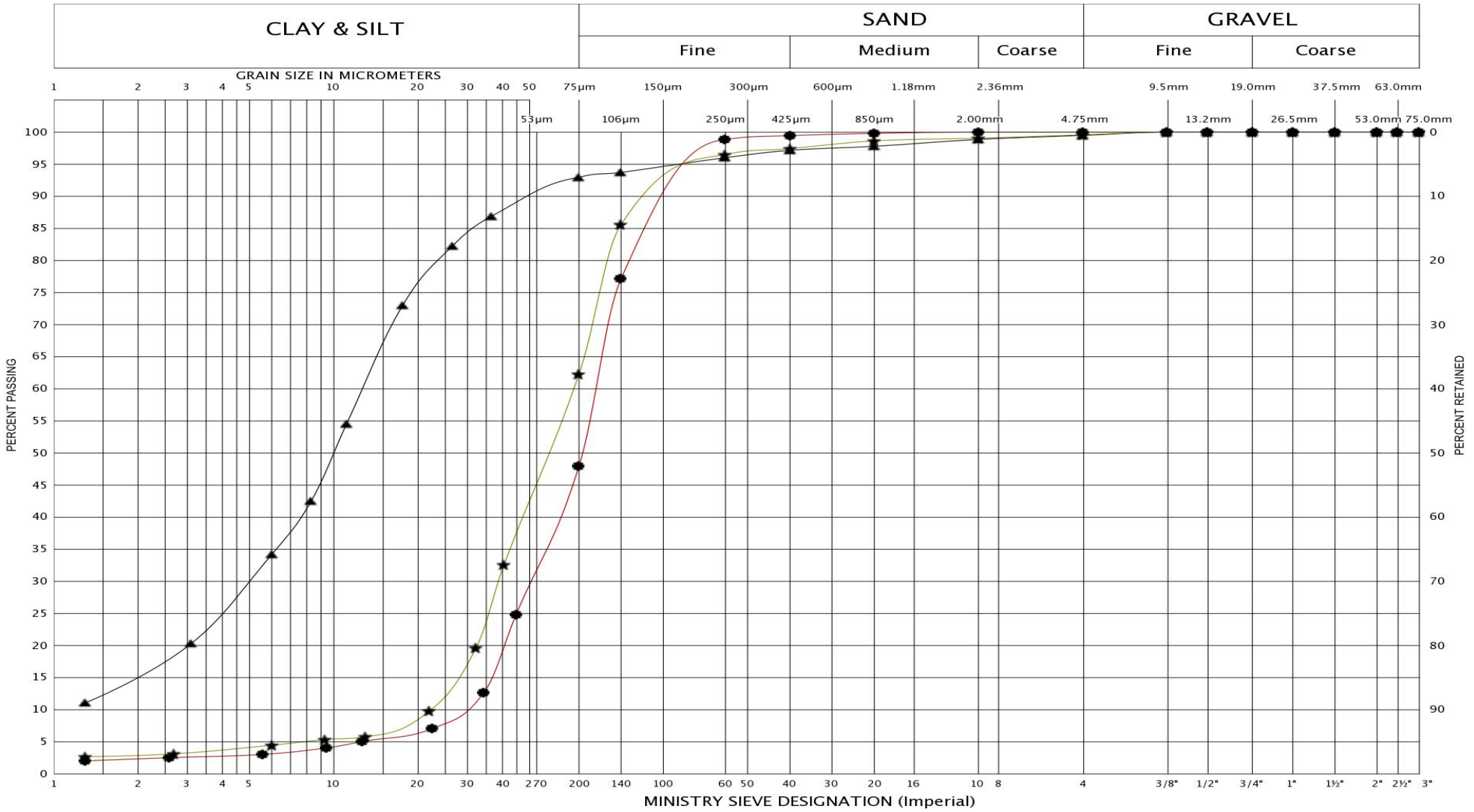
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND to SAND, with gravel

FIG No.:	GS-4C
HWY :	401/97 Interchange
GWP:	3039-16-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	17-1	17-6	17-13
	SAMPLE	12	13	7
	SYMBOL	●	✱	▲

Ontario

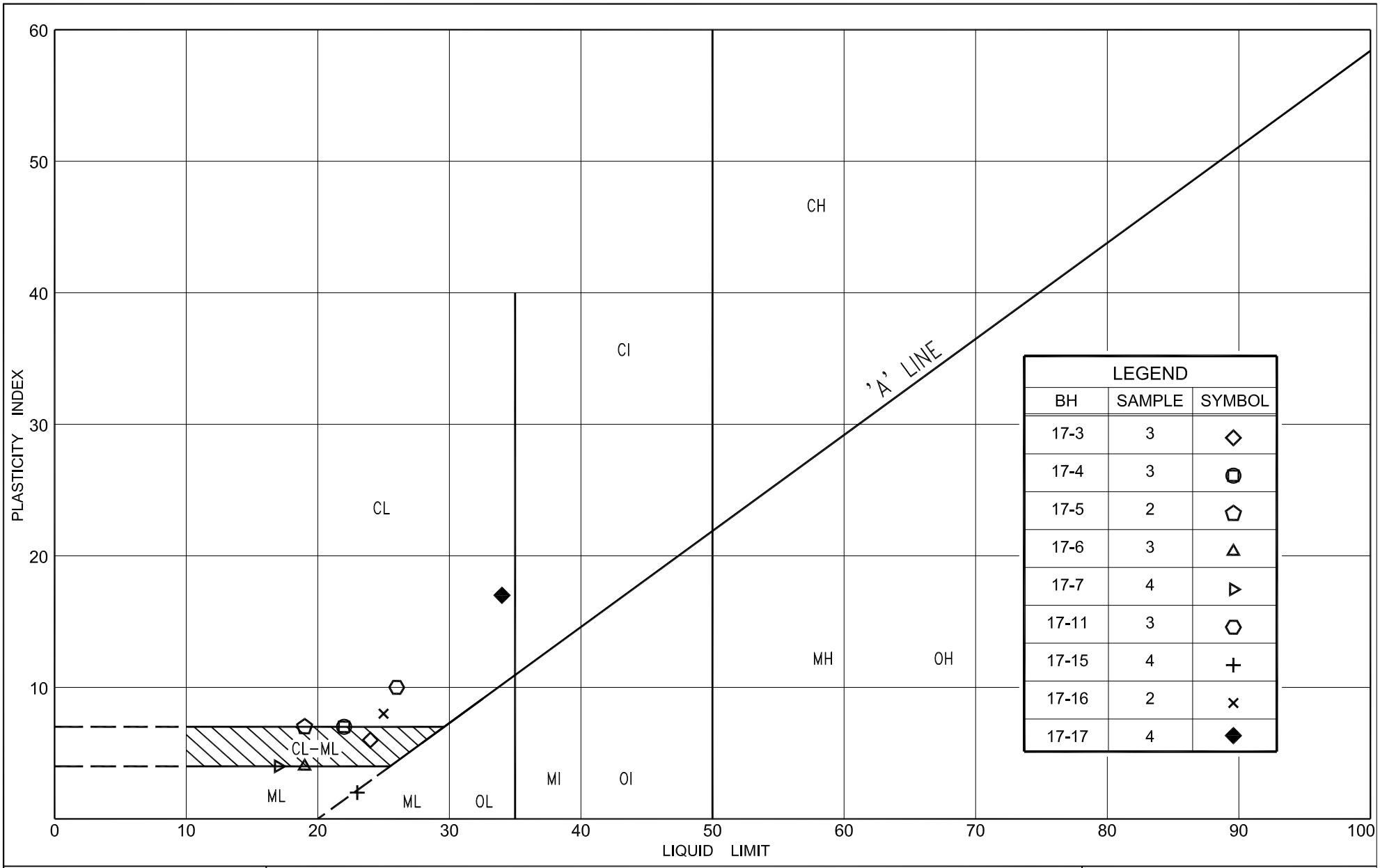
GRAIN SIZE DISTRIBUTION

SANDY SILT/SILT, trace/some clay, trace gravel

FIG No.: GS-5

HWY : 401/97 Interchange

GWP: 3039-16-00

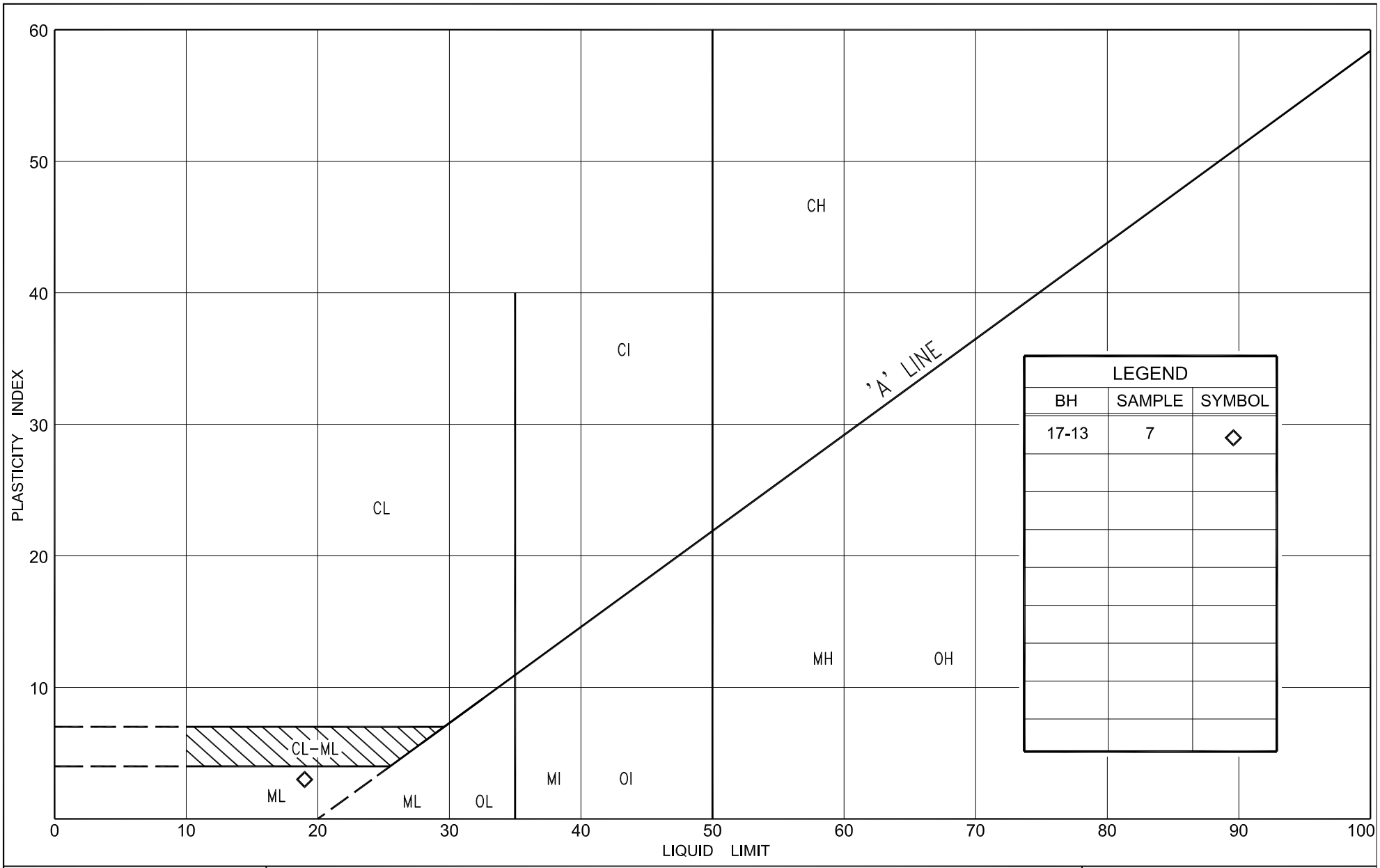


Ontario

PLASTICITY CHART

CLAYEY SILT, trace/with sand (CL-ML / CL) (FILL)

FIG No.	PC-1
HWY:	401/97 Interchange
GWP:	3039-16-00



Ontario

PLASTICITY CHART

Silt Seam (ML)

FIG No.	PC-2
HWY:	401/97 Interchange
GWP:	3039-16-00

FINAL REPORT

CA14781-MAY18 R1

17TF036A Ayr

Prepared for

Peto MacCallum Ltd

FINAL REPORT

CA14781-MAY18 R1

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Peto MacCallum Ltd	Project Specialist	Deanna Edwards, B.Sc, C.Chem
		Laboratory	SGS Canada Inc.
Address	16 Franklin St S Kitchener, ON N2C 1R4.	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Dylan Brice	Telephone	705-652-2000
Telephone	519-893-7500	Facsimile	705-652-6365
Facsimile	519-893-0654	Email	deanna.edwards@sgs.com
Email	dbrice@petomaccallum.com	SGS Reference	CA14781-MAY18
Project	17TF036A Ayr	Received	05/25/2018
Order Number		Approved	05/31/2018
Samples	Soil (6)	Report Number	CA14781-MAY18 R1
		Date Reported	05/31/2018

COMMENTS

Temperature of Sample upon Receipt: 10 degrees C
Cooling Agent Present: Yes
Custody Seal Present: No

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Deanna Edwards, B.Sc, C.Chem

TABLE OF CONTENTS

Client: Peto MacCallum Ltd

Project: 17TF036A Ayr

Project Manager: Dylan Brice

Samplers: O Brice

PACKAGE: **- Corrosivity Index** (SOIL)

Sample Number			5	6	7	8	9	10
Sample Name			BH 17-2 GS 8A	BH 17-3 GS 5A	BH 17-6 SS6	BH 17-7 SS8	BH 17-14 SS5	BH 17-15 SS5
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			14/05/2018	15/05/2018	16/05/2019	18/05/2020	18/05/2020	22/05/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index								
Corrosivity Index	none	1	3	4	3	4	3	3
Soil Redox Potential	mV	-	245	288	299	308	303	290
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	no unit	0.05	9.30	9.43	9.39	9.62	9.30	9.34
Resistivity (calculated)	ohms.cm	-9999	15200	10600	19600	4170	16500	16200

PACKAGE: **- General Chemistry** (SOIL)

Sample Number			5	6	7	8	9	10
Sample Name			BH 17-2 GS 8A	BH 17-3 GS 5A	BH 17-6 SS6	BH 17-7 SS8	BH 17-14 SS5	BH 17-15 SS5
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			14/05/2018	15/05/2018	16/05/2019	18/05/2020	18/05/2020	22/05/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry								
Conductivity	uS/cm	2	66	94	51	240	61	62

PACKAGE: **- Metals and Inorganics** (SOIL)

Sample Number			5	6	7	8	9	10
Sample Name			BH 17-2 GS 8A	BH 17-3 GS 5A	BH 17-6 SS6	BH 17-7 SS8	BH 17-14 SS5	BH 17-15 SS5
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			14/05/2018	15/05/2018	16/05/2019	18/05/2020	18/05/2020	22/05/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics								
Moisture Content	%	0.1	4.8	7.2	2.3	7.8	2.5	3.5
Sulphate	µg/g	0.4	2.3	2.9	1.7	8.9	1.3	2.0

Client: Peto MacCallum Ltd

Project: 17TF036A Ayr

Project Manager: Dylan Brice

Samplers: O Brice

PACKAGE: **- Other (ORP)** (SOIL)

Sample Number	5	6	7	8	9	10
Sample Name	BH 17-2 GS 8A	BH 17-3 GS 5A	BH 17-6 SS6	BH 17-7 SS8	BH 17-14 SS5	BH 17-15 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	14/05/2018	15/05/2018	16/05/2019	18/05/2020	18/05/2020	22/05/2020

Parameter	Units	RL		Result	Result	Result	Result	Result	Result
Other (ORP)									
Chloride	µg/g	0.4		11	9.9	4.0	91	8.0	13

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0477-MAY18	µg/g	0.4	<0.4	14	20	94	80	120	105	75	125
Sulphate	DIO0477-MAY18	µg/g	0.4	<0.4	21	20	97	80	120	96	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0044-MAY18	%	0.02	<0.02	ND	20	93	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0442-MAY18	uS/cm	2	< 0.002	29	10	101	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0442-MAY18	no unit	0.05	NA	1		100			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

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

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

No: 00314

Page ___ of ___

SGS Environment, Health and Safety

- Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Toll Free: 877-747-7658 Fax: 705-652-6365
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361 Web: www.ca.sgs.com

Laboratory Information Section - Lab use only

Received By: Ismail
Received Date: 05/25/18 (mm\dd\yy)
Received Time: 11:30 (am) / pm (circle)
Received By (signature):
Custody Seal Present: Y / (N) (circle)
Custody Seal Intact: Y / (N)
Cooling Agent Present: (Y) / N Type:
Temperature Upon Receipt (°C) 6.2, 7
CA 14781-MAY18
LAB LIMS #:
10x3

REPORT INFORMATION

Company: PETO MacCALLUM LTD
Contact: DYLAN BRICE
Address: 16 FRANKLIN ST S
KIT, ONT, N2C 1R4
Phone: 519-893-7500
Fax: 519-893-0654
Email: dbrice@petomaccallum.com

INVOICE INFORMATION

☒ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email: mzamshad@petomaccallum.com

PROJECT INFORMATION

Quotation #:
P.O. #:
Project #: 17TF036A
Site Location/ID: AYR.

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)
TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 3pm or on weekends : TAT begins the next business day

RUSH TAT (Additional Charges May Apply) ☐ 1 Day ☐ 2 Days ☐ 3-4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:
Rush Confirmation ID:

REGULATIONS

Regulation 153 (2011):
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium
☐ Table ____ ☐ Fine

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

DRINKING WATER SAMPLES (POTABLE WATER FOR HUMAN CONSUMPTION) MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

RECORD OF SITE CONDITION (RSC) ☐ YES ☒ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Corrosivity											COMMENTS: Field Filtered (F) Preserved (P)
1	BH 17-2 GS 8A	May 14/18	1350	1	S	X											
2	BH 17-3 GS 5A	May 15/18	1110			X											
3	BH 17-6 SS 6	May 16/18	1320			X											
4	BH 17-7 SS 8	May 18/18	930			X											
5	BH 17-14 SS 5	May 18/18	1530			X											
6	BH 17-15 SS 5	May 22/18	9??			X											
7																	
8																	
9																	
10																	

Observations/Comments/Special Instructions

Sampled By (NAME): D. BRICE **Signature:** Date: 05/22/18 (mm/dd/yy) Pink Copy - Client

Relinquished by (NAME): D. BRICE **Signature:** Date: 05/25/18 (mm/dd/yy) Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 25 July, 2016

SGS

SAMPLE INTEGRITY REPORT

Project Number: 17TF036A

ONTARIO REGULATION 153/04

SGS Sample ID CA14781 - MAY18

Date / Time Sampled May 14, 15, 18 + 22 /2018

Client Sample ID See CofC

	ALL
Sample Submission General Sample Integrity Violations	
Temperature >10 C upon receipt if not sampled same day	☐
No evidence of cooling trend initiated if sampled same day	☐
Chain of Custody not submitted	☐
Chain of Custody incomplete	☐
Chain of Custody not signed / dated	☐
Chain of Custody not a current version	☐
Bottles / Samples listed on CoC but not received	☐
Bottles / Samples received but not listed on the CoC	☐
Sample container received empty	☐

Sample Specific Sample Integrity Violations							
Sample received past hold time	☐	☐	☐	☐	☐	☐	☐
Incorrect preservation (including no preservation where required)	☐	☐	☐	☐	☐	☐	☐
Headspace present in VOC vial (aqueous)	☐	☐	☐	☐	☐	☐	☐
Sample(s) received frozen	☐	☐	☐	☐	☐	☐	☐
Bottle(s) broken or damaged in transport	☐	☐	☐	☐	☐	☐	☐
Discrepancy between sample label and chain of custody	☑	☐	☐	☐	☐	☐	☐
Analysis requirements absent / unclear	☐	☐	☐	☐	☐	☐	☐
Missing or incorrect sample label(s)	☐	☐	☐	☐	☐	☐	☐
Inappropriate sample container used	☐	☐	☐	☐	☐	☐	☐
Insufficient number of bottles received	☐	☐	☐	☐	☐	☐	☐
Limited sample volume	☐	☐	☐	☐	☐	☐	☐
Insufficient sample volume	☐	☐	☐	☐	☐	☐	☐
Sample contains multiple phases	☐	☐	☐	☐	☐	☐	☐
Sediment Log							
Groundwater samples contain visible sediment / particulate	☐	☐	☐	☐	☐	☐	☐
Groundwater contains greater than 1cm of sediment / particulate matter in bottle	☐	☐	☐	☐	☐	☐	☐

Additional Comments/Remarks:

No issues upon receipt ☐ Initials: KH

* Soil Jar BH 17-15 SSS → Recid labelled BH 17-5 SSG.

APPENDIX B

Site Photographs (P1- P12, Dated May 18, 2018)

Photograph P1: Entrance Gate, Facing West.

Photograph P2: Entrance Gate, Facing Southwest.

Photograph P3: At the entrance gate, Facing South.

Photograph P4: At the entrance gate, Facing Southwest.

Photograph P5: Corner of the Existing Asphalt Pad, Facing West.

Photograph P6: Corner of the Existing Asphalt Pad, Facing Northwest.

Photograph P7: Corner of the Existing Asphalt Pad, Facing North.

Photograph P8: Corner of the Existing Asphalt Pad, Facing Northeast.

Photograph P9: Corner of the Existing Asphalt Pad, Facing East.

Photograph P10: Near East Tree Line, Facing North.

Photograph P11: Near East Tree Line, Facing Northwest.

Photograph P12: Near East Tree Line, Facing West.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART B - PRELIMINARY FOUNDATION DESIGN REPORT

for

RECONSTRUCTION OF AYR PATROL YARD HIGHWAY 401 AND HIGHWAY 97 INTERCHANGE NORTH DUMFRIES TOWNSHIP MUNICIPALITY OF WATERLOO, ONTARIO ASSIGNMENT NO. 3017-E-0002, GWP 3039-16-00 LATITUDE: 43.329863; LONGITUDE: - 80.451409

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PML Ref.: 17TF036A
Index No.: 017FDR
GEOCRES No.: 40P8-259
December 20, 2018

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PART B – PRELIMINARY FOUNDATION DESIGN REPORT
For
Reconstruction of Ayr Patrol Yard
Highway 401 and Highway 97 Interchange, North Dumfries Township
Municipality of Waterloo, Ontario
Assignment No. 3017-E-0002, GWP 3039-16-00

7. INTRODUCTION

This foundation investigation and design report with the interpretation and recommendations are intended for the use of Morrison Hershfield Limited (MH) on behalf of the Ministry of Transportation of Ontario (MTO), and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. Where comments are made on construction, they are provided only to highlight those aspects, which could affect the design of the project. Contractors must make their own interpretation of the factual information provided in Part A of the report, as it may affect equipment selection, proposed construction methods and scheduling.

8. PROJECT DESCRIPTION

8.1 General

This report provides preliminary foundation engineering design recommendations based on interpretation of the geotechnical data presented in the factual part (Part A) to assist in planning, preliminary design and construction of the building facilities for the proposed Reconstruction of Ayr Patrol Yard at the northwest quadrants of the Highway 401 and Regional Road 97 Interchange, located in the Township of New Dumfries, Municipality of Waterloo, Ontario.

The discussions and recommendations presented in this report are based on the information included in the conceptual layout provided by MH on July 30, 2018 and the factual data obtained during the geotechnical investigation carried out by PML. Discussion and recommendations were updated and applicable to the current Cedar Creek Road Site (N-W) Proposed Layout (Sheet NW-1) dated December 11, 2018 provided by MH.

The objective of this report is to assist the design team in the selection and preliminary design of a suitable type of foundation for the proposed structures included in Reconstruction of Ayr Patrol Yard reconstruction project.

The scope of the work does not include providing preliminary design recommendations for the proposed parking lots, septic tank and leaching bed shown on DWG. 1. Parking lots are included under pavement engineering scope of works and design recommendation for septic tank and leaching bed are excluded from this preliminary foundation design report based on Clause 17.8.3A Terms of Reference 'Project Specific' of RFP Part B.

The report is for preliminary design and planning purposes only. Additional foundation investigation and analyses may be required at the detail design stage of the project to finalize the design and to develop construction documents and specifications.

8.2 Proposed Patrol Yard and Associated Facilities

Based on the Cedar Creek Road Site Proposed Layout provided by MH, the proposed Reconstruction of Ayr Patrol Yard is envisaged to accommodate an office building, 3 bay maintenance garage, wash bay, 12 bay vehicle storage, salt and sand storage facility, 9 brine tanks containment bay, 4 bay bulk material storage, storage shed and fuel pad (ref. Cedar Creek Road Site (N-W) Proposed Layout, Sheet NW-1 dated December 11, 2018 provided by MH). Details of the final proposed facilities were not available at the time of preparation of this report. The current concept plan includes a rectangular office building footprint approximately 17.5 m wide and 30.5 m long. It is understood that the design-build team may prepare different concepts including a final site grading resulting in cuts or fills to the existing site elevations.

9. STRUCTURE FOUNDATION

In summary, the subsurface conditions immediately below the existing ground level consist of 800 mm pavement structure in the paved area and 100 mm to 200 mm of topsoil in boreholes that were advanced outside the perimeter of paved area. The topsoil and pavement structure are underlain by fill comprised of silty sand and clayey silt to depths ranging from 1.4 m (El. 333.0) to 4.3 m (El. 331.3). The fill is followed by compact to very dense silty sand to sand to the maximum investigation depth of 12.6 m below the existing ground surface.

Based on the foundation investigation boreholes data, supporting the proposed structures on shallow spread and strip footings founded either on competent native silty sand to silt/sand or engineered fill is considered feasible. Use of drilled pier or caisson foundation may be considered for a relatively higher bearing resistances than shallow footings at this site for the proposed development.

The structure/building founded on shallow footings shall be checked/deigned to resist uplift caused by wind loads.

The floor slab of the buildings for the salt / sand storage and the 12 bay vehicle storage areas should be provided with a geo-membrane designed to prevent the migration of salt and hydrocarbon contaminants and allow for their capture and removal if required. It is understood that the design of the finished floors of these two facilities is considered to be asphaltic concrete pavement structure. The structural design of the asphaltic concrete pavement structure of these two facilities will be prepared under the Pavement Engineering scope of work.

9.1 Potential for Soil Liquefaction

The factors influencing the liquefaction potentials are saturated granular soil, especially fine loose sand and reclaimed soils with poor drainage conditions are susceptible to liquefaction. The footings for the proposed structures will be founded on either silty sand to sand/sand or engineered fill. The compactness of granular soil at or below footing founding level is compact to dense. Since no groundwater was encountered during our field investigation, it is considered that liquefaction will not be a concern at this site.

9.2 Foundation Frost Depth

In accordance with OPSD 3090.101, a minimum of 1.2 m earth cover is required to protect against the frost penetration in the area where the site is located.

9.3 Foundation General

Use of conventional strip and spread footings founded on shallow native competent soil or engineered fill is considered to be feasible option for supporting the proposed structures at this site.

Where it is necessary, the proposed structure can also be supported by drilled piers or caissons founded on undisturbed native soil. The preferred foundation options for each individual facility/structure shall be reviewed and finalized by design build proponent's foundation engineer. The bearing values of native soils and corresponding founding elevations are summarized below.

The bearing resistance for inclined load should be reduced in accordance with the requirements of Clause 10.2.4 of the Canadian Foundation Engineering Manual (CFEM) 4th Edition, 2006 and Clause 4.2.4.6 of the Ontario Building Code (OBC), 2012.

All footings subject to frost action should be provided with 1.2 m of earth cover or equivalent thermal insulation. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover.

9.3.1 Spread and Strip Footings on Native Soils

Footings founded on native compact silty sand to sand or sand may be designed for a geotechnical bearing resistance ranges from 180 to 300 kPa at Serviceability Limit State (SLS), subject to geotechnical inspection during construction. The relevant factored bearing resistance at Ultimate Limit State (ULS) ranges from 270 to 450 kPa. For strip footing a width of 1.2 m and for spread footing a width of 2.5 m were considered for determining the bearing resistances at SLS and ULS. A summary of subsurface soils at borehole locations along with the recommended footings founding depths, elevations and bearing resistances are provided in Table 6 below, where the bearing resistances of 180 - 270 kPa is applicable at SLS.

Table 6: Summary of Shallow Footings Founding Depths and Elevations and Founding Soils at the Borehole Locations

BOREHOLES NO.	GROUND SURFACE ELEVATION (m)	MINIMUM DEPTH BELOW EXISTING GROUND (m)	FOOTINGS FOUNDING ELEVATIONS (m)	Footing Bearing Resistance at SLS (kPa)	Factored Footing Bearing Resistance at ULS (kPa)	FOUNDING SOIL
BH17-1	335.3	3.0	332.2	190	290	Silty Sand to Sand
BH17-2	335.0	2.2	332.8	180	270	Silty Sand to Sand
BH17-3	335.2	2.2	333.0	250	370	Silty Sand to Sand
BH17-4	335.3	3.3	332.0	180	270	Silty Sand to Sand
BH17-5	335.4	2.7	332.7	190	290	Silty Sand to Sand
BH17-6	335.5	2.5	333.0	180	270	Silty Sand to Sand
BH17-7	335.2	3.0	332.2	190	280	Silty Sand to Sand
BH17-8	335.6	4.3	331.3	250	370	Silty Sand to Sand
BH17-9	335.0	2.2	332.8	180	270	Sand
BH17-10	335.4	2.2	333.2	300	450	Sand
BH17-11	335.6	3.2	332.4	280	400	Sand

Table 6: Summary of Shallow Footings Founding Depths and Elevations and Founding Soils at the Borehole Locations

BOREHOLES NO.	GROUND SURFACE ELEVATION (m)	MINIMUM DEPTH BELOW EXISTING GROUND (m)	FOOTINGS FOUNDING ELEVATIONS (m)	Footing Bearing Resistance at SLS (kPa)	Factored Footing Bearing Resistance at ULS (kPa)	FOUNDING SOIL
BH17-12	335.3	1.5	335.3	200	300	Sand
BH17-13	335.2	3.0	332.2	180	270	Sand
BH17-14	336.6	2.2	334.4	300	450	Silty Sand to Sand
BH17-15	337.7	3.0	334.7	180	270	Sand
BH17-16	338.2	2.2	336.0	200	300	Sand
BH17-17	334.8	3.0	331.8	180	270	Sand
BH17-18	334.4	1.4	333.0	180	270	Sand

Note: Footing bearing resistance at SLS for 25 mm settlement and 19 mm of differential settlement.

9.3.2 Footings on Engineered Fill

Spread and strip footings constructed on engineered fill placed on competent native soil could also be employed to support the foundation loads of the proposed structures. The recommended bearing resistances for strip and spread footings width of 1.2 m and 2.5 m respectively, constructed on engineered fill is as follows:

- Geotechnical Bearing Resistance at SLS = 150 kPa
- Factored Geotechnical Bearing Resistance at ULS = 225 kPa

The geotechnical resistance at SLS normally allows for 25 mm of compression of the founding medium. Differential settlement is expected to be less than 75% of this value. A footing embedment depth of minimum 1.2 m was assumed for computation of the geotechnical resistances. The above

geotechnical resistances are provided considering that the loads are perpendicular to the surface of the footings. Inclination of the load due to sloping ground surface or inclined footing foundation surface, if any, should be taken into consideration in accordance with OBC, 2012 and CFEM, 2006.

The engineered fill should comprise OPSS Granular A (sand and gravel) material placed in maximum 200 mm thick lifts, compacted to 100% of the ASTM D698 (standard Proctor) maximum dry density and extended laterally to a line inclined downward at 45º to the horizontal originating at least 1 m from the top of the footing. Approved bi-axial geogrid may be required at mid depth of the engineered fill, if the thickness of the engineered fill exceeds 0.5 m to minimize potential differential settlement.

The above bearing resistances are provided based on vertical concentric loads applied on the footings are founded on flat subgrade without any slope located within the zone of influence. The horizontal load imposed on the proposed footing will be resisted by the passive earth pressure on the footing by compacted engineered fill pad extending beyond the building envelope to minimum 3.6 m. The following parameters for OPSS Granular A and Granular B to be used for engineering fill, if chosen, as shown in Table 7.

Table 7: Properties of OPSS Granular A and Granular B Type II

PARAMETERS	GRANULAR A	GRANULAR B TYPE II
Internal Friction angle (degrees)	35	30
Unit weight, γ (kN/m^3)	22.5± 0.3	21.5 ± 0.3
Coefficient of Active Earth Pressure, K_a	0.27	0.33
Coefficient of Passive earth Pressure, K_p	0.43	0.5
Coefficient of Earth Pressure at Rest, K_0	3.69	3

The footing thickness, sizes and other footing requirements shall be designed in accordance with the OBC 2012 requirements. All footing subgrade shall be inspected and evaluated by a geotechnical engineer prior to pouring concrete to confirm the footings are founded on competent subgrade and capable of providing the recommended geotechnical bearing resistances.

9.3.3 Resistance to Lateral Loads

Resistance to lateral forces/sliding between footings concrete and the underlying subsoil/fill material shall be calculated in accordance with CFEM, 2006. The coefficient of friction for cast-in-place concrete on native soil and properly prepared engineered fill could be considered as shown in Table 8 below.

Table 8: Friction Coefficient for Cast-In-Place Concrete

FOOTING FOUNDING SUBSOIL/MATERIAL	FOOTING CONCRETE	FRICTION FACTOR, tan δ (CFEM, 4th Edition)
Silty Sand to Silt/Sand	Cast-in-situ	0.35
OPSS Granular A or B	Cast-in-situ	0.40

Passive earth pressure acting on the sides of the shallow foundations and friction of the base of the foundations may be considered to provide resistance to lateral forces trending to cause translational sliding.

9.3.4 Drilled Piers or Caissons

The proposed structure can also be supported by drilled piers or caissons founded on undisturbed native sandy silt to sand/sand at depths between 2.2 m and 3.2 m for a geotechnical bearing resistance of 250 kPa at SLS and 300 kPa for a factored bearing resistance at ULS. For drilled piers, the recommended founding depths and elevations are summarized in Table 9 below.

It should be noted that the caissons are assumed to have a depth/diameter ratio equal to or greater than 3. Minimum diameter of the drilled piers or caissons are recommended to be 760 mm.

Table 9: Recommended Founding Depth, Elevations and Founding Subsoil for Drilled Pier or Caisson

BOREHOLES NO.	GROUND SURFACE ELEVATION (m)	MINIMUM DEPTH BELOW EXISTING GROUND (m)	FOOTINGS FOUNDING ELEVATIONS (m)	FOUNDING SOIL
BH17-2	335.0	2.2	332.8	Silty Sand to Sand
BH17-3	335.2		333.0	
BH17-6	335.5		333.3	
BH17-12	335.3	2.5	332.8	Sand

Table 9: Recommended Founding Depth, Elevations and Founding Subsoil for Drilled Pier or Caisson

BOREHOLES NO.	GROUND SURFACE ELEVATION (m)	MINIMUM DEPTH BELOW EXISTING GROUND (m)	FOOTINGS FOUNDING ELEVATIONS (m)	FOUNDING SOIL
BH17-5	335.4	2.7	332.7	Silty Sand to Sand
BH17-4	335.3	3.0	332.3	Silty Sand to Sand
BH17-7	335.2		332.2	Silty Sand to Sand
BH17-13	335.2		332.2	Sand
BH17-11	335.6	3.2	332.4	Sand

Caissons founded at depths between 4.0 m and 5.2 m may be considered for a relatively higher geotechnical bearing resistances of 450 kPa at SLS and 600 kPa at ULS as detailed in Table 10.

Table 10: Recommended Founding Depth, Elevations, and Founding Subsoil for Drilled Pier or Caisson

BOREHOLES NO.	GROUND SURFACE ELEVATION (m)	MINIMUM DEPTH BELOW EXISTING GROUND (m)	FOOTINGS FOUNDING ELEVATIONS (m)	FOUNDING SOIL
BH17-2	335.0	4.0	331.0	Silty Sand to Sand
BH17-3	335.2		331.2	
BH17-4	335.3		331.3	
BH17-5	335.4		331.4	
BH17-6	335.5		331.5	
BH17-7	335.2		331.2	
BH17-11	335.6		331.6	Sand
BH17-12	335.3		331.3	
BH17-13	335.2	5.2	330.0	

All foundation bases must be inspected by PML geotechnical personnel prior to pouring concrete to confirm the design bearing values. Foundations designed to the specified bearing values are expected to settle less than 25 mm total and 19 mm differential.

9.3.5 Lateral Resistance

Drilled piers (treated as shallow circular footings) can be designed to resist lateral loads by friction similar to spread footing foundation design. Caissons (which are designed as deep foundations) can be designed to resist lateral loads by soil structure interaction; and the soil resistance

component is provided by lateral soil pressures. If this option is selected by the Contractor team, the lateral resistance calculations should be carried out in the final detail design stage. In general, for one storey buildings, the caisson design (configurations, size and steel reinforcements) is controlled by vertical loadings.

The preliminary foundation design parameters are provided for static, vertically and concentrically loaded foundations in compression. Once the detail design of the facility/structure are known, a more through geotechnical investigation should be completed at that time.

Installation on deep foundations, final cleaning and verification of base condition of the drilled piers and caissons should be carried out in accordance with OPSS.PROV 903.

9.3.6 Other Recommendations on Foundation

Where it is necessary to place foundations at different levels, the upper foundation must be founded below an imaginary 10 horizontal to 7 vertical lines drawn up from the base of the lower foundation. The lower foundation must be installed first to help minimize the risk of undermining the upper foundation.

It should be noted that the recommended bearing capacities have been provided based on information from the foundation boreholes data. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by PML personnel to validate the information for use during the construction stage.

9.4 Slab-on-Grade

Construction of the floor slab as a concrete slab-on-grade on the undisturbed native soils or engineered fill pad is considered to be feasible. It is recommended that topsoil, fill and other deleterious materials be removed from the building footprint completely. In the event, if complete removal of existing fill is cost prohibitive, the fill material could be removed partially to depths of 1.5 to 2.0 m below ground surface. Following the removal of partial fill, the excavated bottom shall be

proof-rolled using a heavy duty vibratory smooth drum roller under dry condition. Any soft area during proof-rolling shall be sub-excavated and the void shall be filled using the engineered fill.

The exposed subgrade should then be prepared in accordance with OPSS 902 and its amendment (Special Provision No. 109S12). Fill placed under the slab to achieve finished subgrade levels should comprise approved material placed and compacted in accordance with OPSS.PROV 501. A minimum 200 mm thick layer of well compacted 19 mm clear crushed stone or equivalent is typically recommended directly beneath concrete floor slabs for bedding purposes and as a vapour barrier. If a moisture sensitive floor finish is to be provided, extra vapour barrier may be necessary. A heavy-duty polyethylene (or PVC) sheeting or equivalent means may be installed between the concrete slab and the compacted granular base to act as the vapour barrier. This requirement should be selected by the Design-Build team considering the specification of the floor finish product and the thickness of concrete floor slab.

If the concrete slab is required in an unheated area, it is recommended that the slab-on-grade be placed on a layer of high-density closed-cell insulation or equivalent (such as Styrofoam) with a thickness selected to make up the frost protection requirement previously indicated in this report. The floor slab should be structurally separated from the foundation walls and columns. Control joints should be provided along column lines and at regular intervals to minimise temperature cracks and to allow for any differential movement of the floor slab.

The Design-Build team should consider the design of the floor slab base material, vapour barrier and environmental membrane. The merits of environmental membrane may be considered under the sand/salt storage and garage areas.

9.5 Site Grading and Engineered Fill

It is understood, the proposed development site needs to cut and fill up to 1 to 3 m across the development area. The site grading shall be in accordance with OPSS. PROV 206 Construction Specification for Grading. Where grades need to be raised, the fill should be constructed as engineered fill. General guidelines for engineered fill construction are provided in Appendix C.

Highlights are as follows:

1. Strip existing topsoil, fill materials and excavate other obvious deleterious materials down to native soil, as verified by geotechnical review during construction;
2. Following sub-excavation, proof-roll exposed native subgrade using a heavy roller. The proof-rolling should be witnessed by geotechnical personnel to identify any unstable approved equivalent machinery/equipment areas that may require further excavation. Construction during the dry season would be preferred to minimize surface run-off/perched water issues. Construction methods and equipment need to be adopted based on the construction season;
3. Following geotechnical approval of the native subgrade, place approve engineered fill material in maximum 200 mm lifts and compact to 100% standard Proctor maximum dry density under buildings and minimum 95% standard Proctor maximum dry density under roads and services;
4. Site inorganic soil excavated may be suitable for reuse as engineered fill, subject to geotechnical field review during construction, to ensure excessively wet, frozen, organic, or other deleterious materials are not incorporated in the engineered fill;
5. Imported fill for engineered fill shall meet the OPSS.PROV 1010 gradation requirements, free of organics and other deleterious materials, at a moisture content suitable for compaction. Proposed borrow/imported material should be reviewed for geotechnical as well as environmental quality;
6. Engineered fill should extend at least 1 m beyond the structure to be supported then down and outwards at no steeper than 45º to meet the approved native subgrade. Strict survey control by an Ontario Land Surveyor (OLS) will be needed to ensure the extent of engineered fill incorporates all structures/facilities to be supported;
7. Engineered fill construction should be carried out under full time supervision of PML, to verify removal of existing topsoil and other deleterious materials, approve the native subgrade, approve backfill material and ensure satisfactory placement and compaction efforts.

9.6 Site Servicing

The location and invert of the proposed services were not available at the time of this report; however, it is assumed that site servicing will not have inverts more than 2.5 m below existing grade.

9.6.1 Bedding

It is anticipated that underground utility services, will generally be supported by native soils or compacted engineered fill, where bearing capacity is not expected to be a concern. However, where poor subgrade soil is encountered at the design invert, it may be necessary to sub-excavate and provide an increased thickness of bedding, subject to geotechnical field review. Standard granular bedding in accordance with OPSS.PROV 1010, compacted to 95% Standard Proctor maximum dry density, should be satisfactory. For flexible pipes, bedding and cover material should comprise OPSS.PROV 1010 Granular A gradation requirements. For rigid pipes, bedding material should comprise OPSS.PROV 1010 Granular A gradation requirements, and cover material may comprise select trench backfill free of oversized (150 mm) or excessively wet material.

9.6.2 Backfill

Backfill in trenches should be placed in maximum 200 mm thick loose lifts compacted to at least 95% standard Proctor maximum dry density to minimize post construction settlement in the backfill. Backfill for at least the upper 1 m of trench should be close to optimum moisture content to prevent subgrade instability issues. Wet soil will have to be mixed and/or allowed to “dry out” in order to render the material suitable for reuse. Construction during the dry time of the season is encouraged to optimize the reuse of any excavated site soil. Boulders, organics, frozen or otherwise deleterious soils should not be incorporated in the backfill. Earthworks operations should be inspected by PML to approve the subgrade, backfill materials, placement and compaction procedures and to ensure the specified compaction standards are achieved throughout. The placement of backfill material behind the walls should be carried out in accordance with OPSS.PROV 902.

9.7 Construction Consideration

9.7.1 Excavation and Shoring

Excavation for construction of the structure foundations if supported on strip or column footings founded on native soil will extend locally through granular fill and, silty sandy/clayey silt and native sandy soil to depths approximately between 1.4 m and 4.3 m. Excavation through fill materials is expected to be relatively straightforward. All work should be carried out in accordance with the Occupational Health and Safety Act. (OHSA) and local regulations. With the exception of surficial topsoil and pavement structure, the fill materials placed for grading purposes at this site are

classified as Type 3 soils according to OHSA (Ontario Regulation 213/91) criteria. Therefore, temporary cut slopes over the full depth of excavation should be inclined at 45º to the horizontal. The need to excavate flatter side slopes if soft/wet materials or concentrated seepage zones are encountered locally should be considered.

Where local site conditions are different and varies, such as presence of weak soils, proximity of existing structures and underground utilities, or right of way space restrictions, maintaining the above-mentioned slope may not be possible then suitable safety and support measures must be undertaken according to the requirements of the OSHA O. Reg. 213/91 and its amendments. These measures include installation of a suitable shoring system to create and maintain positive support to the sidewalls of the excavated trenches.

Where excavation will be required near the property line and adjoining the existing structures or near the Off-Ramp to Highway 401, shoring will be required to protect the existing above and below ground structures in accordance with OPSS.PROV 539.

The type of shoring to be used depends on the permissible movement of the shoring. The contractor is responsible for the detailed design and performance of the shoring. The horizontal movement of the shoring should be monitored daily during the excavation process with a trigger and response criteria set for various magnitudes of lateral movement. Temporary shoring can be used in combination with open cuts above the top of shoring; however, the earth pressure distribution must take into account the effects of the soil pressures from the upper open cut section.

A geotechnical engineer shall review and approve the shoring under the excavation profile. Refer to the parameters provided in Table 11 for use in preliminary design of any shoring structures. Any excavated material stockpiled near an excavation or trench should be stored at a distance equal to or greater than the depth of the excavation/trench and construction equipment/traffic movement should be limited near open excavation.

Table 11: Recommended Preliminary Earth Pressure Coefficients for On-site Soil

PARAMETERS	TYPE 2 SOIL	TYPE 3 SOIL
Internal Friction Angle, (degrees)	33	30
Unit weight, ɣ (kN/m^3)	18.5	17.5
Coefficient of Active Earth Pressure, K_a	0.29	0.33
Coefficient of Passive Earth Pressure, K_p	3.39	3
Coefficient of Earth Pressure at Rest, K_0	0.46	0.5

10. DECOMMISSIONING OF MONITORING WELLS

Three wells located at Borehole Nos. BH17-8, BH17-3 and BH17-18 shall be properly decommissioned prior to undertake any construction activities. The construction details of these wells are provided on the record of boreholes sheets.

The well decommissioned method must satisfy the minimum requirements of Ontario Regulation 903. Approval of the proposed abandoned methodology including plugging material used, depth of the plugging materials and limit of the casing removal must be obtained from the Contract Administrator. In addition, the contractor shall provide a copy of the well record for abandonment to the Contract Administrator.

11. SEISMIC CONSIDERATIONS

The site specific spectral and Peak Ground Acceleration numbers for the project site, for the 2% in 50 year probability of exceedance, are Sa(0.2)=0.131, Sa(0.5)=0.080, Sa(1.0)=0.046, Sa(2.0)=0.023 and PGA=0.080 (National Building Code (NBC) of Canada, 2015 website). The design values of acceleration and velocity-based site coefficients F_a and F_v for the project site should be calculated in accordance with Table 4.1.8.4.B and 4.1.8.4.C respectively, of the OBC 2012.

For seismic design purposes, the site may be classified as Site Class D in accordance with Clause 4.4.3.2 (Table 4.1) of CHBDC, 2014 and table 4.1.8.4A of OBC 2012. Should higher site class designations be required, additional investigation to measure the seismic site response is recommended.

12. PROPOSED STORM WATER MANAGEMENT (SWM) POND

A SWM pond is proposed to be constructed at southwest corner of the property near off-ramp to Highway 401 as shown in the revised site plan Sheet NW-TT3 received from MH on September 20, 2018, updated to Cedar Creek Road. Site (N-W) proposed layout (Sheet NW-1, dated December 11, 2018). It is understood that the pond will most likely be a wet detention pond and be constructed through both excavation and berm construction. The pond base depth/elevation and the permanent water level elevation were unknown at the time of developing this report. It is assumed, the pond will be constructed with a clay liner. Boreholes BH17-17 and BH17-18 was advanced in the vicinity of the proposed SWM pond, revealed topsoil over clayey silt fill over a sand deposit to the boreholes termination depth of 9.6 m. The monitoring well in Borehole BH17-18 showed no ground water as of June 27, 2018. The following general comments and recommendations are provided for your consideration. When final grading and details of the SWM pond are established they should be submitted to PML for geotechnical review:

- The clay liner will have to be provided with adequate soil cover, to resist hydrostatic uplift, when the pond is empty. The coefficient of permeability of the clay liner material should be 1×10^{-6} cm/sec or less;
- Berms should be constructed as engineered fill, using select material, compacted to a minimum 95% standard Proctor maximum dry density within ±2% of its optimum moisture content;
- Wet SWM pond side slopes should be no steeper than 5H:1V and protected from erosion by provision of vegetation cover, granular blanket, rip rap or the likes.
- Where design slopes are steeper than the above recommended slope, analyses to slope stability in short and long term would be required.

13. CONCRETE RESISTANCE AND CORROSION PROTECTION

Reference is made to the Certificate of Analysis in Appendix A, for the results of sulphate and chloride analysis and measurement of corrosion parameters performed on six soil samples from the subject site. In accordance with Canadian Standard Association, CSA-A23.1-09, Table 3, the test results indicate a negligible potential degree of sulphate attack on buried concrete. Accordingly, the use of normal Portland cement is indicated. Assessment of the corrosion potential test results with the American Water Works Association, ANSI/AWWA C105/A21.5-10 is provided in Table 12.

Table 12: Soil Corrosivity Index

BOREHOLE	SAMPLE	DEPTH (ELEVATION) (m)	CORROSIVITY INDEX
BH17-2	8	5.3 – 5.8 (329.7 – 329.2)	3
BH17-3	5	3.1 – 3.6 (332.1 – 331.6)	4
BH17-6	6	3.8 – 4.3 (331.7 – 331.2)	3
BH17-7	8	5.3 – 5.8 (329.9 – 329.4)	4
BH17-14	5	3.1 – 3.6 (333.5 – 333.0)	3
BH17-15	5	3.1 – 3.6 (334.6 – 334.1)	3

Note: Point values are based on Table A.1 from ANSI/AWWA C105/A21.5-10.

The potential for an aggressive corrosive soil environment was established in reviewing the above measured parameters and according to standard provided by the American Water Works Association (AWWA) C-105/A21.5-10.

In the silty sand to sand deposit, the sulphate content for the sample taken from Borehole BH17-7 was 8.9 μg/g or 0.0008% (Table 3 in Part A). According to Clause 4.1.1.6 of the Canadian Standards Association (CSA) standard A23.1-14, soluble sulphate concentrations less than 1000 μg/g or 0.1% indicate a low degree of sulphate attack when concrete is in contact with soil or groundwater.

The chloride contents provided in Table 5 in Part A for all soil samples (4 ppm to 91 ppm) suggest a non-corrosive environment for buried metal or a steel pile. For a corrosive environment, it is generally recognised that chloride concentrations should be higher than 250 ppm.

Soil sample resistivity values encountered greater than 3000 ohms-cm from limited soil testing are assessed to be not a corrosion potential.

For pH value greater than 8.5, the corrosivity index is 3 in accordance with AWWA C105/A21.5 – 10. The total corrosivity index from the limited soil testing ranged from 3 to 4, which is considered not a corrosion potential.

Based on the limited investigation, no groundwater was encountered. However, if groundwater is encountered during detail design investigation, it is recommended to sample and test for potential corrosivity index.

Generally, no sulphate attack is expected from selected backfill materials. However, it may be advisable to test backfill material for corrosion potential if it is imported from unknown sources.

14. GROUNDWATER CONTROL

Groundwater was not encountered during the drilling on or upon completion of drilling. The water level measured at 2.1 m (El. 333.1) in the monitoring well installed in borehole 17-13 on July 5, 2018 is considered to be perched water. It is considered adequate to utilize conventional sump pumping technique to control any surface run-off, perched water or infiltrations from the existing fill material. Dewatering shall be carried in accordance with OPSS.PROV 517 and to amendments (Special Provision No. 517F01).

Water level is subject to seasonal fluctuations and rainfall pattern.

15. DISCUSSION AND RECOMMENDATIONS

The proposed Reconstruction of Ayr Patrol Yard includes construction of a single storey office building, maintenance garage, wash bay, winter vehicle storage, salt and sand storage facilities, brine tanks containment bay, bulk materials storage structures and fuel pad on a design build basis. From preliminary assessments, shallow foundation comprised spread and strip footings founded on compact to dense native soil or shallow engineered fill would possibly be the suitable foundation option. The detail design and drawings for each structure facility/structure are being developed and the current report is provided for preliminary purpose, the final founding configurations should be determined in the final detailed design stage.

Concrete slab-on-grade for the floor of the structure may be considered on a properly prepared subgrade on engineered fill. Other possible foundations, typically used in Southern Ontario, are driven piles, bored piles or caisson. The driven piles, especially steel H-pile is not suitable at this site as it may encounter cobbles and/or boulders during advancement of pile and damage the pile. However, based on the comparison of these several foundation types, spread and strip footings on engineered fill may be considered as preferred for low bearing pressure, if not cost prohibitive; and bored piles or caisson could be considered for higher bearing pressure. Below in Table 13 is the comparison of foundation types for Reconstruction of Ayr Patrol Yard development project.

Table 13: Comparison of Alternative Foundation Types

FOUNDATION TYPE/ FEASIBILITY	DESCRIPTION	ADVANTAGE	DISADVANTAGE	RISK/CONSEQUENCES
• Drilled Pier (SLS bearing resistance 250 kPa) • Geotechnically Feasible	• Drilled pier installed by augering soil, installing temporary steel casing and fill the auger hole with concrete to form drilled pier.	• High axial bearing resistance. • Provide uplifting and overturning resistance. • Less excavation compared to shallow spread/strip footings. • Less off-site disposal compared to shallow spread /strip footings. • Augering allows for removing cobbles, if encountered. • Permits installations through cobbles and dense gravel layers, provided proper equipment is selected.	• Temporary steel casing will be required to stabilize the sidewalls of the augered hole. • Dewatering resulting from perched or surface run-off may be required, otherwise bottom to be sealed properly with steel casing/liner. • Difficult to clean the bottom properly prior to concrete pouring. • Inspection of the bottom of drilled pier is costly.	• Risk of necking during pulling the steel casing while pouring concrete may results a potential weak zone in drilled pier.

Table 13: Comparison of Alternative Foundation Types

FOUNDATION TYPE/ FEASIBILITY	DESCRIPTION	ADVANTAGE	DISADVANTAGE	RISK/CONSEQUENCES
• Bored pile /Caisson (SLS bearing resistance 450 kPa) • Geotechnically Feasible	• Cast-in-place bored piles are referred to as Caisson. • Caisson installed by augering soil, installing temporary steel casing and fill the auger hole with concrete to form caisson.	• Possible to obtain higher bearing resistance. • High axial bearing resistance. • Provide uplifting and overturning resistance. • Less excavation compared to shallow spread/strip footings. • Less off-site disposal compared to shallow spread /strip footings. • Augering allows for removing cobbles, if encountered. • Permits installations through cobbles and dense gravel layers, provided proper equipment is selected.	• Temporary steel casing will be required to stabilize the sidewalls of the augered hole. • Dewatering resulting from perched or surface run-off may be required, otherwise bottom to be sealed properly with steel casing/liner. • Difficult to clean the bottom properly prior to concrete pouring. • Inspection of the bottom of caisson is costly. • Caisson resistance cannot be confirmed during construction, although the exposed soil conditions used in design can be verified and confirmed during augering. • Susceptible to corrosion exposed to fluctuations in water level. • Construction procedure may influence the integrity and the performance of the caisson. • Integrity testing may be required for potential necking of concrete.	• Risk of necking during pulling the steel casing while pouring concrete may results a potential weak zone in caisson.

Table 13: Comparison of Alternative Foundation Types

FOUNDATION TYPE/ FEASIBILITY	DESCRIPTION	ADVANTAGE	DISADVANTAGE	RISK/CONSEQUENCES
• Spread/Strip Footings on native subsoil • Geotechnically Feasible	• Support the structure by spreading the total applied load onto the founding subsoil.	• Use only excavator to excavate the soil to footing founding level. • The soil condition at footing founding depth can be confirmed.	• Dewatering may be required. • Shoring will be required to protect side sloughing. • Large footing base may be required to provide a relatively large bearing surface. • Footings will be founded at different elevations/level thereby possibility of exceeding the differential settlement limit.	• Risk of relatively large excavation and shoring, thereby increasing construction cost and time. • Limited geotechnical resistance compared to bored pile or caisson. • Excavation as deep as 4.3 m is required. • Construction performance is weather dependent. • Off-site disposal of excavated fill materials is costly.
• Spread Footing on Engineered Fill • Geotechnically Feasible	• Support the structure by spreading the total load onto the shallow engineered fill thereby transferring to underlying native soil.	• Use excavator to excavate down to native soil. • Footings will be constructed in one level which will potentially control the differential settlement.	• Subgrade needs to be inspected and approved prior to place the engineered fill. • Continuous supervision and testing to be carried out on engineered fill material. • Not suitable for structure with higher geotechnical bearing resistance.	• Large excavation and shoring is required thereby increasing project cost and time. • Excavation as deep as 4.3 m is required. • Construction performance is weather dependent. • Limited geotechnical bearing resistances. • Off-site disposal of excavated fill materials is costly.

16. GEOTECHNICAL REVIEW AND CONSTRUCTION INSPECTION AND TESTING

When final grading plans and site layout are established, the project design drawings must be submitted to Contract Administrator (CA) and geotechnical consultant for geotechnical review for compatibility with site subsurface conditions and the recommendations contained in this report, which may require additional analysis and/or investigation.

Earthworks operations should be carried out with review by geotechnical consultant to approve subgrade preparation, backfill materials, placement and compaction procedures and check the specified degree of compaction is achieved throughout. Prior to placement of engineered fill, the subgrade surface must be examined by geotechnical consultant to verify that the design bearing capacity is available throughout. Compaction should be carried out in accordance with OPSS.PROV 501.

17. CLOSURE

The comments and recommendations provided in this part of the report are based on the information obtained from the boreholes data. Conditions away from and between boreholes may vary, which may require modifications to the recommendations contained in the report.

This report was prepared by Mohammed Zamshad, MEng, P.Eng., Senior Engineer, Geotechnical Services and reviewed by Mr. N. Rahman, P.Eng., Senior Engineer, Geotechnical Services. Robert Ng, MBA, PhD., P.Eng., Project Manager and MTO Designated Principal Contact conducted an independent review of the report.

Yours very truly

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MZ/RN:nk-ap

APPENDIX C

List of Standard Specifications Relevant to Report

LIST OF STANDARD SPECIFICATIONS RELEVANT TO REPORT

DOCUMENT	TITLE
OPSS. PROV 206	Construction Specification for Grading.
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 517	Construction Specification for Dewatering
OPSS.PROV 539	Construction Specification for Temporary Protection System
OPSS.PROV 902	Construction Specification for Excavating and Backfilling - Structures
OPSS.PROV 903	Construction Specification for Deep Foundations
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
OPSD 802.010	Flexible Pipe, Embedment and Backfill, Earth Excavation
OPSD 802.030	Rigid Pipe Bedding, Cover, and Backfill Type 1 or 2 Soil - Earth Excavation
OPSD 802.031	Rigid Pipe Bedding, Cover, and Backfill Type 3 Soil - Earth Excavation
OPSD 3090.101	Foundation Frost Depths for Southern Ontario