THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED RETAINING WALLS AT HIGHWAY 85 AND FREDERICK STREET
HIGHWAY 7- NEW, KITCHENER TO GUELPH
G.W.P. 3005-20-00

GEOCRES NO. 40P8-290

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Report

to

WSP

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TABLE OF CONTENTS

PART 1: FACTUAL INFORMATION

APPENDICES

Appendices A to D include:

- Record of Borehole Sheets
- Laboratory Test Results
- Slope Stability Output
- Drawing titled “Borehole Locations and Soil Strata”

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PART 1: FACTUAL INFORMATION

1.0 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at four (4) proposed standalone retaining walls (i.e. 33X-0497/W0, 33X-0538/W0, 33X0860/W0 and 33X-0861/W0) within the vicinity of the proposed Frederick Street bridge replacement along the existing Kitchener-Guelph Expressway (KWE - Highway 85) corridor in the Regional Municipality of Waterloo, Ontario.

The purpose of the investigations was to explore the subsurface conditions at the proposed retaining wall sites and, based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and written descriptions of the subsurface conditions. Models of the subsurface conditions under the proposed retaining walls were developed from the data obtained in the course of the current and previous investigations.

Thurber was retained by WSP to carry out the site investigation under the Ministry of Transportation Ontario (MTO) Agreement Order Number 3014-E-0013.

Reference has been made to information on subsurface conditions contained in a previous foundation report prepared for this site during the preliminary design phase. The title of the report is:

- Foundation investigation and design report for Northeast Corner Retaining Wall, Frederick Street Underpass, Site No. 33-234, G.W.P. 3110-09-00, City of Kitchener, Ontario, prepared by Peto MacCallum Ltd., PML Ref. 10KF079C, Geocres No. 40P8-199, dated May 31,2012 (Reference 1).

2.0 SITE DESCRIPTION

The site is located in the City of Kitchener, approximately 350 m south of the Kitchener-Waterloo Expressway and Victoria Street interchange, where the Frederick Street crosses over the KWE. There is an underpass structure present at this site which carries Frederick Street over the northbound and southbound lanes (NBL and SBL) and existing ramps (E-S and S-E) of the KWE.

The existing cut slopes to the north and south of the bridge are retained by concrete wingwalls which extend from the ends of the bridge abutments.

The area outside of the KWE corridor is surrounded by industrial and commercial lands and is generally flat.

The designations and approximate locations of the proposed retaining walls are as follows:

Table 3.1 – Retaining Wall Details

Site No.	Location	Approx. Chainage (From)	Approx. Chainage (To)	Approx. Length (m)	Approx. Maximum Exposed Height (m)
33X-0497/W0	South of Frederick Street and east of the KWE	20+900	21+241	341	6.0
33X-0538/W0	North of Frederick Street and east of the KWE	21+276	21+455	179	7.2
33X-0860/W0	North of Frederick Street and west of the KWE	10+202	10+295	93	6.6
33x-0861/W0	South of Frederick Street and west of the KWE	10+322	10+339	17	5.4

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till kames or kame moraines, with outwash sands occupying the intervening hollows.

3.0 SITE INVESTIGATION AND FIELD TESTING

The current site investigation for the proposed walls was carried out between May 6, 2018 and August 19, 2020 at which time a total of fourteen (14) boreholes were advanced at the site. Four boreholes were previously drilled by Peto MacCallum Ltd. between April 8, 2011 and July 20, 2011.

A summary of the borehole locations, designations, borehole termination depths and termination elevations for each retaining wall is provided in Table 3.2. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets. Record of Borehole Sheets for each retaining wall are included in Appendices A to D.

Table 3.2 – Borehole Designations

Site No.	Approx. Chainage (From)	Approx. Chainage (To)	Boreholes	Borehole Termination Depth (m)	Borehole Termination Elevation (m)	Appendix
33X-0497/W0	20+900	21+241	RW01-01 to RW01-07	11.1 to 14.3	313.8 to 305.7	A
33X-0538/W0	21+276	21+455	RW02-02 to RW02-04, RW-1 to RW-4	6.4 to 17.4	316.5 to 301.7	B
33X-0860/W0	10+202	10+295	RW16-01 to RW16-03	11.3 to 12.5	310.0 to 307.4	C
33X-0861/W0	10+322	10+339	BH 20-01	38.3	289.2	D

The boreholes were drilled near the retaining wall alignments, with one borehole at each end and an approximate 50 m spacing in between boreholes with the exception of SW retaining wall (33X-0861/W0), where no borehole was drilled within its footprint.BH 20-01 drilled for the West Abutment of the proposed Frederick St. Bridge was the closest to the north end of this proposed SW retaining wall.

The approximate locations of the boreholes are shown on the drawings included in Appendices A through D.

Prior to commencing the site investigation, utility clearances were obtained for all borehole locations. All of the boreholes were drilled on MTO property and did not require Permission to Enter (PTE) to be obtained.

The boreholes were drilled using a track-mounted drill rig and the boreholes were advanced using hollow stem augers and mud rotary drilling. Samples were obtained at selected depth intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the native soils.

The drilling, sampling and in-situ testing operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling of the investigation are presented on the Record of Borehole sheets in Appendices A to D.

Groundwater conditions in the open boreholes were observed during the drilling operations. One (1) piezometer was installed in borehole RW01-04 and one piezometer was installed in BH 20-01

to permit for longer term monitoring of groundwater levels. The piezometer consisted of a 19 mm diameter PVC pipe with a 3.0 m slotted screen enclosed in filter sand. The locations and completion details of the piezometer is summarized in Table 3.3 along with the borehole completion details. The completion of the boreholes and the standpipe piezometers were carried out in accordance with the requirements of O. Reg. 903 (as amended by O. Reg. 372/07). The boreholes were decommissioned following completion of drilling in accordance with O.Reg. 903 (as amended).

Table 3.3 – Borehole Completion Details

Site No.	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
33X-0497/W0	RW01-01	14.3/311.7	-	Borehole backfilled with grout to 4.3 m, bentonite holeplug to 0.2 m, then asphalt to surface.
	RW01-02	11.1/313.8	-	Borehole backfilled with grout to 3.7 m, bentonite holeplug to 0.1 m, then asphalt to surface.
	RW01-03	14.1/313.7	-	Borehole backfilled with bentonite holeplug to surface.
	RW01-04	14.0/312.8	13.7/313.1	Piezometer with 3.0 m slotted screen installed with sand filter from 14.0 m to 9.7 m, bentonite holeplug from 9.7 m to ground surface.
	RW01-05	14.3/307.1	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-06	14.3/306.2	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW01-07	14.3/305.7	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
33X-0538/W0	RW02-02	13.3/306.2	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-03	15.8/303.6	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW02-04	17.4/301.7	-	Borehole backfilled with bentonite holeplug to 0.6 m, sand to 0.2 m, then asphalt to surface.
33X-860/W0	RW16-01	11.3/310.0	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
	RW16-02	11.3/309.1	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.

Site No.	Borehole	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
	RW16-03	12.5/307.4	-	Borehole backfilled with bentonite holeplug and asphalt patch to surface.
33X-0861/W0	BH20-01	38.3/289.2	19.8/307.7	Piezometer with 3.0 m slotted screen installed with sand filter from 19.8 m to 15.8 m, bentonite holeplug to 13.7 m, and grout from 13.7 m to surface

4.0 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing, where appropriate. The results of this testing program are summarized on the Record of Borehole sheets and figures included in Appendix A through D. The results of the previous investigation completed by Peto MacCallum are included in Appendix B.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the native soil from the retaining walls was collected and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of corrosivity parameters. The results of the analytical testing are summarized in this report and presented in Appendix E.

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendices A to D and depicted on the “Borehole Locations and Soil Strata” drawings for each retaining wall alignments in these appendices. An overall description of the stratigraphy encountered in the current boreholes advanced at each retaining wall site is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

5.1 SE Retaining Wall Site #33X-0497/W0 (Sta. 20+900 to 21+241 - Appendix A)

In general, the soil stratigraphy at this site consisted of surficial topsoil or asphalt overlying a granular fill layer, a layer of native sand, silty clay, and a layer of sandy silt to silty sand.

5.1.1 Topsoil

A layer of topsoil was encountered surficially in two boreholes drilled at this site, RW01-03 and RW01-04. It was generally dark brown in colour. The thickness of the topsoil layer ranged from 0.15 m to 0.2 m. The topsoil thickness may vary between the borehole locations and in other areas of the site.

5.1.2 Asphalt

Asphalt with a thickness of 100 mm was encountered at Boreholes RW01-01, RW01-02 and RW01-05. Asphalt with a thickness of 75 mm was encountered at Boreholes RW01-06 and RW01-07.

5.1.3 Granular Fill

Granular fill was encountered immediately below the asphalt at five boreholes at this site, Boreholes RW01-01, RW01-02 and RW01-05 to RW01-07. Granular fill was encountered immediately below the topsoil at Boreholes RW01-03 and RW01-04.

The granular fill consisted of sand to sand and gravel, generally brown in colour, with trace silt to silty and trace clay. Occasional organics were encountered in the granular fill in Borehole RW01-04. A layer of silt fill was also encountered below the sand fill in Boreholes RW01-02 and RW01-03, with trace to some sand and trace clay to clayey.

The thickness of the granular fill ranged from 0.6 m to 3.0 m, with the lower boundary of this layer encountered at depths of 0.7 m to 3.2 m (Elevation 324.6 to 319.4).

SPT N-values recorded in the granular fill ranged from 4 to 36 blows for 0.3 m penetration, indicating a loose to dense relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 27 percent.

Three samples of the granular fill underwent laboratory gradation analysis, and one sample of the clayey silt fill underwent Atterberg limits testing. These results are summarized on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure A1 of Appendix A. The results of the Atterberg Limits tests are plotted on Figure A5. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	0 to 32
Sand	0 to 46
Silt	22 to 76
Clay	5 to 27

Index Property	
Liquid Limit	20
Plastic Limit	13
Plasticity Index	7

The above results indicate that the clayey silt fill is of low plasticity with a group symbol of CL-ML.

5.1.4 Sand

A native sand layer was encountered below the granular fill in all boreholes at this site, Boreholes RW01-01 to RW01-07. The sand layer was encountered at depths ranging from 0.7 m to 3.2 m (Elevation 324.6 to 319.4).

The sand layer was brown in colour and contained some silt to silty, trace clay and trace gravel.

The thickness of the sand ranged from 0.6 m to 4.0 m, with the lower boundary of the sand layer encountered at depths ranging from 1.3 m to 7.2 m (Elevation 321.2 to 317.7).

SPT N-values recorded in the sand ranged from 5 to 37 blows for 0.3 m penetration, indicating a loose to dense relative density.

Moisture content of samples of the sand generally ranged from 4 percent to 23 percent.

Three samples of the sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples are plotted on Figure A2. The results of this testing are summarized as follows:

Soil Particles	Sand (%)
Gravel	0 to 3
Sand	76 to 81
Silt	16 to 19
Clay	2 to 5

5.1.5 Silty Clay

Silty clay was encountered below the sand layer in all boreholes, RW01-01 to RW01-07, at depths ranging from 1.3 m to 7.2 m (Elevation 321.2 to 317.7).

A 4.0 to 5.4 m thick silty sand to sandy silt layer was encountered within the silty clay in Boreholes RW01-05 and RW01-06.

The silty clay was grey and contained some trace to some sand and trace gravel.

The thickness of the silty clay layer where fully penetrated ranged from 1.3 m to 10.4 m, with the lower boundary of the silty clay encountered at depths ranging 5.6 m to 11.7 m (Elevation 319.3 to 308.3). Boreholes RW01-05 and RW01-06 were terminated in the silty clay layer at a depth of 14.3 m for both boreholes (Elevation 307.1 and 306.2).

SPT N-values recorded in the silty clay ranged from 7 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a firm to hard consistency (typically very stiff to hard).

The natural moisture content of samples of the silty clay ranged from 11 percent to 28 percent.

Six samples of the silty clay underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are plotted on Figure A3 of Appendix A. The results of the Atterberg Limits tests are plotted on Figure A6.

Soil Particles	Silty Clay (%)
Gravel	0 to 2
Sand	1 to 10
Silt	39 to 50
Clay	41 to 59

Index Property	
Liquid Limit	28 to 49
Plastic Limit	13 to 23
Plasticity Index	15 to 27

The above results indicate that the silty clay is of low to intermediate plasticity with a group symbol of CL or CI.

5.1.6 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand was encountered below the silty clay layer in Boreholes RW01-01 to RW01-04 at depths ranging from 5.6 m to 10.0 m (Elevation 319.3 to 316.8), and within the larger silty clay layer in Boreholes RW01-05 and RW01-06, at depths of 6.3 m and 7.2 m (Elevation 315.1 and 313.4), respectively.

Sandy silt to silty sand was also encountered below the silty clay layer in Borehole RW01-07 at a depth of 11.7 m (Elevation 308.3).

The sandy silt to silty sand was grey in colour and contained trace to some clay and trace gravel.

Boreholes RW01-01, to RW01-04 were terminated in the sandy silt to silty sand layer at depths ranging from 11.1 to 14.3 m (Elevation 313.8 to 311.7). Borehole RW01-07 was terminated in the sandy silt to silty sand at a depth of 14.3 m (Elevation 305.7).

The thickness of the sandy silt to silty sand encountered within the silty clay, in Boreholes RW01-05 and RW01-06 where the layer was fully penetrated, was 4.0 to 5.4 m, with the lower boundary of the sandy silt to silty sand encountered at depths from 11.2 to 11.7 m (Elevation 309.7 to 309.4).

SPT N-values recorded in the sandy silt to silty sand ranged from 30 blows for 0.3 m penetration to 100 blows for 0.2 m penetration, indicating a dense to very dense relative density.

Moisture content of samples of the sandy silt to silty sand generally ranged from 10 percent to 22 percent.

Seven samples of the sandy silt to silty sand underwent laboratory gradation analysis, and one sample underwent Atterberg limits testing. The results are summarized on the Record of Borehole sheets included in Appendix A and the grain size distribution curves for these samples

are plotted on Figure A5 of Appendix A. The results of the Atterberg Limits tests are plotted on Figure A7. The results of this testing are summarized as follows:

Soil Particles	Sandy Silt to Silty Sand (%)
Gravel	0
Sand	22 to 72
Silt	26 to 68
Clay	1 to 19

Index Property	
Liquid Limit	17
Plastic Limit	12
Plasticity Index	5

The above results indicate one sample of the silty sand to sandy silt of low plasticity with a group symbol of CL-ML, indicating the possibility of silt or clay lenses within the silty sand to sandy silt.

5.1.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. One standpipe piezometer was installed at this site, in Borehole RW01-04, to monitor water levels after completion of drilling. The water levels measured in the piezometer are summarized in Table 5.1. along with the measurements in the open boreholes upon completion of drilling.

Table 5.1 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW01-01	Sept 24, 2019	2.2	323.8	Open borehole
RW01-02	Sept 24, 2019	3.2	321.7	Open borehole
RW01-03	June 05, 2018	5.0	322.8	Open borehole
RW01-04	June 25, 2018	4.9	321.9	Piezometer
RW01-05	Aug 12, 2019	4.1	317.3	Open borehole

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW01-06	Aug 13, 2019	2.3	318.2	Open borehole
RW01-07	Aug 14, 2019	4.1	315.9	Open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

Upon completion of drilling, Borehole RW01-05 caved-in at 7.9 m, and Borehole RW01-07 caved-in at 8.2 m.

5.2 NE Retaining Wall Site #33X-0538/W0 (Sta. 21+276 to 21+455 – Appendix B)

In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of silty clay, a layer of silt and sand, and a layer of sand. A layer of upper sand was encountered in Boreholes RW-03 and RW-04.

It should be noted that Borehole RW-03 and RW-04 were drilled behind the retaining wall and on the embankment, and not shown within the stratigraphy profiles.

5.2.1 Asphalt

Asphalt with thicknesses ranging from 112 mm to 200 mm was encountered surficially at Boreholes RW02-02 to RW02-04. Asphalt was also encountered surficially at Boreholes RW01 and RW-02.

5.2.2 Granular Fill

Granular fill consisting of sand was encountered immediately below the asphalt at Boreholes RW02-02 to RW02-04, RW01 and RW-02.

The granular fill below the asphalt consisted of sand generally brown in colour with gravel, trace silt to silty and trace clay.

The thickness of the granular fill ranged from 0.5 m to 1.4 m, with the lower boundary of this layer encountered at depths of 0.6 m to 1.4 m (Elevation 318.8 to 318.3).

Additionally, granular fill was encountered surficially in Boreholes RW-03 and RW-04 behind the retaining wall, in a previous investigation by others.

The granular fill in Boreholes RW-03 and RW-04 consisted of silty sand, silt, gravelly sand and contained clayey silt fill layers, generally brown in colour. The thickness of the fill layer was 2.3 m in both boreholes, with the lower boundary encountered at the depth of 2.3 m (Elevation 320.0 and 321.2).

SPT N-values recorded in the granular fill ranged from 3 to 27 blows for 0.3 m penetration, indicating a very loose to compact relative density.

Moisture content of samples of the granular fill generally ranged from 3 percent to 18 percent.

Six samples of the granular fill underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figures RW-GS-1 to RW-GS-4 from previous investigations. The results of this testing are summarized as follows:

Soil Particles	Granular Fill (%)
Gravel	3 to 23
Sand	20 to 68
Silt	11 to 54
Clay	4 to 18

It should be noted that cohesive clayey silt fill layers were observed within the granular fill in Boreholes RW-03 and RW-04.

5.2.3 Upper Sand

An upper native sand layer was encountered below the granular fill layer in Boreholes RW02-02 to RW02-04, at depths ranging from 0.6 m to 0.8 m (Elevation 318.8 to 318.5).

The sand was generally brown in colour, with some silt to silty, trace clay and trace gravel.

The thickness of the upper sand layer in Boreholes RW02-02 to RW02-04 ranged from 3.3 to 4.2 m, with the lower boundary encountered at a depth ranging from 4.1 to 5.0 m (Elevation 315.4 to 314.3).

Additionally, an upper native sand layer was encountered beneath the fill layer in Boreholes RW-03 and RW-04 behind the retaining wall, at the depth of 2.3 m (Elevation 320.0 and 321.2).

The sand was generally brown in colour, with trace to with gravel, trace to some silt and trace clay. The sand encountered in Borehole RW-04 below Elevation 319.7 was gravelly to with gravel.

The thickness of the upper sand layer in Boreholes RW-03 and RW-04 was 2.1 m and 3.6 m, with the lower boundary encountered at the depth of 4.4 m and 5.9 m (Elevation 317.9 and 317.6), respectively.

SPT N-values recorded in the upper sand generally ranged from 9 blows to 34 blows for 0.3 m penetration, indicating a generally compact to dense relative density with local loose layers.

Moisture content of samples of the upper sand generally ranged from 3 percent to 24 percent.

Ten samples of the upper sand underwent laboratory gradation analysis. These results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B1 and Figure RW-GS-6. The results of this testing are summarized as follows:

Soil Particles	Upper Sand (%)
Gravel	0 to 38
Sand	43 to 94
Silt	3 to 31
Clay	0 to 6

It should be noted that soil descriptions in the “Borehole Locations and Soil Strata” drawing in Appendix B do not include information from Boreholes RW-03 and RW-04.

5.2.4 Silty Clay

Silty clay was encountered below the granular fill in Boreholes RW02-02 to 02-04, RW01 and RW-02 at depths ranging from 1.4 m to 5.9 m (Elevation 318.3 to 314.3).

The silty clay was generally brown to grey in colour and contained trace to with sand and trace gravel.

Borehole RW02-04 was terminated within the silty clay layer at a depth of 17.4 m (Elevation 301.7). Boreholes RW01 and RW-02 were both terminated within the silty clay layer at a depth of 9.8 m (Elevation 309.9).

The thickness of the silty clay layer was 3.8 m and 8.7 m in Boreholes RW02-02 and RW02-03, respectively, with the lower boundary of the silty clay encountered at depths of 7.9 and 13.7 m (Elevation 311.6 and 305.8).

Additionally, silty clay was encountered in Boreholes RW-03 and RW-04 below the upper sand layer at depths of 4.4 m and 5.9 m (Elevation 317.9 and 316.5), respectively. The silty clay was generally brown to grey in colour and contained trace sand, trace gravel and occasional cobbles.

Boreholes RW-03 and RW-04 were terminated in the silty clay at depths of 6.4 m and 7.0 m (Elevation 315.9 and 316.5), respectively.

SPT N-values recorded in the silty clay generally ranged from 6 blows for 0.3 m penetration to 70 blows for 0.15 m penetration, indicating a firm to hard consistency.

The natural moisture content of samples of the silty clay ranged from 9 percent to 41 percent.

Nine samples of the silty clay underwent laboratory gradation analysis and seven samples underwent Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix B and the grain size distribution curves for these samples are plotted on Figure B2 and Figure RW-GS-7 of Appendix B. The results of the Atterberg Limits tests are plotted on Figure B5 and Figure RW-PC-2.

Soil Particles	Silty Clay (%)
Gravel	0 to 7
Sand	0 to 37
Silt	30 to 50
Clay	24 to 69

Index Property	
Liquid Limit	35 to 46
Plastic Limit	17 to 23
Plasticity Index	18 to 27

The above results indicate that the silty clay is of low to intermediate plasticity with a group symbol of CL or CI.

5.2.5 Silt and Sand

A silt and sand layer was encountered below the silty clay in RW02-02. The silt and sand was grey in colour and contained trace clay and trace gravel.

Borehole RW02-02 was terminated within the silt and sand layer at a depth of 12.8 m (Elevation 306.8). A DCPT was performed from the base of the sampled borehole and was terminated at 13.3 m depth (Elevation 306.2) upon DCPT refusal.

SPT N-values recorded in the silt and sand ranged from 83 to 98 blows for 0.3 m penetration, indicating a very dense relative density.

Moisture content of samples of the silt and sand generally ranged from 19 percent to 20 percent.

One sample of the silt and sand underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B3 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Silt and Sand (%)
Gravel	0
Sand	43
Silt	56
Clay	1

5.2.6 Lower Sand

A lower sand layer was encountered below the silty clay in RW02-03. The sand was grey in colour and contained trace to some silt and trace clay.

Borehole RW02-03 was terminated within the lower sand layer at the depth of 15.8 m (Elevation 303.6).

SPT N-values recorded in the lower sand ranged from 43 to 75 blows for 0.3 m penetration, indicating a dense to very dense relative density.

Moisture content of samples of the lower sand ranged from 17 percent to 18 percent.

One sample of the sand underwent laboratory gradation analysis. The results are summarized on the Record of Borehole sheets included in Appendix B and the grain size distribution curves for these samples are plotted on Figure B4 of Appendix B. The results of this testing are summarized as follows:

Soil Particles	Lower Sand (%)
Gravel	0
Sand	87
Silt	10
Clay	3

5.2.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed at this site for previous investigations by others, in Boreholes RW01 and RW-03. The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.2.

Table 5.2.– Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW02-02	Aug 22, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 4.6 m.
RW02-03	Sept 24, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 4.6 m
RW02-04	June 05, 2018	1.5	317.6	Open borehole
RW01 (*)	April 8, 2011	2.9	316.8	Piezometer
RW-02 (*)	April 8, 2011	7.3	312.4	Open borehole
RW-03 (*)	July 19, 2011 Sept 23, 2011 Oct 8, 2011	Dry 3.3 3.3	Dry 319.0 319.0	Piezometer

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW-04 (*)	July 20, 2011	N/A	N/A	Water level in open borehole N/A. Cave-in observed at 5 m.

(*) Peto MacCallum Ltd borehole (Reference 1)

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

Upon completion of drilling, Borehole RW02-02 caved-in at 4.6 m, Borehole RW02-03 caved-in at 4.6 m, Borehole RW02-04 caved-in at 8.7 m, Borehole RW-02 caved-in at 8.7 m and Borehole RW-04 caved-in at 5.0 m.

5.3 NW Retaining Wall Site #33X-0860/W0 (Sta. 10+202 to 10+295 – Appendix C)

In general the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand or clayey silt, a layer of silty clay and a lower layer of silty sand to sandy silt..

5.3.1 Asphalt

Asphalt with a thickness of 150 mm was encountered at all boreholes at this site, Boreholes RW16-01, RW16-02 and RW16-03.

5.3.2 Granular Fill

Granular fill consisting of sand and gravel was encountered immediately beneath the asphalt layers for boreholes RW16-02 and RW16-03, and sandy silt fill for Borehole RW16-01.

The granular fill consisted of sand and gravel or sandy silt with gravel and was generally brown in colour.

The thickness of the granular fill ranged from 0.5 m to 0.6 m, with the lower boundary of this layer encountered at depths of 0.7 m to 0.8 m (Elevation 320.5 to 319.3).

Moisture content of samples of the granular fill generally ranged from 1 percent to 3 percent.

5.3.3 Sand

Native sand was encountered immediately beneath the asphalt layer in Boreholes RW16-01 and RW16-02.

The sand was brown in colour and contained some silt to silty, trace to some clay, trace gravel, with occasional cobbles.

The thickness of the sand layer was 1.5 m and 0.7 m, with the lower boundary of the sand encountered at a depth of 2.3 m and 1.4 m, at Boreholes RW16-01 and RW16-02, respectively (Elevation 319.0 and 319.0).

SPT N-values within the sand varied from 8 to 26 blows for 0.3 m penetration, indicating loose to compact relative density.

Measured moisture contents within the sand were 14% to 18%.

The result of grain size distribution analysis carried out on one sample of the native sand is presented on the Record of Borehole Sheets included in Appendix C and on Figure C1 of Appendix C. The result of the grain size distribution analysis is summarized below:

Soil Particle	Sand (%)
Gravel	2
Sand	78
Silt	16
Clay	4

5.3.4 Clayey Silt

A layer of clayey silt was encountered immediately below the granular fill at 0.7 m depth (Elevation 319.3) in Borehole RW16-03.

The clayey silt was grey in colour and contained some sand and gravel.

The thickness of the clayey silt was 0.7 m, with the lower boundary of the layer encountered at a depth of 1.4 m (Elevation 318.5).

The SPT N-value recorded in the clayey silt was 39 blows for 0.3 m penetration, indicating a hard consistency.

The moisture content of the sample of the clayey silt was 21 percent.

5.3.5 Silty Clay

A layer of silty clay was encountered below the upper sand layer in Boreholes RW16-01 and RW16-02, and below the clayey silt in Borehole RW16-03, at 2.3 m, 1.4 m and 1.4 m depth, respectively (Elevation 319.0, 319.0 and 318.5).

The silty clay was brown to grey in colour and contained trace to some sand, trace gravel and trace shale.

Borehole RW16-02 was terminated in the silty clay layer at a depth of 11.3 m (Elevation 309.1).

The thickness of the silty clay was 6.5 m and 7.3 m at Boreholes RW16-01 and RW16-03, respectively, with the lower boundary of the layer encountered at depths of 8.8 m and 8.7 m (Elevation 312.5 and 311.3).

SPT N-values recorded in the silty clay ranged from 15 to 58 blows for 0.3 m penetration, indicating a very stiff to hard consistency.

Moisture content of samples of the silty clay generally ranged from 10 percent to 33 percent.

Four samples of the silty clay underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix C and the grain size distribution curves for these samples are plotted on Figure C2 of Appendix C. The results of the Atterberg Limits tests are plotted on Figure C4.

Soil Particles	Silty Clay (%)
Gravel	0
Sand	1 to 5
Silt	32 to 53
Clay	42 to 67

Index Property	
Liquid Limit	36 to 46
Plastic Limit	18 to 21
Plasticity Index	17 to 26

The above results indicate that the silty clay is of intermediate plasticity with a group symbol of CI.

Audible grinding of the auger during drilling in Borehole RW16-03 was noted between depths of 3.6 m and 9.1 m (Elevation 316.3 and 310.8), indicating the possibility of occasional cobbles within the silty clay layer and in the underlying sandy silty layer.

5.3.6 Silty Sand and Sandy Silt

A silty sand to sandy silt layer was encountered immediately below the silty clay in Boreholes RW16-01 and RW16-03, at depths of 8.8 m and 8.7 m, respectively (Elevation 312.5 and 311.3).

The silty sand to sandy silt was grey in colour and contained trace clay.

Boreholes RW16-01 and RW16-03 were both terminated in the silty sand to sandy silt layer at a depth of 11.3 m (Elevation 310.0 and 308.7).

SPT N-values within the silty sand to sandy silt varied from 18 to 45 blows for 0.3 m penetration, indicating compact to dense relative density.

Measured moisture contents within the silty sand to sandy silt were 12 percent to 20 percent.

The result of grain size distribution analysis carried out on one sample of the silty sand to sandy silt is presented on the Record of Borehole Sheets included in Appendix C and on C3 of Appendix C. The result of the grain size distribution analysis is summarized below:

Soil Particle	Silty Sand to Sandy Silt (%)
Gravel	0
Sand	24
Silt	70
Clay	6

5.3.7 Groundwater Conditions

Water levels were observed in the boreholes during and upon completion of drilling. No standpipe piezometers were installed at this site. The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.3.

Table 5.3 – Water Level Measurements

Borehole	Date	Water Level (m)		Comment
		Depth	Elevation	
RW16-01	Aug 19, 2019	N/A	N/A	Water level in open borehole not available. Cave-in observed at 0.2 m.
RW16-02	Aug 19, 2019	3.7	316.7	Open borehole
RW16-03	Aug 15, 2019	8.8	311.1	Open borehole

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

Upon completion of drilling, Boreholes RW16-01 caved-in at 0.2 m, RW16-02 caved-in at 10.4 m and RW16-03 caved-in at 9.1 m.

5.4 SW Retaining Wall Site #33X-0861/W0 (Sta. 10+322 to 10+339 – Appendix D)

No borehole was drilled within the footprint of this retaining wall. The subsurface conditions are interpreted based on an adjacent borehole (BH20-01) advanced behind the proposed west abutment of Frederick St Underpass and it is only for preliminary design purposes. Additional boreholes need to be completed at each end of the retaining wall by the Design-Build Contractor to confirm subsurface conditions and detail design assumptions. In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand over silty clay/ clayey silt layer. The cohesive layer is in turn overlying a lower silty sand to sandy silt layer over a lower silty clay deposit underlain by silty clay till

5.4.1 Asphalt

Asphalt with a thickness of 200 mm was encountered at this site in BH20-01.

5.4.2 Granular Fill

Granular fill consisting of sand and gravel to sand was encountered immediately beneath the asphalt layer in BH20-01. The granular fill was generally brown in colour.

The thickness of the granular fill was 3.9, with the lower boundary of this layer encountered at Elevation 323.4 m.

Moisture content of samples of the granular fill generally ranged from 3% to 5%.

SPT N-values within the granular fill varied from 3 to 28 blows for 0.3 m penetration, indicating a compact to very loose relative density.

The result of grain size distribution analysis carried out on one sample of the granular fill is presented on the Record of Borehole Sheets included in Appendix D and on Figure D1 of Appendix D. The result of the grain size distribution analysis is summarized below:

Soil Particle	Granular Fill (%)
Gravel	0
Sand	89
Silt	11
Clay	

5.4.3 Sand

Native sand was encountered immediately beneath the granular fill in BH20-01.The sand was brown in colour and contained a trace of silt.

The thickness of the sand layer was 3.1 m, with the lower boundary of the layer encountered at a depth of 7.2 m (Elevation 320.3).

SPT N-values within the sand varied from 17 to 27 blows for 0.3 m penetration, indicating a compact relative density.

Measured moisture contents within the sand ranged from 14% to 20%.

5.4.4 Upper Clayey Silt/ Silty Clay

A layer of clayey silt/ silty clay was encountered immediately below the sand layer at 7.2 m depth (Elevation 320.3) in BH 20-01.

The clayey silt/ silty clay layer was brown to grey in colour and contained traces of sand and gravel.

The thickness of the clayey silt and silty clay layers were 1.5 m and 4.6 m respectively, with the lower boundary of the silty clay layer encountered at a depth of 13.3 m (Elevation 314.2 m).

The SPT N-value recorded in the clayey silt/ silty clay layer varied between 9 and 31 blows for 0.3 m penetration, indicating a stiff to hard consistency.

The moisture contents of the samples of the clayey silt/ silty clay layer were 18% to 40%.

Three samples of the silty clay/ clayey silt underwent laboratory gradation analysis and Atterberg Limits testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets in Appendix D and the grain size distribution curves for these samples are plotted on Figure D2 of Appendix D. The results of the Atterberg Limits tests are plotted on Figure D6.

Soil Particles	Clayey Silt/ Silty Clay (%)
Gravel	0 to 1
Sand	0 to 7
Silt	30 to 78
Clay	14 to 70

Index Property	
Liquid Limit	49
Plastic Limit	20
Plasticity Index	29

The above results indicate that the silty clay is of intermediate plasticity with a group symbol of CI.

5.4.5 Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand containing trace clay was encountered underlying the upper clayey silt / silty clay deposit in BH 20-01. The thickness of the sandy silt to silty sand deposit was 6.1 m and the base of the deposit was encountered at depth of 19.4 m below ground surface (Elevation 308.1).

SPT ‘N’ values measured in the sandy silt to silty sand ranged from 45 to 88 blows per 0.3 m of penetration, indicating a dense to very dense relative density (typically very dense). The natural moisture contents measured on samples of the sandy silt to silty sand ranged from 12% to 31 %.

The result of a grain size analysis testing conducted on one sample of the sandy silt to silty sand is provided on the Record of Borehole Sheets in Appendix D and shown on Figure D3 in Appendix D. A summary of the test result is provided below:

Soil Particles	(%)
Gravel	0
Sand	28
Silt	66
Clay	6

5.4.6 Lower Silty Clay

A relatively thick deposit of grey silty clay containing a trace of sand was encountered underlying the sandy silt to silty sandy deposit in BH 20-01. This lower silty clay deposit was 14.4 m thick and the base of the layer was located at a depth of 33.8 m (Elevation of 293.7 m).

SPT ‘N’ values measured within the lower silty clay ranged from 23 to 39 blows per 0.3 m of penetration, indicating a very stiff to hard consistency. The natural moisture contents measured on samples of the lower silty clay ranged from 16 % to 25 %.

Grain size analysis was carried out on one sample of the lower silty clay as part of the current investigation. The result of grain size analysis is provided on the Record of Borehole Sheets in Appendix D and illustrated in Figure D4 in Appendix D. The results are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	4
Silt	36
Clay	60

The results of an Atterberg Limits test conducted on a sample of the lower silty clay are shown in Figure D7 in Appendix D and summarized below.

Liquid Limit	42
Plastic Limit	18
Plasticity Index	24

The results indicate that the silty clay is of intermediate plasticity with a group symbol of CI.

5.4.7 Silty Clay Till

Silty clay till, sandy with trace gravel, was encountered underlying the lower silty clay layer in BH20-01. The surface of the till was encountered at a depth of 33.8 m (Elevation 293.7 m). BH20-01 was terminated in this till deposit at a depth of 38.3 m (Elevation 289.2 m).

SPT 'N' values measured within the till ranged from 76 blows per 0.250 m of penetration to 105 blows per 0.175 m of penetration, indicating a hard consistency. The natural moisture contents measured on samples of the till ranged from 9 % to 10 %.

The result of a grain size analysis conducted on a sample of the till is provided on the Record of Borehole Sheets in Appendix D and illustrated in Figure D5 in Appendix D. The results are summarized as follows:

Soil Particles	(%)
Gravel	3
Sand	31
Silt	51
Clay	15

5.4.8 Groundwater Conditions

A monitoring well was installed in BH20-01 to permit monitoring of the water level. Water level measured in the piezometer on August 24, 2020 was at a depth of 5.5 m (Elevation 322.0 m).

In general, the groundwater level is expected to be located slightly below the adjacent highway grade (i.e. at or below Elev. 320 m).

The above value is a short-term reading, and seasonal fluctuation of the groundwater level is to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6.0 CORROSIVITY AND SULPHATE TEST RESULTS

Samples of the sand from Boreholes RW01-02, SS4 (depth of 2.3 m) and RW16-01, SS2 (depth of 0.8 m), and the sand fill from Boreholes RW02-04, SS3 (depth of 1.5 m) and BH20-01, SS4 (depth of 3.4m) were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are shown in Table 6.1. The laboratory certificates of analysis are presented in Appendix E.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Test Results			
		RW01-02 SS4 2.3 m	RW02-04 SS3 1.5 m	RW16-01 SS2 0.8 m	BH20-01 SS 4 3.4 m
		(Soil Sample)			
Corrosivity Index	none	9	5	4	8
Soil Redox Potential	mV	309	218	309	287
Sulphide	%	< 0.02	< 0.02	< 0.02	<0.04
Moisture Content	%	17.2	17.5	13.8	5.0
pH	pH Units	8.79	8.97	8.95	9.66
Chloride	µg/g	190	100	140	210
Sulphate	µg/g	13	5.8	12	8.3
Conductivity	uS/cm	543	356	117	547
Resistivity (calculated)	ohms.cm	1840	2810	8550	1830

7.0 MISCELLANEOUS

Landshark Drilling of Brantford, Ontario supplied a rubber track mounted B-57 drill rig and conducted the drilling, sampling and in-situ testing operations for the investigation.

The coordinates for the boreholes were obtained with GPS equipment by Thurber, and the elevations were provided by WSP.

The drilling and sampling operations in the field, were supervised on a full-time basis by Thurber field technicians.

Geotechnical laboratory testing was carried out at Thurber's geotechnical laboratory in Oakville. Analytical laboratory testing was carried out by SGS Canada Inc.

Overall supervision of the field program for the investigation was conducted by Dr. Nancy Berg, P.Eng. and Mr. Geoff Lay, P.Eng. Interpretation of the data and preparation of the report was carried out by Mr. Hooman Robin Motamedi, P.Eng., and Mr. Geoff Lay, P.Eng.

Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

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THURBER

FOUNDATION INVESTIGATION AND DESIGN REPORT
PROPOSED RETAINING WALLS AT HIGHWAY 85 AND FREDERICK STREET
HIGHWAY 7- NEW, KITCHENER TO GUELPH
G.W.P.3005-20-00

GEOCRES NO. 40P8-290

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

8.0 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team in selecting and designing suitable foundation systems for four (4) proposed retaining walls (i.e. 33X-0497/W0, 33X-0538/W0, 33X-0860/W0 and 33X-0861/W0) within the vicinity of the proposed Frederick Street bridge replacement along KWE in the Regional Municipality of Waterloo, Ontario.

- Retaining Wall Site #33X-0497/W0 located south of Frederick Street and east of the KWE to support the construction of the proposed S-Bruce Street ramp
- Retaining Wall Site #33X-0538/W0 located north of Frederick Street and east of the KWE to support the construction of the proposed S-Bruce Street ramp
- Retaining Wall Site #33X-0860/W0 located north of Frederick Street and west of the KWE to support the widening of the E-S ramp
- Retaining Wall Site #33X-0861/W0 located south of Frederick Street and west of the KWE to support the widening of the E-S ramp

Based on GA drawings provided by WSP, it is understood that the retaining walls will consist of secant pile walls. It is also understood that the Design-Build Contract (1st contract) will consist of constructing a 17 m long retaining wall adjacent to the proposed Frederick Street Underpass Structure at each of its corners. Further details regarding the walls are provided in the table below.

Table 8.1 – Summary of Proposed Retaining Walls

Site No.	Location	Wall Type	Approx. Chainage (From)	Approx. Chainage (To)	Approx. Length (m)	Approx. Maximum Exposed Height (m)
33X-0497/W0	South of Frederick Street and east of the KWE	Secant Pile Wall	20+900	21+241	341	6.0
33X-0538/W0	North of Frederick Street and east of the KWE	Secant Pile Wall	21+276	21+455	179	7.2
33X-0860/W0	North of Frederick Street and west of the KWE	Secant Pile Wall	10+202	10+295	93	6.6
33x-0861/W0	South of Frederick Street and west of the KWE	Secant Pile Wall	10+322	10+339	17	5.4

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects, which could affect the design of the project. Contractors must make their own interpretation of the information provided as it may affect equipment selection, proposed construction methods and scheduling.

The discussion and recommendations presented in this report are based on the information provided by WSP and on the factual data obtained in the course of the previous and the present investigations.

9.0 FOUNDATION DESIGN

9.1 Summary of Subsurface Stratigraphy

A general description of the subsurface stratigraphy and groundwater condition for each retaining wall is presented below.

<u>SE Retaining Wall Site #33X-0497/W0 (Boreholes RW01-01 to RW01-07)</u>

In general, the soil stratigraphy at this site consisted of surficial topsoil or asphalt overlying a granular fill layer, a layer of native sand, silty clay, and a layer of sandy silt to silty sand. The groundwater level measured in piezometer RW01-04 was at a depth of 4.9 m below the ground surface (Elevation 321.9).

NE Retaining Wall Site #33X-0538/W0 (Boreholes RW02-02 to RW02-04 and RW-1 to RW-4)

In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of silty clay, a layer of silt and sand, and a layer of sand. Behind the existing NE Corner Retaining Wall of Frederick Street Underpass, the backfill materials consisted of heterogeneous fills such as silts, silty sands and clayey silts (Reference 1). The groundwater level measured in the open boreholes upon completion was at a depth of 1.5 m to 3.3 m below the ground surface (Elevation 319.0 to 317.6).

NW Retaining Wall Site #33X-0860/W0 (Boreholes RW16-01 to RW16-03)

In general, the soil stratigraphy at this site consisted of asphalt and granular fill overlying a layer of native sand or clayey silt, a layer of silty clay, and a lower layer of silty sand to sandy silt. The groundwater level measured in the open boreholes upon completion ranged from 3.7 m to 8.8 m below the ground surface (Elevation 316.7 to 311.1).

SW Retaining Wall Site #33X-0861/W0 (Borehole 20-01)

In general, the subsurface conditions at the site consist of a pavement structure and layers of sand fill and sand overlying clayey silt and silty clay above a deposit of sandy silt to silty sand. The sandy silt to silty sand is underlain by a lower silty clay layer which is in turn underlain by a deposit of silty clay till. The groundwater level measured in the piezometer was 5.5 m below the ground surface (Elev. 322.0).

9.2 Retaining Wall and Foundation Alternatives

Selection of the type of wall should take into consideration the height and configuration of the retained soil, the subsurface conditions along the wall alignment, and construction constraints. Consideration has been given to the following retaining wall types:

- Cast in Place Concrete Cantilever Wall on Spread Footings
- Retained Soil System (RSS) Wall
- Secant Pile Wall

- Concrete Toe Wall

Cast in Place Concrete Cantilever Wall on Spread Footings

Cast in Place (CIP) concrete cantilever wall on spread footings are considered feasible at the site where space is available to accommodate construction within the right-of-way. This option will require excavation upslope for backfill placement and drainage installation. Temporary shoring may be required to facilitate construction of this wall type.

Retained Soil System (RSS) Wall

RSS walls may be used to support the widening as an alternative to CIP concrete walls. This option will require significant excavation upslope for reinforcing strip installation (up to the order of 0.7 to 1.0 times the wall height) and backfill placement. Temporary shoring may be required to facilitate construction of this wall type.

The RSS wall design, internal stability and construction are usually carried out by proprietary suppliers.

Secant Pile Wall

Secant pile wall are considered feasible to support the widening and may be used where the property line is very close to the proposed retaining walls. This type of wall does not require excavation behind the wall and also serves the dual purpose of temporary shoring and a permanent wall.

Concrete toe wall

It is understood that concrete toe wall is being considered for locations where the wall height is less than 1.8m.

Table 9.1 – Retaining Wall Feasibility

Site No.	Boreholes	Ground Elevation	Elevation of Native Soils	CIP Concrete Cantilever Wall on Spread Footings	RSS Wall	Secant Wall
33X-0497/W0	RW01-01 RW01-02 RW01-03 RW01-04 RW01-05 RW01-06	326.0 324.9 327.8 326.8 321.4 320.5	324.1 322.7 324.6 324.5 320.7 319.9	Feasible if required space is available	Feasible if required space is available	Feasible

	RW01-07	320.0	319.4			
33X-0538/W0	RW01 RW-02 RW-03 RW-04 RW02-02 RW02-03 RW02-04	319.7 319.7 322.3 323.5 319.6 319.5 319.1	318.3 318.3 320.0 321.2 318.8 318.7 318.5	Feasible if required space is available	Feasible if required space is available	Feasible
33X-0860/W0	RW16-01 RW16-02 RW16-03	321.3 320.4 319.9	320.5 319.7 319.3	Feasible if required space is available	Feasible if required space is available	Feasible
33X-0861/W0	BH20-01	327.5	323.4	Feasible if required space is available	Feasible if required space is available	Feasible

9.3 CIP Concrete Cantilever Wall on Spread Footings

It is recommended that concrete cantilever wall footings be founded on the native undisturbed soil shown in Table 9.2. The highest permitted founding elevations for spread footings below frost depth are given in Table 9.2.

Table 9.2 – Geotechnical Resistances and Highest Permitted Founding Elevations

Site No.	Borehole	Appr. Chainage	Estimated Subexcavation Depth (m)	Highest Founding Elevation (Soil Condition) (m)	Factored ULS (kPa)	Factored SLS (kPa)
33X-0497/W0	RW01-01 RW01-02 RW01-03 RW01-04 RW01-05 RW01-06 RW01-07	20+920 20+980 21+030 21+080 21+130 21+180 21+230	3.0 to 5.5	323.5 (Dense Sand) 322.5 (Compact Sand) 324.0 (Compact Sand) 324.0 (Compact Sand) 320.5 (Compact Silty Sand) 319.5 (Compact Sand) 319.0 (Dense Silty Sand)	300	200
33X-0538/W0	RW-1 RW-2 RW02-02 RW02-03 RW02-04	21+260 21+270 21+320 21+370 21+420	5.0 to 8.0	318.0 (V.Stiff Silty Clay 317.5 (Hard Silty Clay) 318.5 (Compact Silty Sand) 318.5 (Compact Sand) 318.0 (Compact Sand)	300	200
33X-0860/W0	RW16-01 RW16-02 RW16-03	18+800 18+840 18+880	3.0 to 6.0	320.5 (Compact Sand) 319.0 (V. Stiff Silty Clay) 319.0 (V. Stiff Silty Clay)	350	225
33X-0861/W0	BH 20-01	21+250	5.5 to 7.5	323.0 (Compact Sand)	300	200

The values of the Factored Geotechnical Resistance at ULS were assessed assuming a Consequence Factor equal to 1 (Typical), and a Resistance Factor equal to 0.5 (Typical degree

of understanding of the subsurface conditions), as per CHBDC 2019. The Factored Geotechnical Resistance at SLS was assessed assuming a factor of 0.8 for typical degree of understanding of the subsurface conditions.

The resistance values assume a minimum 2 m wide footing subjected to vertical concentric loading. Where eccentric or inclined loads are applied, the resistance values used in design must be reduced in accordance with the CHBDC (2019) Clause 6.10.2 to Clause 6.10.5. If the footing width is different than 2 m, the above resistance values should be reassessed.

The sliding resistance of mass concrete poured on the native very stiff to hard silty clay/silty clay till and the compact to dense sand and silty sand may be computed on the basis of an ultimate coefficient of friction of 0.45 and 0.4 respectively. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

9.4 Retained Soil System (RSS Wall)

If chosen, RSS walls used for this project must be specified to be “High Performance” and “High Appearance”. Therefore, it is important that the RSS walls be founded on soils capable of supporting the imposed loading and limiting settlements to within acceptable magnitudes. Reference should be made to CHBDC (2019) Clause 6.19 for design of the RSS walls.

Provided the RSS design takes into account the subsurface conditions at this site and proper foundation preparation is carried out prior to construction of the walls, RSS systems are expected to meet the aesthetic and structural requirements.

Provided a minimum strip length of 70% of the RSS wall height is maintained, the design of RSS wall bearing on native undisturbed soil at or below elevations indicated in Table 9.2 should be designed using a factored geotechnical resistance shown in Table 9.2.

If required, the RSS may be founded on engineered fill founded on the native, compact to dense sand and silt or stiff to hard silty clay/silty clay till. Engineered fill placed under the RSS mass to achieve the design founding level must consist of OPSS Granular “A” compacted to 100% of its SPMDD at a moisture content within 2% of optimum.

The geotechnical resistances provided above are for concentric, vertical loading. The effects of load inclination and eccentricity need to be taken into account according to the CHBDC (2019) Clauses 6.10.2 to 6.10.5.

As per MTO RSS Design Guidelines, the minimum soil cover to the underside of the levelling pad shall be at least 800mm, or 40% of the actual frost depth for the area, whichever is greater.

The entire block of reinforced earth must be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall or engineered granular fill in contact with the sand and silt and silty clay/silty clay till may be estimated using an ultimate friction coefficient of 0.4 and 0.45 respectively. As per Table 6.2 in CHBDC 2019, a resistance factor of 0.6 for cohesive soils and 0.8 for cohesionless soils should be applied to the above value.

Topsoil, organics, fill, and any soft/wet material must be stripped from the footprint of the RSS. The subgrade under the RSS foundation should be inspected and any soft spots sub-excavated and replaced with compacted granular materials prior to placing fill. The subgrade preparation for the RSS wall and placement and compaction of the granular fill must be carried out in the dry.

The proprietary RSS system must meet MTO's specifications for performance and appearance. The RSS supplier/designer may specify more stringent criteria or other requirements related to the particular design. The internal stability of the RSS wall must be analyzed by the supplier/designer of the proprietary product selected for this site.

Lateral earth pressures acting on the walls should be computed as described in Section 9. If the wall is retaining sloping backfill, appropriate earth pressure parameters for sloping backfill should be used.

Reference should be made to MTO RSS Design Guideline (2008) and, the TAC Design, Construction, Maintenance and Inspection Guide for MSE Walls (2017) for design and construction of retaining wall structures.

RSS walls must be constructed in accordance with MTO RSS SP 599S22 and SP 599S23.

9.4.1 Global Stability of the Retained Soil System

Global stability of the RSS walls was conducted at each retaining wall locations utilizing the commercially available slope stability analysis program Slope/W (Version 2019) of the GeoStudio software package developed by Geo-Slope International with the option for Morgenstern-Price method of slices for the limit equilibrium analyses. Analyses were completed for both static and seismic loading conditions.

The soil parameters used in the analyses were estimated from empirical correlations using the results of the in situ Standard Penetration Tests (SPTs) and geotechnical laboratory testing. The groundwater level in our analysis was based on readings obtained from standpipe piezometers.

The stability of the RSS wall was also checked under seismic loading assuming an acceleration of 0.097 g.

Results of the stability analyses are presented in Appendix A to Appendix D. The results are also summarized in Table 9.3 below.

Table 9.3 – Computed Factors of Safety

Site No.	Condition	Factor of Safety	Figure (Appendix A to D)
33X-0497/W0	Static Undrained	1.7	A8
	Static Drained	1.7	A9
	Seismic = 0.097 g	1.6	A10
33X-0538/W0	Static Undrained	2.0	B6
	Static Drained	2.0	B7
	Seismic = 0.097 g	1.8	B8
33X-0860/W0	Static Undrained	1.7	C5
	Static Drained	1.7	C6
	Seismic = 0.097 g	1.6	C7
33X-0861/W0	Static Undrained	1.7	D8
	Static Drained	1.7	D9
	Seismic = 0.097 g	1.5	D10

As per typical MTO requirements, a Factor of Safety (F.S.) of 1.3 is acceptable for short term conditions and for total stress (undrained) conditions. A F.S. of 1.5 is acceptable for long term (drained) conditions. Under the assumed seismic loading, the minimum acceptable factor of safety is 1.1. Accordingly, the computed factors of safety are considered to be acceptable for the proposed RSS wall configuration.

9.4.2 Settlement of the Retained Soil System

The new fill placed at this site will induce settlement in the general vicinity of the retaining walls. It is estimated that immediate settlement of the retaining walls will occur as the wall is constructed. It is expected that most of the settlement will occur shortly after the completion of embankment/RSS wall construction. Total settlement is expected to range from 20 mm to 25 mm as shown in Table 9.4. The RSS wall supplier must be consulted if the proprietary can accommodate the settlement.

Table 9.4 – Estimated Settlement of RSS

Site No.	Maximum Embankment Height from G.S (m)	Estimated Settlement (mm)
33X-0497/W0	6.0	20 to 25
33X-0538/W0	7.2	20 to 25
33X-0860/W0	6.6	20 to 25
33X-0861/W0	5.4	20 to 25

In general, inspection of the RSS walls and placing of additional granular material to re-establish grades should be implemented, as necessary, during and after construction.

9.5 Secant Pile Wall

Geotechnical parameters are provided below for lateral pile design of the secant pile walls. The actual pressure distribution acting on the secant pile wall is a function of the construction sequence, and the relative flexibility of the wall and these factors must be considered when designing the secant pile wall system. The structural designer must check whether the depth of caisson is sufficient to provide base fixity.

Table 9.5 – Geotechnical Design Parameters for Lateral Pile Resistance

Soil Unit	Elevation (m)		γ′ (kN/m3)	nh (kN/m3)	Kp	KA	Ko	Su (kPa)
	Top	Bottom						
Site # 33X-0497/W0								
Compact Sand and Gravel Fill	Top of Secant Pile	324.6 to 319.4	21.0	1,900	3.0	0.33	0.50	-
Compact Sand/Silty Sand	324.6 to 319.4	321.2 to 317.7	10.0 (*)	3,000	3.2	0.31	0.48	-
Very Stiff to Hard Silty Clay/Silty Clay	321.2 to 317.7	319.3 to 308.3	10.0 (*)	-	3.3	0.30	0.46	175
Compact to Very Dense Silty Sand/Sandy Silt	319.3 to 308.3	309.7 to 309.4	11.0 (*)	4,500	3.4	0.29	0.46	-

Soil Unit	Elevation (m)		γ′ (kN/m3)	nh (kN/m3)	Kp	KA	Ko	Su (kPa)
	Top	Bottom						
Site # 33X-0538/W0								
Existing Slope Materials	Top of Secant Pile	318.8 to 318.5	20.0	1,000	2.8	0.36	0.53	-
Compact to Dense Sand Fill	318.8 to 318.5	315.4 to 314.3	10.0 (*)	1,900	3.0	0.33	0.50	-
Firm to Hard Silty Clay/Silty Clay	318.3 to 314.3	311.6 to 301.7	9.5 (*)	-	3.0	0.33	0.50	150
Dense to Very Dense Silt and Sand	311.6 to 305.8	306.8 to 303.6	10.0 (*)	8,000	3.9	0.26	0.41	-
Site # 33X-0860/W0								
Existing Slope Materials	Top of Secant Pile	321.3 to 319.9	20.0	1,000	2.8	0.36	0.53	-
Loose to Compact Sand	321.3 to 319.9	319.0	20.0	3,000	3.0	0.33	0.50	
Very Stiff to Hard Silty Clay	319.0	312.5 to 309.1	9.5 (*)	-	3.3	0.30	0.47	150
Compact to Dense Sandy Silt	312.5 to 311.3	310.0 to 308.7	10.0 (*)	5,500	3.5	0.29	0.44	
Site # 33X-0861/W0								
Existing Slope Materials	Top of Secant Pile	323.4	21.0	1,000	2.8	0.36	0.53	-
Compact Sand – Above Ground Water	323.4	322.0	20.0	4,000	3.1	0.32	0.48	-
Compact Sand – Below Ground Water	322.0	320.3	10.0 (*)	2,500	3.0	0.33	0.50	-
Stiff to Hard Clayey Silt / Silty Clay	320.3	314.2	10.0 (*)	-	3.0	0.33	0.5	120
Very Dense to Dense Silty Sand	314.2	308.1	12.0 (*)	10,900	4.2	0.24	0.38	-
Lower Silty Clay - V. Stiff to Hard	308.1	293.5	11.0 (*)	-	3.0	0.33	0.5	175

Note: (*) Submerged Unit Weight

The lateral resistance in the cohesionless soils may be calculated using coefficient of horizontal subgrade reaction (ks) and ultimate lateral resistance (pult) as follows:

ks	=	nh z / D	(kN/m3)
pult	=	3 γ' z Kp	(kPa)

Where:

z	=	depth of embedment of caisson (m)	
D	=	caisson diameter (m)	
nh	=	coefficient related to soil relative density (kN/m3)	
γ'	=	effective unit weight (kN/m3)	
Kp	=	passive earth pressure coefficient	

The lateral resistance in the cohesive soils may be calculated using coefficient of horizontal subgrade reaction (ks) and ultimate lateral resistance (pult) as follows:

ks	=	67 su / D	(kN/m3)
pult	=	9 su	(kPa)

Where:

su	=	undrained shear strength (kPa)
D	=	caisson diameter (m)

The above equations and parameters provided in Table 9.5 below may be used to analyze the interaction between a caisson and the surrounding soil. Lateral pressures obtained from analysis must not exceed the ultimate lateral resistance.

The lateral earth pressure coefficient selected for lateral design should be based on the magnitude of wall movement. See Figure C6.27 of CHBDC (2019) Commentary for selection of appropriate coefficient of lateral earth pressure based on the wall movement.

The spring constant, Ks, for analysis may be obtained by the expression, Ks = ks L D (kN/m), where ks is the coefficient of horizontal subgrade reaction (kN/m3), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, Pult, can be obtained from the expression, Pult = pult L D. This represents the ultimate load at which the soil fails and will not support any additional load at greater pile displacement.

The group efficiency factors can be calculated based on side-by-side and line-by-line factors shown in Figures C6.22, C6.23 and C6.24 of the CHBDC (2019), S6:19 (Commentary).

Depending on the height and size of secant pile wall, tie back soil anchors may be considered to provide additional lateral resistance to earth pressures or lateral fixity to secant pile wall. Geotechnical parameters (i.e. soil anchor bond strength) can be provided if soil anchors are required.

Secant pile walls will be subjected to freezing ambient temperatures at the wall face during winter. The walls will also be in direct contact with the ground behind the wall. The design and construction of such walls will require that consideration be given to providing sufficient thickness of insulation to protect the soils behind the secant pile walls from frost action and development of frost jacking loads on the wall.

It is also recommended that 150 mm diameter perforated vertical drains with clear stone backfill be installed in 300 mm diameter augered holes behind the walls with a spacing of about 1.5 m to 2.0 m to provide sufficient drainage behind the wall.

9.5.1 Caisson Installation

Caissons should be installed in accordance with OPSS.PROV 903 and SP 109F57 as applicable.

The caissons will likely extend through cohesionless soils below the groundwater table. Therefore, construction of caissons will require the use of temporary steel liners to support the caisson sidewalls and to provide seepage cut-off where required. Synthetic slurry should be used to balance hydrostatic head and to prevent basal heave. The contractor is responsible for constructing the caisson foundations without disturbing the materials at the sides or bases of the foundations. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it prove to be impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.

Caisson installation may encounter cobbles, boulders and/or large rock fragments in the soils. The installation methods and equipment must be capable of dislodging, removing or otherwise penetrating such obstructions.

Suggested wording for an NSSP addressing caisson construction is provided in Appendix F.

9.5.2 Temporary Access Road for Secant Wall Construction

A temporary access road will be required to permit caisson construction where access and/or permission issues preclude installation of caissons from top of slope. The temporary access road will need to support the caisson rig used by the contractor to construct the secant pile walls.

Consideration may be given to constructing the temporary access road using a sloped embankment constructed to a 2H:1V side slope inclination. Due to the proximity of the retaining walls to the KWE, this option would likely require temporary closure of one lane of the KWE.

Alternatively, consideration could be given to building a temporary wall to support the access road. The temporary wall would need to be designed to withstand the loads applied by the caisson installation rig and checked for the various modes of failure including sliding and overturning.

It is recommended that the access road be constructed using granular material consisting of OPSS.PROV Granular A or Granular B Type II or Granular B Type I. The granular material should be compacted to 98% of its standard proctor maximum dry density (SPMDD) at a moisture content within 2% of its optimum in maximum 300 mm thick lifts. Excess soils excavated from Retaining Wall Site # 33X-0860/W0 may be considered for platform construction however there is currently no information on the soils at that site and therefore the Contractor would need to do sufficient testing and investigation on any excess soil to confirm its suitability for reuse.

Fill placement for the temporary access road may cause settlement of existing buried infrastructure and utilities. The location, size and depth of any buried utilities should be verified and an assessment of the impact of fill placement on the buried utilities should be carried out prior to wall construction.

A preliminary stability assessment of the access road/wall was conducted for planning purposes. The results are provided in Appendix G. Based on the analysis, a sloped embankment constructed to a 2H:1V side slope inclination should be stable with a computed Factor of Safety (FOS) of 1.5 (Figure G1). The analysis also indicates that a minimum reinforcing strip length of 0.7 times the wall height would be needed behind a temporary wall in order to achieve a FOS of 1.5 (Figure G2). The design, construction and performance of the temporary access road are ultimately the responsibilities of the Contractor. The Contractor's Engineer should carry out a stability analysis to confirm that the proposed solution satisfies the minimum FOS.

The proprietary product should be an approved product in the MTO DSM list. If a temporary wall is used, a stability and settlement analysis should be carried out by the Contractor's Engineer to confirm that the access road/wall satisfy the minimum factors of safety against instability and that settlements are within tolerable limits.

It is recommended that the temporary wall be designed for Performance Level 2 as per Clause 539.04.01.01 of OPSS.PROV 539.

The access road should be removed following completion of construction.

9.6 Concrete Toe Wall

In low fill/cut situations where the retaining wall height is less than 1.8 m a toe wall may be appropriate. The toe wall design should be in accordance with OPSD 3120.100.

The highest permitted founding elevations for toe walls founded on compact to dense native soils to achieve a factored geotechnical resistance of 300 kPa at ULS and 200 kPa at SLS are as presented for spread footings in Table 9.2. The toe walls cannot be founded on the existing fill onsite and are not suitable to retain sloping fill.

If the toe wall is required to be founded at higher elevations, it may be placed on an engineered fill pad founded at the elevations given in Table 9.2. The engineered fill must consist of OPSS Granular “A” compacted to 100% of the SPMDD at within 2% of the optimum moisture content.

The sliding resistance of mass concrete poured on the native very stiff to hard silty clay/silty clay till and the compact to dense silty sand may be computed on the basis of an ultimate coefficient of friction of 0.45 and 0.4 respectively. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance.

9.7 Frost Cover

The design depth of frost penetration at these retaining wall sites is 1.4 m. The base of footings must be provided with a minimum of 1.4 m of earth cover, or its thermal insulation equivalent, as protection against frost action. In addition, the soils behind the retaining walls must be protected from frost action by incorporating sufficient thickness of insulation in the design.

10.0 BACKFILL TO RETAINING WALLS AND DRAINAGE REQUIREMENTS

10.1 CIP Concrete Walls

Backfill to the CIP concrete retaining walls should consist of Granular A or Granular B Type II material meeting the requirements of OPSS.PROV 1010 and in accordance with OPSS 902. The backfill should be placed to the extents shown in OPSD 3121.150 where applicable. Backfill to the toe walls should be in accordance with OPSD 3120.100.

The design of the CIP concrete retaining walls must incorporate a subdrain as shown in OPSD 3121.150 and 3190.100. For RSS walls, supplier specifications should be followed.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with OPSS.PROV.501.

10.2 Secant Pile Walls

It is recommended that 150 mm diameter perforated vertical drains with clear stone backfill be installed in 300 mm diameter augered holes behind the secant pile walls with a spacing of about 1.5 m to 2.0 m to provide sufficient drainage behind the wall. The perforated vertical pipes within each drain should be wrapped with a woven geotextile to prevent migration of fines into the drains.

A 600 mm thick clay cap should be installed at the ground surface behind the caissons above the vertical drainage system to prevent ingress of water into the drainage system behind the wall.

11.0 LATERAL EARTH PRESSURES FOR DESIGN OF PERMANENT RETAINING WALLS

Earth pressures acting on the retaining walls may be assumed to be triangular and governed by the characteristics of the retaining wall backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC 2019 but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where:

p_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient

γ = unit weight of retained soil

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa).

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added. Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS.PROV 501.

For the design of permanent walls placed against native soil, it is recommended that static lateral earth pressure be calculated with the lateral earth pressure coefficients (ko) provided in Table 9.5.

For the design of permanent walls backfilled with granular materials, the lateral earth pressure coefficients provided in Table 9.6 may be used.

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Table 9.6 – Earth Pressure Coefficients

Wall Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II ϕ = 35°, γ = 22.8 kN/m3		OPSS Granular B Type I ϕ = 32°, γ = 21.2 kN/m3	
	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)	Horizontal Surface Behind Wall	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.38	0.31	0.46
At rest (Restrained Wall)	0.43	0.62	0.47	0.68
Passive (Movement Towards Soil Mass)	3.7	-	3.2	-

If the support system allows yielding of the wall (unrestrained system), active horizontal earth pressure may be used in the geotechnical design of the structure. If the support system does not allow yielding (restrained system), at-rest horizontal earth pressures should be used.

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) is preferred as it results in lower earth pressures acting on the wall.

The factors in Table 9.6 are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to be used in the design can be estimated from Figure C6.27 in the Commentary to the CHBDC 2019.

12.0 SUBGRADE PREPARATION FOR CIP WALLS AND RSS WALLS

If CIP concrete retaining walls and/or RSS walls are used, after the foundation excavation reaches the design subgrade level, the exposed surface should be inspected by qualified foundation/geotechnical personnel to confirm that the subgrade is suitable, and uniformly competent and has been adequately prepared. Any unsuitable materials such as topsoil/organics, disturbed soils, loose/soft deposits and deleterious materials within the wall footprint must be removed. Where subexcavation is required to remove unsuitable material from below the design founding level, the founding surface should be re-established using engineered fill or mass concrete of the same class of concrete as used in the footing. The engineered fill must consist of OPSS Granular “A” placed in 150 mm lifts, compacted to 100% of its SPMDD at ±2% of optimum moisture content. All footing construction procedures should follow the

guidelines provided in OPSS 902. Once the subgrade is prepared, the construction traffic and equipment must not travel on the subgrade. It is recommended that a 100 mm thick layer of mass concrete (i.e. working slab) be placed within 4 hours following completion of excavation to protect the subgrade. The working slab should be formed with the same class of concrete as that of the footings. The subgrade preparation should be carried out in the dry.

RSS walls should be founded on a minimum 500 mm thick layer of bedding material conforming to OPSS Granular A requirements to form a uniform subgrade. Engineered fill placed under the RSS mass to achieve the design founding level should be compacted to 100% of its SPMDD at a moisture content within 2% of optimum. The engineered fill layer should extend at least 500 mm beyond the limits of the RSS mass. Where sub-excavation is required to reach competent bearing stratum, the sub-excavation will be backfilled with engineered Granular 'A' fill compacted to 100% of its SPMDD. Construction inspection should be carried out during construction by qualified geotechnical personnel.

13.0 SEISMIC CONSIDERATIONS

Based on the encountered subsurface conditions from the investigation, Site Class D should be assumed to evaluate the seismic site response, as per Table 4.1, Clause 4.4.3.2 of the CHBDC 2019.

The peak ground acceleration, PGA, for a 2% in 50-year probability of exceedance at this site is 0.075 g as per the National Building Code of Canada (NBCC). Since this site is classified as Class D, the factored PGA for a 2% in 50-year probability of exceedance at this site is 0.097 g.

In accordance with Clause 6.14.7 of the CHBDC 2019, retaining structures should be designed using active (KAE) and passive (KPE) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in the following table may be used:

Loading Condition	OPSS Granular A or Granular B Type II $\phi = 35°, \gamma = 22.8$ kN/m3	OPSS Granular B Type I or Type III $\phi = 32°, \gamma = 21.2$ kN/m3	Existing Slope Materials $\phi = 28°, \gamma = 20.0$ kN/m3

	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (2H:1V)
Active (KAE)*	0.31	0.51	0.35	0.65	0.40	0.85
Passive (KPE)	3.6	-	3.1	-	2.7	-
At-rest (KOE)**	0.55	0.76	0.60	0.83	0.70	

* After Mononobe and Okabe

** After Woods

Based on review of the SPT data, seismically-induced liquefaction of foundation soils at the proposed retaining wall sites is not anticipated under the design earthquake.

14.0 EXCAVATION AND GROUNDWATER CONTROL

All excavations must be carried out in accordance with OPSS.PROV 902 and the Occupational Health and Safety Act (OHSA).

Earth excavations for CIP concrete walls supported on footings will generally penetrate through the granular fill and into native loose to dense sand. Locally, the excavations may penetrate very stiff to hard clayey silt to silty clay at Site # 33X-0860/W0. For the purposes of OHSA, the granular fill, loose to dense sand, and very stiff to hard clayey silt to silty clay above the groundwater level deposit are classified as Type 3 soils and Type 4 soils above and below the water table, respectively.

The excavations for shallow retaining wall foundations are generally expected to remain above the groundwater level. Where the excavations for retaining walls extend below the water level, a dewatering system must be in place and effective to prevent instability due to sloughing, base boiling, and groundwater inflow. In general, filtered sumps are expected to be adequate for nominal penetration below the groundwater level, while sheeted excavation (cofferdam) or vacuum well-points may be required for deeper excavations. The dewatering scheme must be effective to lower the groundwater level in the excavation to at least 0.5 m below the final excavation base to facilitate a dry stable base for construction.

Seepage or perched water from the granular fill should also be expected. Surface runoff and precipitation must be diverted away from the excavations. All retaining wall foundations must be constructed in the dry. Unwatering must remain operational and effective until the retaining walls are constructed and backfilled.

Dewatering of all excavations should be carried out in accordance with OPSS. PROV 517, SP 517F01 Amendment to OPSS 517, November 2016 (issued July 2017), NSP FOUN0003 and OPSS. PROV 902 and SP 109S12. It is recommended that a Professional Engineer with greater than 5 years of experience in designing dewatering systems be retained by the Contractor.

The design of dewatering systems is the responsibility of the Contractor and the Contract Documents must alert them to this responsibility.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. Excavations should regularly be inspected for evidence of instability if they have been left open for extended periods of time and following periods of heavy rain or thawing. If required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers. Provision must be made for the handling of potential obstructions in the existing fill materials, and cobbles and boulders in the till. Laboured excavation should be anticipated in the very dense or hard native soils.

15.0 PERMANANT CUT

Permanent earth cuts may be required above the proposed retaining walls and to accommodate expansion of the current KWE. The earth cut will be formed through the existing slopes on the east and west side of KWE.

All permanent exposed cut slopes behind the retaining wall are expected to be stable at inclinations not steeper than 2H:1V.

Permanent drainage will be required adjacent to the retaining wall to remove water originating from

- Surface (and storm) runoff and precipitation
- Seepage from the sides and base of the cut

The cohesionless sands and silts encountered at this site are permeable. Consequently, seepage from these soils into the cut will occur. It is recommended that surface runoff and seepage be managed by means of drains and weepholes incorporated behind and through the retaining walls, and connected with sub-drains installed along the retaining walls in accordance with OPSD 3121.150 and 3190.100. The sub-drains along the retaining walls must be placed at 1.4 m depth or lower under the finished grade and must lead to a positive outlet.

It is recommended that all exposed slope surfaces be vegetated and seeded in accordance with

current MTO practice and with reference to OPSS 804. An interceptor ditch should be provided at the top of the earth cuts in accordance with OPSD 200.020.

Further drawdown of the groundwater table is expected to occur during and after the construction of the proposed retaining walls into the existing cut slopes. The settlement impact on the adjacent structures and utilities beyond the MTO Right-of-Way (ROW) due to groundwater drawdown and the extension of zone of influence should be assessed. However no boreholes and piezometer installation were undertaken in these areas. Therefore, it is recommended that additional boreholes be advanced and piezometers be installed on private property on both sides of the KWE behind the proposed crest of cut slopes in order to assess the impact of groundwater drawdown. The proposed number of boreholes are shown as follows:

Site No.	Location	Approx. Chainage (From)	Approx. Chainage (To)	Approx. Length (m)	Approx. Maximum Exposed Height (m)	Proposed Number of Boreholes
33X-0497/W0	South of Frederick Street and east of the KWE	20+900	21+241	341	6.0	4
33X-0538/W0	North of Frederick Street and east of the KWE	21+276	21+455	179	7.2	3
33X-0860/W0	North of Frederick Street and west of the KWE	10+202	10+295	93	6.6	2
33x-0861/W0	South of Frederick Street and west of the KWE	10+322	10+339	17	5.4	1

16.0 TEMPORARY PROTECTION

If CIP concrete retaining walls or RSS walls are selected, temporary protection may be required to permit retaining wall construction. An item titled “Protection System” as per OPSS 539 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.01.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the Contractor. However, it is anticipated that steel sheetpile walls (SSW) or soldier pile and lagging walls would be suitable at this site. It is anticipated that the soldier piles will need to be installed within the very stiff to hard

silty clay in order to develop the required toe resistance. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable.

A temporary soldier pile and lagging wall may be designed using the parameters given below:

γ	=	20 kN/m^3
γ_w	=	10 kN/m^3
K_a	=	0.33 (fills and native silty sand)
	=	0.33 (clayey silt and silty clay)
K_p	=	3.0 (fills and native silty sand)
	=	3.0 (clayey silt and silty clay)

The designer of the roadway protection system should check whether the depth of pile is sufficient to provide base fixity.

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

17.0 CORROSION AND SULPHATE ATTACH POTENTIAL

The results of the corrosivity and sulphate analytical tests conducted on the native soil during the current investigation indicates the following conditions at the locations tested:

- The potential for sulphate attack on concrete foundations from the surrounding native soil is considered to be negligible due to the low concentration of sulphate and chloride in the samples tested. The selection of class of concrete should consider the effects of the road de-icing salts.
- The potential for soil corrosion on metal is considered to be very mild to mild at RW16 (NW wall – 33X-0860/W0), moderate at RW2 (NE wall – 33X-0538/W0) and severe to very severe at RW1 (SE wall – 33X-0497/W0).
- Appropriate protection measures commensurate with the above are recommended if metal structural elements are used. The effects of road de-icing salts should be also considered.

18.0 ADJACENT STRUCTURES AND BURIED UTILITIES

There are currently storm sewers which run beneath the E-S ramp and S-Bruce Street ramp. The exact locations and elevations of these sewers and any other buried utilities within the vicinity of the walls should be confirmed by the designer prior to construction and compared to the extent of the potential work zones. Protection and/or relocation of utilities may be required. Underground utilities and/or adjacent building foundations should not be undermined or damaged during new retaining wall construction or due to settlement resulting from fill placement or groundwater drawdown.

19.0 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to, the following:

- The secant wall caissons will need to penetrate very dense/hard soils and potential obstructions (e.g. cobbles, boulders, rock fragments) within the existing fill and native materials. The Contractor must be equipped and prepared these very dense/hard zones and remove, penetrate or otherwise handle these obstructions during construction.

- Based on water levels measured in the piezometers, excavations for CIP concrete cantilever retaining wall and RSS wall foundations are generally above the groundwater level. However, effective sump pumping amongst other measures of groundwater and surface water control should be implemented to maintain a reasonably dry excavation base for construction. If excavation is carried out in cohesionless soil without prior implementation of adequate measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel working on site, or to a loss of bearing resistance in the soil. Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.

- Existing vegetation is likely having stabilizing effects on the existing slope and should be preserved. Any existing vegetation behind the wall (upslope) that is destroyed or otherwise disturbed must be reinstated after the retaining wall is constructed.

- No borehole was drilled within the footprint of South-West retaining wall. The subsurface conditions are interpreted based on an adjacent borehole and it is for preliminary design purposes only. Additional boreholes should be completed at each end of the retaining wall to confirm subsurface conditions and detail design assumptions.

- Groundwater table drawdown is expected to occur during and after the construction of the proposed retaining walls into the permanent earth cuts on the east and west sides of KWE. Additional boreholes and piezometers are required on the private property to assess the extension of zone of influence and settlement impact on the adjacent structures and utilities due to groundwater table drawdown.

20.0 CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Mr. Geoff Lay, P.Eng.. The report was reviewed by Mr. Jason Lee, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

Geoff Lay, P.Eng.
Geotechnical Engineer

Jason Lee, P.Eng.
Principal, Senior Foundation Engineer

P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

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APPENDIX A
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations, Soil Strata Drawing and Slope Stability Output
SE Retaining Wall - Site # 33X-0497/W0

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

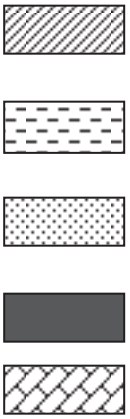
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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RECORD OF BOREHOLE No RW01-01 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 375.5 E 226 297.0 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.455902 LONGITUDE -80.469603 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
326.0	GROUND SURFACE					
0.0	**ASPHALT:** (100mm)					
0.1	**SAND**, some to trace gravel Compact Brown Moist (FILL)		1	GS		
			2	SS	12	
	clayey silt layer at 1.4m (500mm)		3	SS	22	
324.1						
1.9	**SAND**, some silt to silty, trace gravel, trace clay Compact to Dense Brown Wet		4	SS	34	▽
			5	SS	27	
			6	SS	37	
320.4						
5.6	Silty **CLAY**, trace sand Very Stiff Grey Moist		7	SS	21	
			8	SS	17	
316.9						
9.1	Silty **SAND**, trace gravel Dense to Very Dense Grey Moist		9	SS	37	
316.0						

ELEVATION SCALE: 325, 324, 323, 322, 321, 320, 319, 318, 317

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
	0	81	17	2
Switch to tricone				
	0	1	44	55

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-01 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 375.5 E 226 297.0 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.455902 LONGITUDE -80.469603 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
10.0	Silty **SAND**, trace gravel Dense to Very Dense Grey Moist										
			10	SS	71		315		○		
	silt layer at 12.0m (600mm)						314				
313.4			11	SS	70				○		
12.6	Silty **SAND**, trace clay Very Dense Grey Wet						313		○		
			12	SS	74		312		⊙		0 72 26 2
311.7											
14.3	END OF BOREHOLE AT 14.3m. WATER LEVEL AT 2.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 4.3m, BENTONITE HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.										

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

$\frac{20}{15 \quad 10}$ 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-02 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 419.6 E 226 272.7 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.456484 LONGITUDE -80.470036 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
324.9	GROUND SURFACE					
0.0	**ASPHALT:** (100mm)					
0.1	**SAND**, some to trace gravel Loose Brown Moist (FILL)		1	GS		
			2	SS	6	
	Clayey silt layer at 1.1m (400mm)					
323.4						
1.5	**SILT**, some sand, trace clay Dense Brown Moist		3	SS	36	
322.7	(FILL)					
2.3	**SAND**, some silt, trace gravel Compact to Loose Brown Moist to Wet		4	SS	15	
			5	SS	9	▽
320.7						
4.3	Silty **CLAY**, some sand, trace gravel Hard Grey Moist		6	SS	31	
319.3						
5.6	Sandy **SILT**, trace clay Very Dense Grey Moist		7	SS	57	
			8	SS	95	
			9	SS	106	

ELEVATION SCALE: 324, 323, 322, 321, 320, 319, 318, 317, 316, 315

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	19	76	5
Switch to tricone				
	0	27	65	8

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 419.6 E 226 272.7 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.09.24 - 2019.09.24 LATITUDE 43.456484 LONGITUDE -80.470036 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
314.7											
10.2	Continued From Previous Page Silty **SAND**, trace gravel Very Dense Grey Wet		10	SS	105		314		○		
313.8											
11.1	END OF BOREHOLE AT 11.1m. WATER LEVEL AT 3.2m UPON COMPLETION. BOREHOLE BACKFILLED WITH GROUT TO 3.7m, HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-03 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 475.3 E 226 263.8 ORIGINATED BY AF

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP

DATUM Geodetic DATE 2018.06.05 - 2018.06.05 LATITUDE 43.457067 LONGITUDE -80.470499 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.8	GROUND SURFACE										
0.0	**TOPSOIL**(150mm)										
0.2	**SAND** and **GRAVEL**, some silt to silty, trace asphalt Compact Brown Moist (FILL)		1	SS	13		327		○		
			2	SS	20		326		○		
325.5											
2.3	**SILT**, some clay, trace sand Compact Brown Moist (FILL)		3	SS	19		325		⊢●		0 0 73 27
324.6											
3.2	**SAND**, some silt to silty, trace clay, trace gravel Compact Brown Wet		4	SS	25		324		○		
			5	SS	15	▽	323		○		
			6	SS	19		322		○		
320.6							321				
7.2	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Grey Moist		7	SS	27		320		○		
			8	SS	100/ 0.175		319		○		
317.8							318				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 475.3 E 226 263.8 ORIGINATED BY AF

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP

DATUM Geodetic DATE 2018.06.05 - 2018.06.05 LATITUDE 43.457067 LONGITUDE -80.470499 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
10.0	Continued From Previous Page										
	SILT, some sand to sandy, some clay Dense to Very Dense Grey Moist										
			9	SS	47		317		○		
							316				
			10	SS	100/ 0.250				⊣⊢		0 19 62 19
							315				
313.7			11	SS	100/ 0.200		314		○		
14.1	END OF BOREHOLE AT 14.1m. WATER LEVEL AT 5.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-04 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 519.0 E 226 257.8 ORIGINATED BY JB

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA

DATUM Geodetic DATE 2018.05.06 - 2018.05.06 LATITUDE 43.457461 LONGITUDE -80.470575 CHECKED BY NB

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 + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.8	GROUND SURFACE										
0.0	**TOPSOIL** (200mm)										
0.2	**SAND**, some silt to silty, trace to some gravel, occasional organics Loose to Compact Brown Moist (FILL)		1	SS	4		326				
			2	SS	6		325				
324.5											
2.3	**SAND**, some silt to silty, trace clay Compact Brown Moist		3	SS	20		324				
			4	SS	21						0 79 19 2
			5	SS	24	▼	323 322				
321.2											
5.6	Silty **CLAY**, trace sand, trace gravel Very Stiff to Hard Grey Wet		6	SS	7		321				
			7	SS	17		320 319				
			8	SS	39		318				0 5 47 48
316.8							317				

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No RW01-04 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 519.0 E 226 257.8 ORIGINATED BY JB

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA

DATUM Geodetic DATE 2018.05.06 - 2018.05.06 LATITUDE 43.457461 LONGITUDE -80.470575 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
10.0	Sandy **SILT**, some clay, trace gravel Very Dense Grey Moist										
			9	SS	64		316		○		
							315				
			10	SS	90				○		
							314				
312.8			11	SS	100/ 0.150		313		○		0 22 59 19
14.0	END OF BOREHOLE AT 14.0m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.06.25 4.9 321.9										

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

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RECORD OF BOREHOLE No RW01-05 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 571.9 E 226 227.3 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.12 - 2019.08.13 LATITUDE 43.457951 LONGITUDE -80.470715 CHECKED BY NB

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 + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.4	GROUND SURFACE										
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL** Brown Dry		1	GS			321		○		
320.7	(FILL)										
0.7	Silty **SAND**, trace gravel Compact Brown Moist		2	SS	16		320		○		
			3	SS	16				○		
319.2							319				
2.2	Silty **CLAY**, trace sand Stiff to Hard Grey Moist		4	SS	11				○		
			5	SS	23	▽	318		○ —		0 3 39 58
			6	SS	36		317		○		
315.1							316		○		
6.3	Silty **SAND** to Sandy **SILT**, trace clay Dense to Very Dense Grey Moist		7	SS	42		315		○		
			8	SS	67		314		○		
			9	SS	32		313				
311.4							312		○		

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW01-05 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 571.9 E 226 227.3 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.12 - 2019.08.13 LATITUDE 43.457951 LONGITUDE -80.470715 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
10.0	Silty **SAND**, trace clay Dense Grey Moist						311				
			10	SS	45				○		0 71 28 1
309.7							310				
11.7	Silty **CLAY**, trace sand Hard Grey Moist										
			11	SS	32		309		○		
							308				
			12	SS	42				⊖		0 2 39 59
307.1											
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 7.9m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW01-06 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 618.5 E 226 222.2 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.13 - 2019.08.13 LATITUDE 43.458395 LONGITUDE -80.470785 CHECKED BY NB

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 + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.5	GROUND SURFACE										
0.0	**ASPHALT:** (75mm)										
0.1	**SAND** and **GRAVEL**, trace silt, trace clay Brown Dry (FILL)		1	GS			320		○		
319.9											
0.7	**SAND**, some silt, trace clay, trace gravel Loose to Dense Brown Moist to Wet		2	SS	15				○		
			3	SS	5	▽	319		○		3 76 16 5
			4	SS	34		318		○ ○		
317.7											
2.8	Silty **CLAY**, trace sand Very Stiff to Hard Grey Moist		5	SS	34		317		○		
			6	SS	30		316		○		
			7	SS	29		315		○		
313.4							314				
7.2	Sandy **SILT** to **SILT** and **SAND**, trace to some clay, trace gravel Compact to Dense Grey Moist to Wet		8	SS	30		313		○		0 38 49 13
			9	SS	32		312				
							311		○		

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW01-06 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 618.5 E 226 222.2 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.13 - 2019.08.13 LATITUDE 43.458395 LONGITUDE -80.470785 CHECKED BY NB

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 (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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
309.4			10	SS	30		310				
11.2	Silty **CLAY**, trace to some sand Hard Grey Moist		11	SS	33		309 308				0 10 45 45
306.2			12	SS	33		307				
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 4.4m AND WATER LEVEL AT 2.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) (20 40 60)

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW01-07 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 661.7 E 226 221.5 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.14 - 2019.08.14 LATITUDE 43.458833 LONGITUDE -80.471043 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.0	GROUND SURFACE						320			
0.0 / 0.1	**ASPHALT:** (75mm)									
319.4	**SAND** and **GRAVEL**, some silt, trace clay Brown Dry (FILL)		1	GS					○	32 46 22 (SI+CL)
318.8	Silty **SAND**, trace gravel Dense Brown Moist		2	SS	32		319		○	
1.3	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Grey Moist		3	SS	32		318		○	
			4	SS	32		317		○	
			5	SS	35		316		○	
			6	SS	34	▽	315		⊖	2 7 50 41
			7	SS	28		314		○	
			8	SS	24		313		○	
			9	SS	23		312		○	
							311		○	

Continued Next Page

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

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW01-07 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 1, MTM NAD 83 Zone 10: N 4 813 661.7 E 226 221.5 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

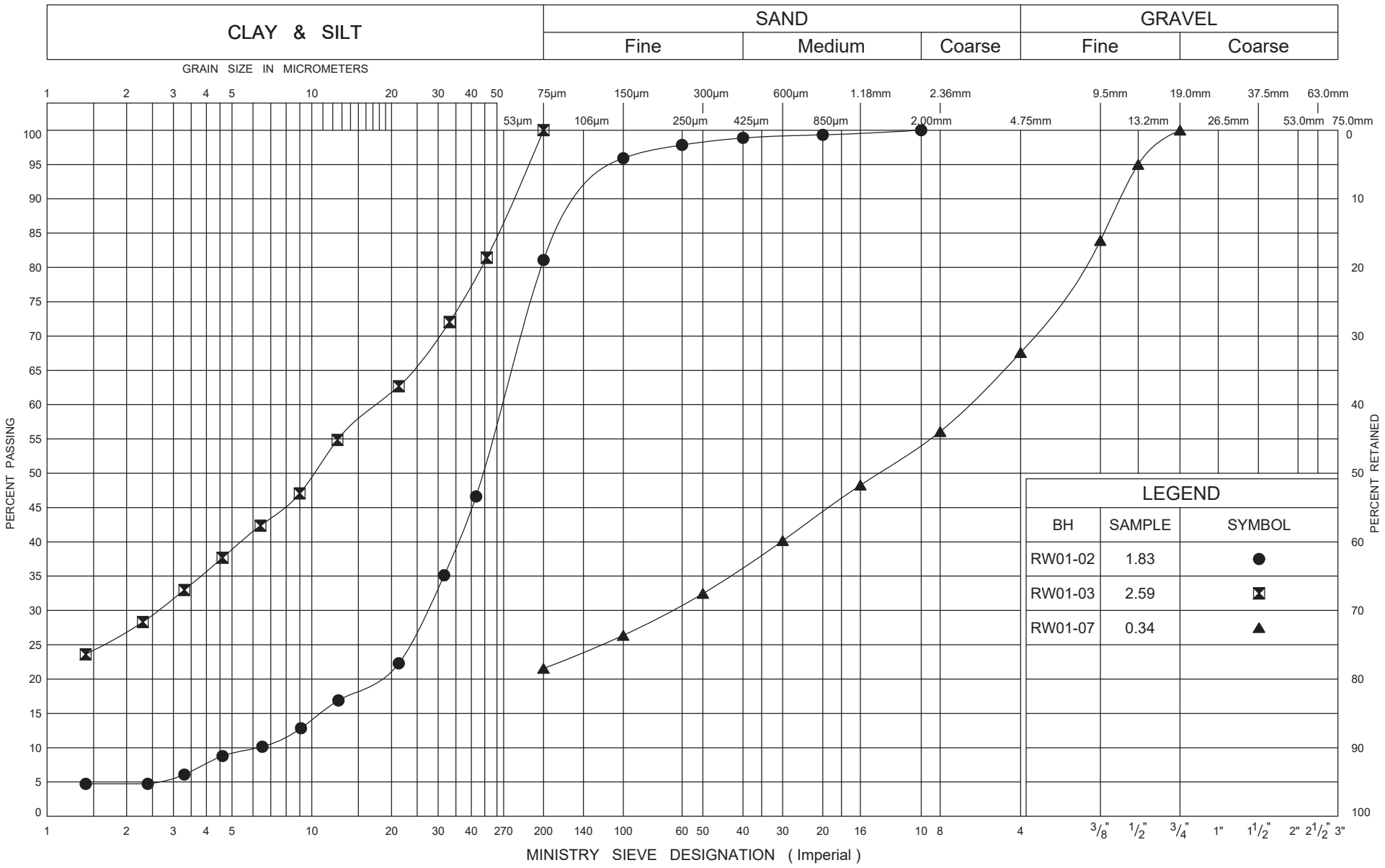
DATUM Geodetic DATE 2019.08.14 - 2019.08.14 LATITUDE 43.458833 LONGITUDE -80.471043 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page									
	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Grey Moist						310			
			10	SS	19		309		○	
308.3										
11.7	Sandy **SILT**, trace clay Dense to Very Dense Grey Moist						308		○	
			11	SS	31		307			
			12	SS	55		306		○	0 25 68 7
305.7										
14.3	END OF BOREHOLE AT 14.3m. BOREHOLE CAVED TO 8.2m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT TO SURFACE.									

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19



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Ontario

GRAIN SIZE DISTRIBUTION

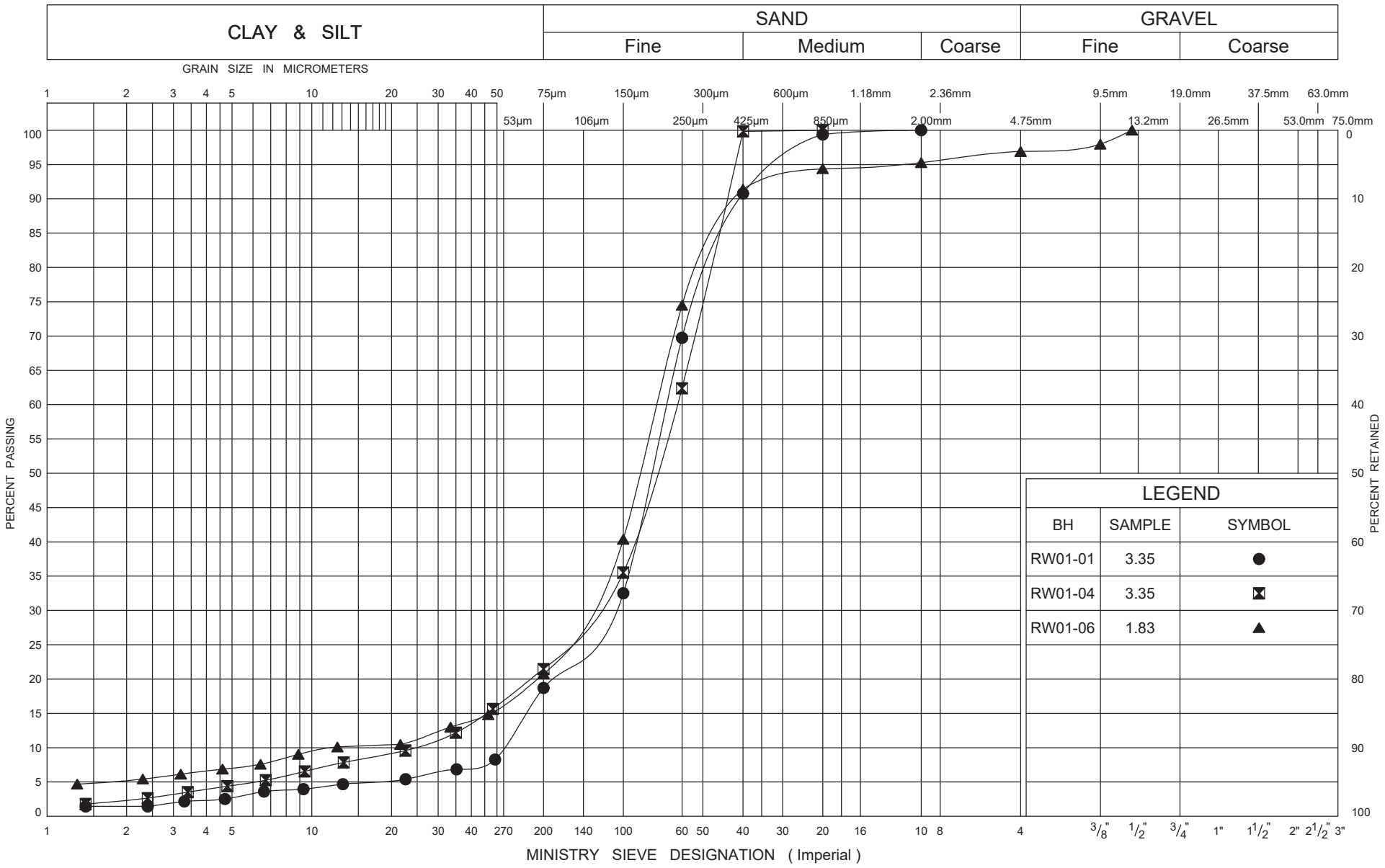
Granular FILL

FIG No A1

W P 408-88-00

Retaining Wall 1

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



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Ontario

GRAIN SIZE DISTRIBUTION

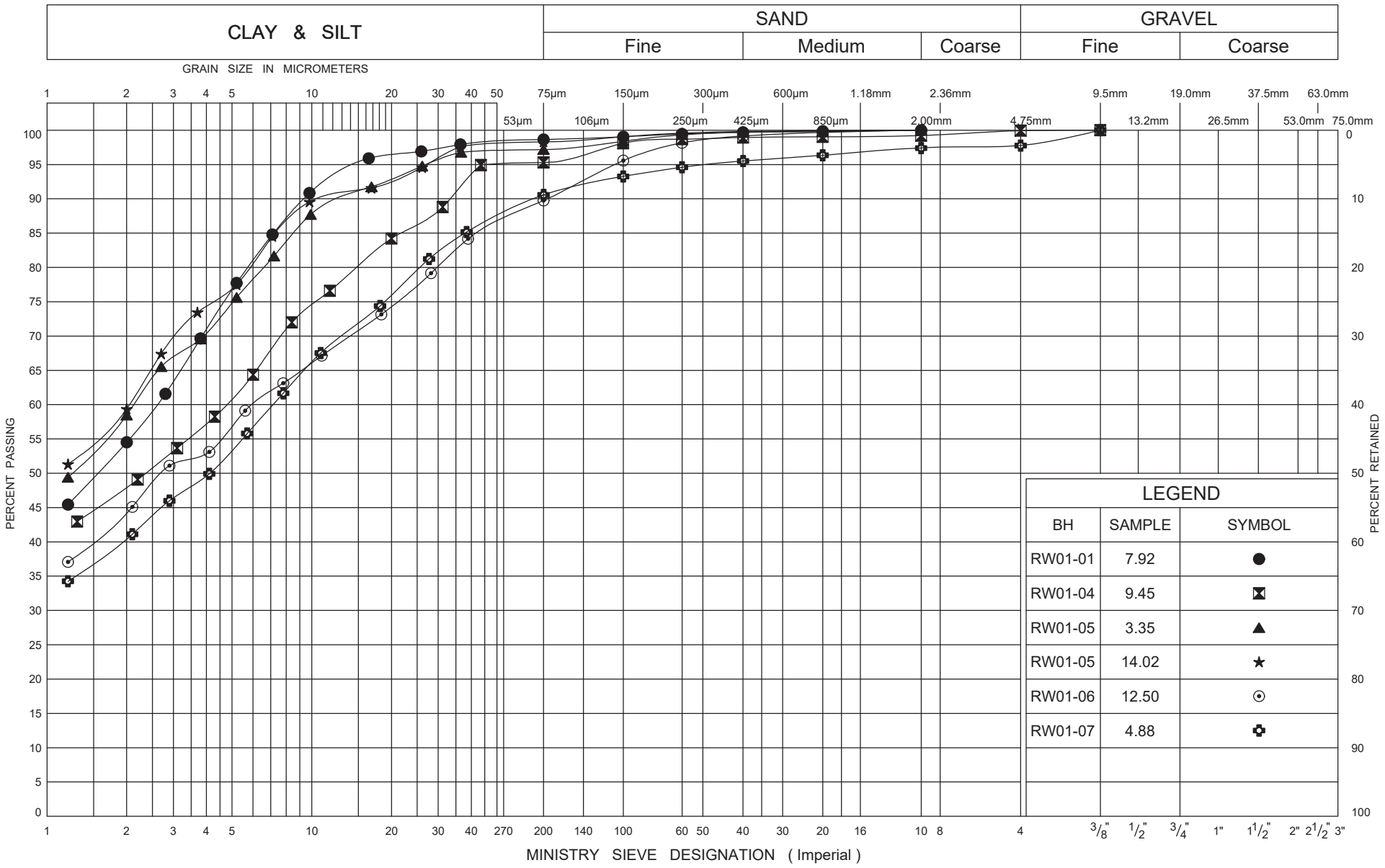
SAND

FIG No A2

W P 408-88-00

Retaining Wall 1

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



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Ontario

GRAIN SIZE DISTRIBUTION

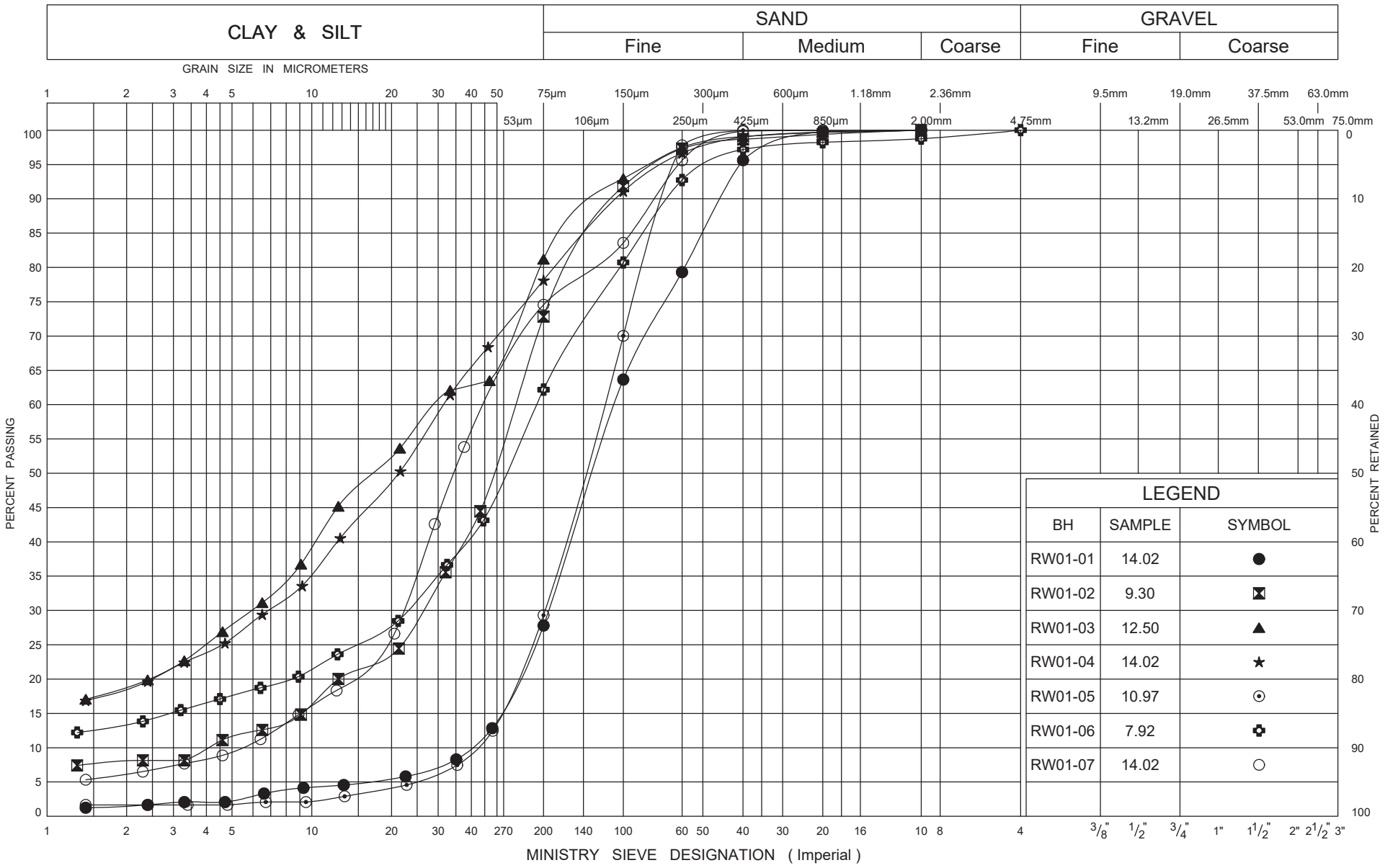
Silty CLAY

FIG No A3

W P 408-88-00

Retaining Wall 1

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Sandy SILT / Silty SAND

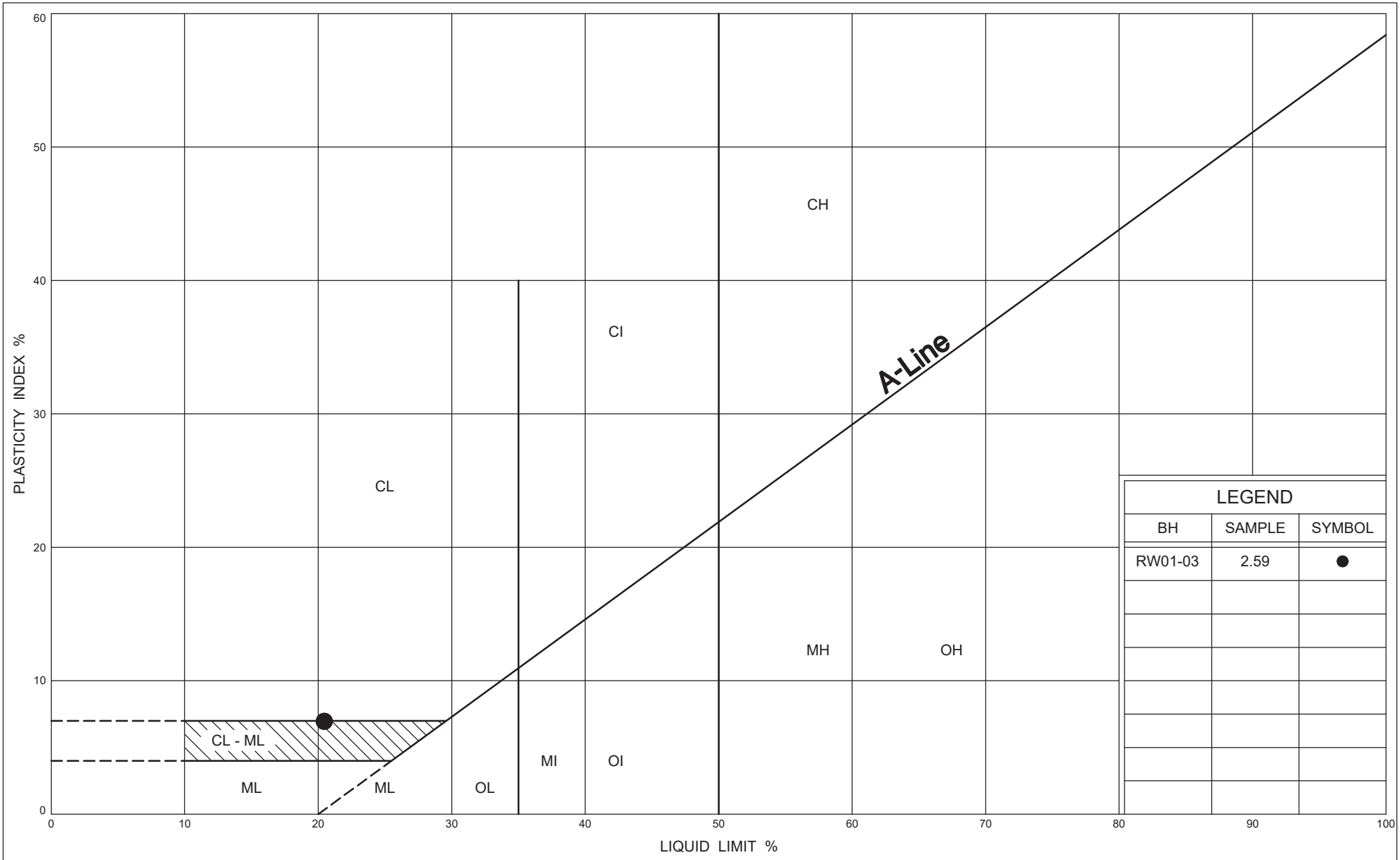
FIG No A4

W P 408-88-00

Retaining Wall 1

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

Ministry of Transportation
Ontario

PLASTICITY CHART

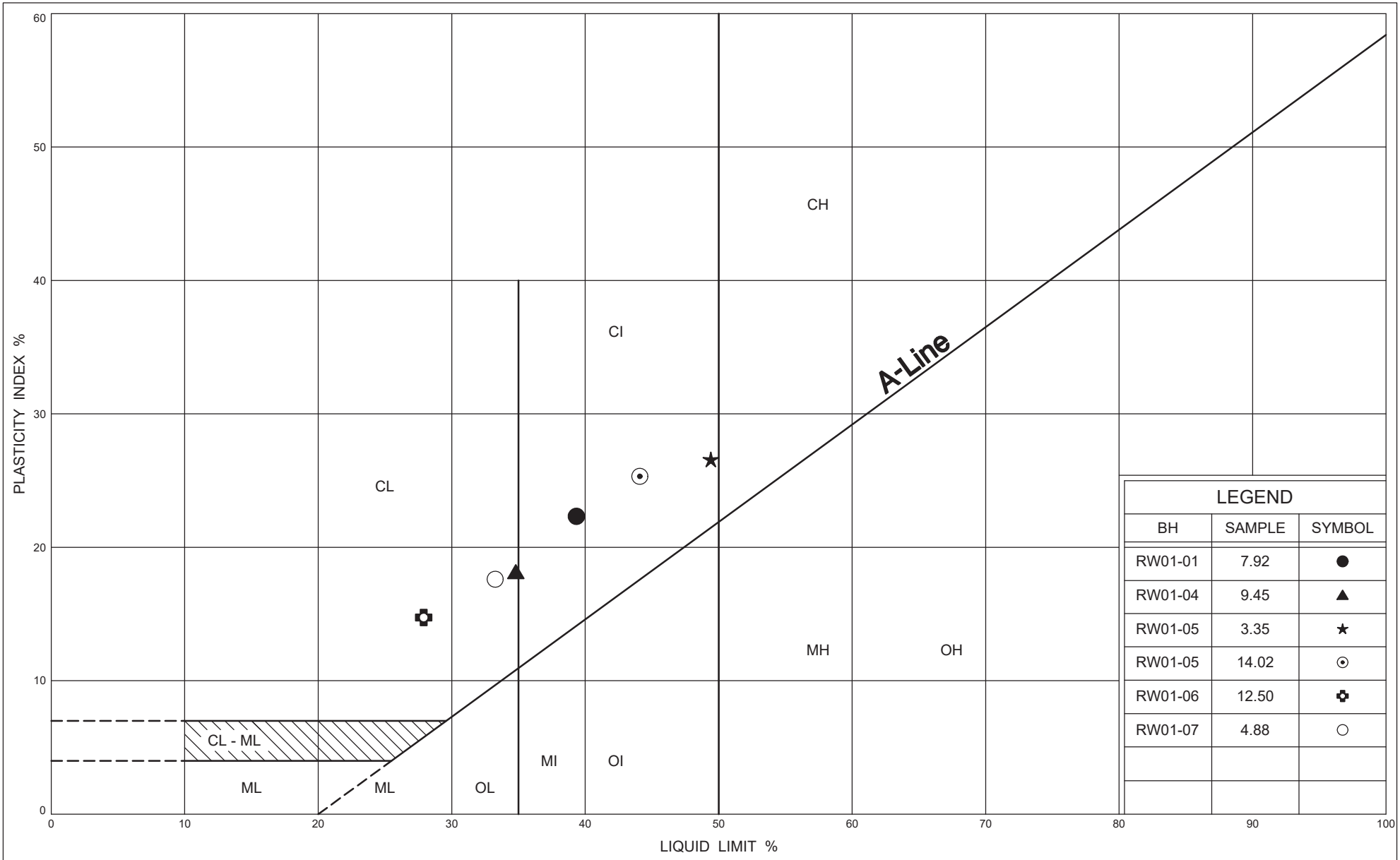
Granular (Silt) FILL

FIG No A5

W P 408-88-00

Retaining Wall 1

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
RW01-01	7.92	●
RW01-04	9.45	▲
RW01-05	3.35	★
RW01-05	14.02	⊙
RW01-06	12.50	✿
RW01-07	4.88	○

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Ontario

PLASTICITY CHART

Silty CLAY

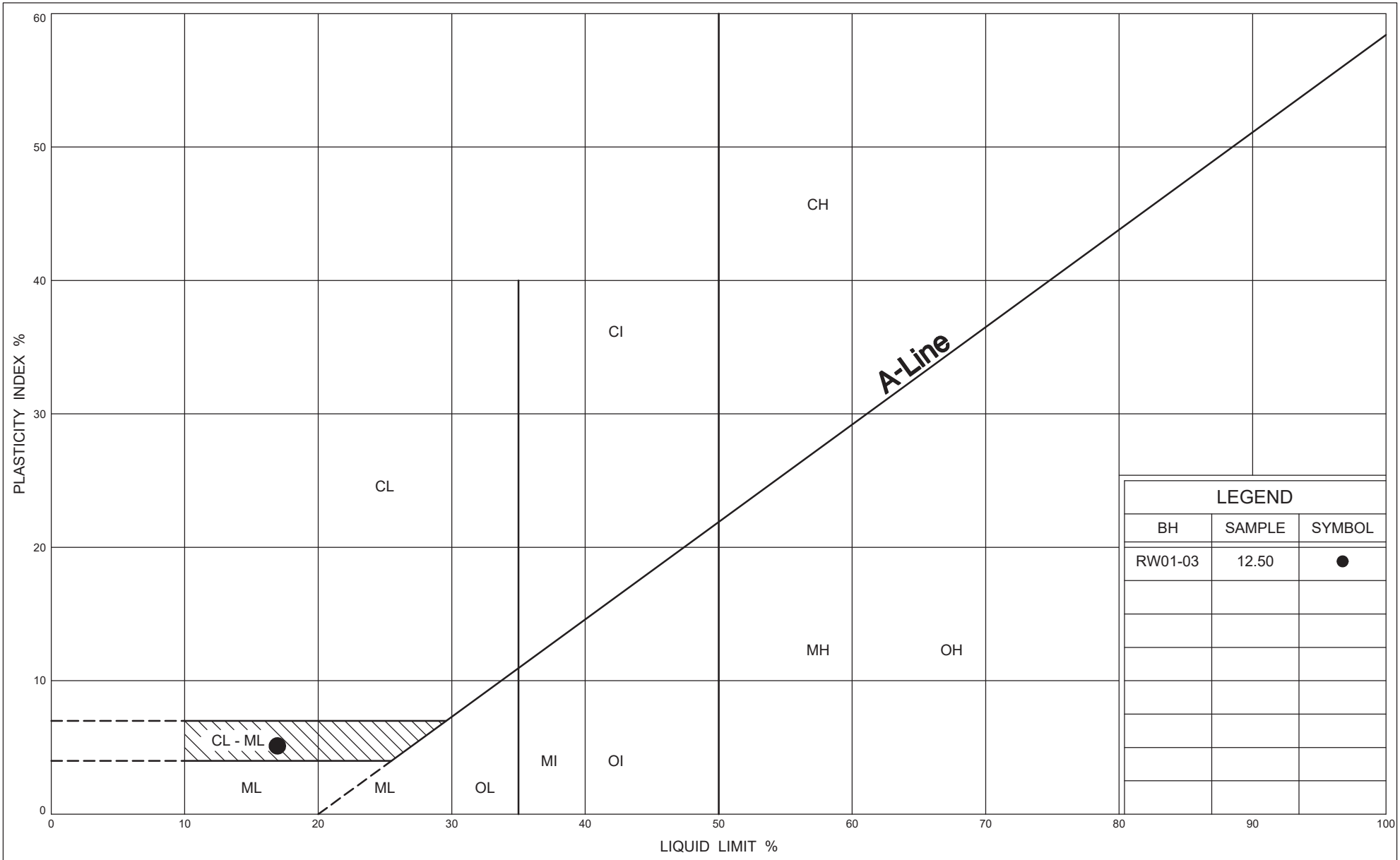
FIG No A6

W P 408-88-00

Retaining Wall 1

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

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Ontario

PLASTICITY CHART

Sandy SILT / Silty SAND

FIG No A7

W P 408-88-00

Retaining Wall 1

Figure A8

File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 35 °
Silty Sand 19 kN/m³ 0 kPa 30 °
Silt Clay 20 kN/m³ 120 kPa

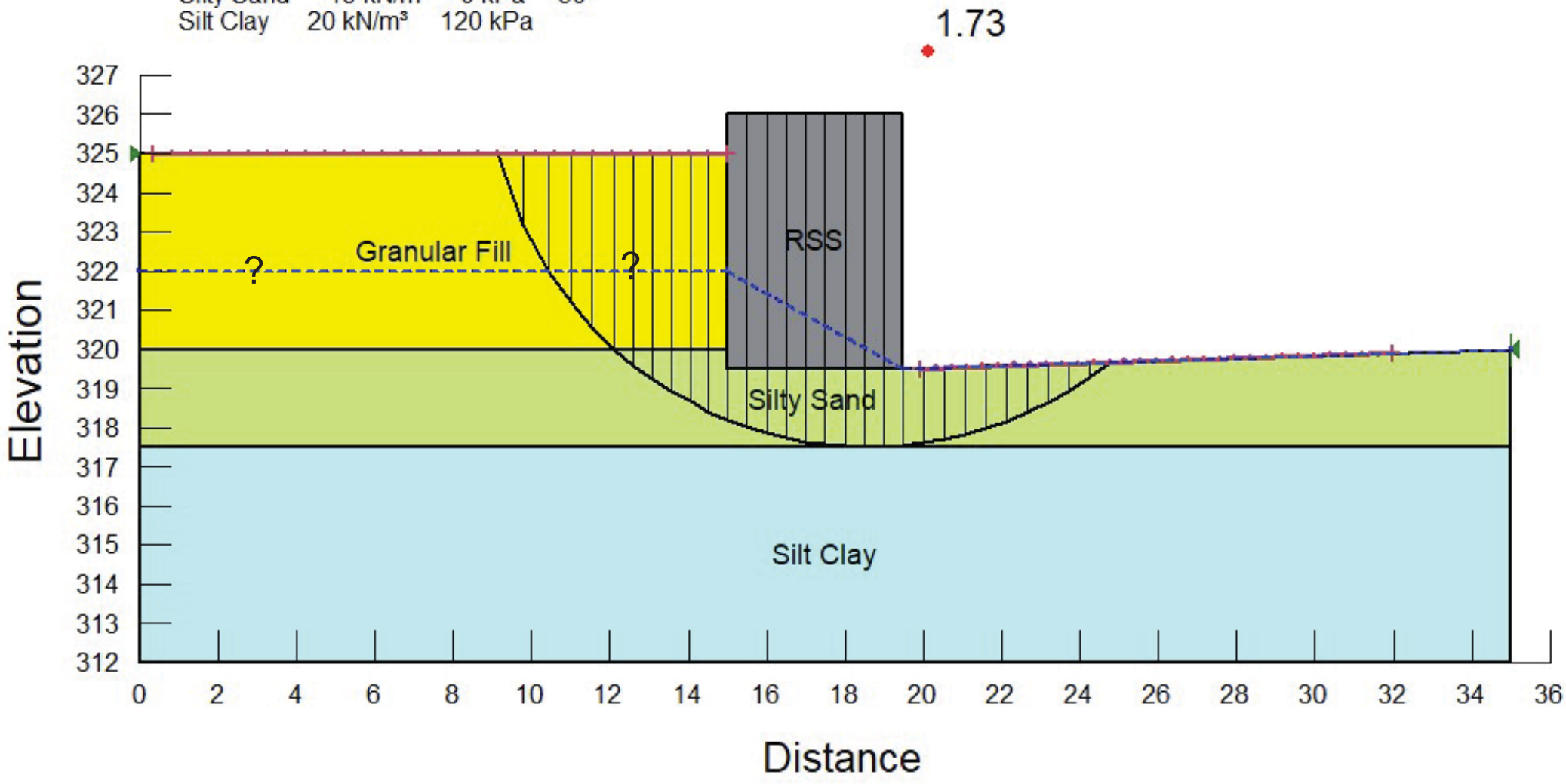
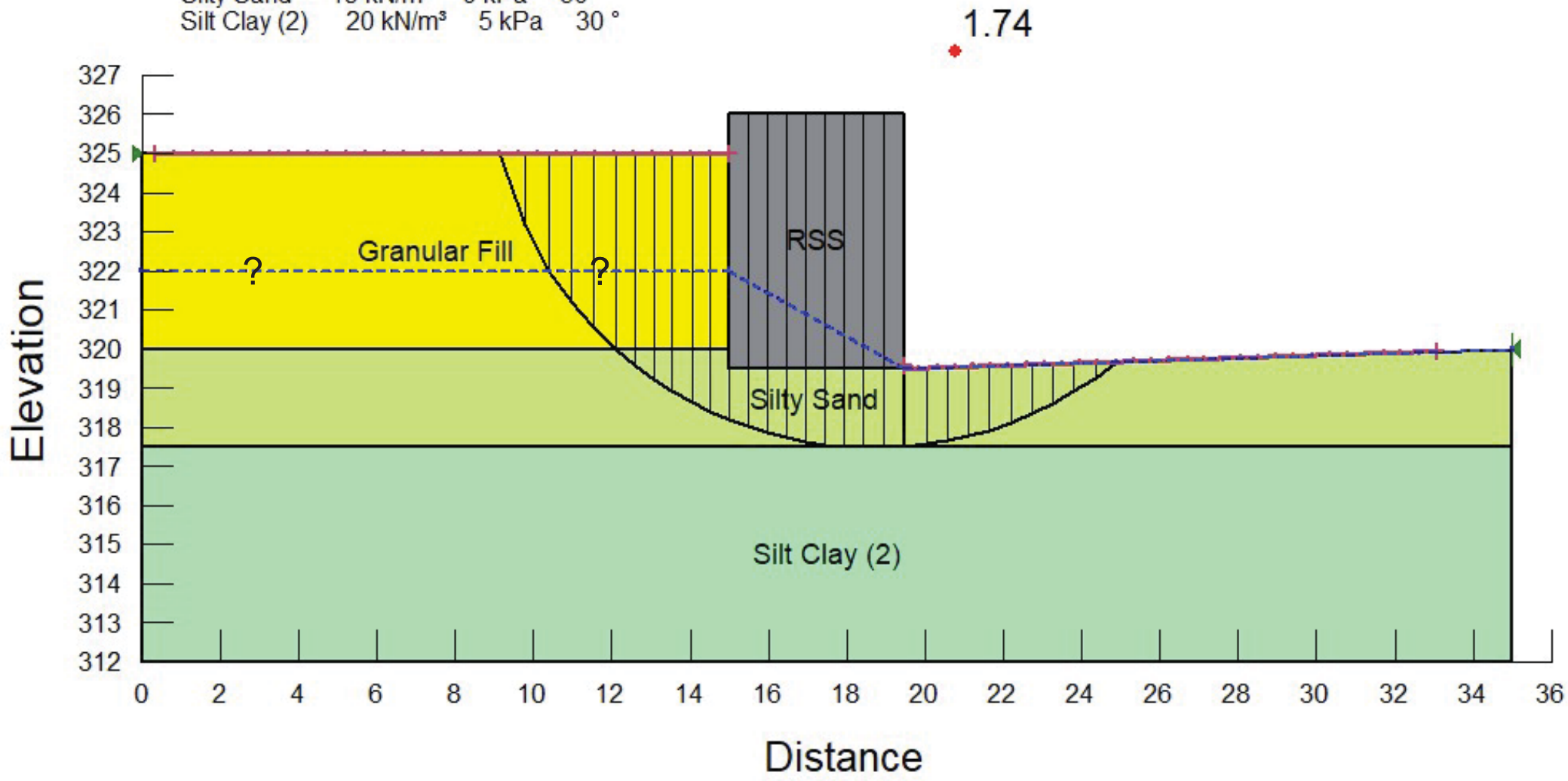


Figure A9

File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

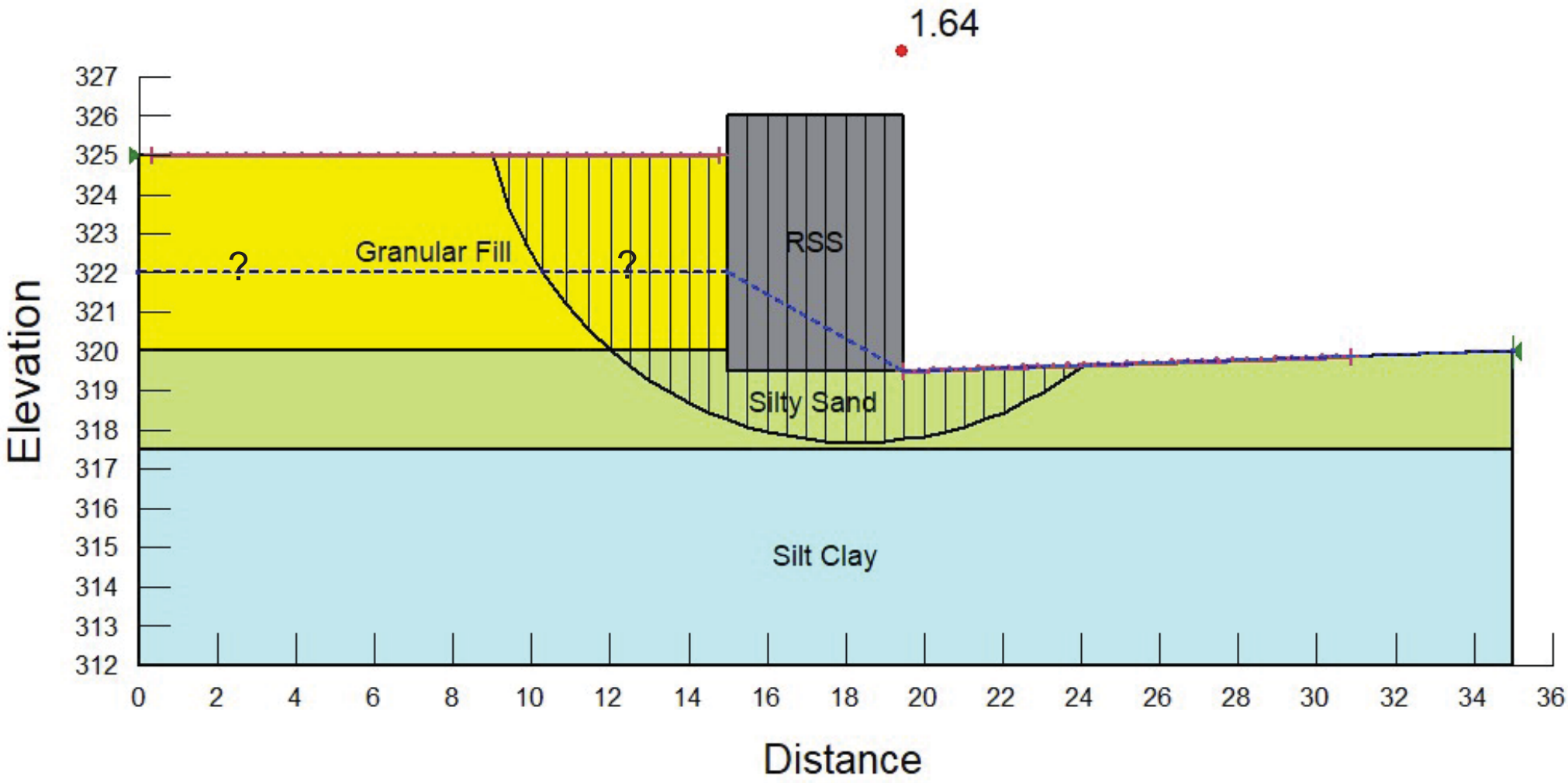
RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	35 °
Silty Sand	19 kN/m³	0 kPa	30 °
Silt Clay (2)	20 kN/m³	5 kPa	30 °



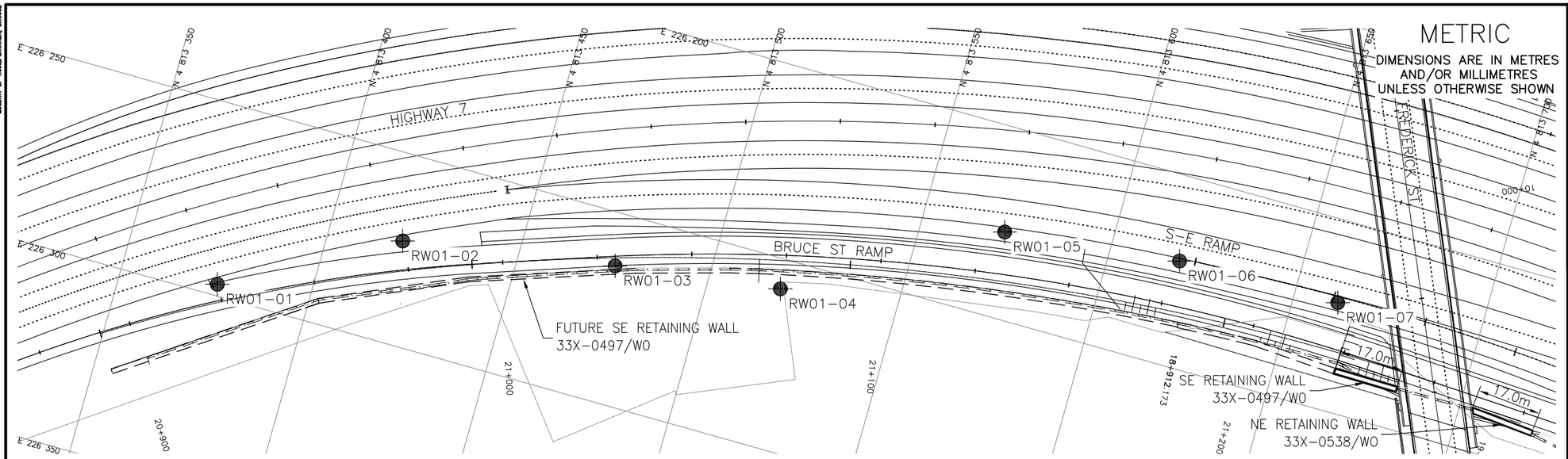
File Name: RW1 Sta 21+250.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Horz. Seismic Coef.: 0.0485

Figure A10

RSS 22 kN/m³ 200 kPa 45 °
Granular Fill 21 kN/m³ 0 kPa 35 °
Silty Sand 19 kN/m³ 0 kPa 30 °
Silt Clay 20 kN/m³ 120 kPa



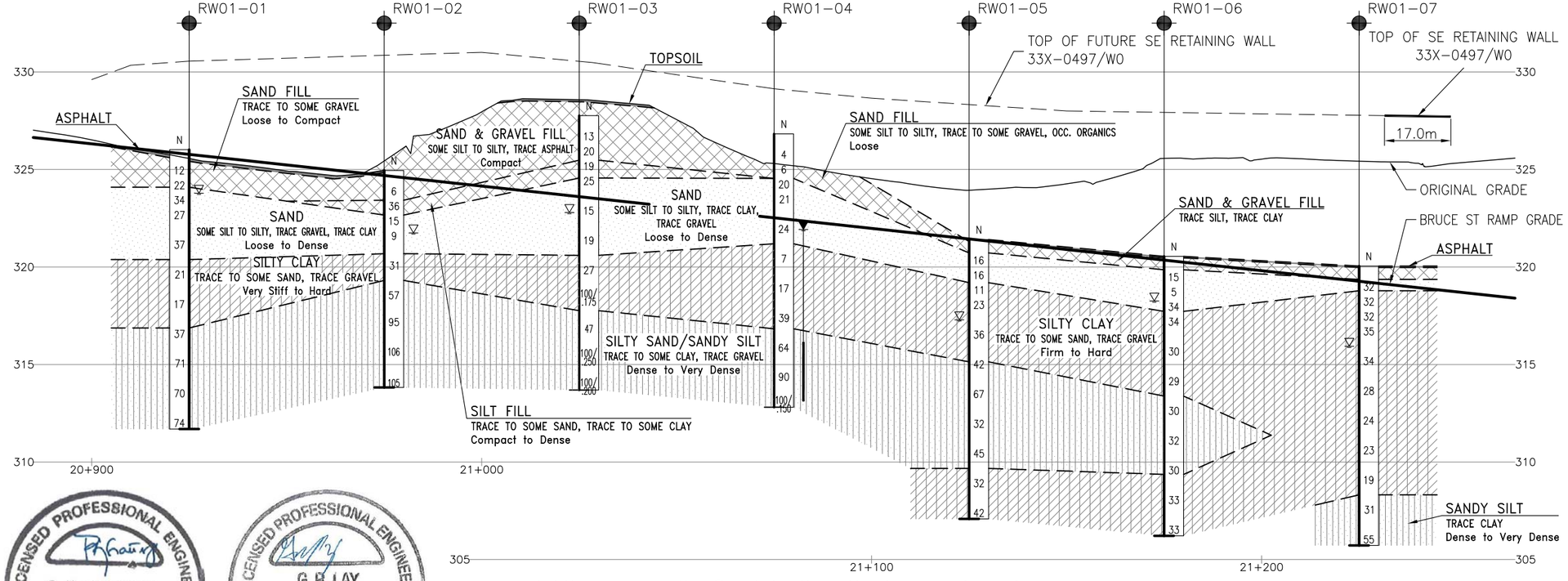
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

25 0 25 50m

SCALE 1:1250



PROFILE ALONG BRUCE STREET RAMP
FREDERICK STREET-S/E-BECKER STREET

25 0 25 50m H 1:1250

5 0 5 10m V 1:250

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
06/08/2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
G. R. LAY
100194778
06/08/2021
PROVINCE OF ONTARIO

CONT No
GWP No 3005-20-00

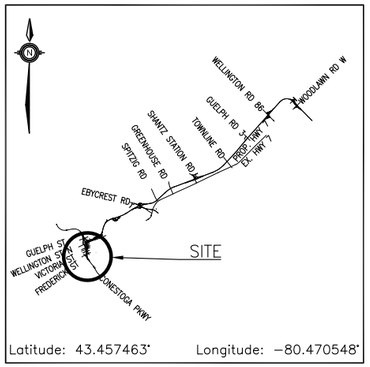
SHEET

HIGHWAY 7
FREDERICK ST.-S/E-BECKER ST.
SE RETAINING WALL 33X-0497/W0
BOREHOLE LOCATIONS AND SOIL STRATA

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

wsp

THURBER ENGINEERING LTD.



Latitude: 43.457463° Longitude: -80.470548°

KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW01-01	326.0	4 813 375.5	226 297.0
RW01-02	324.9	4 813 419.6	226 272.7
RW01-03	327.8	4 813 475.3	226 263.8
RW01-04	326.8	4 813 519.0	226 257.8
RW01-05	321.4	4 813 571.9	226 227.3
RW01-06	320.5	4 813 618.5	226 222.2
RW01-07	320.0	4 813 661.7	226 221.5

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P8-290

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE	LOAD
DRAWN	MFA	CHK	NB	SITE	STRUCT

DATE JUN 2021
DWG 1

FILENAME: H:\Drafting\11000\11375\ED-11375-BHPP-RW01.dwg
PLOTDATE: 6/8/2021 5:34 PM

THURBER

APPENDIX B
Record of Borehole Sheets, Laboratory Test Results and Borehole Locations Soil Strata Drawing and Slope Stability Output
NE Retaining Wall - Site # 33X-0538/W0

THURBER

Record of Borehole Sheets, Laboratory Test Results and Borehole Locations
and Soil Strata Drawing for Current Investigation
(RW02-02 to RW02-04)

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-02 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 757.0 E 226 227.0 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.22 - 2019.08.22 LATITUDE 43.459602 LONGITUDE -80.470929 CHECKED BY NB

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 + FIELD VANE ● QUICK TRIAXIAL × 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
319.6	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	Silty **SAND**, with gravel Brown Dry		1	GS					○		
318.8	(FILL)						319				
0.8	Silty **SAND**, trace clay, trace gravel Dense to Compact Brown Moist		2	SS	30				○		
			3	SS	34		318		○		
			4	SS	24		317		○		
			5	SS	21		316		○		1 63 31 5
315.4											
4.1	Silty **CLAY**, some to with sand, trace gravel Stiff to Hard Grey Moist		6	SS	14		315		○		
			7	SS	35		314		○		7 37 32 24
311.6			8	SS	89		313		○		
7.9	**SILT** and **SAND**, trace clay, trace gravel Very Dense Grey Wet						312		○		
			9	SS	89		311		○		
							310				

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 757.0 E 226 227.0 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.22 - 2019.08.22 LATITUDE 43.459602 LONGITUDE -80.470929 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT and **SAND**, trace clay Very Dense Grey Wet						309				
			10	SS	83				○		
							308				
306.8			11	SS	98		307		○		0 43 56 1
12.8 306.2	End of sampling and start DCPT										
13.3	END OF BOREHOLE AT 13.3m UPON DCPT REFUSAL. BOREHOLE CAVED TO 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/13/19

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-03 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 807.5 E 226 232.5 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.21 - 2019.08.21 LATITUDE 43.460057 LONGITUDE -80.470870 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.5	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2	Silty **SAND**, with gravel Brown Dry		1	GS							
318.7	(FILL)										
0.8	**SAND**, trace to some silt, trace clay Compact Brown Wet		2	SS	26						0 91 8 1
			3	SS	22						
			4	SS	16						
			5	SS	11						
314.5			6	SS	27						
5.0	Silty **CLAY**, trace sand Very Stiff Grey Moist										
	Firm		7	SS	6						Switch to tricone
			8	SS	29						
			9	SS	15						0 1 38 61
309.5											

Continued Next Page

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 807.5 E 226 232.5 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.21 - 2019.08.21 LATITUDE 43.460057 LONGITUDE -80.470870 CHECKED BY NB

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) 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
10.0	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Grey Moist						309				
	Sandy silt layer at 11.0m (500mm)		10	SS	28		308		○ ○		
			11	SS	68		307		○		
305.8							306				
13.7	**SAND**, trace to some silt, trace clay Dense to Very Dense Grey Wet		12	SS	75		305		○ ○		
303.6			13	SS	43		304		○		0 87 10 3
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE CAVED TO 4.6m AND WATER LEVEL NOT AVAILABLE UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT TO SURFACE.										

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-04 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 856.9 E 226 242.2 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA

DATUM Geodetic DATE 2019.09.23 - 2019.09.23 LATITUDE 43.460514 LONGITUDE -80.470774 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.1	GROUND SURFACE						319		
0.0	**ASPHALT:**(112mm)								
0.1	**SAND**, with gravel Brown Moist		1	GS					
318.5	(FILL)						318		
0.6	**SAND**, trace silt and clay, trace gravel Compact to Dense Brown Wet		2	SS	26				
			3	SS	32		317		
			4	SS	21				1 94 5 (SI+CL)
			5	SS	34		316		
314.3							315		
4.8	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Grey Moist		6	SS	17				
			7	SS	16		314		0 21 45 34
			8	SS	26		313		
	Wet		9	SS	17		312		
							311		
							310		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/13/19

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW02-04 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 2, MTM NAD 83 Zone 10: N 4 813 856.9 E 226 242.2 ORIGINATED BY ES

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MFA

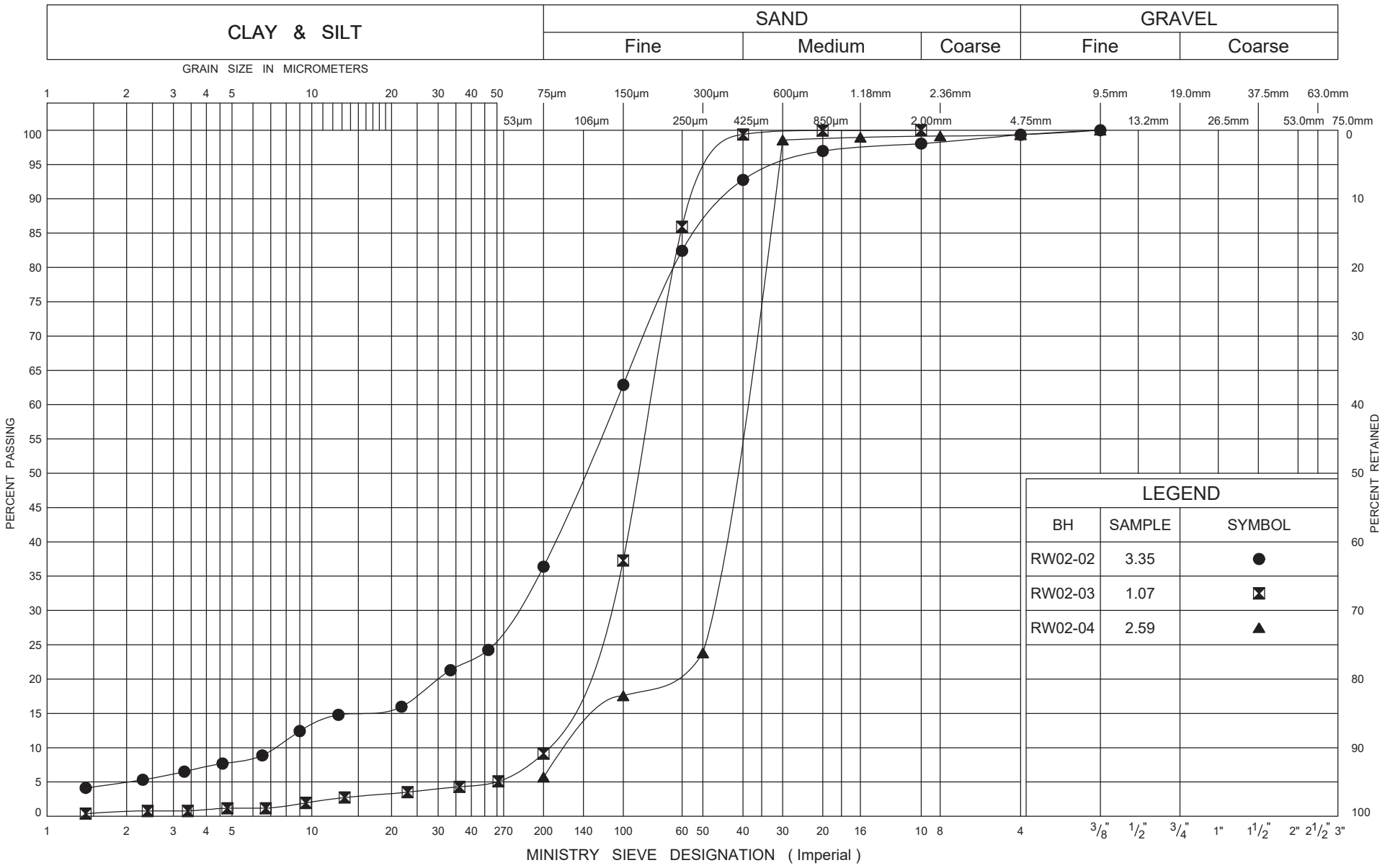
DATUM Geodetic DATE 2019.09.23 - 2019.09.23 LATITUDE 43.460514 LONGITUDE -80.470774 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff Grey Moist Hard						309				
			10	SS	37		308				
306.9							307				
12.2	Silty **CLAY**, trace sand Stiff Grey Wet		11	SS	9						0 1 30 69
							306				
			12	SS	12		305				
			13	SS	12		304				
	silty sand layer at 15.8m (80mm)						303				
			14	SS	37		302				0 2 39 59
301.7											
17.4	END OF BOREHOLE AT 17.4m. WATER LEVEL AT 1.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.6m, SAND TO 0.2m, THEN ASPHALT TO SURFACE.										

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

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/13/19



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GRAIN SIZE DISTRIBUTION

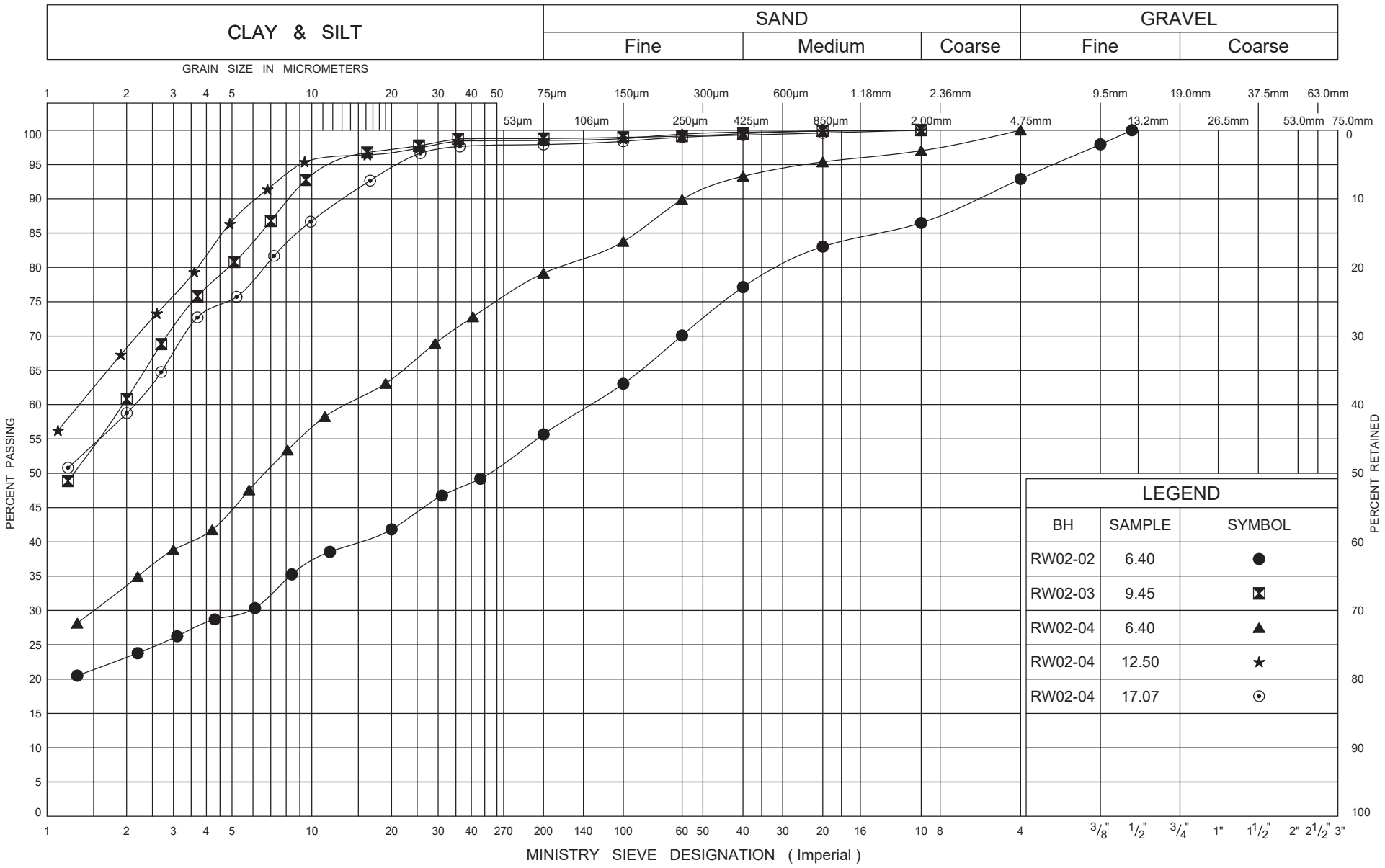
Upper SAND

FIG No B1

W P 408-88-00

Retaining Wall 2

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



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GRAIN SIZE DISTRIBUTION

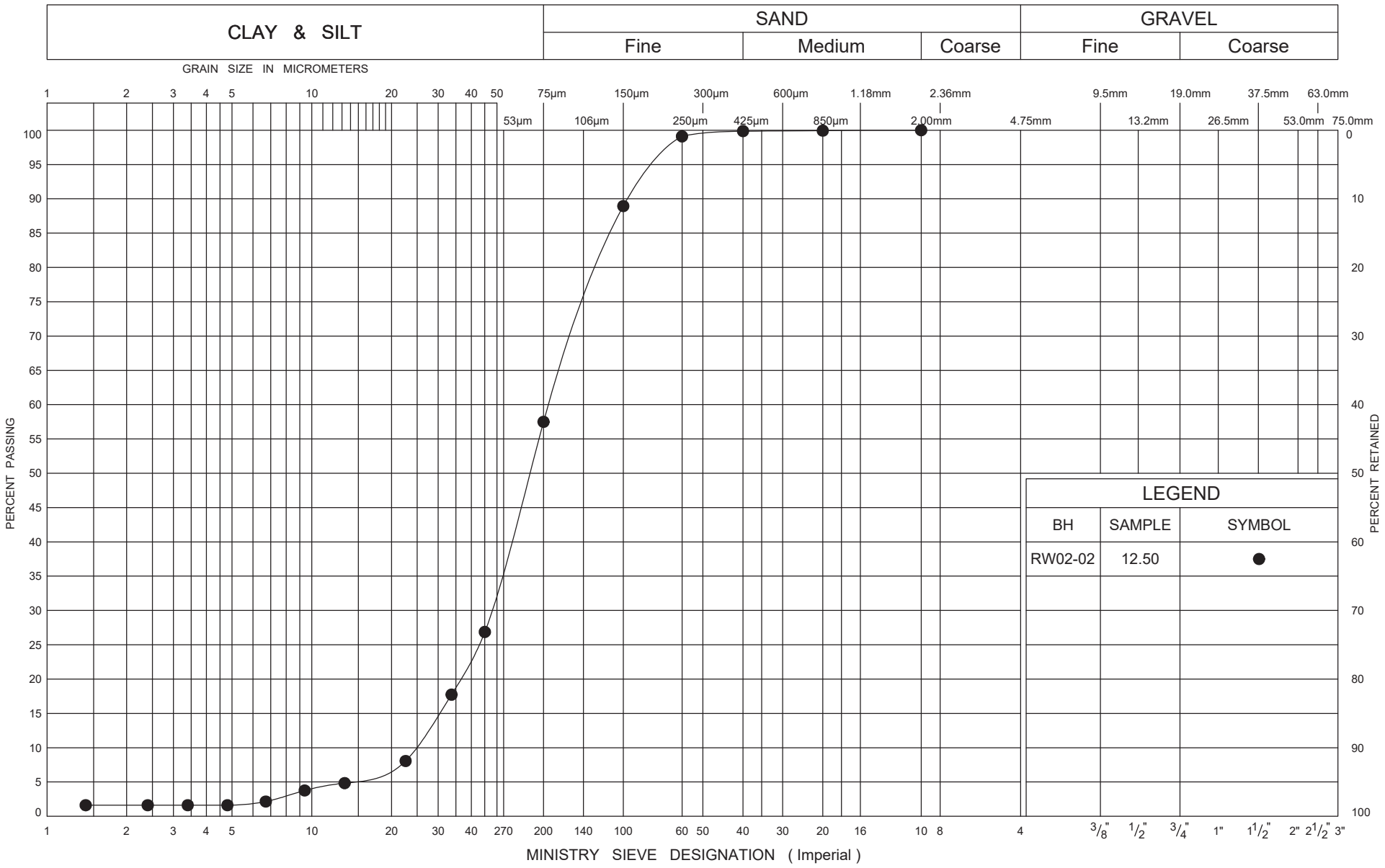
Silty CLAY

FIG No B2

W P 408-88-00

Retaining Wall 2

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



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GRAIN SIZE DISTRIBUTION

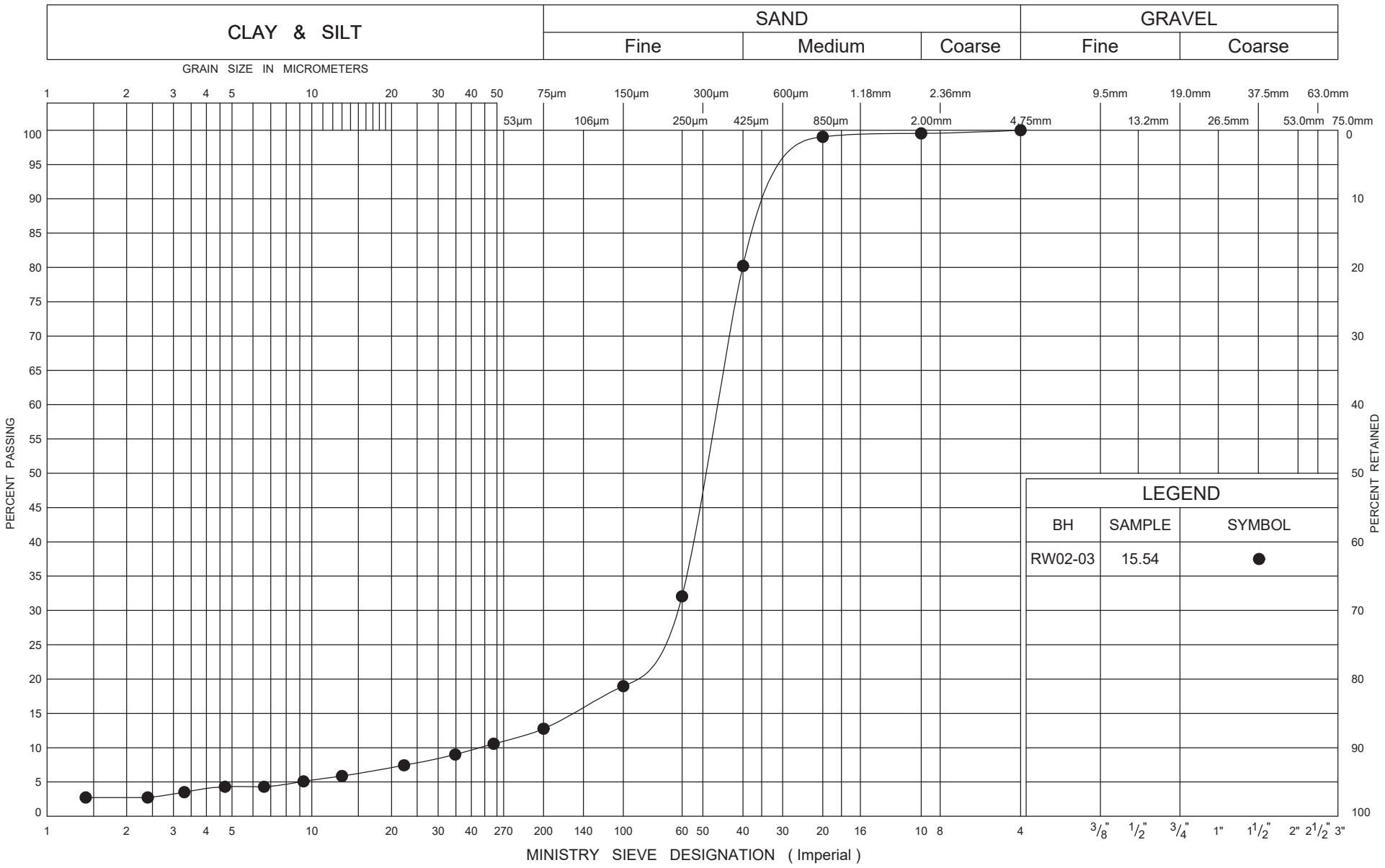
SILT and SAND

FIG No B3

W P 408-88-00

Retaining Wall 2

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

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GRAIN SIZE DISTRIBUTION

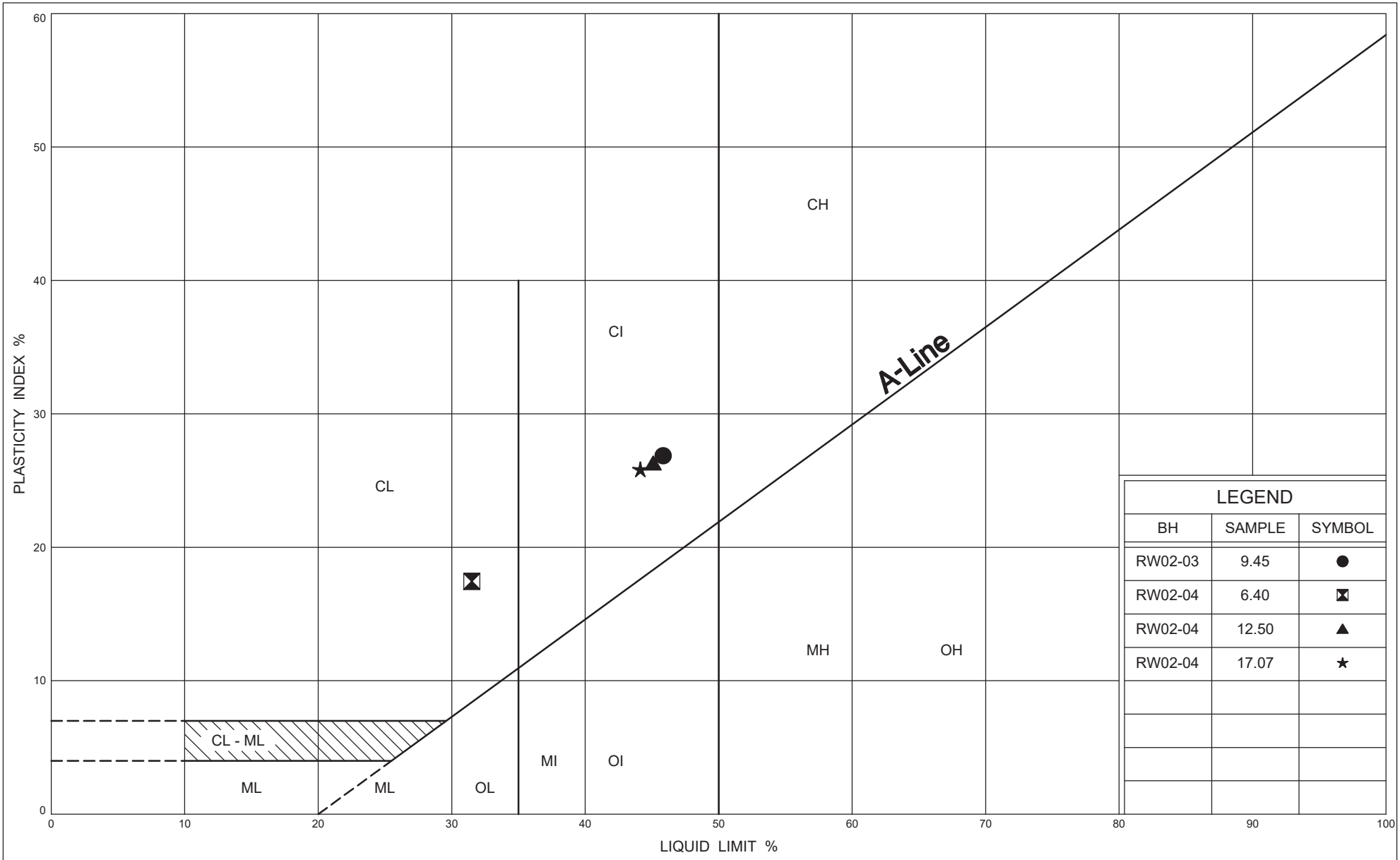
Lower SAND

FIG No B4

W P 408-88-00

Retaining Wall 2

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

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PLASTICITY CHART

Silty CLAY

FIG No B5

W P 408-88-00

Retaining Wall 2

THURBER

Record of Borehole Sheets and Laboratory Test Results for Previous Investigation (Geocres No. 40P8-199 - Reference 1)

(RW-01 to RW-04)

Foundation investigation and design report for Northeast Corner Retaining Wall, Prederick Street Underpass, Site No. 33-234, G.W.P. 3110-09-00, City of Kitchener, Ontario, prepared by Peto MacCallum Ltd., PML Ref. 10KF079C, Geocres No. 4098-199, dated May 31, 2012

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

Ontario

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Foundation Design

RECORD OF BOREHOLE No RW-1 1 of 1 METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 701.9 N; 226 222.6 E **ORIGINATED BY** R.B.

DIST London **HWY** 7/ 85 **BOREHOLE TYPE** C.F.H.S.A. and Dynamic Cone Penetration Test **COMPILED BY** N.S.B

DATUM Geodetic **DATE** April 08, 2011 **CHECKED BY** B.R.G.

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
319.7	Ground Surface										
0.0	Asphalt over sand some silt, some gravel Very loose Brown Wet (FILL)		1	AS	-						
318.3			2	SS	3		319				
1.4	Silty clay, trace sand Very stiff Brown Moist sand layers to 4.9m		3	SS	17		318		225		(**)
	Hard to Greyish very stiff brown		4	SS	34	*	317		225		
			5	SS	25				225		
			6	SS	28		316		225		
	Hard		7	SS	37		315		225		
			8	SS	31		314		225		
			9	SS	33		313		225		
			10	SS	39		312		225		
309.9							311				
9.8	End of borehole						310				

* Borehole dry

(**) Base of footing -El.318.2

Note: Borehole cave-in at 8.5m

C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers

Water Level Readings:

Date	Depth (m)	Elev.
Apr. 08,'11	2.9	316.8

Piezometer Legend:

- Bentonite seal
- Filter sand
- 19mm dia. PVC screen
- Bentonite grout

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RW-2 1 of 1 METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 710.4 N; 226 223.0 E **ORIGINATED BY** R.B.

DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers **COMPILED BY** N.S.B

DATUM Geodetic **DATE** April 08, 2011 **CHECKED BY** B.R.G.

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
319.7	Ground Surface										
0.0	Asphalt over sand and crushed gravel, trace silt Compact Brown Moist (FILL)		1	AS	-						
			2	SS	11		319				
318.3											
1.4	Silty clay, trace gravel sand layers Stiff Dark brown Moist		3	SS	9		318		225		(**) 1 4 43 52
	sand layers to 3.7m Hard Greyish brown		4	SS	31		317		225		
			5	SS	23				225		0 2 45 53
							316				
			6	SS	44		315		225		
							314				
			7	SS	43				225		0 0 32 68
						▼*	313				
			8	SS	35		312		225		
							311				
			9	SS	29				225		
309.9							310				
9.8	End of borehole										

* 2011 04 08

▼ Water level measured after drilling

(**) Base of footing -El.318.2

Note: Borehole cave-in at 8.7m

Numbers refer to Sensitivity 20 15 5 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RW-3 1 of 1 METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 719.3 N; 226 229.5 E **ORIGINATED BY** F.P.

DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Dynamic Ram Sounder **COMPILED BY** N.S.B

DATUM Geodetic **DATE** July 19, 2011 **CHECKED BY** B.R.G.

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
322.3	Ground Surface										
0.0	Silty sand some clay, trace gravel organic inclusions Compact Grey Moist (FILL) clayey silt layers gravelly sand Compact Brown Damp clayey silt layers		1	SS	14		322				8 37 37 18
			2	SS	27		321				3 50 34 13 4 26 45 25
			3	SS	20						23 39 27 11 4 25 42 29
320.0							320				
2.3	Sand trace to some gravel trace clay Compact Brown Moist to wet		4	SS	21						15 76 6 3
			5	SS	18		319				10 76 10 4
317.9			6	SS	14		318				(11**) 73 12 4
4.4	Silty clay trace sand, trace gravel silty sand and gravelly sand layers, cobbles Hard Grey Moist		7	SS	36						3 23 50 24
			8	SS	67		317				
315.9			9	SS	70/15cm		316				
6.4	End of borehole										

Sample 9: Sampler bouncing

* 2011 07 19

▽ Water level observed during drilling

(**) Base of footing -El.318.2

Water Level Readings:

Date	Depth (m)	Elev.
July 19,'11	Dry	----
Sept. 23,'11	3.3	319.0
Oct. 08, '11	3.3	319.0

Piezometer Legend:

- Bentonite seal
- Filter sand
- 30mm dia. PVC screen
- Filter bed

Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No RW-4 1 of 1 METRIC

G.W.P. 3110-09-00 **LOCATION** Coords: 4 813 705.4 N; 226 228.2 E **ORIGINATED BY** A.L.

DIST London **HWY** 7/ 85 **BOREHOLE TYPE** Dynamic Ram Sounder **COMPILED BY** N.S.B

DATUM Geodetic **DATE** July 20, 2011 **CHECKED BY** B.R.G.

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
323.5	Ground Surface										
0.0	Silty sand, some clay trace gravel, rootlets Compact Brown Moist (FILL)		1	SS	21		323		○		4 47 35 14
	Silt with sand, trace gravel Compact Grey		2	SS	21				○		22 20 54 4
	Sand, some silt some gravel, trace clay Compact Brown		3	SS	21		322	125 ■	○		15 68 11 6
321.2	Clayey silt, trace sand										
2.3	Very stiff Grey Sand trace to some gravel trace to some silt trace clay Compact Brown Moist to wet		4	SS	20		321		○		9 83 (8)
			5	SS	13				○		11 73 12 4
	Gravelly to with gravel		6	SS	13	▽*	320		○		38 43 13 6
			7	SS	9		319		○		26 68 3 3
			8	SS	14		318	175 ■	○		(**)
317.6											
5.9	Silty clay, trace gravel cobbles Stiff to hard Grey Moist		9	SS	49						
			10	SS	52/15cm		317				
316.5			11	SS	50/13cm						
7.0	End of borehole Samples 10 and 11: Sampler bouncing * 2011 07 20 ▽ Water level observed during drilling (**) Base of footing -El.318.2 Note: Borehole cave-in at 5.0m										

ON MTO_VER3 NEW LOGO 10KF079 RW LOGS.GPJ ON_MOT.GDT 5/28/2012 2:05:32 PM

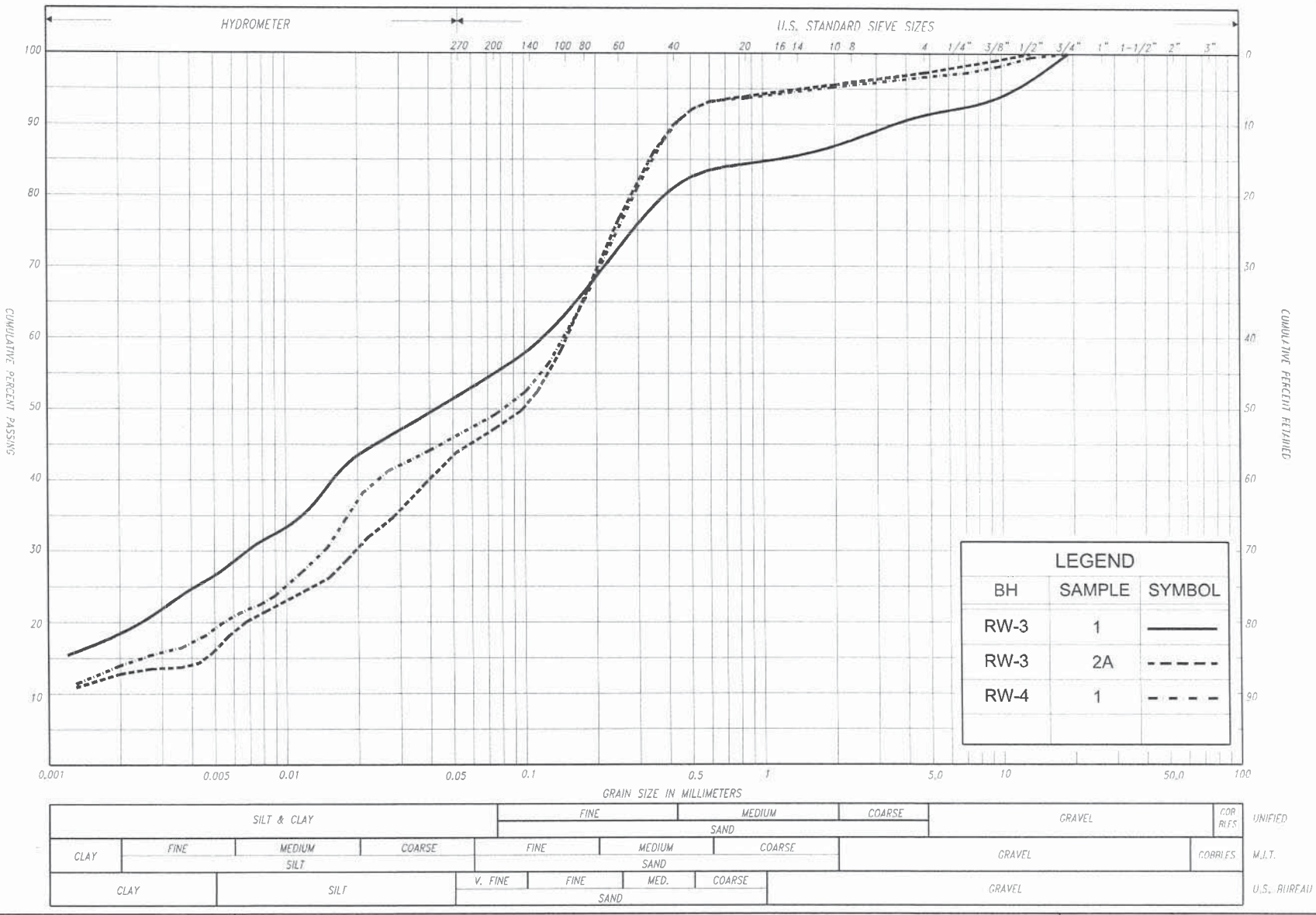
Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

TABLE A-1

LIST OF ATTERBERG LIMITS RESULTS

SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	DEPTH / ELEVATION (m)	MOISTURE CONTENT (W %)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
Clayey Silt Fill	RW-3	3B	2.1 / 320.2	-	22	12	10
Silty Clay	RW-2	3	1.9 / 317.8	19	36	18	18
	RW-2	5	3.3 / 316.3	19	35	17	18
	RW-2	7	6.3 / 313.4	21	45	23	22

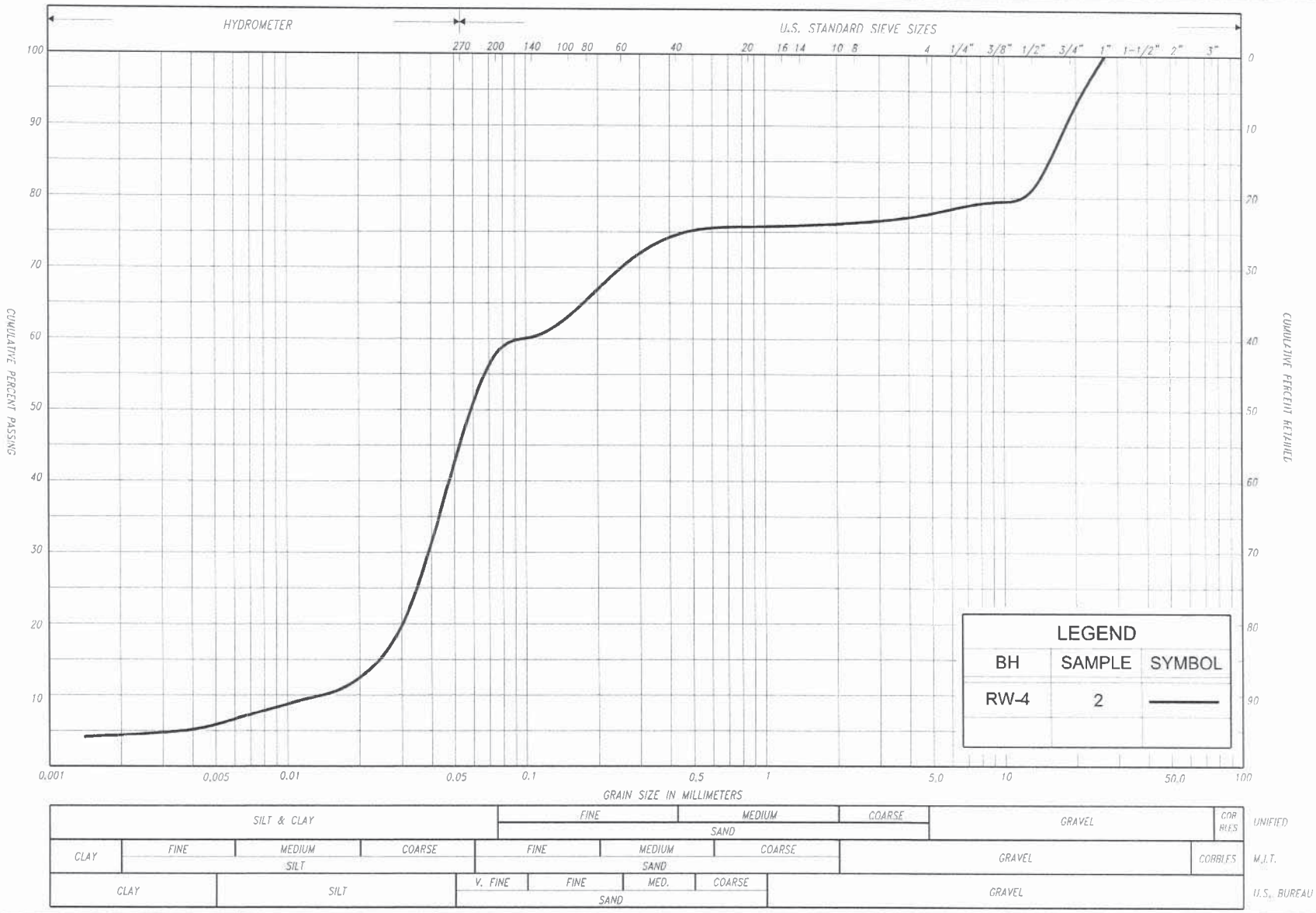


Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND, some clay, trace gravel
(FILL)

FIG No.	RW-GS-1
HWY:	7 / 85
G.W.P. No.	3110-09-00

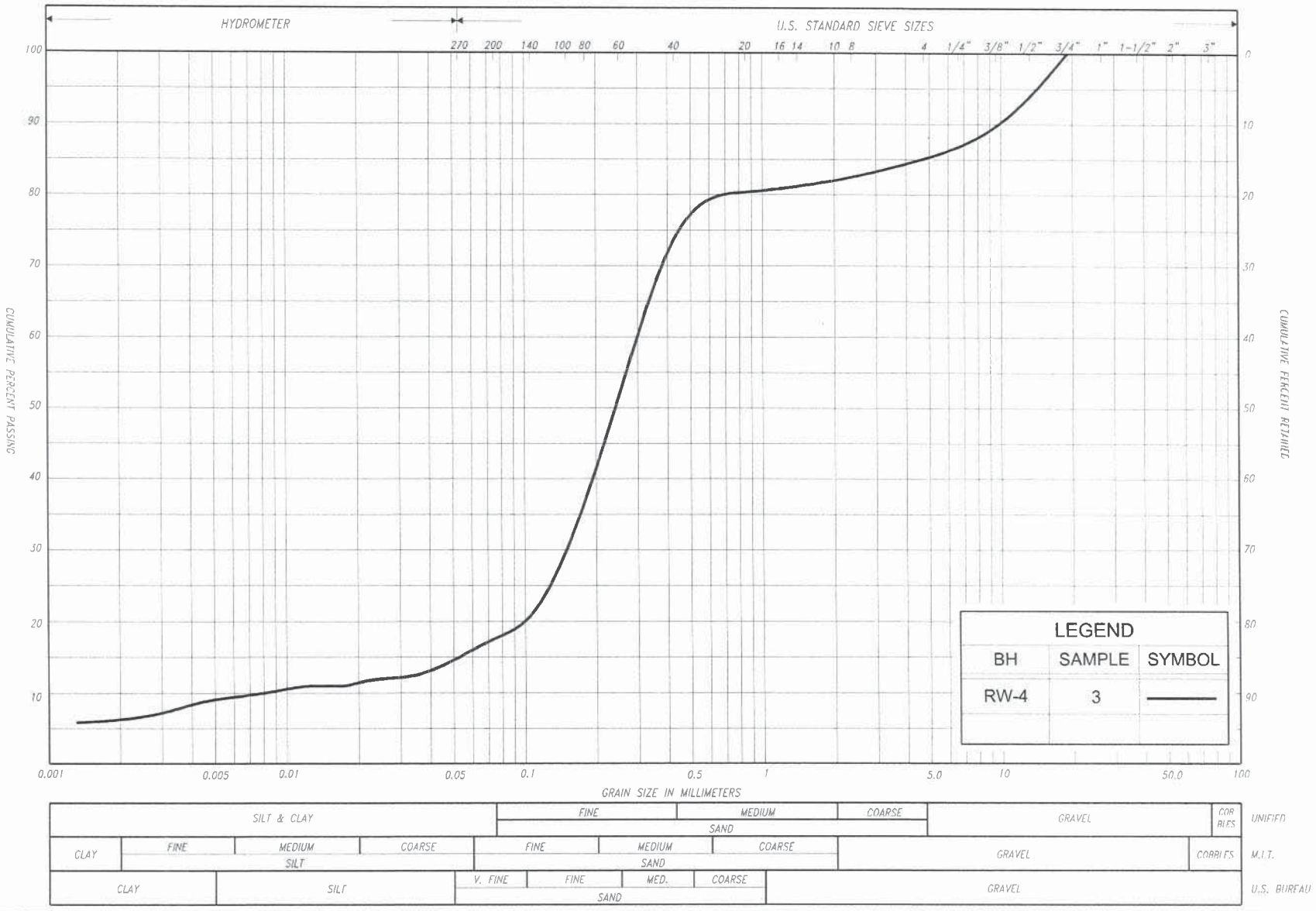


Ontario

GRAIN SIZE DISTRIBUTION

SILT, some sand, some gravel, trace clay
(FILL)

FIG No.	RW-GS-2
HWY:	7 / 85
G.W.P. No.	3110-09-00

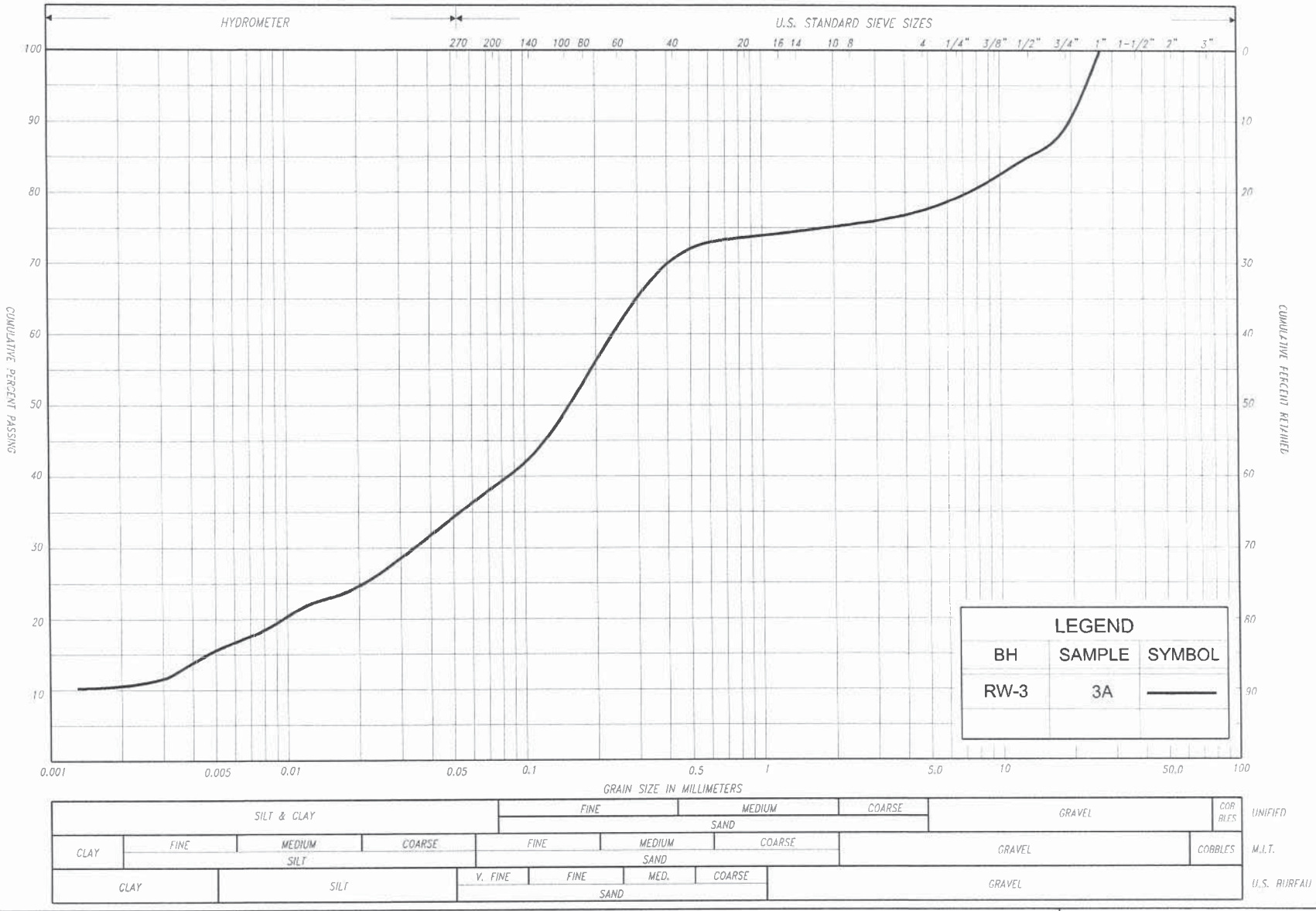


Ontario

GRAIN SIZE DISTRIBUTION

SAND, some silt, some gravel, trace clay
(FILL)

FIG No.	RW-GS-3
HWY:	7 / 85
G.W.P. No.	3110-09-00

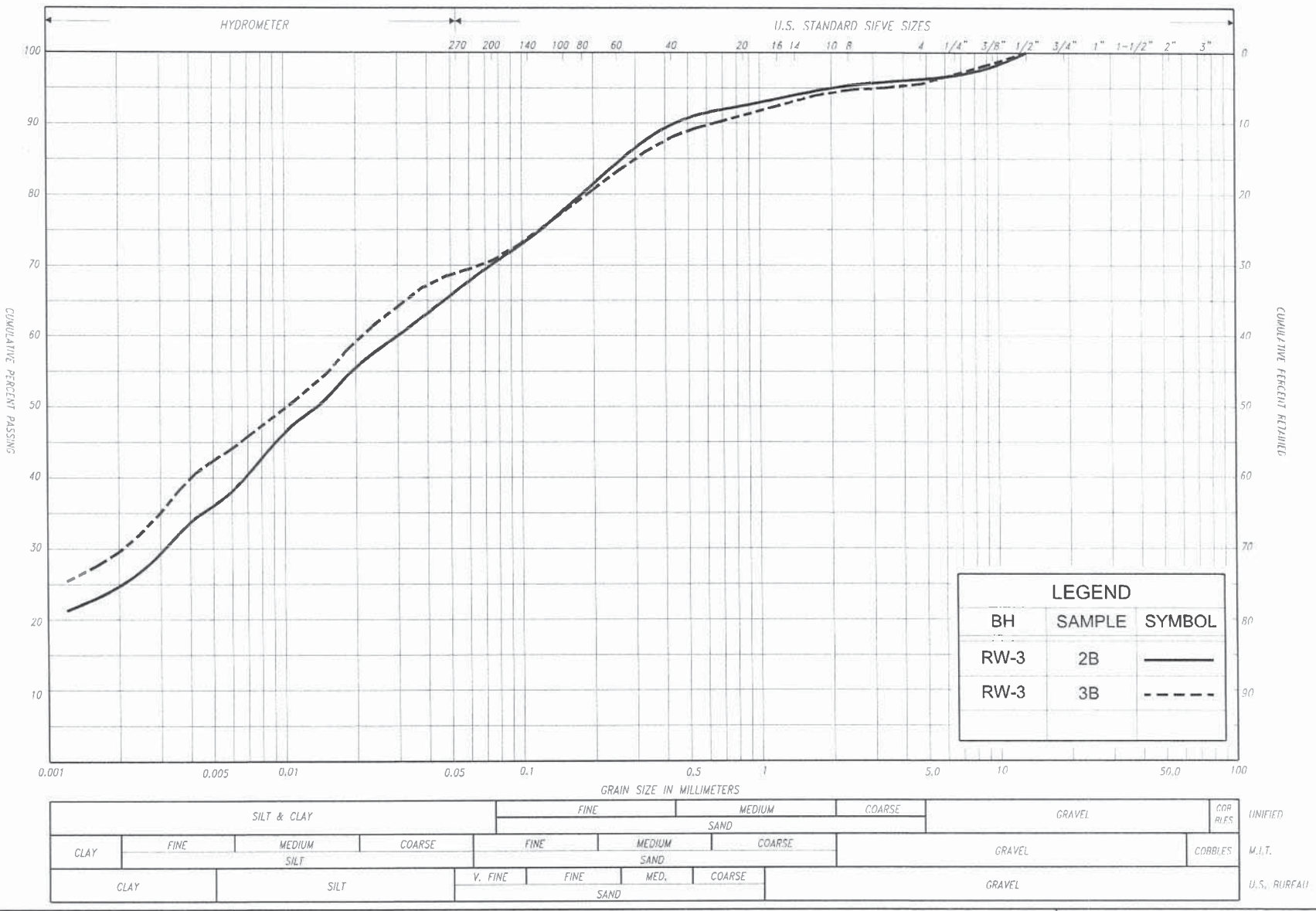


Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, with silt, some clay
(FILL)

FIG No.	RW-GS-4
HWY:	7 / 85
G.W.P. No.	3110-09-00

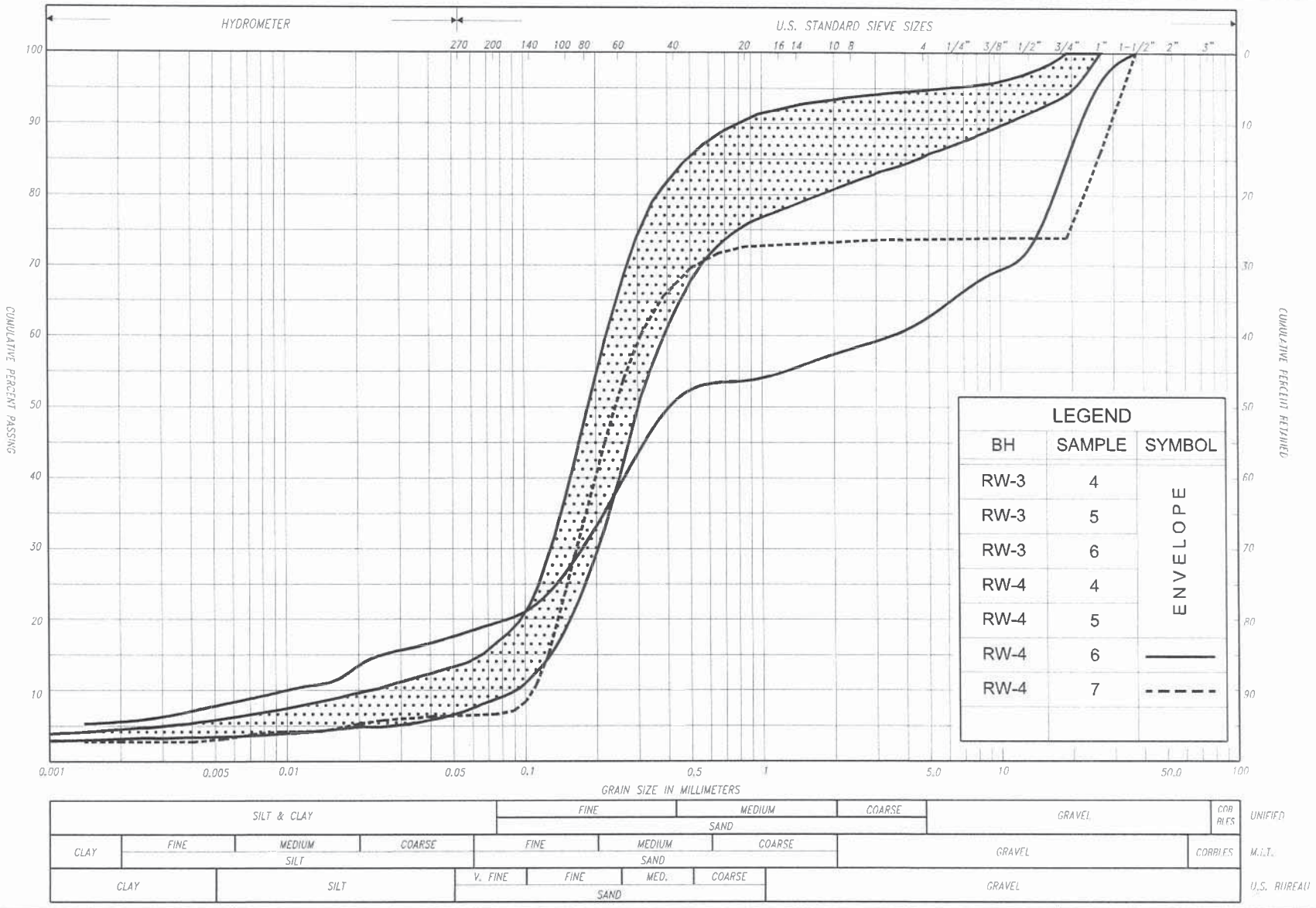


Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand, trace gravel (CI)
(FILL)

FIG No.	RW-GS-5
HWY:	7 / 85
G.W.P. No.	3110-09-00

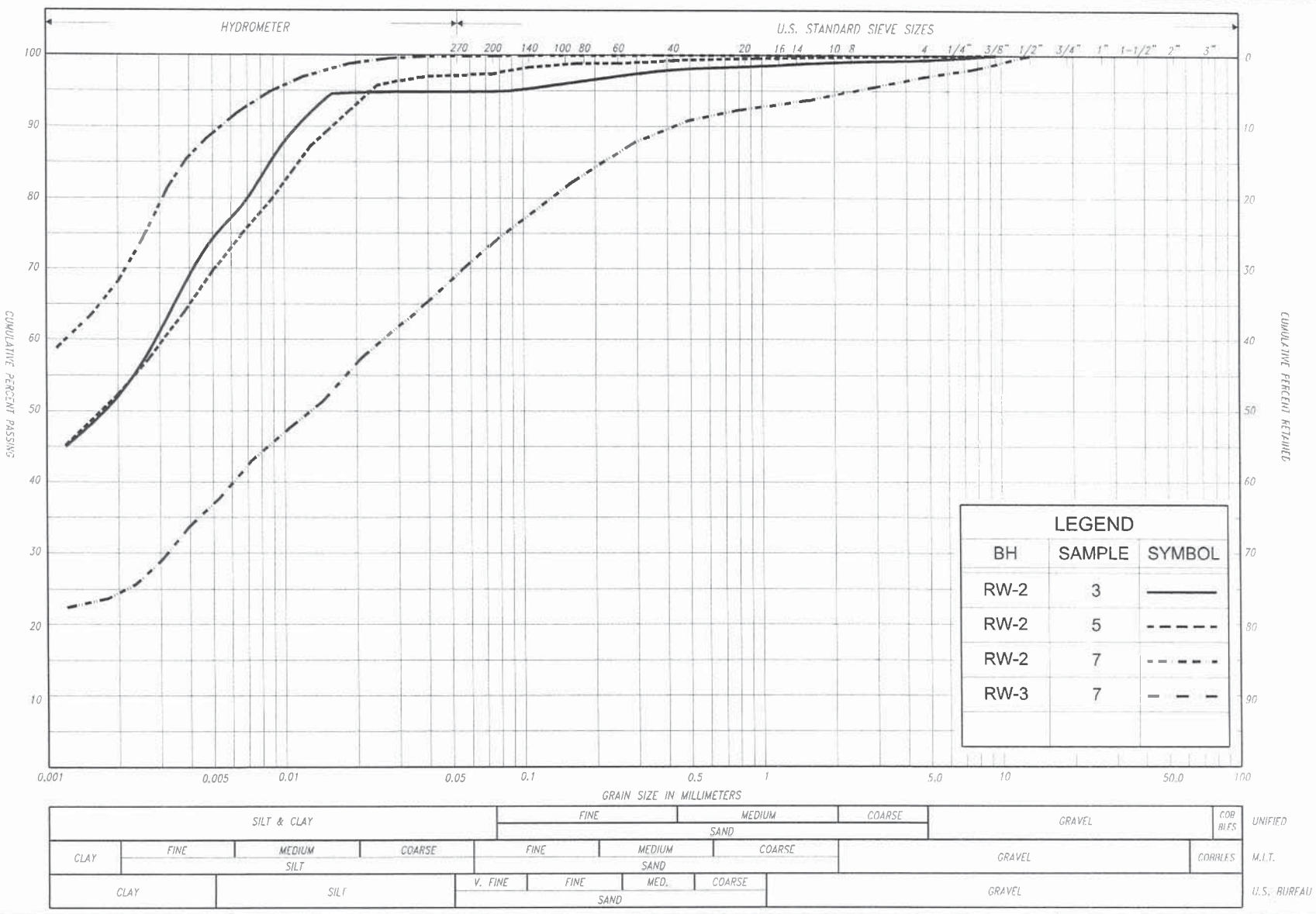


Ontario

GRAIN SIZE DISTRIBUTION

SAND, trace gravel to gravelly, trace to some silt, trace clay

FIG No.	RW-GS-6
HWY:	7 / 85
G.W.P. No.	3110-09-00

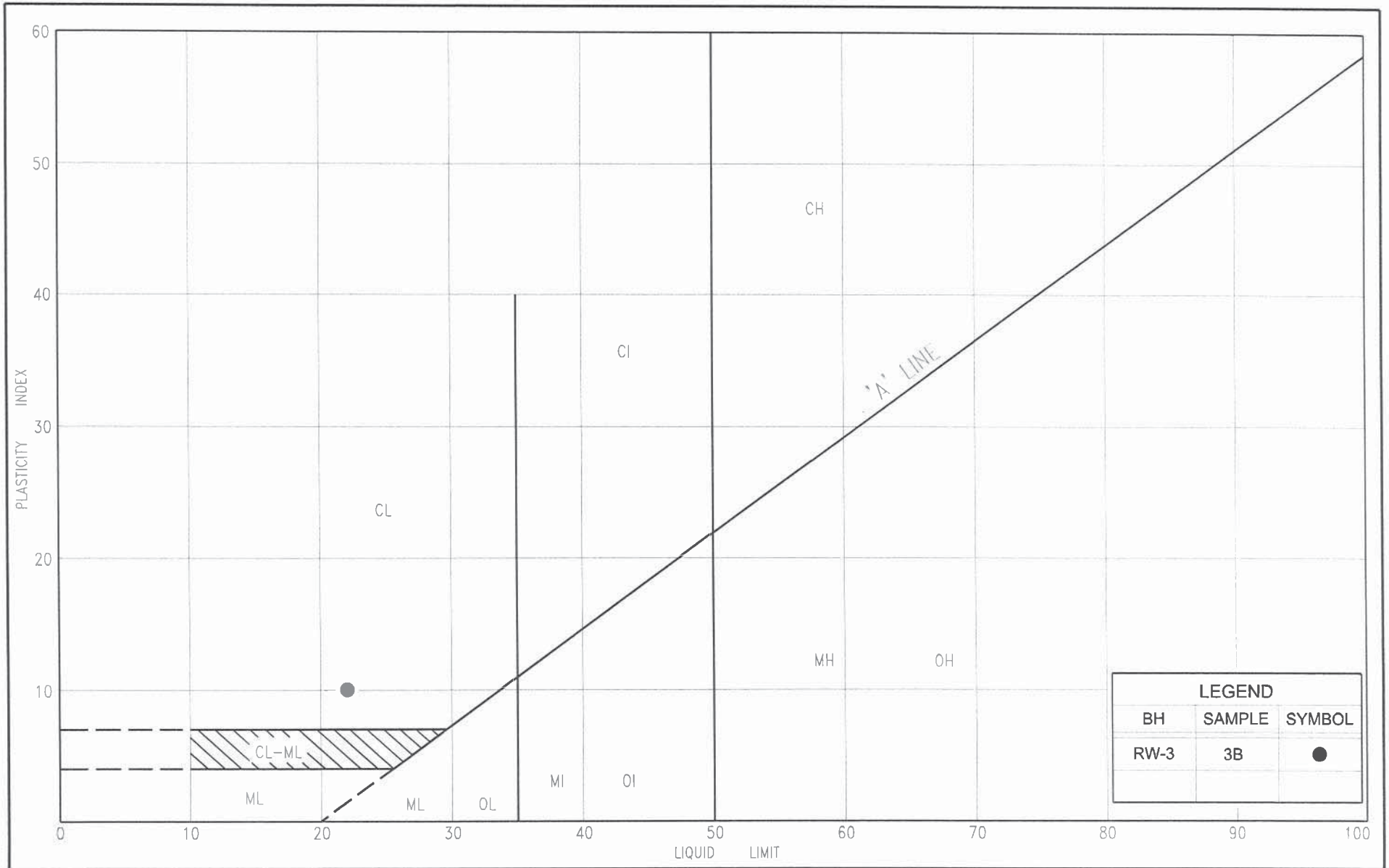


Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, trace to with sand, trace gravel (CI)

FIG No.	RW-GS-7
HWY:	7 / 85
G.W.P. No.	3110-09-00

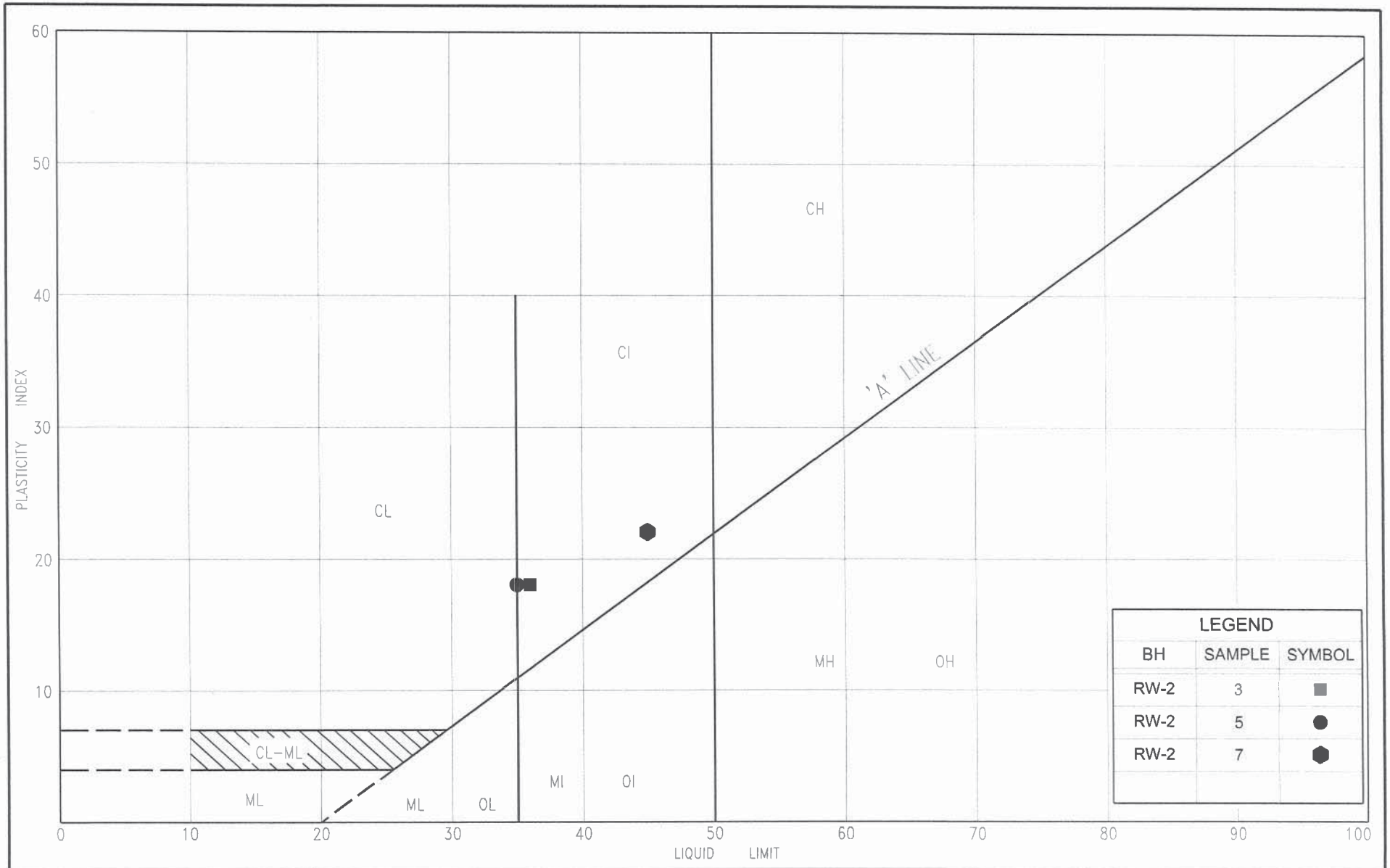


Ontario

PLASTICITY CHART

CLAYEY SILT, with sand, trace gravel (CL)
(FILL)

FIG No.	RW-PC-1
HWY:	7 / 85
G.W.P. No.	3110-09-00



Ontario

PLASTICITY CHART

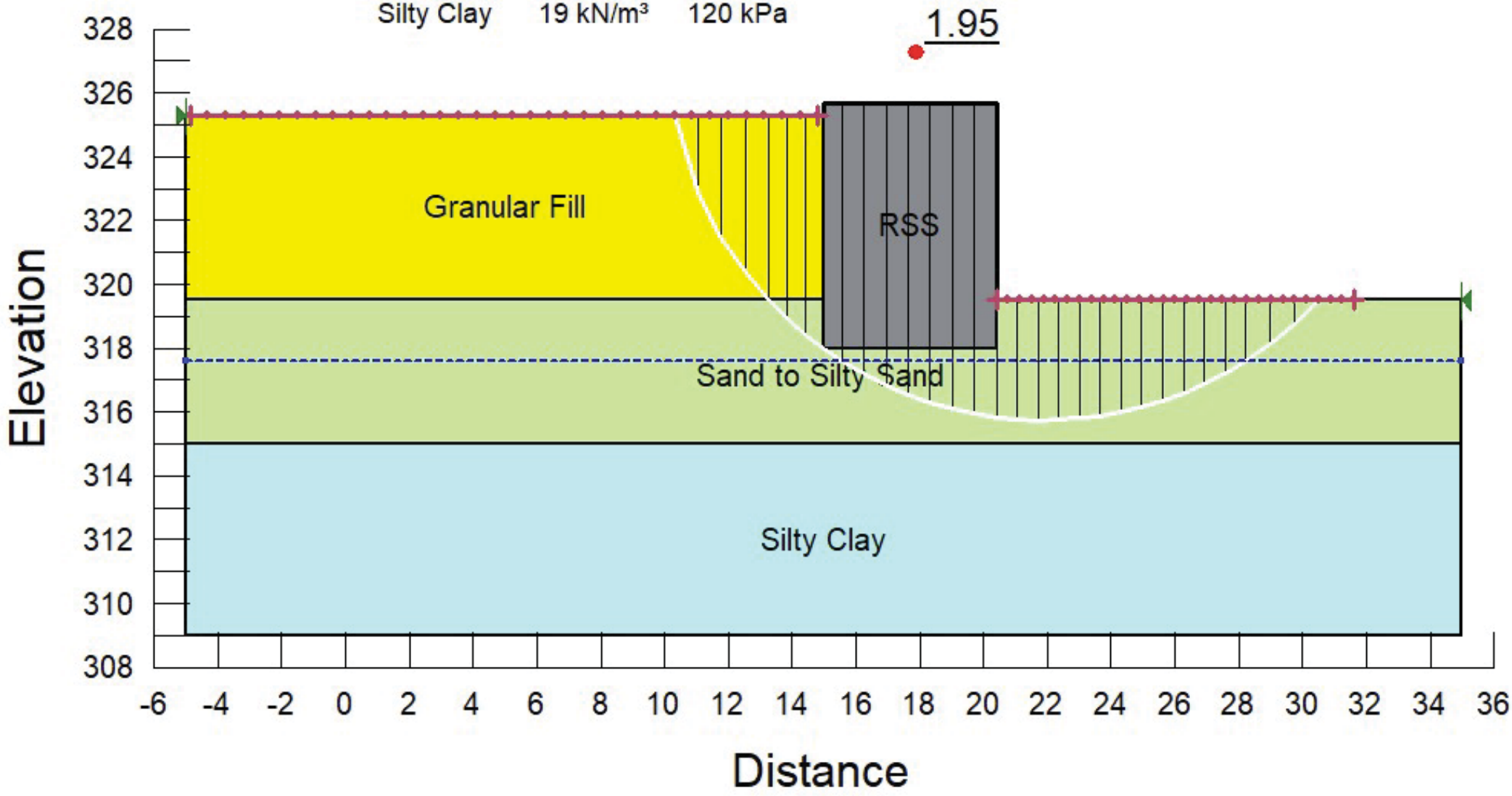
SILTY CLAY, trace to with sand, trace gravel (CI)

FIG No.	RW-PC-2
HWY:	7 / 85
G.W.P. No.	3110-09-00

Figure B6

File Name: RW2 Sta 21+325.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	35 °
Sand to Silty Sand	18 kN/m³	0 kPa	30 °
Silty Clay	19 kN/m³	120 kPa	



File Name: RW2 Sta 21+325.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure B7

RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	35 °
Sand to Silty Sand	18 kN/m³	0 kPa	30 °
Silty Clay (2)	19 kN/m³	5 kPa	30 °

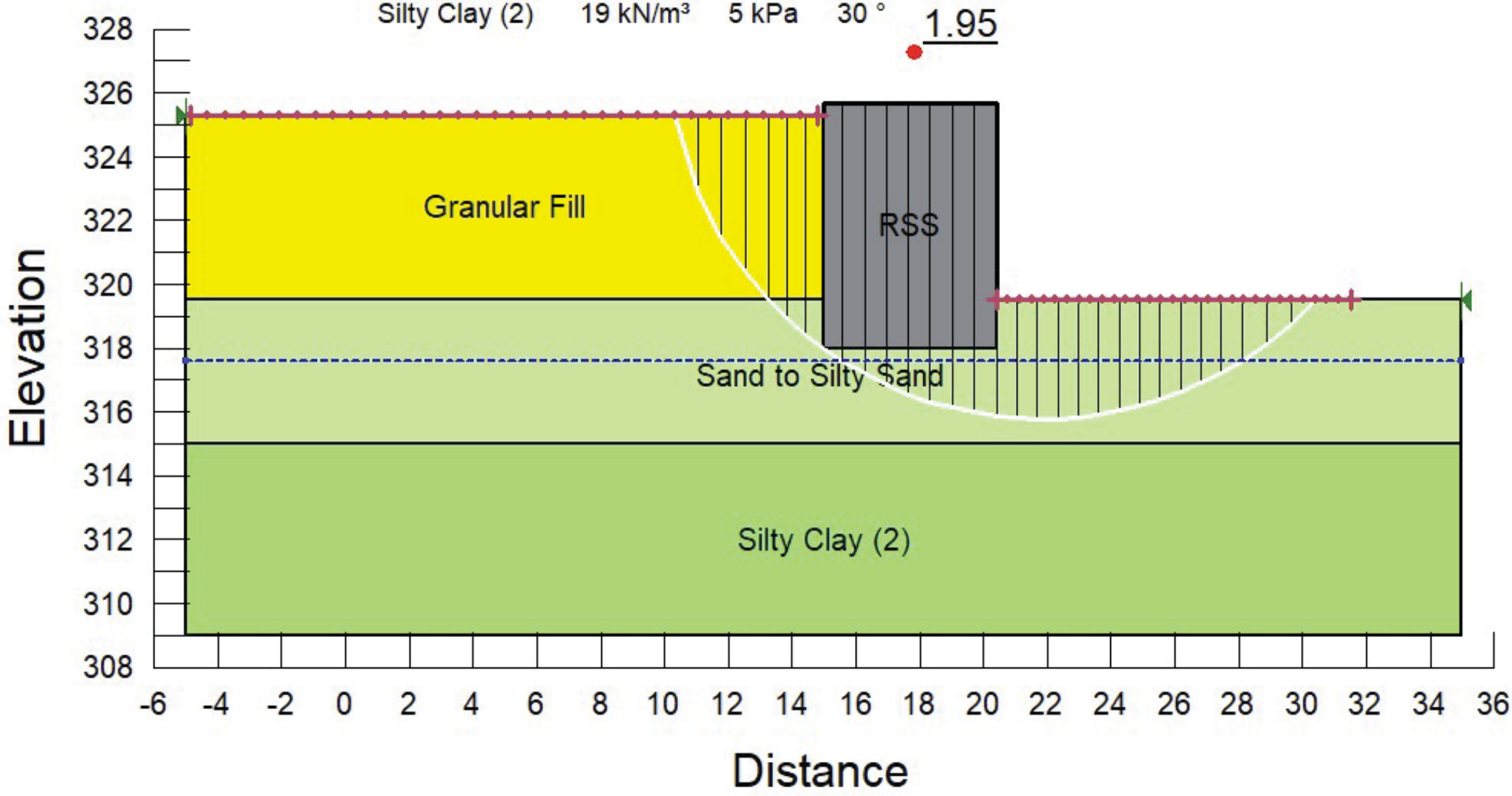
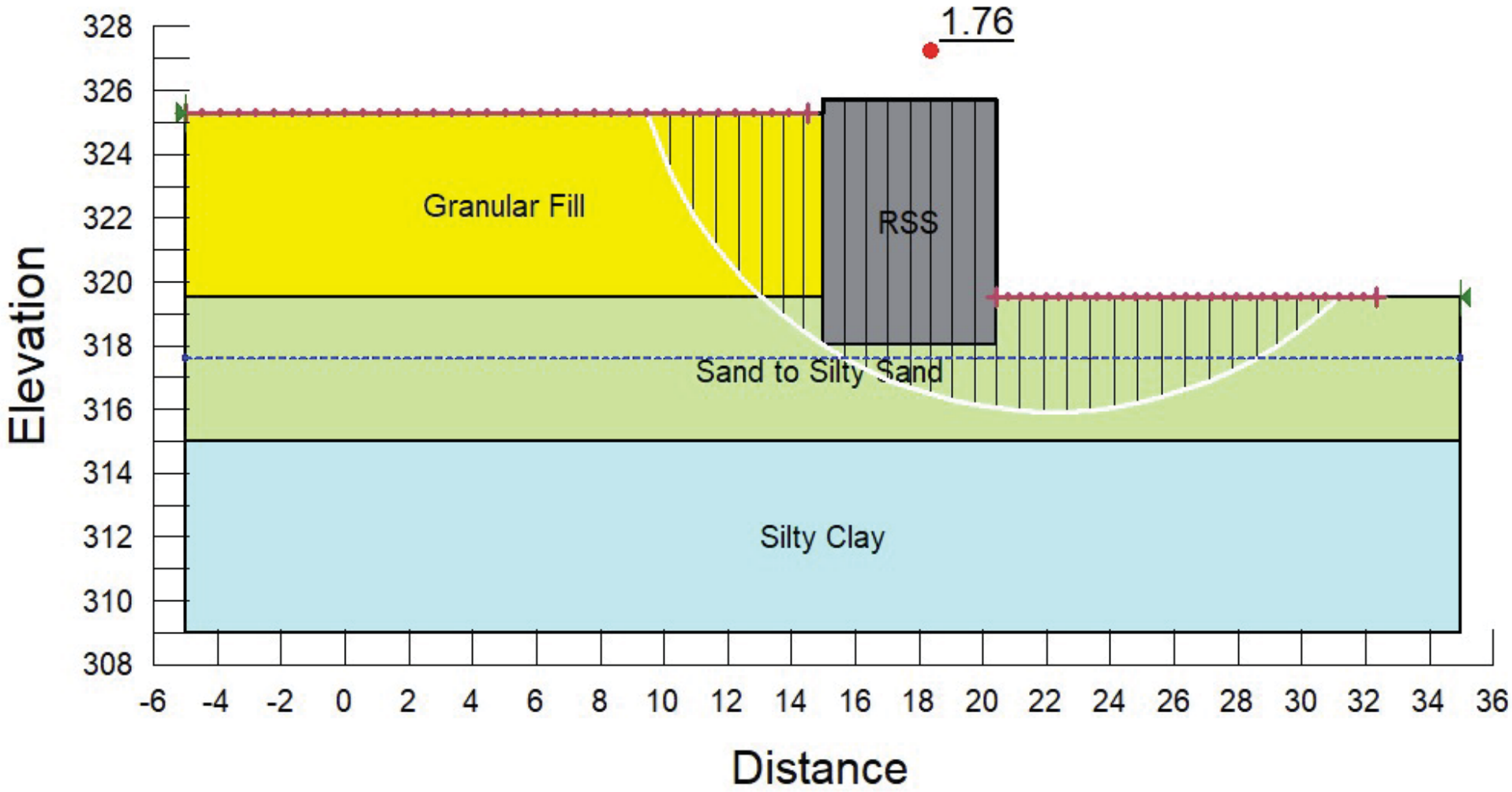


Figure B8

File Name: RW2 Sta 21+325.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Horz Seismic Coef.: 0.0485

RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	35 °
Sand to Silty Sand	18 kN/m³	0 kPa	30 °
Silty Clay	19 kN/m³	120 kPa	



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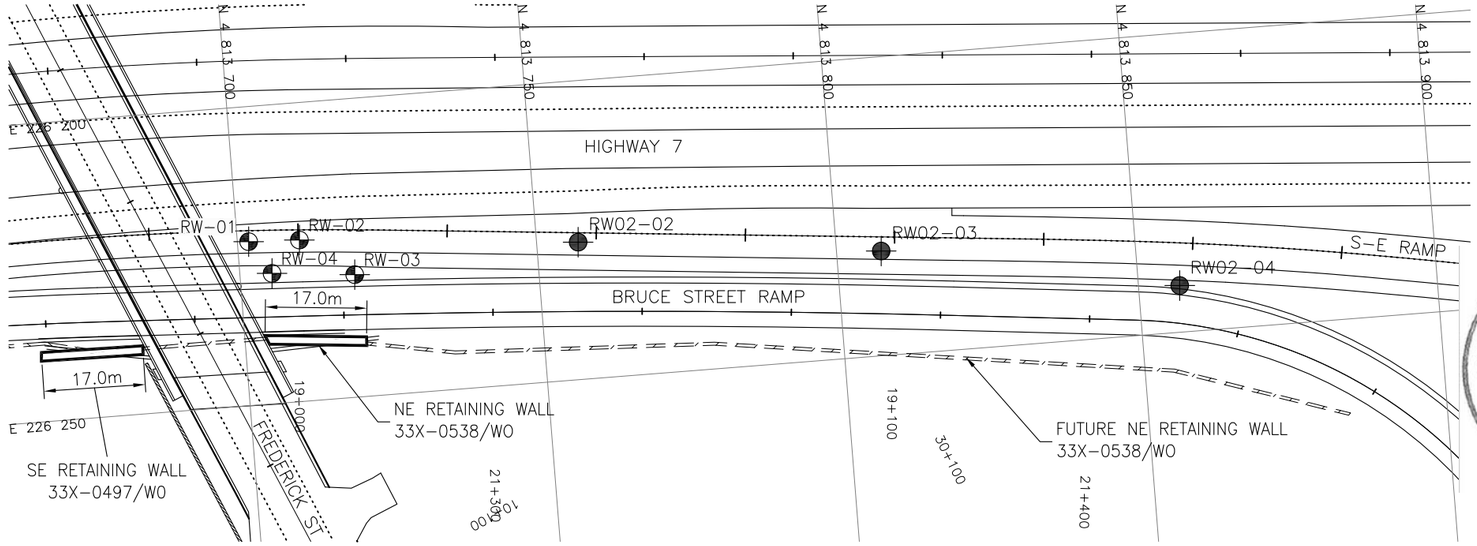
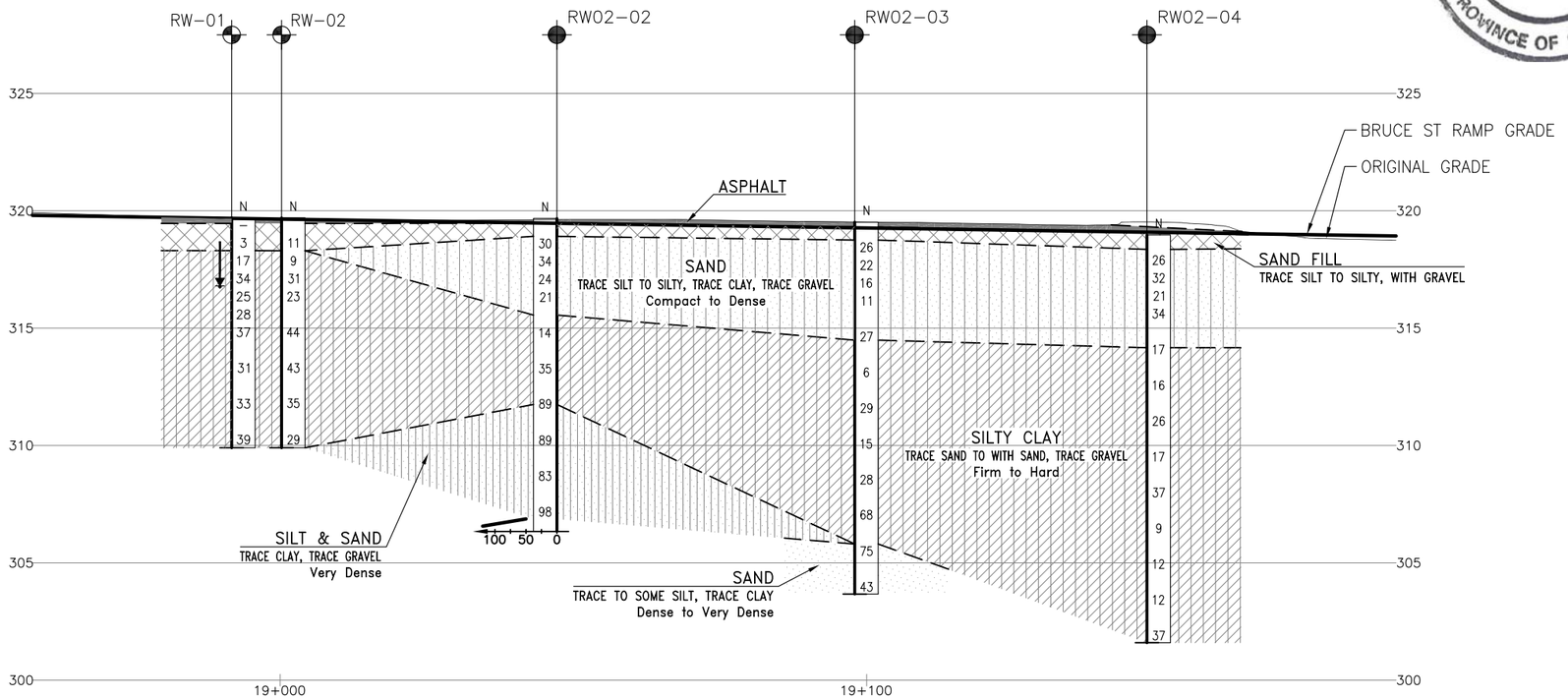


PLAN

20 0 20 40m

SCALE 1:1000



PROFILE ALONG BRUCE STREET RAMP
FREDERICK STREET–N/E–ANN STREET

20 0 20 40m H 1:1000

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
G. R. LAY
100194778
06/08/2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
06/08/2021
PROVINCE OF ONTARIO

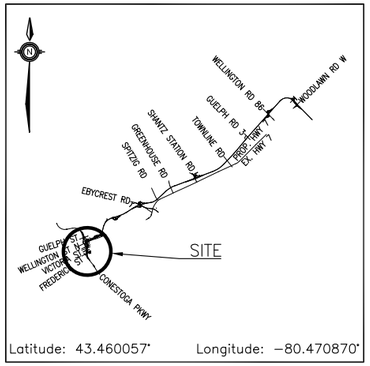
CONT No
GWP No 3005–20–00

SHEET

HIGHWAY 7
FREDERICK ST.–N/E–ANN ST.
NE RETAINING WALL 33X–0538/WO
BOREHOLE LOCATIONS AND SOIL STRATA

wsp

THURBER ENGINEERING LTD.



Latitude: 43.460057° Longitude: –80.470870°

KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW02–02	319.6	4 813 757.0	226 227.0
RW02–03	319.5	4 813 807.5	226 232.5
RW02–04	319.1	4 813 856.9	226 242.2
RW–01	319.7	4 813 710.9	226 222.6
RW–02	319.7	4 813 710.4	226 233.0
RW–03	322.3	4 813 719.2	226 229.5
RW–04	323.5	4 813 705.4	226 228.2

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P8-290

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	NB	CHK PKC	CODE	LOAD	DATE JUN 2021
DRAWN	MFA	CHK NB	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\11000\11375\TED–11375–BHPP–RW02.dwg
PLOTDATE: 6/8/2021 5:37 PM

THURBER

APPENDIX C
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing
NW Retaining Wall - Site # 33X-0860/W0

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THURBER

RECORD OF BOREHOLE No RW16-01 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 677.3 E 226 163.6 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.19 - 2019.08.19 LATITUDE 43.458863 LONGITUDE -80.471748 CHECKED BY NB

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.3	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	Sandy **SILT**, with gravel Brown Dry		1	GS			321	○	○		
320.5	(FILL)										
0.8	**SAND**, some silt to silty, trace clay, trace gravel Compact Brown Wet		2	SS	25		320		○		
			3	SS	26				○		2 78 16 4
319.0							319				
2.3	Silty **CLAY**, trace sand, trace gravel Very Stiff Grey Moist		4	SS	25				○		
			5	SS	22		318		○		
			6	SS	21		317		○		
			7	SS	28		316				0 1 32 67
	Hard		8	SS	58		315		○		
312.5							314				
8.8	Sandy **SILT**, trace clay Dense Grey Wet		9	SS	42		313				
							312		○		

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW16-01 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 677.3 E 226 163.6 ORIGINATED BY JP

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.19 - 2019.08.19 LATITUDE 43.458863 LONGITUDE -80.471748 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						311				
310.0			10	SS	45				○		0 24 70 6
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED TO 0.2m AND WATER LEVEL NOT OBSERVED. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No RW16-02 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 716.6 E 226 163.9 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.15 - 2019.08.19 LATITUDE 43.459222 LONGITUDE -80.471733 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
320.4	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND** and **GRAVEL**, granular Brown Dry		1	GS			320				
319.7	(FILL)										
0.7	Silty **SAND**, some clay, occasional cobbles Loose Brown		2	SS	8						
319.0	Moist						319				
1.4	Silty **CLAY**, trace sand, trace shale Very Stiff to Hard Brown Dry to Moist		3	SS	25						
			4	SS	35		318				0 5 53 42
	Grey		5	SS	39	▽	317				
			6	SS	38		316				
			7	SS	21		315				
			8	SS	32		314				
			9	SS	41		313				
							312				
310.4							311				0 1 45 54

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No RW16-02 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 716.6 E 226 163.9 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.15 - 2019.08.19 LATITUDE 43.459222 LONGITUDE -80.471733 CHECKED BY NB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
10.0	Silty **CLAY**, trace sand, trace shale Very Stiff to Hard Brown Dry to Moist						310				
309.1			10	SS	21				○		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE CAVED TO 10.4m AND WATER LEVEL AT 3.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

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

20
15 5
10
(%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No RW16-03 1 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 755.4 E 226 164.5 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.08.15 - 2019.08.15 LATITUDE 43.459582 LONGITUDE -80.471709 CHECKED BY NB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
319.9	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	**SAND** and **GRAVEL**, granular Brown Dry		1	GS							
319.3	(FILL)										
0.7	Clayey **SILT**, some sand and gravel Hard Grey Moist		2	SS	39		319				
318.5											
1.4	Silty **CLAY**, trace sand Very Stiff Grey Moist		3	SS	18		318				
			4	SS	16		317				
			5	SS	21		316				Auger grinding
			6	SS	15		315				
											Auger grinding
			7	SS	23		314				
							313				Auger grinding
			8	SS	23		312				0 2 36 62
311.3											Auger grinding
8.7	Sandy **SILT** to Silty **SAND** Compact Grey Wet		9	SS	18	▽	311				
							310				

Continued Next Page

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No RW16-03 2 OF 2 METRIC

GWP# 408-88-00 LOCATION Retaining Wall 16, MTM NAD 83 Zone 10: N 4 813 755.4 E 226 164.5 ORIGINATED BY BL

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

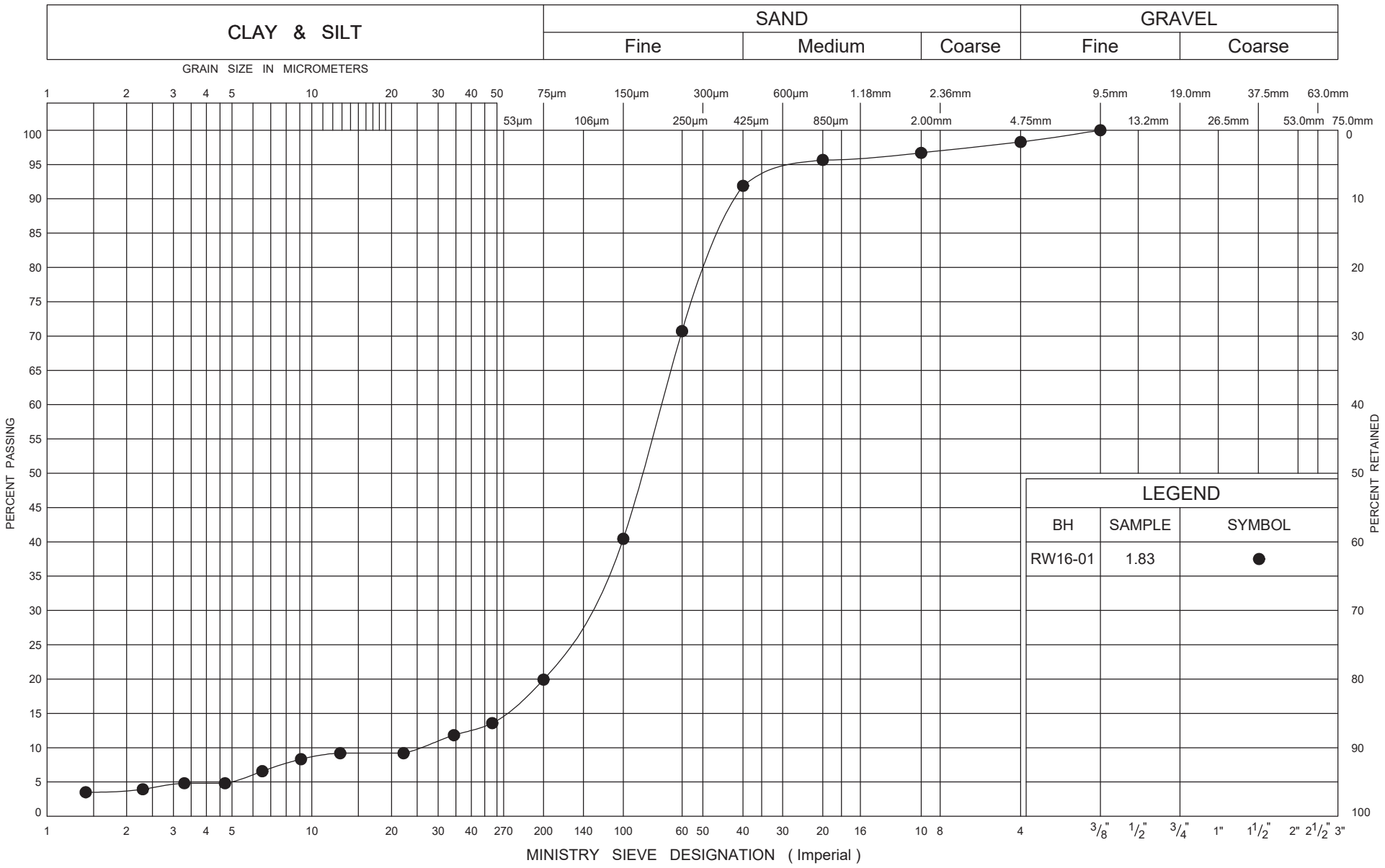
DATUM Geodetic DATE 2019.08.15 - 2019.08.15 LATITUDE 43.459582 LONGITUDE -80.471709 CHECKED BY NB

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
308.7	Sandy **SILT** to Silty **SAND** Compact Grey Wet		10	SS	27		309				Auger grinding
307.4	End of sampling DCPT from 11.3m to 12.5m (11.3)						308				
12.5	END OF BOREHOLE AT 12.5m. BOREHOLE CAVED TO 9.1m AND WATER LEVEL AT 8.8m UPON DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND ASPHALT PATCH TO SURFACE.										

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375.GPJ 2017TEMPLATE(MTO).GDT 12/10/19



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

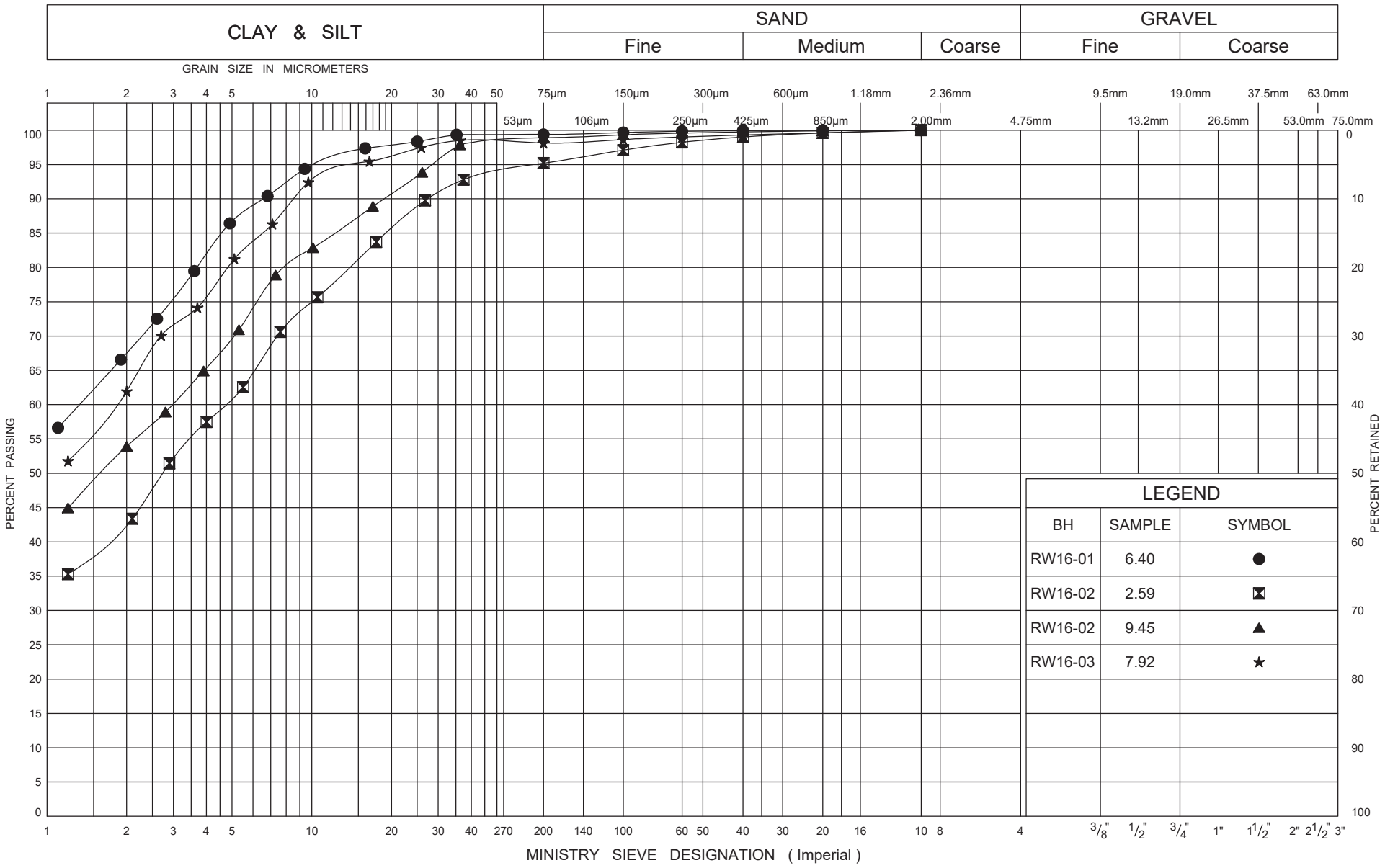
SAND

FIG No E1

W P 408-88-00

Retaining Wall 16

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

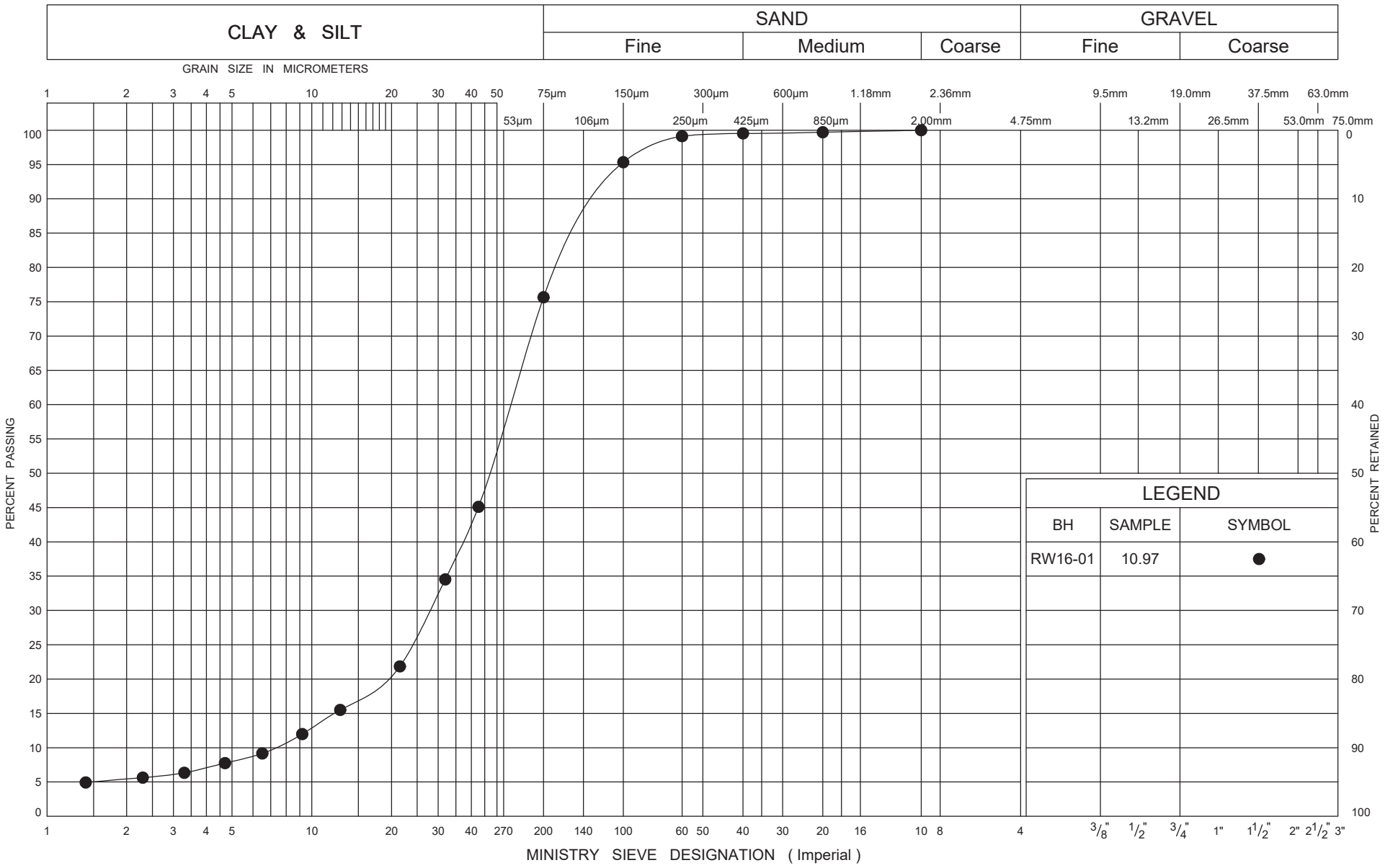
Silty CLAY

FIG No E2

W P 408-88-00

Retaining Wall 16

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19



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Ontario

GRAIN SIZE DISTRIBUTION

Silty SAND to Sandy SILT

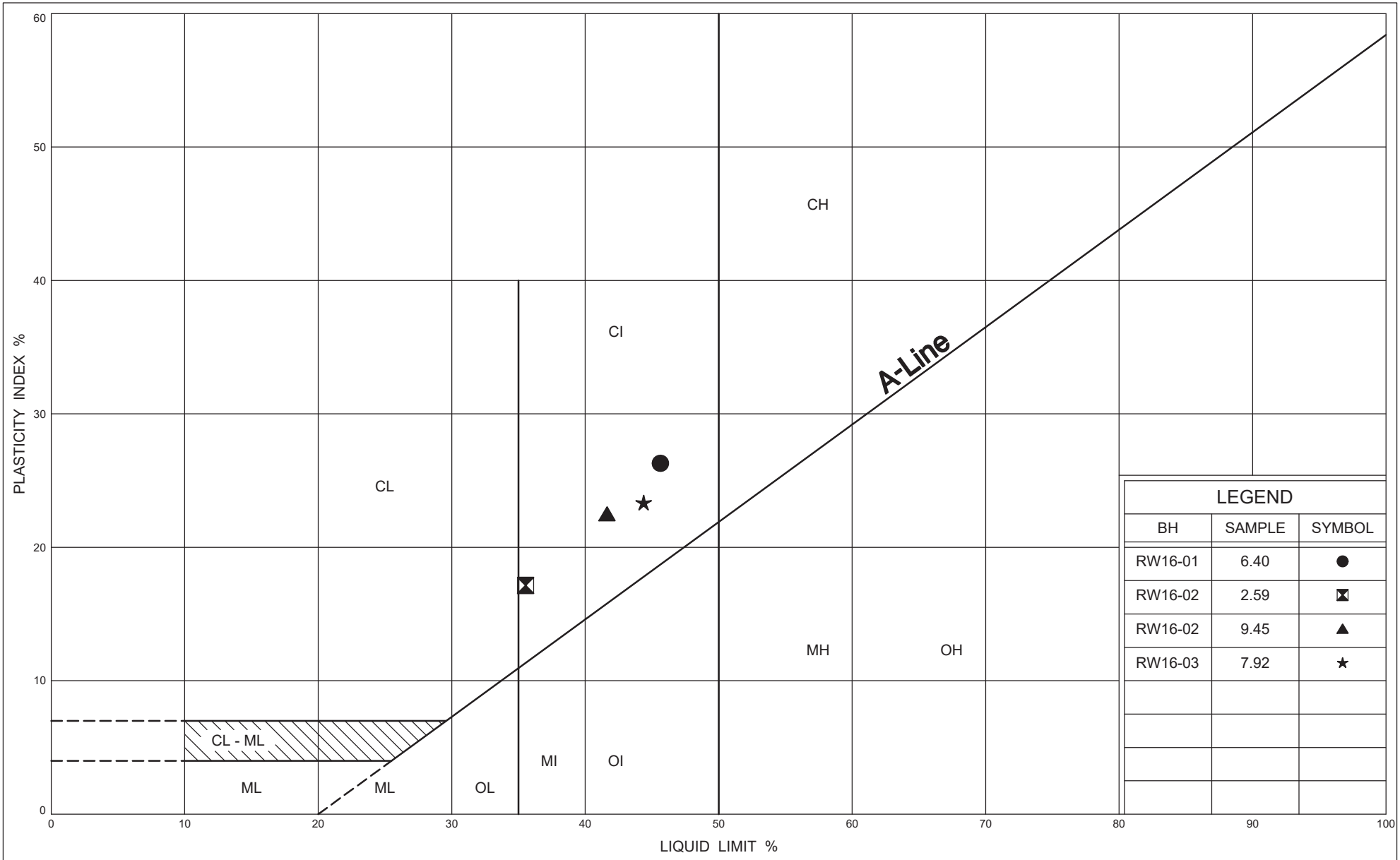
FIG No E3

W P 408-88-00

Retaining Wall 16

ONTARIO MOT GRAIN SIZE 2 MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

Oct 75, FF - S - 21



LEGEND		
BH	SAMPLE	SYMBOL
RW16-01	6.40	●
RW16-02	2.59	⊠
RW16-02	9.45	▲
RW16-03	7.92	★

ONTARIO MOT PLASTICITY CHART MTO-11375.GPJ ONTARIO MOT.GDT 12/10/19

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Ontario

PLASTICITY CHART

Silty CLAY

FIG No E4

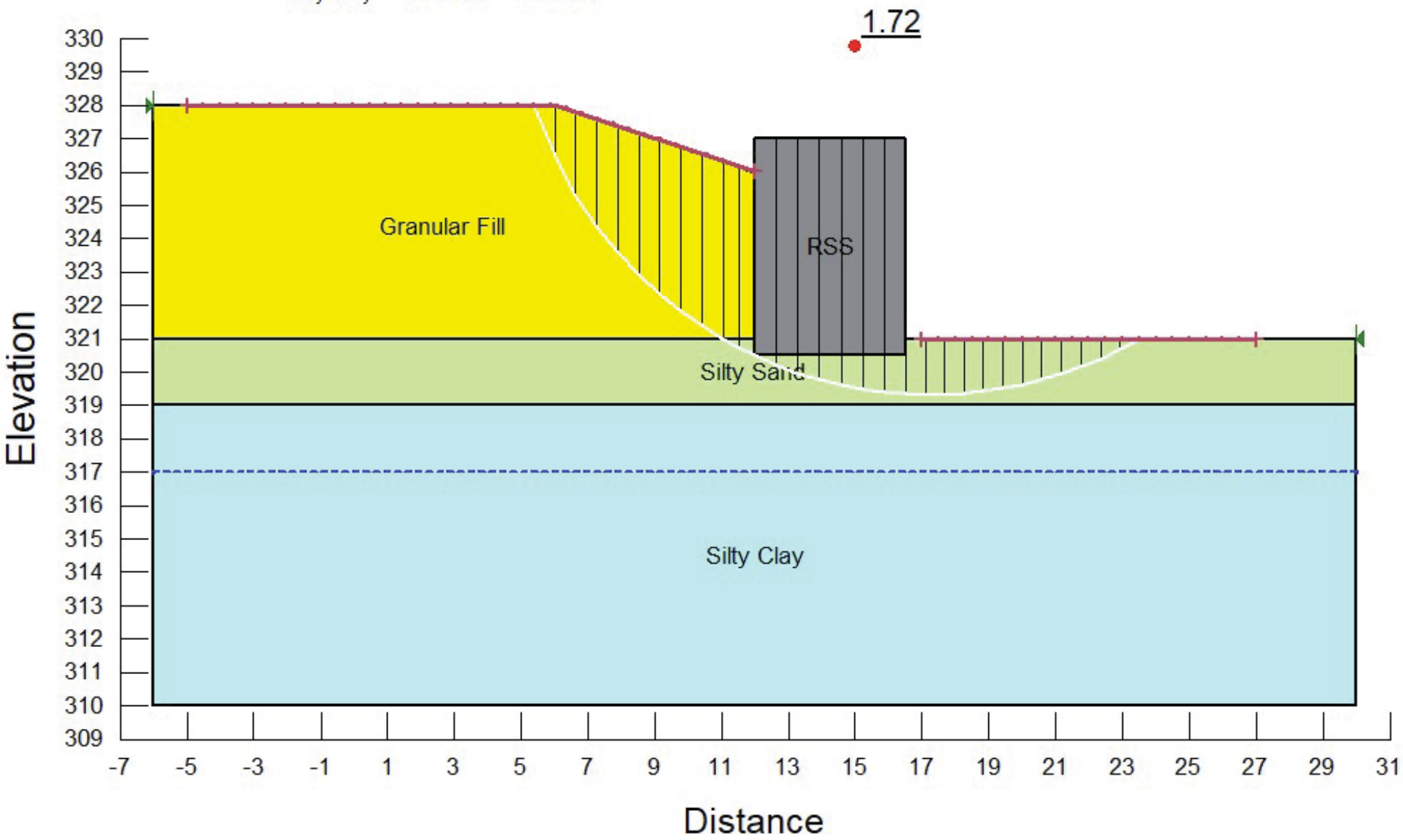
W P 408-88-00

Retaining Wall 16

Figure C5

File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

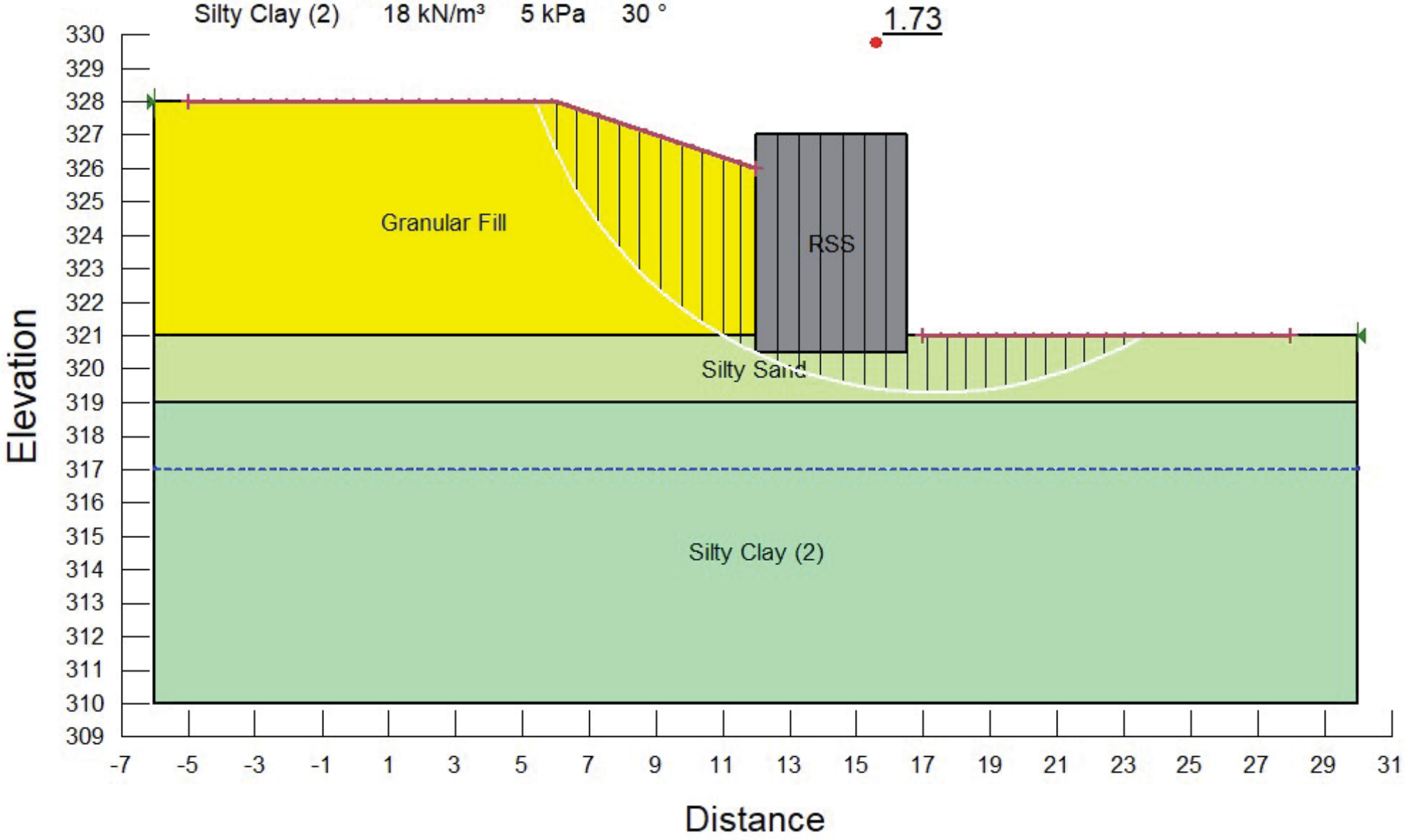
RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	30 °
Silty Sand	19 kN/m³	0 kPa	31 °
Silty Clay	18 kN/m³	120 kPa	



File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m

Figure C6

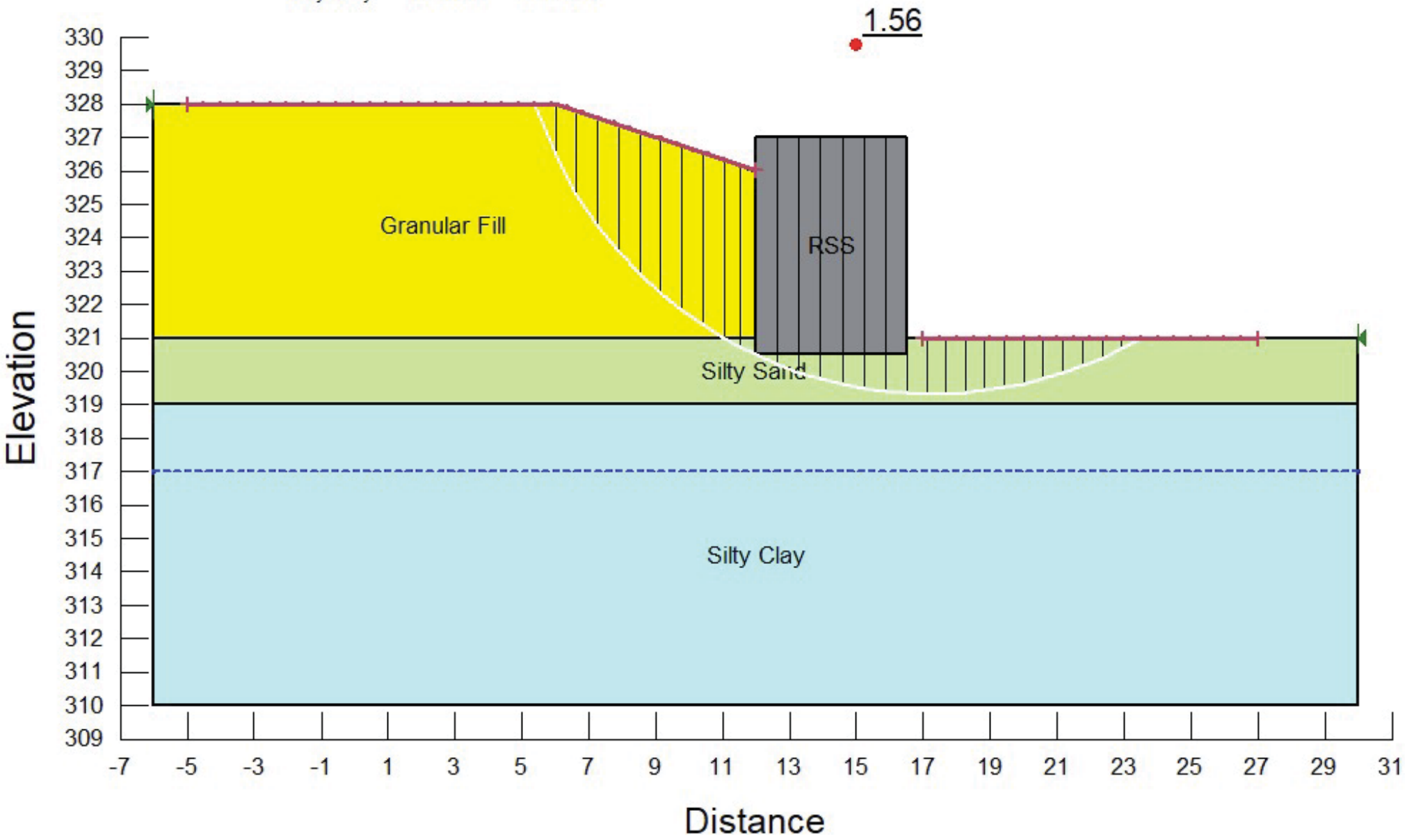
RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	30 °
Silty Sand	19 kN/m³	0 kPa	31 °
Silty Clay (2)	18 kN/m³	5 kPa	30 °



File Name: RW16 Sta 18+810.gsz
Last Edited By: Nancy Berg
Date: 2020-01-03
Method: Morgenstern-Price
Minimum Slip Surface Depth: 1 m
Horz. Seismic Coef.: 0.0485

RSS	22 kN/m³	200 kPa	45 °
Granular Fill	21 kN/m³	0 kPa	30 °
Silty Sand	19 kN/m³	0 kPa	31 °
Silty Clay	18 kN/m³	120 kPa	

Figure C7



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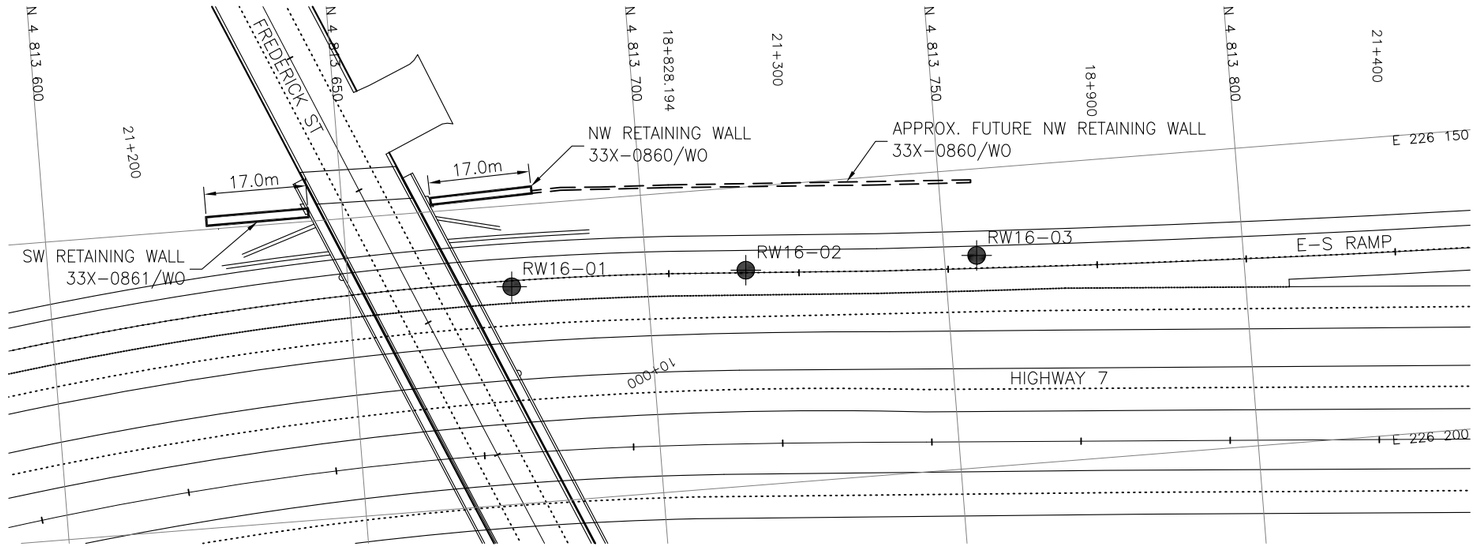
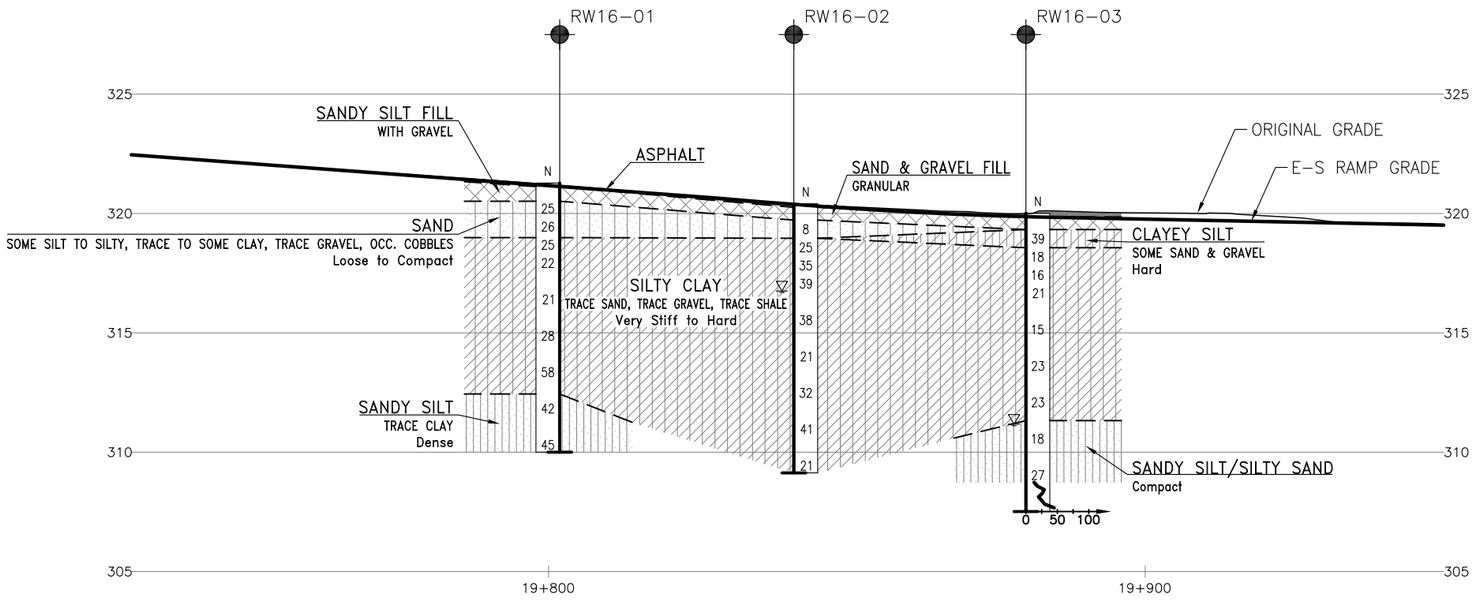


PLAN

20 0 20 40m

SCALE 1:1000



PROFILE ALONG HWY 85 SB/E-S RAMP

20 0 20 40m H 1:1000

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

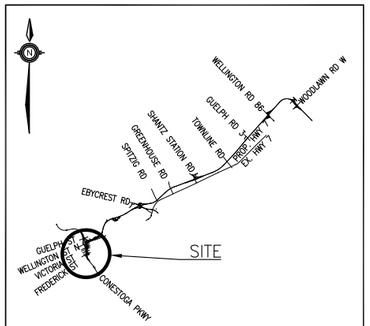
CONT No
GWP No 3005-20-00

SHEET

HIGHWAY 7
HWY 85 SB/E-S RAMP
NW RETAINING WALL 33X-0860/WO
BOREHOLE LOCATIONS AND SOIL STRATA

wsp

THURBER ENGINEERING LTD.



Latitude: 43.459222° Longitude: -80.471733°

KEYPLAN

LEGEND

●	Borehole (Current Investigation)
⊕	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
RW16-01	321.3	4 813 677.3	226 163.6
RW16-02	320.4	4 813 716.6	226 163.9
RW16-03	319.9	4 813 755.4	226 164.5

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P8-290

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	NB	CHK	PKC	CODE		LOAD	DATE JUN 2021
DRAWN	MFA	CHK	NB	SITE		STRUCT	DWG 1

FILENAME: H:\Drafting\11000\11375\TED-11375-BHPP-RW16.dwg
PLOTDATE: 6/8/2021 5:39 PM

THURBER

APPENDIX D
Record of Borehole Sheets, Laboratory Test Results, Borehole Locations and Soil Strata Drawing
SW Retaining Wall - Site # 33X-0861/W0

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH20-01 1 OF 4 METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.5	GROUND SURFACE										
0.0	**ASPHALT:** (200mm)										
0.2 / 326.7	**SAND** and **GRAVEL** Brown Dry (FILL)						327				
0.8 / 325.3	**SAND**, some silt, some gravel Compact Brown Dry (FILL)		1	SS	28				○		
			2	SS	12		326		○		
2.2 / 323.4	**SAND**, trace silt Very Loose to Loose Brown Dry (FILL)		3	SS	3		325		○		
			4	SS	8		324		○		0 89 11 (SI+CL)
4.1 / 320.3	**SAND**, trace silt Compact Brown Wet		5	SS	27	▼	323		○		
			6	SS	17		322		○		
7.2 / 318.8	Clayey **SILT**, trace sand, trace gravel Stiff Brown Wet		7	SS	9		321		○		1 7 78 14
8.7	Silty **CLAY**, trace sand Very Stiff to Hard Grey Wet		8	SS	31		320		○		
							319				
							318				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH20-01 2 OF 4 METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			9	SS	24		317				0 0 30 70
							316				
			10	SS	31		315				
314.2											
13.3	Silty **SAND** to Sandy **SILT**, trace clay Very Dense to Dense Grey Wet		11	SS	72		314				
							313				
			12	SS	85		312				
							311				
			13	SS	88						0 28 66 6
							310				
			14	SS	45		309				
308.1											
19.4	Silty **CLAY**, trace sand Hard Grey Wet						308				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 2/9/21

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THURBER

RECORD OF BOREHOLE No BH20-01 3 OF 4 METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60	γ kN/m³	GR SA SI CL
	Continued From Previous Page		15	SS	39		307				
			16	SS	37		306				
			17	SS	32		305				
			18	SS	30		304				0 4 36 60
							303				
							302				
							301				
							300				
							299				
							298				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH20-01 4 OF 4 METRIC

GWP# 408-88-00 LOCATION , MTM NAD 83 Zone 10: N 4 813 653.3 E 226 144.0 ORIGINATED BY MC

DIST HWY 7 BOREHOLE TYPE Hollow Stem Augers/Tricone COMPILED BY AN

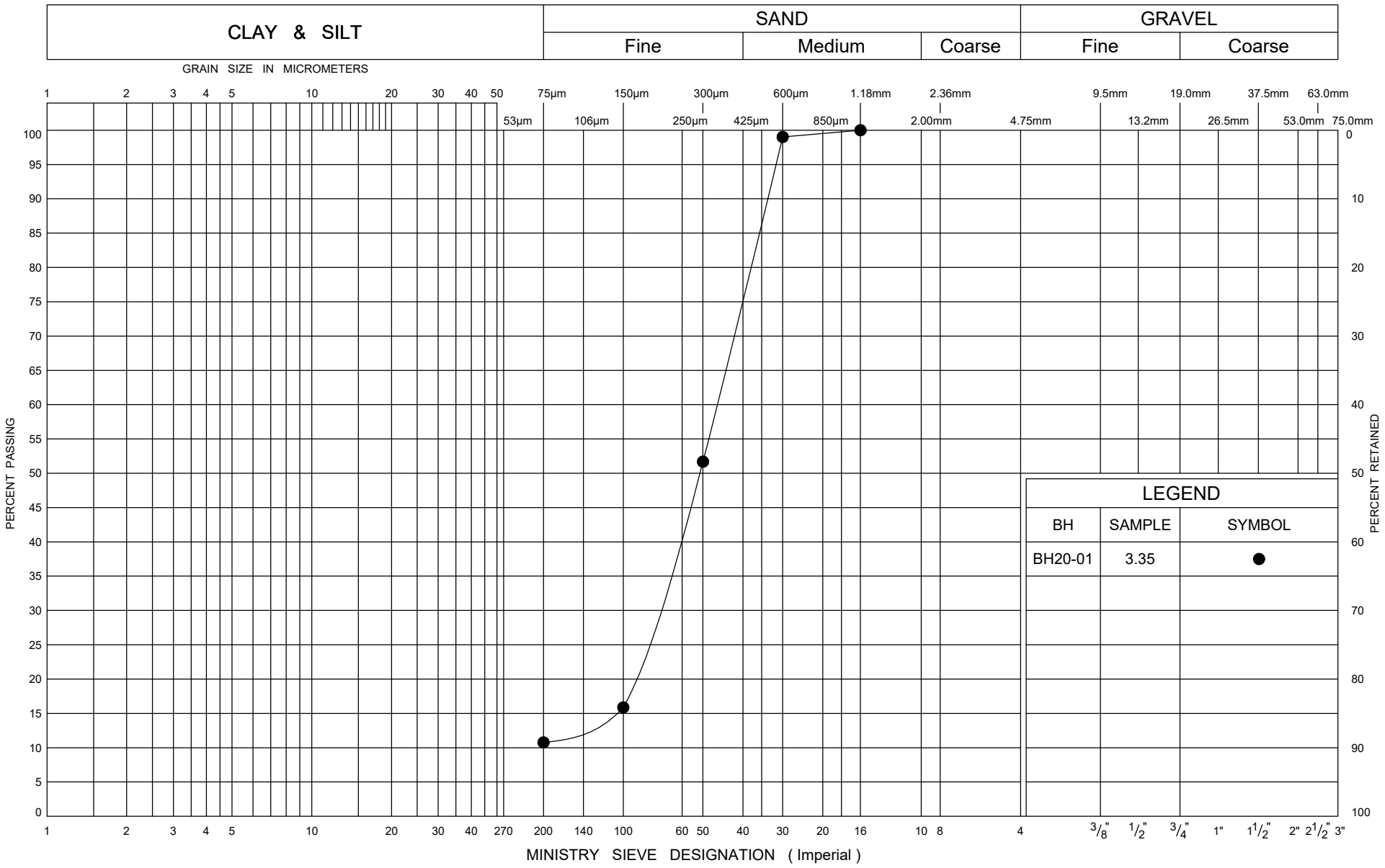
DATUM Geodetic DATE 2020.08.17 - 2020.08.19 LATITUDE 43.458660 LONGITUDE -80.471975 CHECKED BY GRL

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
							297				
							296				
	Very Stiff		19	SS	23		295		○		
293.7							294				
33.8	Silty **CLAY**, sandy, trace gravel Hard Grey Wet (TILL)		20	SS	100/ 0.275		293				
							292				
			21	SS	76/ 0.250		291		○		3 31 51 15
							290				
289.2			22	SS	105/				○		
38.3	END OF BOREHOLE AT 38.3m. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2020.08.24 5.5 322.0				0.175						

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

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-11375(GINTDATA).GPJ 2017TEMPLATE(MTO).GDT 2/9/21



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Ontario

GRAIN SIZE DISTRIBUTION

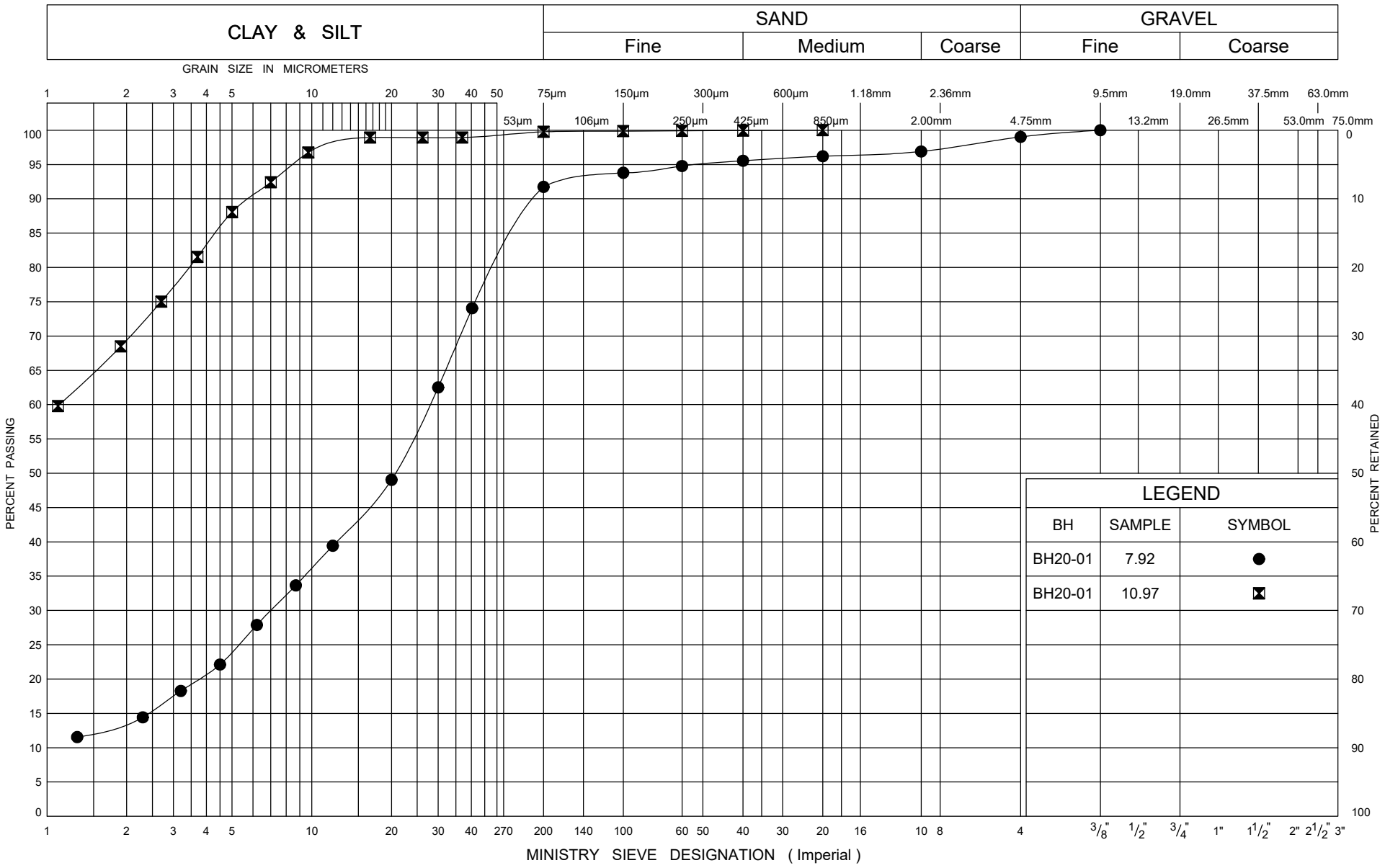
Granular FILL

FIG No D1

W P 408-88-00

SW Retaining Wall

ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21



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GRAIN SIZE DISTRIBUTION

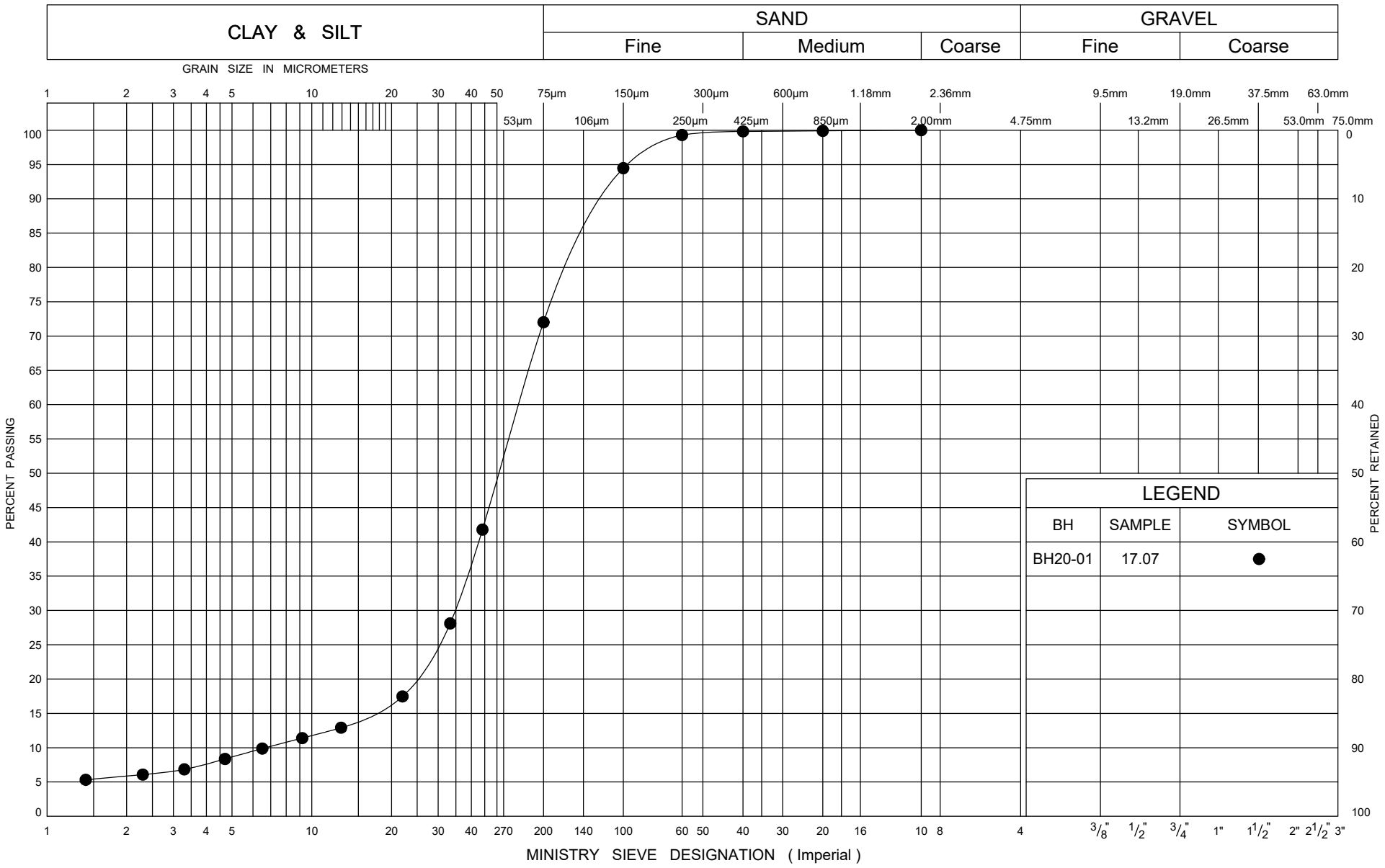
Upper Clayey SILT

FIG No D2

W P 408-88-00

SW Retaining Wall

ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21



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Ontario

GRAIN SIZE DISTRIBUTION

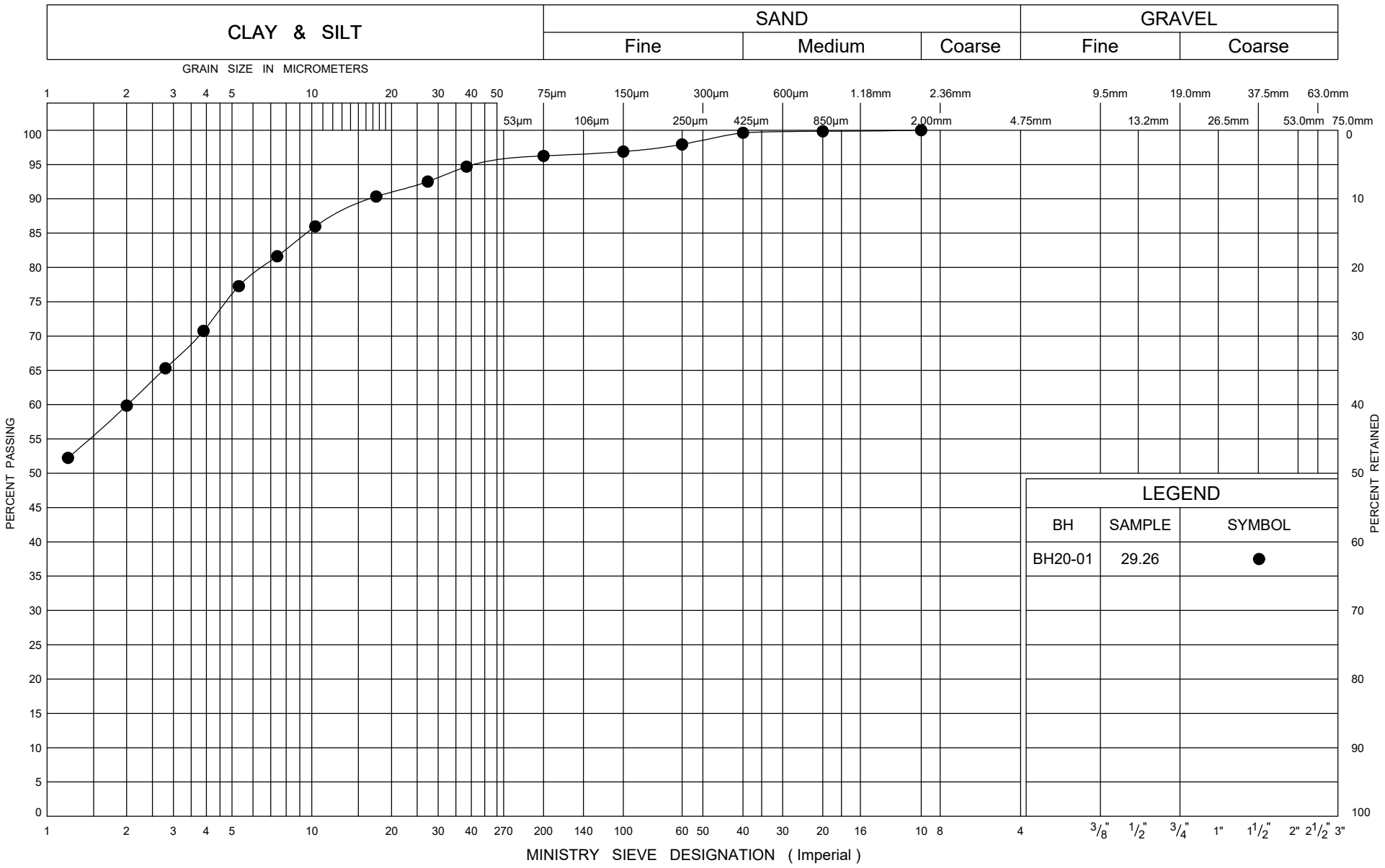
Silty SAND to Sandy SILT

FIG No D3

W P 408-88-00

SW Retaining Wall

ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21



ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21

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Ontario

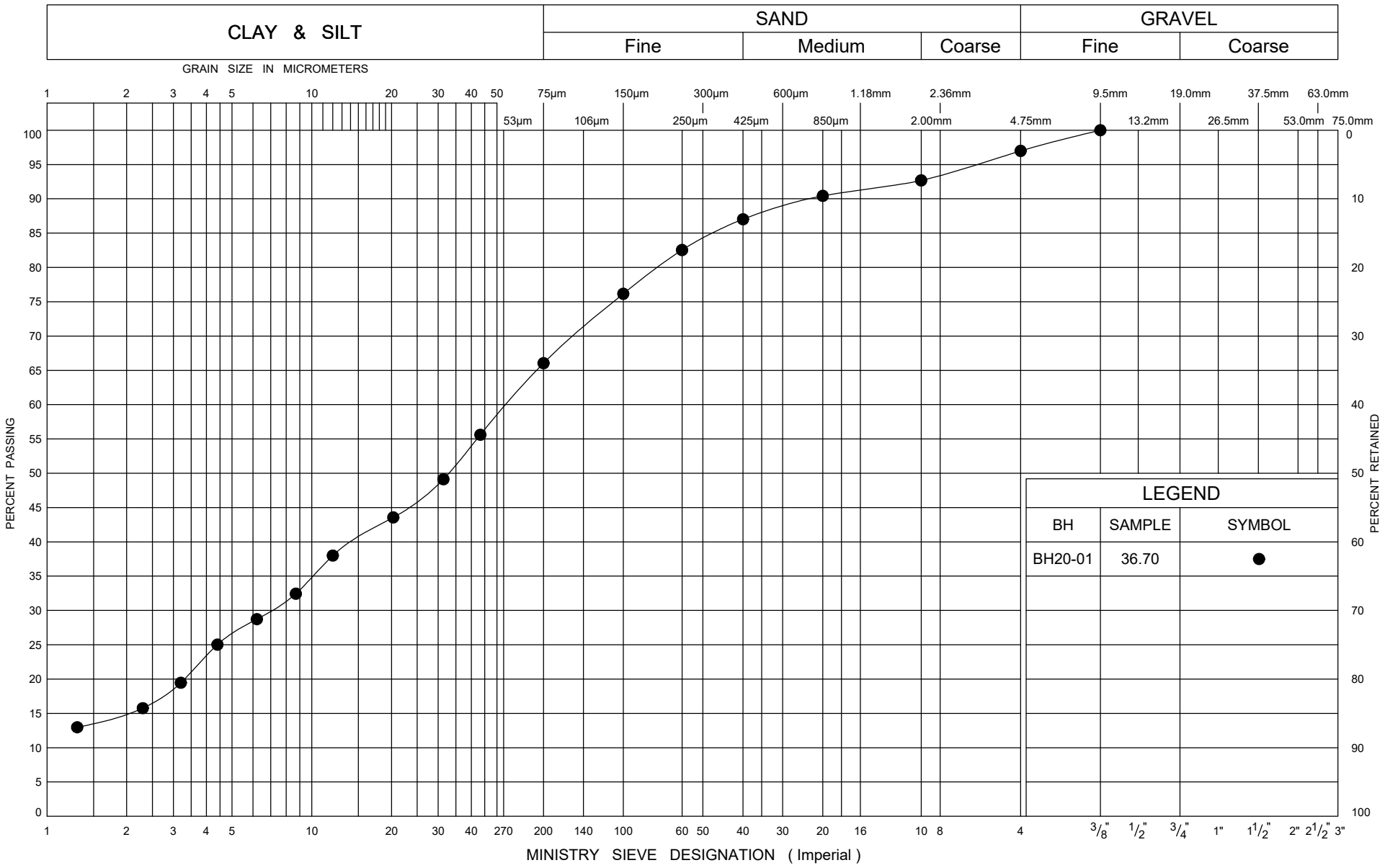
GRAIN SIZE DISTRIBUTION

Lower Silty CLAY

FIG No D4

W P 408-88-00

SW Retaining Wall



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Ontario

GRAIN SIZE DISTRIBUTION

Silty CLAY TILL

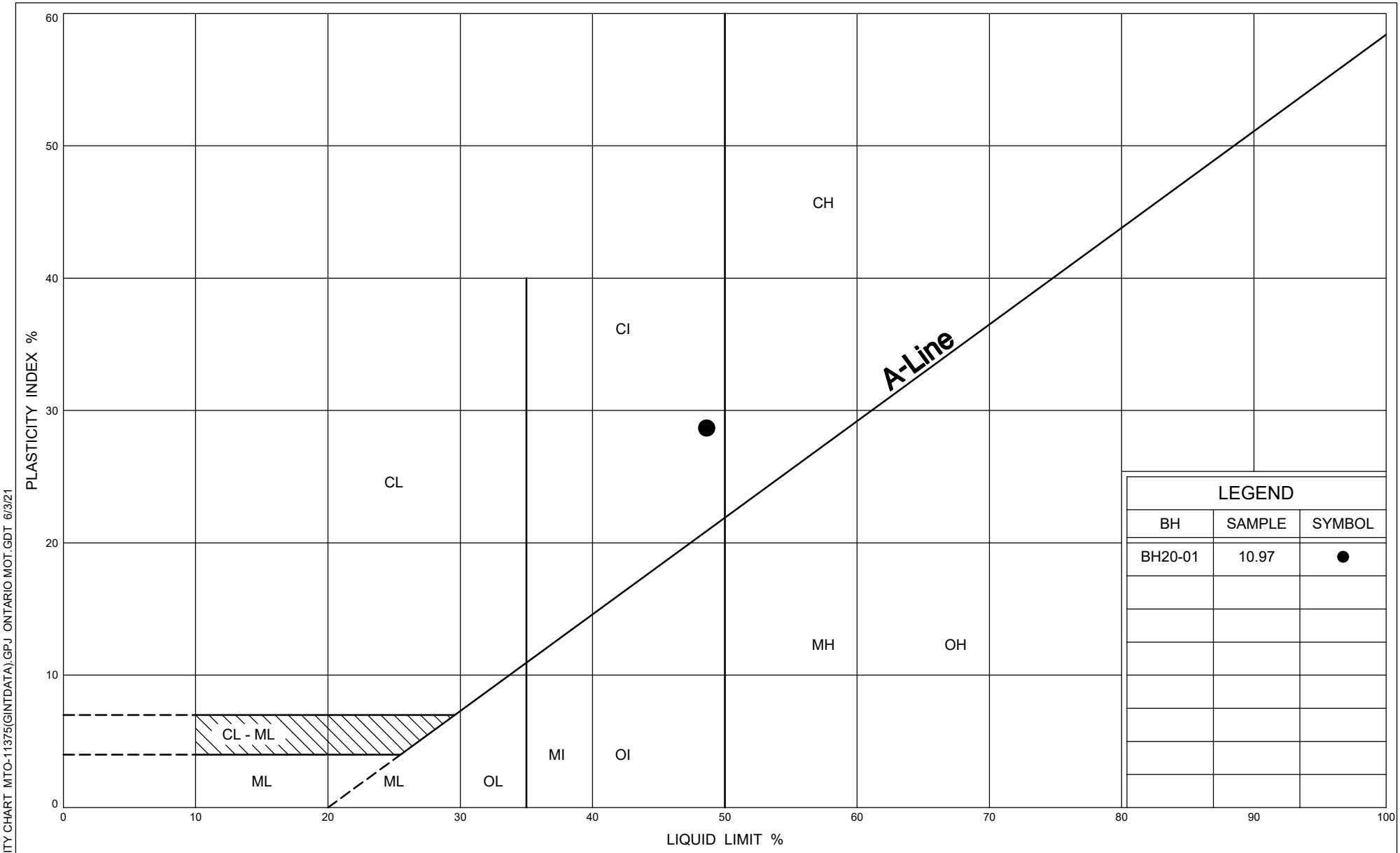
FIG No D5

W P 408-88-00

SW Retaining Wall

ONTARIO MOT GRAIN SIZE 2 MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21

Ministry of Transportation
Ontario

PLASTICITY CHART

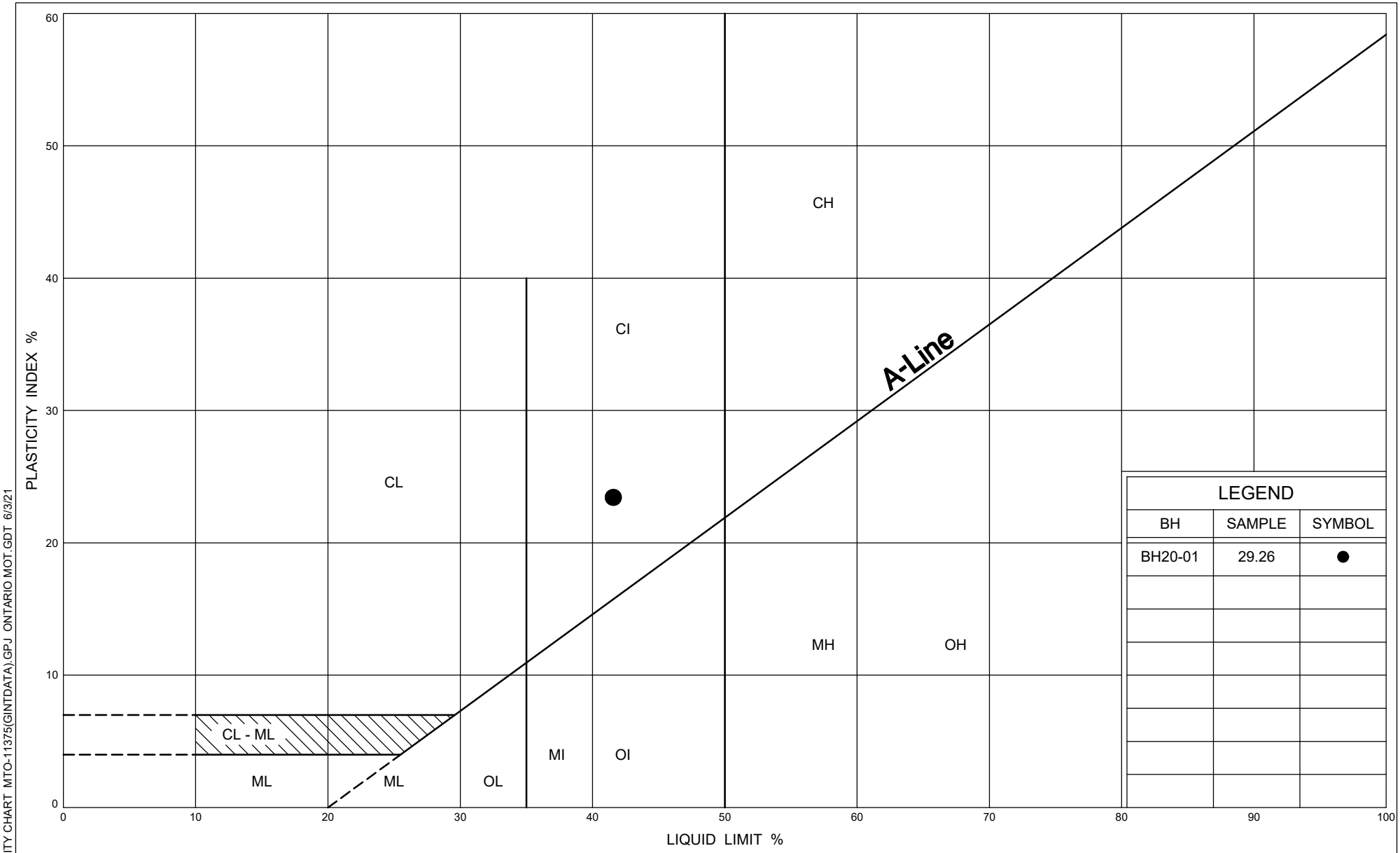
Upper Clayey SILT

FIG No D6

W P 408-88-00

SW Retaining Wall

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-11375(GINTDATA).GPJ ONTARIO MOT.GDT 6/3/21

Ministry of Transportation
Ontario

PLASTICITY CHART

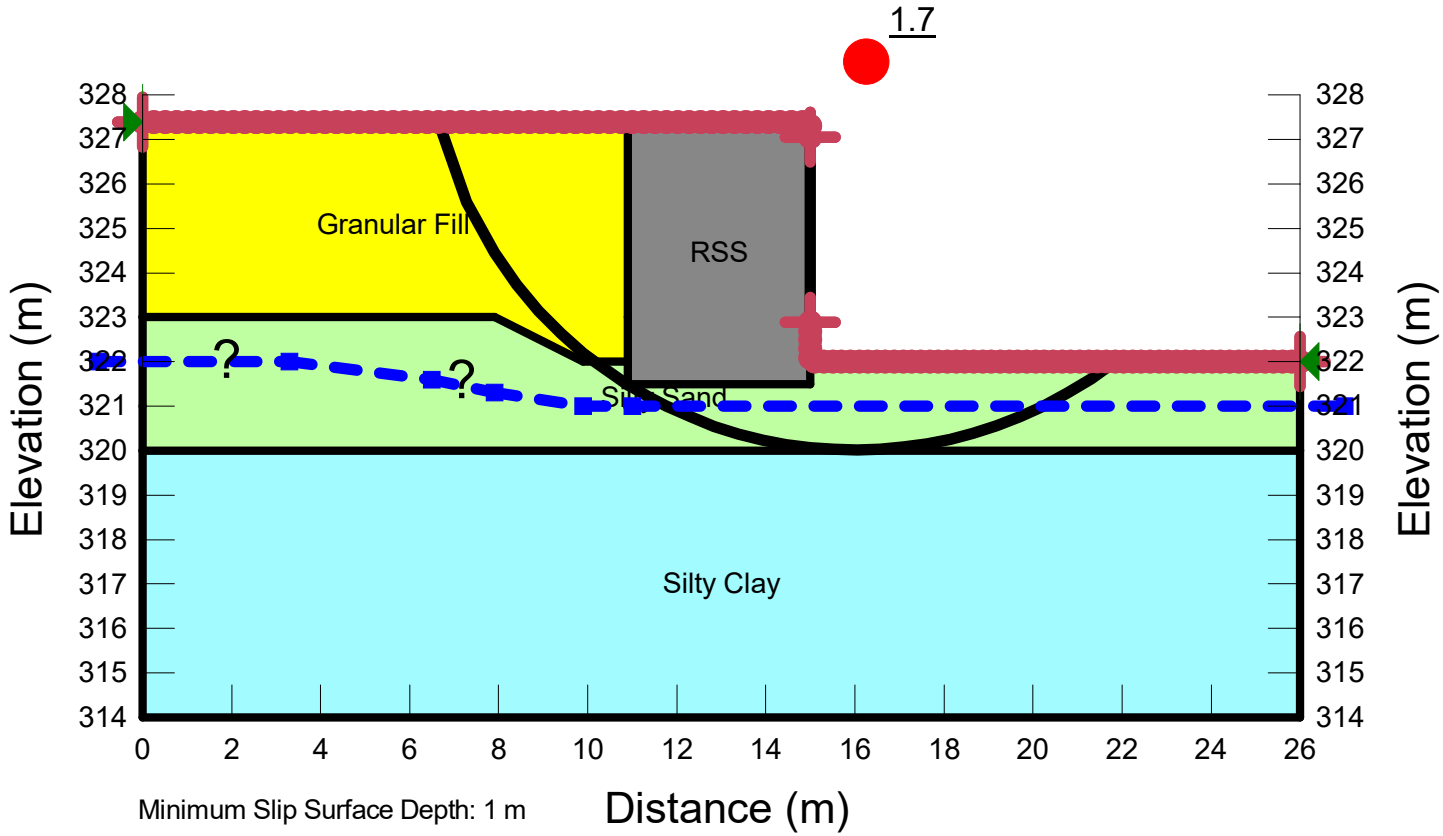
Lower Silty CLAY

FIG No D7

W P 408-88-00

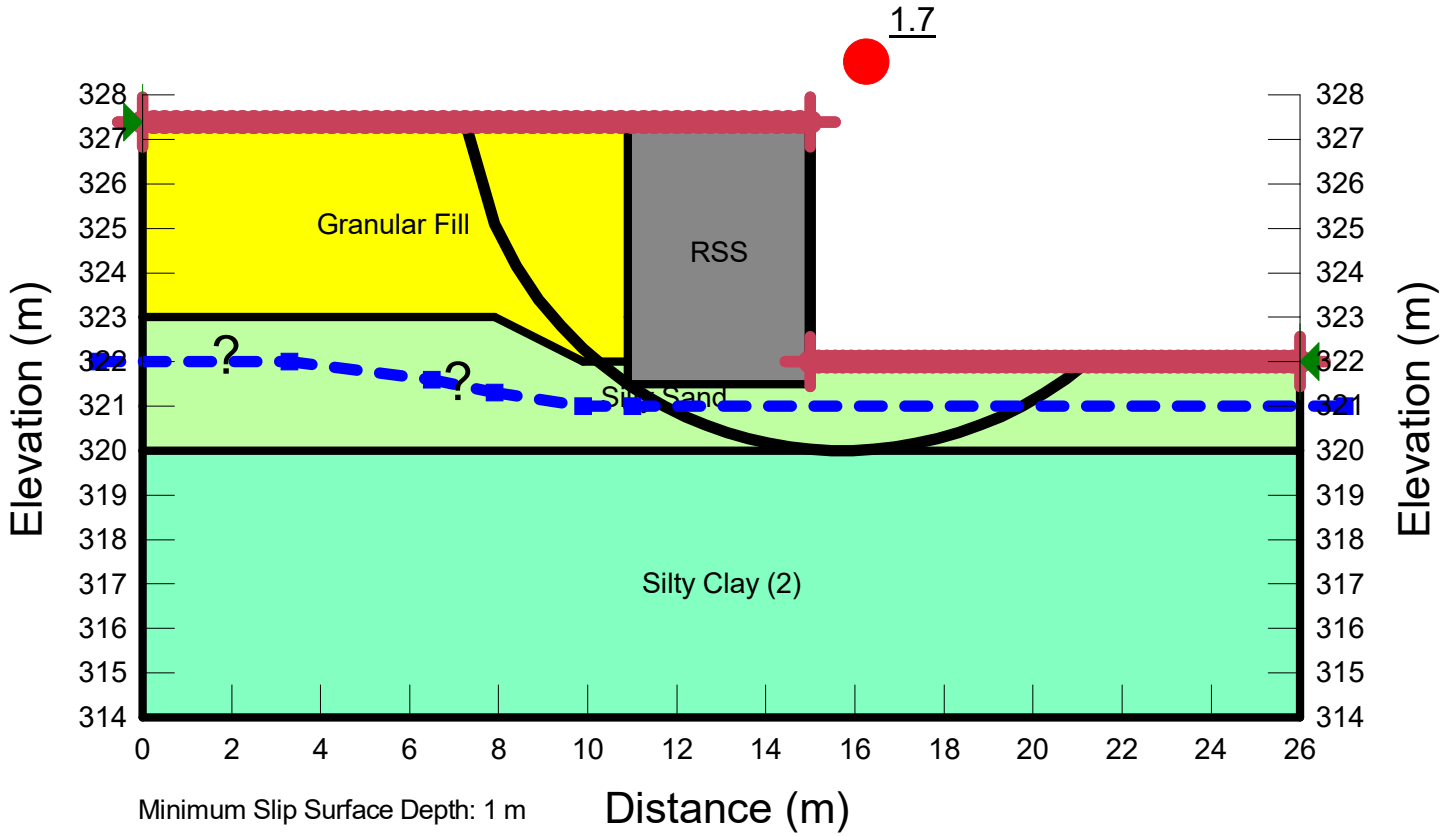
SW Retaining Wall

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	21		0	30
	RSS	Mohr-Coulomb	22		200	45
	Silty Clay	Undrained (Phi=0)	18	120		
	Silty Sand	Mohr-Coulomb	19		0	31



THURBER ENGINEERING LTD.	Global Stability - RSS Wall	Short Term (Undrained) Conditions
	11375- Frederick St. Retaining Walls Site #: 33x-0861/W0	June 2, 2021 | Appendix D-Figure D8

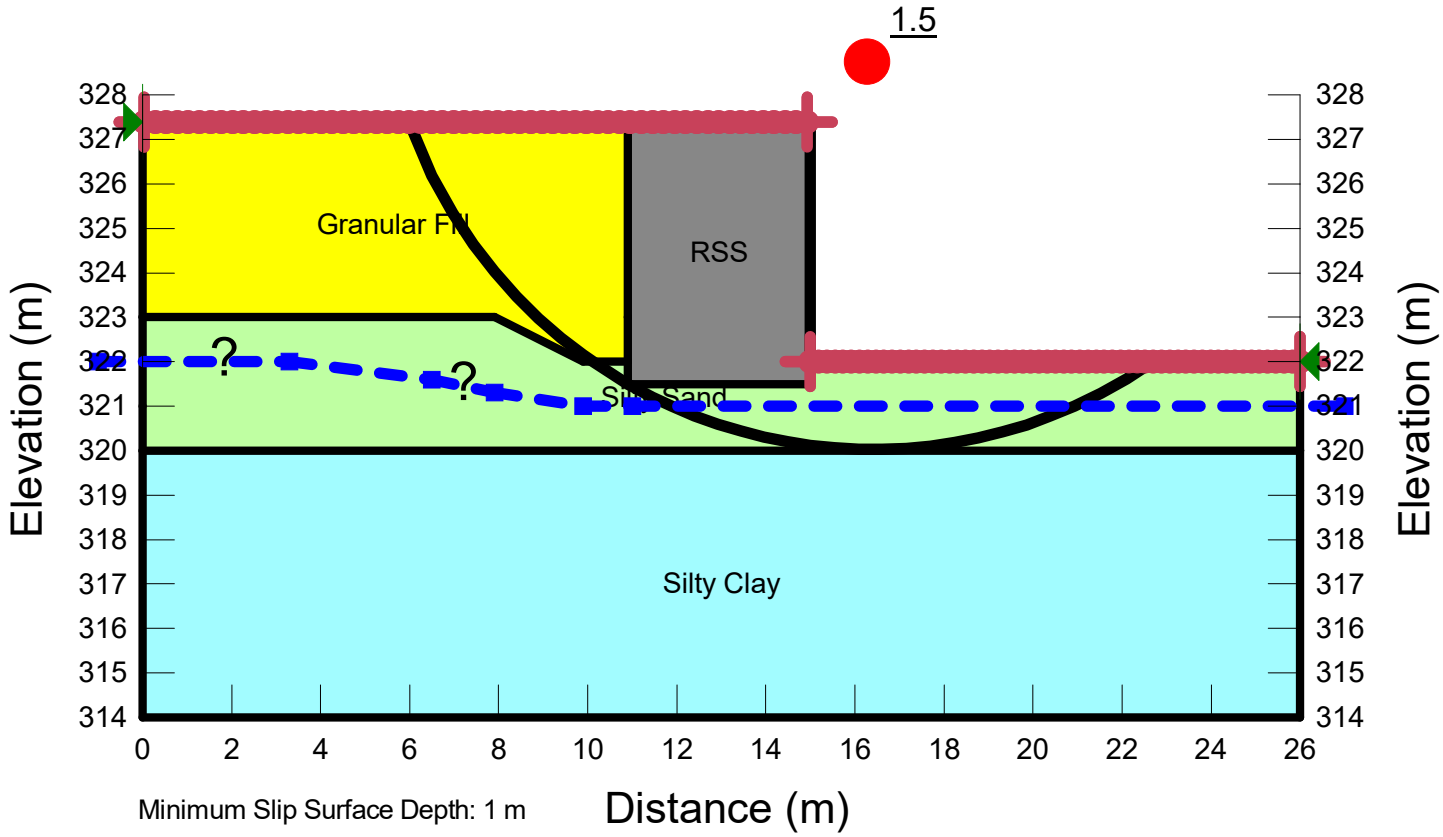
Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	21	0	30
	RSS	Mohr-Coulomb	22	200	45
	Silty Clay (2)	Mohr-Coulomb	18	5	30
	Silty Sand	Mohr-Coulomb	19	0	31



THURBER ENGINEERING LTD.	Global Stability - RSS Wall	Long Term (Drained) Conditions
	11375- Frederick St. Retaining Walls Site #: 33x-0861/W0	June 2, 2021 / Appendix D-Figure D9

Color	Name	Material Model	Unit Weight (kN/m³)	Cohesion (kPa)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	21		0	30
	RSS	Mohr-Coulomb	22		200	45
	Silty Clay	Undrained (Phi=0)	18	120		
	Silty Sand	Mohr-Coulomb	19		0	31

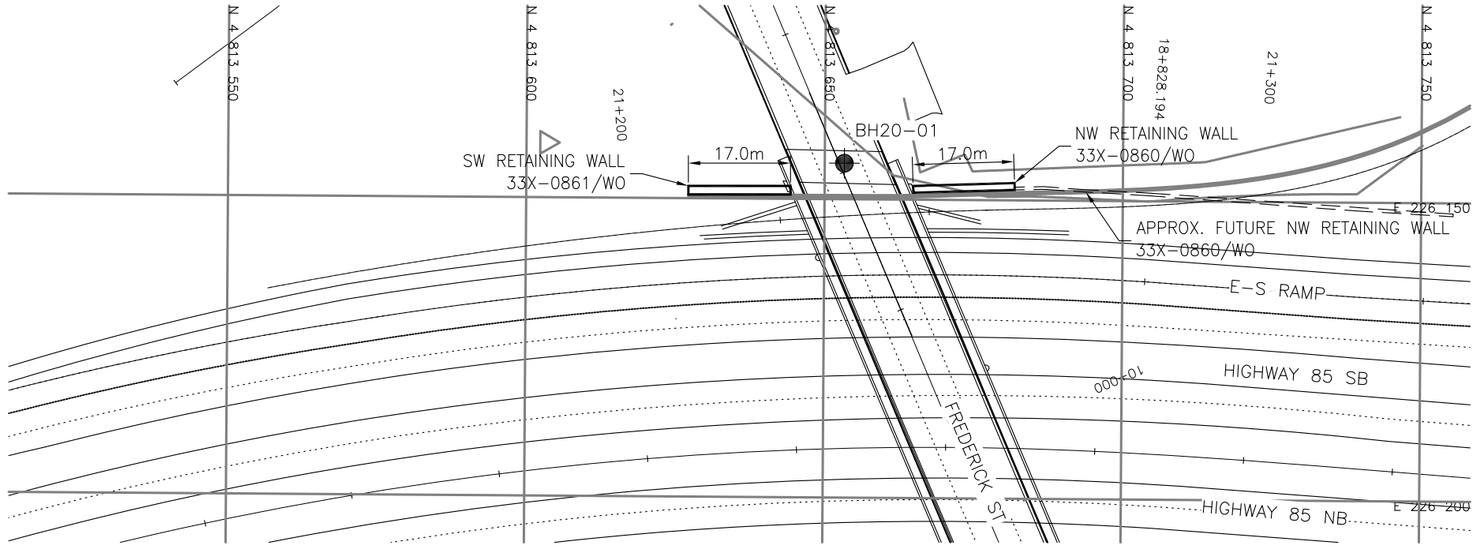
kh= 0.0485



Minimum Slip Surface Depth: 1 m

THURBER ENGINEERING LTD.	Global Stability - RSS Wall	Pseudo Static Analysis
	11375- Frederick St. Retaining Walls Site #: 33x-0861/W0	June 2, 2021
		Appendix D - Figure D10

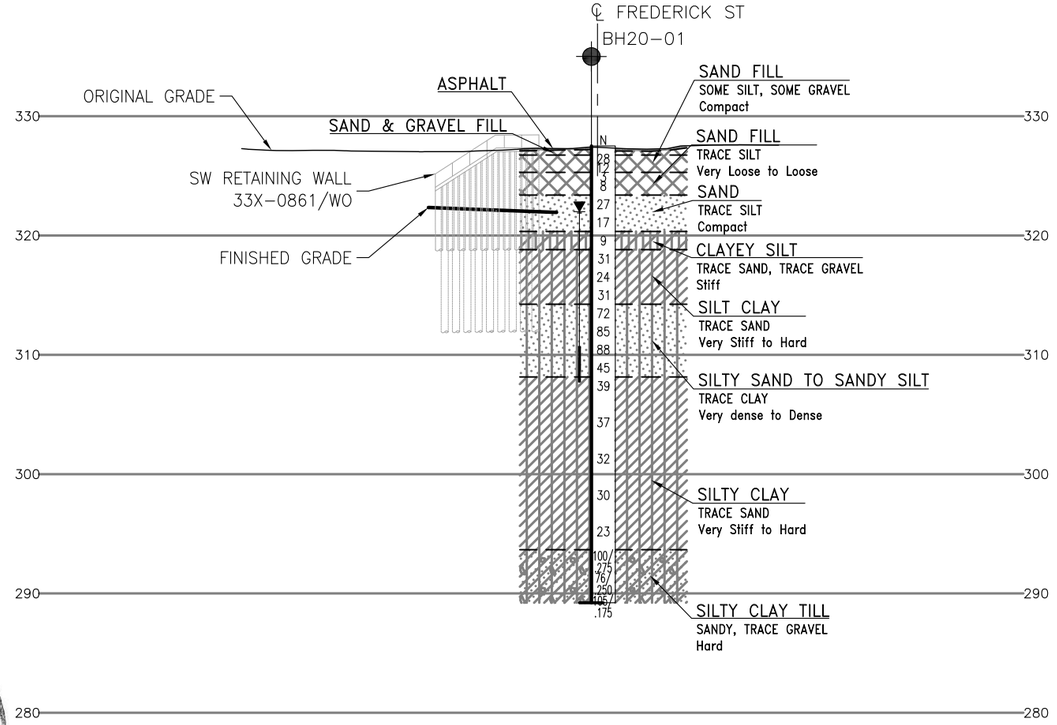
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

20 0 20 40m

SCALE 1:1000



PROFILE ALONG SW RETAINING WALL

20 0 20 40m H 1:1000

10 0 10 20m V 1:500

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
06/08/2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
G. R. LAY
100194778
06/08/2021
PROVINCE OF ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

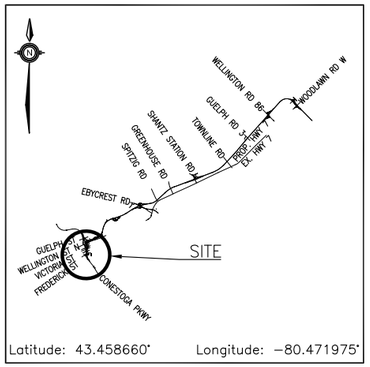
CONT No
GWP No 3005-20-00

SHEET

HIGHWAY 7
HWY 85 & FREDERICK ST I/C
SW RETAINING WALL 33X-0861/WO
BOREHOLE LOCATIONS AND SOIL STRATA

wsp

THURBER ENGINEERING LTD.



Latitude: 43.458660° Longitude: -80.471975°

KEYPLAN

LEGEND

⊕	Borehole (Current Investigation)
⊕	Borehole (by Others)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH20-01	327.5	4 813 653.3	226 144.0

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 40P8-290

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	HM	CHK	PKC	CODE		LOAD	
DRAWN	MFA	CHK	HM	SITE		STRUCT	DWG 1

DATE JUN 2021

FILENAME: H:\Drafting\11000\11375\2020\TED-11375-BHPP-RW(SW).dwg
PLOTDATE: 6/8/2021 5:44 PM

THURBER

APPENDIX E
Corrosivity Results

FINAL REPORT

CA14058-MAY18 R1

11375

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7.
Contact	Rocío Palomeque
Telephone	905-829-8666 x 263
Facsimile	
Email	rreyna@thurber.ca
Project	11375
Order Number	
Samples	Soil (7)

LABORATORY DETAILS

Project Specialist	Deanna Edwards, B.Sc, C.Chem
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	deanna.edwards@sgs.com
SGS Reference	CA14058-MAY18
Received	05/02/2018
Approved	05/09/2018
Report Number	CA14058-MAY18 R1
Date Reported	05/09/2018

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present: No
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

Member of the SGS Group (SGS SA)

TABLE OF CONTENTS

FINAL REPORT

CA14058-MAY18 R1

Client: Thurber Engineering Ltd.
Project: 11375
Project Manager: Rocío Palomeque
Samplers: N/A

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

			Sample Number	5	6	7	8	9	10	11
			Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index										
Corrosivity Index	none	1		4	3	4	4	4	3	4
Soil Redox Potential	mV	-		230	182	274	164	133	232	215
Sulphide	%	0.02		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
pH	no unit	0.05		8.67	9.11	9.04	9.19	8.50	9.11	9.25
Resistivity (calculated)	ohms.cm	-9999		4610	17100	6670	13200	5250	13400	10100

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

			Sample Number	5	6	7	8	9	10	11
			Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry										
Conductivity	uS/cm	2		217	59	150	76	190	75	99

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

			Sample Number	5	6	7	8	9	10	11
			Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics										
Moisture Content	%	0.1		9.3	4.4	11.3	8.3	13.4	4.1	8.8
Sulphate	µg/g	0.4		15	1.1	13	5.5	11	4.0	8.7

Client: Thurber Engineering Ltd.
Project: 11375
Project Manager: Rocío Palomeque
Samplers: N/A

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

Sample Number	5	6	7	8	9	10	11
Sample Name	RW12-05	RW10-04 SS4	RW 09-02 SS3	NE 16-16 SS4	RW13-01 SS4	SE16-05 SS3	SE16-06 SS5
Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date	20/04/2018	18/04/2018	11/04/2018	11/04/2018	11/04/2018	12/04/2018	23/04/2018

Parameter	Units	RL		Result	Result	Result	Result	Result	Result	Result
Other (ORP)										
Chloride	µg/g	0.4		70	3.2	53	12	46	19	30

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	DIO0131-MAY18	µg/g	0.4	<0.4	6	20	95	80	120	106	75	125
Sulphate	DIO0131-MAY18	µg/g	0.4	<0.4	42	20	98	80	120	98	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	ECS0004-MAY18	%	0.02	<0.02	8	20	99	80	120			

pH

Method: SM 4500 | 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	EWL0048-MAY18	no unit	0.05	NA	1		100			NA		

QC SUMMARY

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.

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-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environmental Services - 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

No: Page 1 of 1

Laboratory Information Section - Lab use only

Received By: Ismail
Received Date (mm/dd/yyyy): 05/02/18 (mm\dd\yy)
Received Time: 1:00 Am
Received By (signature):
Custody Seal Present: ☐ NO
Custody Seal Intact: ☐ NO
Cooling Agent Present: ☐ NO
Temperature Upon Receipt (°C) 12, 11.1, 10.8x3
LAB LIMS #: CA14058-May 18

REPORT INFORMATION

Company: Thurber Eng.
Contact: Rocio Palomeque Reyna
Address: 103-2010 Winston Park Dr
Oakville, ON L6H 5R7
Phone:
Fax:
Email: rreyna@thurber.ca

INVOICE INFORMATION

A (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #: P.O. #:
Project #: 11375 Site Location/ID:

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 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ Res/Park ☐ Ind/Com ☐ Agri/Other Soil Texture: ☐ Coarse ☐ Medium ☐ 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	PHC F1-F4 BTEX	O.Reg153 Metals (ICP & hydride metals)	☐Hg ☐B-HWS ☐Cr(VI)	O.Reg 153 VOCs	Corrosivity	COMMENTS: Field Filtered (F) Preserved (P)
1	RW12-05	April 20/18		1	Soil					✓	
2	RW10-04 SS4	April 18/18		1	"					✓	
3	RW09-02 SS3	April 11/18		1	"					✓	
4	NE16-16 SS4	April 13/18		1	"					✓	
5	RW13-01 SS4	April 9/18		1	"					✓	
6	SE16-05 SS3	April 12/18		1	"					✓	
7	ES16-06 - SS5	April 23		1	"						
8											
9											
10											

Observations/Comments/Special Instructions

Sampled By (NAME):		**Signature:**	Date: ____/____/____ (mm/dd/yy)
Relinquished by (NAME):		**Signature:**	Date: 01/05/2018 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.0
Date of Issue: 01 June, 2014

SGS

SAMPLE INTEGRITY REPORT

Project Number: 11375

ONTARIO REGULATION 153/04

SGS Sample ID: CA14058-May18

Date / Time Sampled: Apr 11, 12, 18, 19, 20, 23

Client Sample ID: See CoC

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: BM

FINAL REPORT

CA14209-NOV19 R1

11375, Hwy 7 New, Kitchener

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada
Contact	Nancy Berg
Telephone	905-829-8666 x 228
Facsimile	
Email	nberg@thurber.ca
Project	11375, Hwy 7 New, Kitchener
Order Number	
Samples	Soil (3)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA14209-NOV19
Received	11/07/2019
Approved	11/13/2019
Report Number	CA14209-NOV19 R1
Date Reported	11/13/2019

COMMENTS

Temperature of Sample upon Receipt: 18 degrees C
Cooling Agent Present:Yes
Custody Seal Present:No

Chain of Custody Number:009973

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

Brad Moore Hon. B.Sc

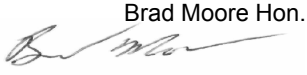

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 11375, Hwy 7 New, Kitchener
Project Manager: Nancy Berg
Samplers: Nancy Berg

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

Sample Number			5	6	7
Sample Name			RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix			Soil	Soil	Soil
Sample Date			23/09/2019	20/08/2019	24/09/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**
Corrosivity Index					
Corrosivity Index	none	1	5	4	9
Soil Redox Potential	mV	-	218	309	309
Sulphide	%	0.02	< 0.02	< 0.02	< 0.02
pH	pH Units	0.05	8.97	8.95	8.79
Resistivity (calculated)	ohms.cm	-9999	2810	8550	1840

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

Sample Number			5	6	7
Sample Name			RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix			Soil	Soil	Soil
Sample Date			23/09/2019	20/08/2019	24/09/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**
General Chemistry					
Conductivity	uS/cm	2	356	117	543

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

Sample Number			5	6	7
Sample Name			RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix			Soil	Soil	Soil
Sample Date			23/09/2019	20/08/2019	24/09/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**
Metals and Inorganics					
Moisture Content	%	0.1	17.5	13.8	17.2
Sulphate	µg/g	0.4	5.8	12	13

Client: Thurber Engineering Ltd.
Project: 11375, Hwy 7 New, Kitchener
Project Manager: Nancy Berg
Samplers: Nancy Berg

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

Sample Number	5	6	7
Sample Name	RW02-04 SS#3	RW16-01 SS#2	RW01-02 SS#4
Sample Matrix	Soil	Soil	Soil
Sample Date	23/09/2019	20/08/2019	24/09/2019

Parameter	Units	RL		Result	Result	Result
Other (ORP)						
Chloride	µg/g	0.4		100	140	190

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	DIO0141-NOV19	µg/g	0.4	<0.4	6	20	100	80	120	114	75	125
Sulphate	DIO0141-NOV19	µg/g	0.4	<0.4	2	20	97	80	120	91	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	ECS0018-NOV19	%	0.02	<0.02	5	20	112	80	120			

QC SUMMARY

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	EWL0137-NOV19	uS/cm	2	< 2	3	10	101	90	110	NA		
Conductivity	EWL0179-NOV19	uS/cm	2	< 0.002	0	10	99	90	110	NA		

pH

Method: SM 4500 | 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	EWL0137-NOV19	pH Units	0.05	NA	0		100			NA		
pH	EWL0179-NOV19	pH Units	0.05	NA	0		100			NA		

QC SUMMARY

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.

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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.

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-- End of Analytical Report --

SGS Request for Laboratory Services and CHAIN OF CUSTODY

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

No: 009973

Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Ahmed Al-Mandalawi
Received Date (mm/dd/yyyy): 11/07/19 (mm\dd\yy)
Received Time: 14:15
Received By (signature):
Custody Seal Present: ☒ NO
Custody Seal Intact: ☒ NO
Cooling Agent Present: ☒ ICE
Temperature Upon Receipt (°C): 18°, 18°, 18°
↑ Nord added
CA 14209-NOV19
LAB LIMS #:

REPORT INFORMATION

Company: Thurber Engineering Ltd
Contact: Nancy Berg
Address: 103-2010 Winston Park Dr
Oakville ON L6H 5Z7
Phone: 647-633-8417
Email: nberg@thurber.ca
Email:

INVOICE INFORMATION

☐ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email:

PROJECT INFORMATION

Quotation #:
P.O. #:
Project #: 11375
Site Location/ID: Hwy 7 New, Kitchener

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

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

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:
Rush Confirmation ID:

REGULATIONS

Regulation 153/04:
☐ Table 1 ☐ R/P/I
☐ Table 2 ☐ I/C/C
☐ Table 3 ☐ A/O
☐ Table ____
Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

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

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

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

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH ☐ ABN ☐ SVOC(all) ☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ VOC ☐ BTEX ☐ BTEX/F1 ☐ F2-F4 ☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC ☐ OP ☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit. ☐	Water Pkg Gen. ☐ Ext. ☐	Sewer Use:	Corrosivity					COMMENTS:
1	BW02-04 SS#3	Sept. 23/19		1	soil											✓					
2	RW16-03 SS#2	Aug 30/19		1	soil											✓					
3	RW01-02 SS#4	Sept 24/19		1	soil											✓					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions

Sampled By (NAME): Nancy Berg
Signature:
Date: 11/05/19 (mm/dd/yy)

Relinquished by (NAME):
Signature:
Date: ___/___/___ (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

FINAL REPORT

CA14437-AUG19 R1

11375 Hwy 7 New, Kitchener

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA14437-AUG19 R1

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Rob Irwin B.Sc., C.Chem
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Nancy Berg	Telephone	705-652-2361
Telephone	905-829-8666 x 228	Facsimile	705-652-6365
Facsimile		Email	rob.irwin@sgs.com
Email	nberg@thurber.ca	SGS Reference	CA14437-AUG19
Project	11375 Hwy 7 New, Kitchener	Received	08/13/2019
Order Number		Approved	08/19/2019
Samples	Soil (5)	Report Number	CA14437-AUG19 R1
		Date Reported	08/19/2019

COMMENTS

Temperature of Sample upon Receipt: 4 degrees C
Cooling Agent Present: yes
Custody Seal Present: no

Chain of Custody Number: 009972

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

Rob Irwin B.Sc., C.Chem

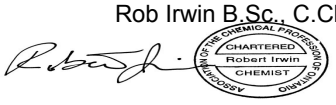

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 11375 Hwy 7 New, Kitchener
Project Manager: Nancy Berg
Samplers: Nancy Berg

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

			Sample Number	5	6	7	8	9
			Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index								
Corrosivity Index	none	1		4	1	5	11	14
Soil Redox Potential	mV	-		306	312	255	263	227
Sulphide	%	0.02		< 0.02	< 0.02	0.02	< 0.02	< 0.02
pH	pH Units	0.05		8.56	8.29	7.88	8.18	8.66
Resistivity (calculated)	ohms.cm	-9999		5100	3200	2500	780	1400

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

			Sample Number	5	6	7	8	9
			Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry								
Conductivity	uS/cm	2		195	317	400	1280	736

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

			Sample Number	5	6	7	8	9
			Sample Name	CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
			Sample Matrix	Soil	Soil	Soil	Soil	Soil
			Sample Date	19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics								
Moisture Content	%	0.1		20.1	6.1	24.6	13.1	6.5
Sulphate	µg/g	0.4		25	12	100	31	13

Client: Thurber Engineering Ltd.
Project: 11375 Hwy 7 New, Kitchener
Project Manager: Nancy Berg
Samplers: Nancy Berg

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

Sample Number			5	6	7	8	9
Sample Name			CN16-10 SS5	CN16-04 SS4	CN16-15 SS4	RW24-02 SS4	NE16-09 SS4
Sample Matrix			Soil	Soil	Soil	Soil	Soil
Sample Date			19/07/2019	23/07/2019	18/07/2019	06/08/2019	06/08/2019
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**
Other (ORP)							
Chloride	µg/g	0.4	25	7.8	60	760	430

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	DIO0262-AUG19	µg/g	0.4	<0.4	9	20	93	80	120	98	75	125
Sulphate	DIO0262-AUG19	µg/g	0.4	<0.4	13	20	94	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	ECS0029-AUG19	%	0.02	<0.02	ND	20	110	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	EWL0246-AUG19	uS/cm	2	< 0.002	0	10	100	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	EWL0246-AUG19	pH Units	0.05	NA	0		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.

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-- End of Analytical Report --

SGS Request for Laboratory Services and CHAIN OF CUSTODY

No: 009972

Page 1 of 1

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- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Laboratory Information Section - Lab use only

Received By: Oleg Mozhin
Received Date (mm/dd/yyyy): 8/13/19 (mm\dd\yy)
Received Time: 11:05
Received By (signature):
Custody Seal Present: ☐ no
Custody Seal Intact: ☐ no
Cooling Agent Present: ☑ ice
Temperature Upon Receipt (°C): 9°, 9°, 9°
LAB LIMS #: CA14437-Aug19

REPORT INFORMATION	INVOICE INFORMATION	PROJECT INFORMATION
Company: Thurber Engineering Ltd	☐ (same as Report Information)	Quotation #: P.O. #:
Contact: Nancy Berg	Company:	Project #: 11375 Site Location/ID: Hwy 7 New, Kitchener
Address: 103 - 2010 Winston Park Dr Oakville On L6H 5Z7	Contact:	**TURNAROUND TIME (TAT) REQUIRED**
Phone: 647-633-8417	Address:	☑ Regular TAT (5-7days) TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day
Email: nberg@thurber.ca	Phone:	**RUSH TAT (Additional Charges May Apply):** ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days
Email:	Email:	**PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION**
		Specify Due Date: Rush Confirmation ID:

REGULATIONS

Regulation 153/04: ☐ Table 1 ☐ Table 2 ☐ Table 3 ☐ Table ____ ☐ R/P/I ☐ I/C/C ☐ A/O Soil Texture: ☐ Coarse ☐ Medium ☐ Fine

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

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

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

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	Metals & Inorganics	PAH ☐ ABN ☐ SVOC(all) ☐	PCB Total ☐ Aroclor ☐	PHC F1-F4 ☐ VOC ☐ BTEX ☐ BTEX/F1 ☐ F2-F4 ☐	VOC ☐ BTEX ☐ THM ☐	Pesticides OC ☐ OP ☐	TCLP M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit. ☐	Water Pkg Gen. ☐ Ext. ☐	Sewer Use:	Corrosivity					COMMENTS:
1	CN16-10 SS5	July 19/19		1	soil											✓					
2	CN16-04 SS4	July 23/19		1	soil											✓					
3	CN16-15 SS4	July 18/19		1	soil											✓					
4	RW24-02 SS4	Aug 6/19		1	soil											✓					
5	NE16-09 SS4	Aug 7/19		1	soil											✓					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

Observations/Comments/Special Instructions

Sampled By (NAME): Nancy Berg	Signature:	Date: 08/12/19 (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Nancy Berg	Signature:	Date: 08/13/19 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.1
Date of Issue: 04 April, 2018

FINAL REPORT

CA14882-AUG20 R1

1375 Frederick St.

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA14882-AUG20 R1

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Geoff Lay	Telephone	2165
Telephone	905-829-8666	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	glay@thurber.ca	SGS Reference	CA14882-AUG20
Project	1375 Frederick St.	Received	08/28/2020
Order Number		Approved	09/03/2020
Samples	Soil (2)	Report Number	CA14882-AUG20 R1
		Date Reported	09/03/2020

COMMENTS

Temperature of Sample upon Receipt:7 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody Number:NA

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

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 1375 Frederick St.
Project Manager: Geoff Lay
Samplers: Brett Thomas

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

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Corrosivity Index					
Corrosivity Index	none	1		8	13
Soil Redox Potential	mV	-		287	285
Sulphide	%	0.04		< 0.04	< 0.04
pH	pH Units	0.05		9.66	9.37
Resistivity (calculated)	ohms.cm	-9999		1830	892

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

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
General Chemistry					
Conductivity	uS/cm	2		547	1120

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

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Metals and Inorganics					
Moisture Content	%	0.1		3.8	4.4
Sulphate	µg/g	0.4		8.3	21

FINAL REPORT

CA14882-AUG20 R1

Client: Thurber Engineering Ltd.
Project: 1375 Frederick St.
Project Manager: Geoff Lay
Samplers: Brett Thomas

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

Sample Number	5	6
Sample Name	BH20-01 SS#4	BH20-02 SS#3
Sample Matrix	Soil	Soil
Sample Date	17/08/2020	20/08/2020

Parameter	Units	RL		Result	Result
Other (ORP)					
Chloride	µg/g	0.4		210	750

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	DIO0461-AUG20	µg/g	0.4	<0.4	2	20	96	80	120	103	75	125
Sulphate	DIO0461-AUG20	µg/g	0.4	<0.4	8	20	98	80	120	95	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	ECS0001-SEP20	%	0.04	< 0.04	ND	20	100	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	EWL0414-AUG20	uS/cm	2	< 0.002	1	20	99	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	EWL0414-AUG20	pH Units	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.

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- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Request for Laboratory Services and CHAIN OF CUSTODY

No:

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: Scott R
Received Date: 08/28/2020 (mm/dd/yy)
Received Time: 16:20 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C): 12 , 2 , 2 °C
LAB LIMS #: 14882

REPORT INFORMATION	INVOICE INFORMATION	
Company: Thurber Engineering Ltd.	☑ (same as Report Information)	Quotation #:
Contact: Geoff Lay	Company:	P.O. #:
Address: 2010 Winston Park Drive #103 Oakville, ON L6H 5R7	Contact:	Project #: 11375
	Address:	Site Location/ID: Frederick St
Phone: (905) 829-8666	Phone:	
Fax:		
Email: glay@thurber.ca	Email:	

TURNAROUND TIME (TAT) REQUIRED

☑ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

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

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

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

REGULATIONS

Regulation 153/04: ☐ Table 1 ☑ Table 2 ☐ Table 3 ☐ Table ____ ; ☑ Res/Park ☐ Ind/Com ☐ Agri/Other ; Soil Texture: ☑ Coarse ☐ Medium/Fine

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

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

M & I: Field Filtered (Y/N); Metals & Inorganics (incl CrVI, CN, Hg pH, (B(HWS), EC, SAR-soil) (Cl, Na-water)); Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI); ICP Metals only (Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn)
SVOC: PAHs only; SVOCs (all incl PAHs, ABNs, CPs)
PCB: PCBs ☐ Total ☐ Aroclor
PHC: F1-F4 + BTEX; F1-F4 only (no BTEX)
VOC: VOCs (all incl BTEX); BTEX only
Pest: Pesticides (Organochlorine or specify other)
Other (please specify): Corrosivity; Sewer Use: (Specify pkg); Water Characterization Pkg ☐ General ☐ Extended
TCLP: Specify TCLP tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.

#	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Corrosivity	COMMENTS
1	BH20-01 SS #4	Aug.17/2020	9 AM	2	Soil	✓	
2	BH20-02 SS #3	Aug. 20/2020	9 AM	2	Soil	✓	
3							
4							
5							
6							
7							4day
8							
9							
10							Soil
11							
12							

Observations/Comments/Special Instructions

Sampled By (NAME): Brett Thomas Signature: [signature] Date: 08 / 28 / 2020 (mm/dd/yy) Pink Copy - Client

Relinquished by (NAME): Brett Thomas Signature: [signature] Date: 08 / 28 / 2020 (mm/dd/yy) Yellow & White Copy - SGS

Revision # 1.5 Date of Issue: 13 Oct, 2016

Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. (2) Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). (3) Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

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APPENDIX F
NSSP Wording

1. Suggested Text for NSSP on "Installation of Caissons"

All caissons shall be installed in accordance with OPSS.PROV 903 and SP 109F57 (April 2018).

The caissons will extend through cohesionless soils below the groundwater table. Therefore, construction of caissons will require the use of temporary steel liners to support the caisson sidewalls and to provide seepage cut-off where required. Synthetic slurry should be used to balance hydrostatic head and to prevent basal heave. The contractor is responsible for constructing the caisson foundations without disturbing the materials at the sides or bases of the foundations. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Should it prove to be impractical to remove the accumulated water inside the hole, it is recommended that the concrete be placed by the tremie method.

Caisson installation may encounter cobbles, boulders and/or large rock fragments in the soils. The installation methods and equipment must be capable of dislodging, removing or otherwise penetrating such obstructions.

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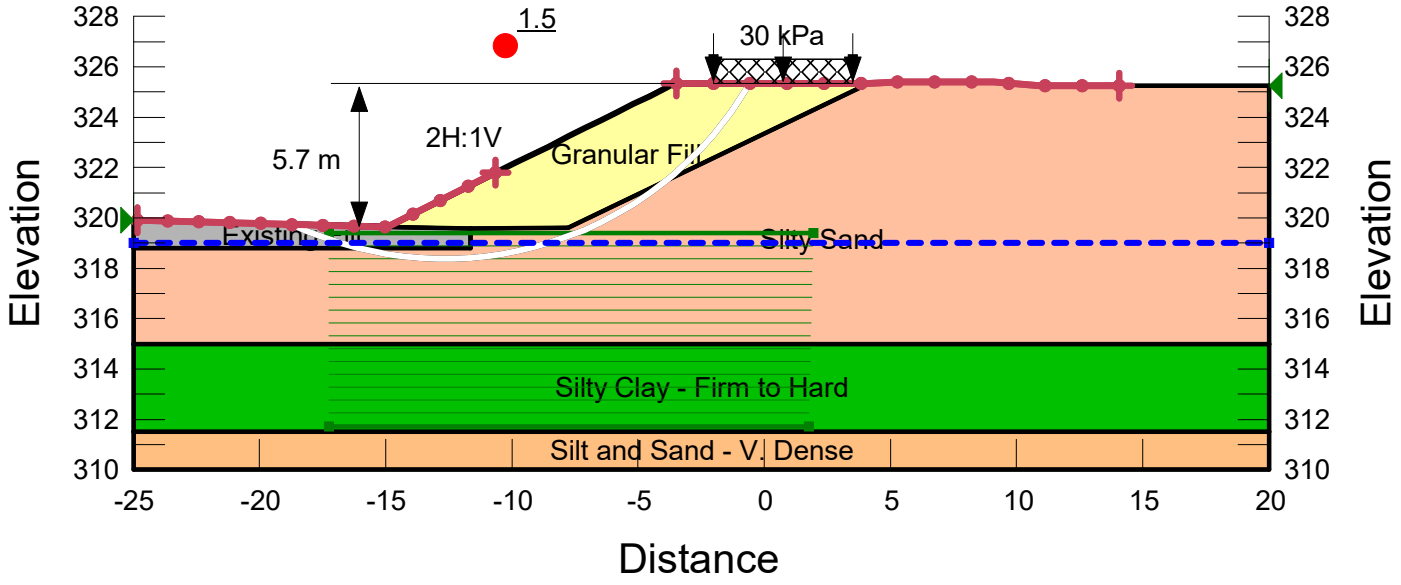
APPENDIX G
Stability Analysis of Temporary Access Road/Wall

FREDERICK STREET (STA 21+325)
2H:1V GRANULAR SLOPE

FIGURE G1

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Existing Fill	Mohr-Coulomb	20	0	30
	Granular Fill	Mohr-Coulomb	22	0	35
	Silt and Sand - V. Dense	Mohr-Coulomb	22	0	32
	Silty Clay - Firm to Hard	Mohr-Coulomb	19	0	30
	Silty Sand	Mohr-Coulomb	20	0	28



FREDERICK STREET (STA 21+325)
ARMOUR STONE WALL - RSS 0.7H

FIGURE G2

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Armour Stone Wall	Mohr-Coulomb	24	1,000	34
	Existing Fill	Mohr-Coulomb	20	0	30
	Granular Fill	Mohr-Coulomb	22	0	35
	RSS	Mohr-Coulomb	22	200	34
	Silt and Sand - V. Dense	Mohr-Coulomb	22	0	32
	Silty Clay - Firm to Hard	Mohr-Coulomb	19	0	30
	Silty Sand	Mohr-Coulomb	20	0	28