

Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**FOUNDATION INVESTIGATION AND DESIGN REPORT
DEEP CUT
HIGHWAY 9 AND GORE ROAD INTERSECTION IMPROVEMENT
G.W.P. 2072-17-00, ASSIGNMENT NO.: 2018-E-0070
MINISTRY OF TRANSPORTATION, ONTARIO
CENTRAL REGION
GEOCRES NO. 30M13-244**

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TABLE OF CONTENTS

PART A – FOUNDATION INVESTIGATION REPORT (DEEP CUT)	I
1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	1
3.0 INVESTIGATION PROCEDURES	1
4.0 REGIONAL GEOLOGY	2
5.0 SUBSURFACE CONDITIONS	2
5.1 Topsoil	3
5.2 Fill – Gravelly Sand	3
5.3 Fill – Sand and Silt	3
5.4 Sand	4
5.5 Gravelly Sand	4
5.6 Silt	4
5.7 Silty Sand to Sandy Silt	5
5.8 Clayey Silt	5
5.9 Ground Water Levels	6
6.0 MISCELLANEOUS	6
PART B – FOUNDATION DESIGN REPORT (DEEP CUT)	II
7.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS	7
7.1 General	7
7.2 Cut Sections	7
7.3 Seismic Design	7
7.3.1 Seismic Site Classification	7
7.3.2 Spectral Response Values	7
7.4 Liquefaction Potential	8
7.5 Global Stability	8
7.5.1 Static Conditions	8
7.5.2 Seismic Conditions	9
7.6 Surficial Stability & Erosion Protection	10
8.0 CLOSURE	10

REFERENCES

LIST OF DRAWINGS

Drawing 1	Borehole Locations and Soil Strata – Hwy. 9 CL Profile
Drawing 2	Borehole Locations and Soil Strata – Section A-A'
Drawing 3	Site Photographs



LIST OF APPENDICES

APPENDIX A Record of Borehole Sheets

List of Symbols and Abbreviations

Record of Borehole Sheets – BH 9, BH 10, BH 11, BH 12, BH 13 & BH 14

APPENDIX B Field and Laboratory Test Results

Figure B1	Grain Size Distribution – Fill – Gravelly Sand
Figure B2	Grain Size Distribution – Fill – Sand and Silt
Figure B3	Grain Size Distribution – Sand
Figure B4	Grain Size Distribution – Gravelly Sand
Figure B5	Grain Size Distribution – Silt
Figure B6	Grain Size Distribution – Silty Sand to Sandy Silt

APPENDIX C Slope Stability Models and Results



PART A – FOUNDATION INVESTIGATION REPORT (DEEP CUT)

**HIGHWAY 9 AND GORE ROAD INTERSECTION IMPROVEMENT
MINISTRY OF TRANSPORTATION (CENTRAL REGION), ONTARIO
G.W.P. 2072-17-00, ASSIGNMENT NO.: 2018-E-0070**



1.0 INTRODUCTION

Terraprobe has been retained by HDR Corporation ("HDR") on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of detailed designs for the Highway 9 and Gore Road intersection improvement, in the Town of Caledon, Region of Peel, Ontario.

This project is based on the Ministry of Transportation, Ontario (MTO) Request for Quotation (RFQ) titled "*Detail Design of Highway 9 and Gore Road Intersection Improvement, Central Region. G.W.P. 2072-17-00. Assignment No.: 2018-E-0070, dated December 04, 2019.*" The terms of reference and scope of work for the foundation engineering services are outlined in MTO's RFQ.

This report presents the factual data on the subsurface conditions along a 300 m long section of Highway 9, where a deep cut is required to accommodate the proposed Highway 9 widening.

2.0 SITE DESCRIPTION

The site is located in the vicinity of the Highway 9/Gore Road intersection in the Town of Caledon, Region of Peel, Ontario. Highway 9 is an east-west oriented undivided highway with a rural cross-section comprising of a single west bound through lane with a dedicated turning lane for Concession Road 3, and two east bound through lanes.

The ground surface topography is rolling and the highway traverses through the floodplain of a Humber River tributary and also areas where the ground surface is higher than the highway. The lowland (marsh) areas are vegetated primarily with grass and cattails and the highland areas are well vegetated primarily with deciduous and evergreen trees and shrubs.

The deep cut area is located just east of the Highway 9/Gore Road intersection on the north side of Highway 9. The proposed cut section is approximately 300 m long with a maximum height of $8.0 \pm \text{m}$. The key plan on the Borehole Locations and Soil Strata Drawings, provides an overview of the site location and site photos are provided in Drawing 3.

3.0 INVESTIGATION PROCEDURES

The field work for this aspect of the project was carried out between January 31 and February 16, 2022 and consisted of drilling and sampling six boreholes (numbered BH 9 to BH 14) to depths ranging from 8.1 m to 14.2 m below ground surface. The approximate borehole locations are shown on Drawing 1.

The borehole locations were marked in the field by Terraprobe's staff based on the drawings provided by HDR. The boreholes were also surveyed for coordinates and geodetic elevation with a Trimble R10 Receiver connected to the Global Navigation Satellite System. The borehole locations in MTM NAD83 northing and easting coordinates, the ground surface elevations referenced to geodetic datum and investigated depths are summarized in the following table.

Borehole No.	MTM NAD 83 Coordinates (Zone 10)		Ground Surface Elevation (m)	Depth (m)
	Northing (m)	Easting (m)		
BH 9	4 868 862.3	271 335.9	323.0	8.1
BH 10	4 868 875.3	271 386.9	323.5	8.1
BH 11	4 868 889.1	271 437.6	323.5	8.1



Borehole No.	MTM NAD 83 Coordinates (Zone 10)		Ground Surface Elevation (m)	Depth (m)
	Northing (m)	Easting (m)		
BH 12	4 868 891.0	271 350.1	329.1	14.2
BH 13	4 868 906.6	271 397.5	328.9	14.2
BH 14	4 868 915.1	271 440.0	328.1	12.6

The boreholes were drilled with truck and track mounted drill rigs supplied and operated by a specialist drilling contractor. Terraprobe's staff observed and recorded the drilling, sampling and in situ testing operations and logged the boreholes.

Samples of the overburden soils were obtained at intervals of 0.75 m and 1.5 m depth using a 50 mm outer diameter (O.D.) split-spoon sampler in conjunction with the Standard Penetration Testing (SPT) procedures as specified in ASTM Method D 1586¹.

Ground water conditions were observed in the boreholes during and immediately following the drilling operations. To permit longer term ground water level monitoring, standpipe piezometers consisting of a 50 mm diameter PVC pipe with a slotted screen enclosed in sand were installed in Boreholes 9, 11, 12 and 14. The boreholes were backfilled and the standpipe piezometers were decommissioned in accordance with current MTO procedures and Ontario Regulation 903 (as amended).

The recovered soil samples were subjected to Visual Identification (VI) and select soil samples were also subjected to a laboratory testing programme consisting of natural moisture content and grain size distribution analyses in accordance with MTO and/or ASTM Standards as appropriate.

4.0 REGIONAL GEOLOGY

The site is located at the fringes of the physiographic region known as the Oak Ridges Moraine. The crest of the moraine is extensively covered with sand and gravel deposits. Beds of stratified fine sand, silt and clay are also common where parts of the moraine were submerged by melt waters during the latter stages of its deposition.

5.0 SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole Sheets in Appendix A. Details of the encountered soil stratigraphy are presented in this appendix and on the "*Borehole Location and Soil Strata*" drawings. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

The stratigraphic boundaries shown on the Record of Boreholes and on the interpreted stratigraphic sections are inferred from non-continuous soil sampling and therefore represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

In summary, topsoil and fill soils consisting of very dense gravelly sand and loose to compact sand and silt were encountered at the site. The native overburden deposits consist of compact to very dense sand,

¹ ASTM D1586 – Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

dense to very dense gravelly sand, compact to very dense silt, compact to very dense silty sand to sandy silt, and very stiff to hard clayey silt.

5.1 Topsoil

Approximately 140 mm to 300 mm of topsoil was encountered at this site. The topsoil thickness will vary between and beyond the borehole locations.

5.2 Fill – Gravelly Sand

Boreholes 9, 10 and 11 were advanced through the Highway 9 shoulder and encountered gravelly sand fill material. The locations, thicknesses, depths and base elevations of the gravelly sand fill are summarized in the following table.

Borehole No.	Fill Thickness (m)	Fill Depth (m)	Fill Base Elevation (m)
BH 9	0.9	0.9	322.1
BH 10	0.8	0.8	322.7
BH 11	0.7	0.7	322.8

Standard Penetration tests performed in the gravelly sand fill measured SPT N-values that range from 59 blows to 98 blows per 0.3 m of penetration indicating a very dense relative density. The natural water content of samples of the gravelly sand fill ranges from 5% to 6% by weight.

A grain size distribution test was carried out on a sample of the gravelly sand fill and the grain size distribution curve is provided in Figure B1, in Appendix B. The test results show a grain size distribution consisting of 30% gravel, 54% sand, 13% silt, and 3% clay size particles.

5.3 Fill – Sand and Silt

Sand and silt fill material was encountered at this site. The locations, thicknesses, depths and base elevations of the sand and silt fill are summarized in the following table.

Borehole No.	Fill Thickness (m)	Fill Depth (m)	Fill Base Elevation (m)
BH 12	0.6	0.7	328.4
BH 13	0.4	0.7	328.2
BH 14	0.5	0.7	327.4

Standard Penetration tests performed in the sand and silt fill measured SPT N-values that range from 7 blows to 12 blows per 0.3 m of penetration indicating a loose to compact relative density. The natural water content of a sample of the sand and silt fill is 24% by weight.

A grain size distribution test was carried out on a sample of the sand and silt fill and the grain size distribution curve is provided in Figure B2, in Appendix B. The test results show a grain size distribution consisting of 0% gravel, 54% sand, 40% silt, and 6% clay size particles.



5.4 Sand

Native sand deposits were encountered at this site and the locations, thicknesses, depths, and base elevations of the sand deposits are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH 9	3.5	4.4	318.6
	1.0	8.1*	314.9
BH 10	6.3	7.1	316.4
BH 11	1.0	8.1*	315.4
BH 12	4.2	10.1	319.0
	1.0	14.2*	314.9
BH 14	3.8	5.9	322.2
	5.5	12.6*	315.5

* Borehole termination depth.

Standard Penetration tests carried out in the sand deposits measured SPT N-values of 17 blows to more than 100 blows for 0.3 m of penetration indicating a compact to very dense relative density. The natural water content of samples of the sand deposits ranges from 2% to 21% by weight.

Grain size distribution tests were carried out on six samples of the sand deposits and the grain size distribution curves are illustrated in Figure B3 in Appendix B. These results show a grain size distribution consisting of 0% to 13% gravel, 69% to 91% sand, 8% to 21% silt and, 1% to 4% clay size particles.

5.5 Gravelly Sand

Gravelly sand deposits were encountered at this site. The locations, thicknesses, depths, and base elevations of the gravelly sand deposits are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH 9	2.7	7.1	315.9
BH 12	2.2	12.3	316.8

Standard Penetration tests carried out in the gravelly sand deposits measured SPT N-values of 32 blows to more than 100 blows for 0.3 m of penetration indicating a dense and very dense relative density. The natural water content of two samples of the gravelly sand deposits is 3% and 4% by weight.

Grain size distribution tests were carried out on two samples of the gravelly sand deposits and the grain size distribution curves are illustrated in Figure B4 in Appendix B. These results show a grain size distribution consisting of 21% and 32% gravel, 52% and 57% sand, 14% and 18% silt and, 2% and 4% clay size particles.

5.6 Silt

Silt deposits were encountered at this site and the locations, thicknesses, depths, and base elevations of the silt deposits are summarized in the following table.



Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH 11	6.4	7.1	316.4
BH 13	3.8	5.2	323.7
BH 14	0.7	2.1	326.0

Standard Penetration tests carried out in the silt deposits measured SPT N-values of 13 blows to 70 blows for 0.3 m of penetration indicating a compact to very dense relative density. The natural water content of samples of the silt deposits ranges from 9% to 18% by weight.

Grain size distribution tests were carried out on two samples of the silt deposits and the grain size distribution curves are illustrated in Figure B5 in Appendix B. These results show a grain size distribution consisting of 0% gravel, 10% and 12% sand, 81% and 83% silt and, 5% and 9% clay size particles.

5.7 Silty Sand to Sandy Silt

Cohesionless deposits ranging in composition from silty sand to sandy silt were encountered at this site. The locations, thicknesses, depths, and base elevations of the silty sand to sandy silt deposits are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH 12	5.2	5.9	323.2
BH 13	0.7	1.4	327.5
	9.0	14.2*	314.7
BH 14	0.7	1.4	326.7
	1.2	7.1	321.0

* Borehole termination depth.

Standard Penetration tests carried out in the silty sand to sandy silt deposits measured SPT N-values of 12 blows to 51 blows for 0.3 m of penetration indicating a compact to very dense relative density. The natural water content of samples of the silty sand to sandy silt deposits range from 6% to 26% by weight.

Grain size distribution tests were carried out on five samples of the silty sand to sandy silt deposits and the grain size distribution curves are illustrated in Figure B6 in Appendix B. These results show a grain size distribution consisting of 0% to 2% gravel, 20% to 74% sand, 22% to 77% silt, and 2% to 9% clay size particles.

5.8 Clayey Silt

Clayey silt deposits were encountered at this site and the locations, thicknesses, depths, and base elevations of the clayey silt deposits are summarized in the following table.

Borehole No.	Thickness (m)	Depth (m)	Base Elevation (m)
BH 10	1.0	8.1*	315.4
BH 12	0.9	13.2	315.9

* Borehole termination depth.

Standard Penetration tests performed in the clayey silt deposits measured SPT N-values of 29 blows and 40 blows for 0.3 m of penetration indicating a very stiff to hard consistency.



5.9 Ground Water Levels

Ground water conditions were observed in the boreholes during and upon completion of drilling and Boreholes 9, 11, 12 and 14 were instrumented with a 50 mm diameter standpipe piezometer. Summarized below are the ground water levels that were measured on separate visits after the completion of drilling.

Borehole No.	Date	Water Levels	
		Depth (m)	Elevation (m)
BH 9	February 23, 2022	6.8	316.2
	March 17, 2022	5.9	317.1
	June 03, 2022	5.8	317.2
BH 11	February 23, 2022	6.6	316.9
	June 03, 2022	6.4	317.1
BH 12	February 23, 2022	12.2	316.9
	June 03, 2022	12.0	317.1
BH 14	February 23, 2022	11.5	316.6
	June 03, 2022	11.3	316.8

The ground water levels are expected to follow the ground surface topography and can be expected to fluctuate seasonally as well as in response to major weather events. The ground water levels will also be influenced by the Humber River tributary and the wetland area located west of this site.

6.0 MISCELLANEOUS

The investigation was carried out using equipment supplied and operated by DBW Drilling Limited of Ajax, Ontario, and the field operations were organized by Mr. Dhruvish Halari, EIT. and Ms. Leila Baninajarian, EIT. The routine laboratory tests were carried out at Terraprobe's Brampton laboratory.

This report was prepared by Ms. Sepideh D-Monfared, P.Eng., and reviewed by Mr. Rehman Abdul, P.Eng., a Principal and Terraprobe's Designated MTO Contact.

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PART B – FOUNDATION DESIGN REPORT (DEEP CUT)

**HIGHWAY 9 AND GORE ROAD INTERSECTION IMPROVEMENT
MINISTRY OF TRANSPORTATION (CENTRAL REGION), ONTARIO
G.W.P. 2072-17-00, ASSIGNMENT NO.: 2018-E-0070**

7.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

7.1 General

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to design suitable cut slope geometries for the proposed widening along a 300 m long section of Highway 9. The discussion and recommendations presented in this report are based on our understanding of the project and our interpretation of the factual data obtained from the subsurface investigations.

Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on the aspects of construction should make their own interpretation of the factual information provided, as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

7.2 Cut Sections

Earth cuts are required along a 300 m long section of Highway 9 between Sta. 14+520 and Sta. 14+810. The maximum depth of this cut section is 8.0 m \pm and the toe of the existing cut slope will be moved 4.0 m \pm to 9.0 m \pm horizontally to accommodate the widened highway platform.

7.3 Seismic Design

7.3.1 Seismic Site Classification

Ground conditions for seismic site characterization were established based on the field investigation and laboratory testing data. The energy-corrected average penetration resistance, \bar{N}_{60} , in the upper 30 m of soil below founding level was used to define the seismic site classification in accordance with Table 4.1 of the Canadian Highway Bridge Design Code (CHBDC). Based on this methodology and the borehole data, the site is classified as Site Class D.

7.3.2 Spectral Response Values

The CHBDC requires that the seismic hazard values associated with the design earthquake be established based on the National Building Code of Canada (NBCC). These values, Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV) and Spectral Acceleration (Sa) were obtained from the Geological Survey of Canada (GSC) “2015 National Building Code of Canada Seismic Hazard Calculator” and are for a reference ground condition of Site Class C.

In accordance with Section 4.4.3.3 of the CHBDC, the NBCC values were adjusted to reflect local site conditions i.e., Site Class D. As per Section 4.4.3.3 of the CHBDC, the value of PGA_{ref} for use with Tables 4.2 to 4.9 was taken as 80% of the PGA since the $Sa(0.2)/PGA$ ratio is less than 2.0. A PGA_{ref} value of 0.0584 for the 2,475 year return was used. The NBCC spectral response values and the site-specific design values are tabulated below.

NBCC Seismic Hazard Values							
2% Exceedance in 50 years (2,475 Year Return Period)							
PGA (g)	PGV (m/s)	Sa (0.2) (g)	Sa (0.5) (g)	Sa (1.0) (g)	Sa (2.0) (g)	Sa (5.0) (g)	Sa (10.0) (g)
0.073	0.064	0.120	0.079	0.047	0.024	0.006	0.003
Site Specific Design Seismic Hazard Values Site Class D							
2% Exceedance in 50 years (2,475 Year Return Period)							
PGA (g)	PGV (m/s)	S (0.2) (g)	S (0.5) (g)	S (1.0) (g)	S (2.0) (g)	S (5.0) (g)	S (10.0) (g)
0.094	0.094	0.149	0.116	0.073	0.038	0.009	0.004

7.4 Liquefaction Potential

As stipulated in Clause 6.14.8.1.2 of the CHBDC, an assessment of potential for liquefaction is not warranted for saturated low plasticity silts and sands within the upper 30 m with a corrected SPT blow count, $(N_1)_{60}$, of more than 25 blows for 0.3 m of penetration. Since the SPT blow counts, $(N_1)_{60}$, in Borehole 13 are less than 25 blows for 0.3 m of penetration, the potential for liquefaction of the subsurface soils at this borehole location was assessed using the simplified stress-based method of analysis. For this analysis the cyclic stress ratio for a magnitude 7.5 earthquake event is related to the peak ground acceleration, the ratio of total to effective overburden stress and a reduction factor, as follows:

$$CSR = 0.65 r_d (a_{max}/g) (\sigma_o / \sigma'_o)$$

where CSR = cyclic stress ratio;

a_{max} = maximum or effective peak acceleration at the ground surface;

σ_o = total overburden pressure on the layer under consideration (kPa);

σ'_o = effective overburden pressure on the layer under consideration (kPa);

r_d = stress reduction factor; and

g = acceleration due to gravity (m/s^2).

Based on a derived CSR of 0.054, liquefaction is not considered to be an issue for a magnitude 7.5 earthquake event.

7.5 Global Stability

7.5.1 Static Conditions

The global, internal and surficial stability of the cuts will depend on their slope geometries and also to a large degree on the soil properties and the ground water table location relative to ground surface. For the purpose of stability analyses, the commercially available slope stability program Slide 2018 developed by Rocscience Inc. was used.

The Morgenstern-Price and Spencer methods for stability analysis were employed and the target factors of safety for temporary and permanent conditions were derived based on the site consequence factor (ψ) and the geotechnical resistance factors (ϕ_{gu}) provided in Table 6.2 of the CHBDC. Accordingly, minimum target factors of safety of 1.3 and 1.5 were established for temporary (short term) and permanent (long term) conditions respectively.

The soil parameters used for the slope stability analyses and the factors of safety that were obtained are provided in the following table. The slope stability models depicting the corresponding factors of safety are provided in Figures C1 and C2 in Appendix C.

Material Type	Total Stress Analysis		Effective Stress Analysis		Unit Weight
	ϕ (degrees)	c (kPa)	ϕ' (degrees)	c' (kPa)	γ (kN/m ³)
Gravelly Sand Fill	32	0	32	0	20
Sand and Silt Fill	29 - 30	0	29 - 30	0	19
Silt	30 - 32	0	30 - 32	0	19
Sand	32 - 35	0	32 - 35	0	20
Sandy Silt to Sand and Silt	30 - 32	0	30 - 32	0	19
Gravelly Sand	35	0	35	0	20
Clayey Silt	0	150	28	0	19
Design Factors of Safety	≥ 1.5		≥ 1.5		-

The analyses indicate that for cut slopes with a maximum total height of 8± m the factors of safety will be equal or greater than the target factors of safety, provided that the cuts are constructed at a minimum side slope geometry of 2 Horizontal to 1 Vertical (2H:1V) or flatter. Where cut slopes are higher than 6 m, a mid-height bench should be incorporated at the mid-height of the cut slopes. The bench should:

- extend for the length through which the cut section height exceeds 6 m;
- be at least 2 m wide; and
- have 2% positive drainage to shed run-off water.

7.5.2 Seismic Conditions

Under earthquake conditions, embankment stability can be assessed using conventional pseudo-static methods of slope stability analysis under the earthquake-induced peak ground acceleration. A calculated factor of safety of 1.1 to 1.3 indicates that the slope is considered to be generally stable and meets the seismic design requirements. A calculated factor of unity or less does not necessarily indicate full-scale slope failure because the soil mass is subjected to the peak load in a given direction for only a fraction of a second.

Because soil slopes are not rigid and the peak acceleration generated during an earthquake lasts for only a short period of time, seismic coefficients used in practice generally correspond to acceleration values well below the predicted peak accelerations.

For a 2 % probability of exceedance in 50 years, the derived site-specific peak ground acceleration (PGA) is 0.094g consistent with Site Class D. The horizontal and vertical seismic coefficients shall not be less than one-half of the corresponding peak ground acceleration resulting in a design seismic coefficient value of 0.047 i.e., 50% of the site-specific PGA.

The pore water pressure in the subsurface soils will increase under earthquake conditions. In cohesionless deposits the pore water pressures are expected to dissipate very quickly due to the soils relatively high permeability, and the effective stress parameters of these soils were used for the pseudo-static analyses. For the impermeable clayey silt, total stress parameters were used for the pseudo-static analysis to account for excess pore water pressures generated during earthquake conditions.

Pseudo-static seismic slope stability analyses results indicate that the factors of safety with respect to global stability will be equal or greater than 1.3 for the cut slopes. The results of the seismic stability analyses are presented in Appendix C, Figure C3.

Shallow sloughing and toe failure could occur during seismic events. This sloughing and toe failure is expected to be limited, would not impair the use of the road, and would mainly be a maintenance issue. The potential for sloughing following seismic events could be reduced by providing well-vegetated side slopes.

7.6 Surficial Stability & Erosion Protection


The majority of the cut widenings will generally be carried out through sands and silts. The groundwater levels recorded from standpipe piezometers indicate a groundwater table that is below the adjacent Highway 9 grade. No evidence of ground water seepage was observed on the face of the existing cut slopes at the time of the field investigations.

Proper erosion control measures should be implemented both during construction and permanently. Vegetation cover should be established on all cut slope faces to protect against surficial erosion, as per OPSS.PROV 803 and the face of all cut slopes shall be treated for erosion protection as per OPSS.PROV 804. It is also imperative that the cut slopes be designed as much as practical to prevent surface water runoff from flowing down the face of the slope. This can be accomplished by including an interceptor ditch along the crest where space permits. Surface water runoff must also be controlled and directed to roadside ditches via armoured outfalls/outlets.

8.0 CLOSURE

This report was prepared by Ms. Sepideh D-Monfared, P.Eng., and reviewed by Mr. Rehman Abdul, P.Eng., a Principal and Terraprobe's Designated MTO Contact.

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Ontario Provincial Standard Specifications (OPSS)

- | | |
|---------------|---|
| OPSS.PROV 803 | Construction Specification For Sodding. |
| OPSS.PROV 804 | Construction Specification For Seed and Cover. |
| OPSS 805 | Construction Specification For Temporary Erosion And Sediment Control Measures. |



DRAWINGS & SITE PHOTOGRAPHS

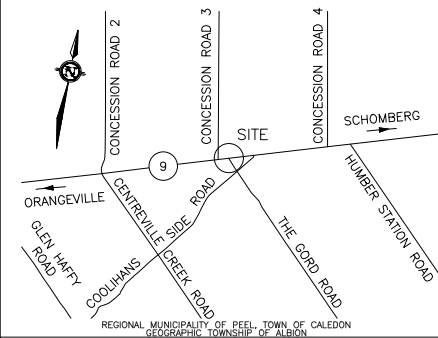




SHEET






11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650



KEY PLAN NOT TO SCALE

	LEGEND
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	Bore Hole
'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
	WL at Time of Investigation
	WL in Piezometer
	Piezometer
A/R	Auger Refusal

[illegible]

NOTE

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

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

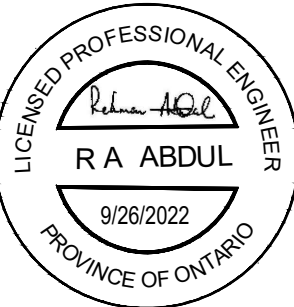
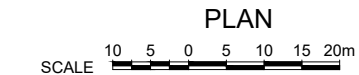
The complete foundation investigation and design report for this project and all related documents may be examined at the Maryland Engineering and Research Office, Downsview. Information contained in this report and related documents are specifically excluded in accordance with Section GC 2.01 of OPS General Conditions

REFERENCE

Drawings provided in digital format by HDR, received by email dated July 25, 2022.

REVISIONS			
	DATE	BY	DESCRIPTION

Hwy. 9	PROJECT No. 1-20-0088		GEOCRESS No.: 30M13-2
SUBM'D. SD	CHKD. RA	DATE: AUGUST 2022	SITE: ---
DRAWN: KC	CHKD. RA	APPD: RA	DWG. 1



HORIZ. SCALE 10 0 10 20m
VERT. SCALE 1.25 0 1.25 2.5m

HIGHWAY 9 - CENTRELINE PROFILE

C:\Users\Kamal_Kamal\Desktop\GEO Foundation Engineering - Hwy 9 Improvements\A Dwg's, Logs\AutoCAD\OneDrive_7-25-2022\1-20-0088-Fig 1 & 2 2022-09-26 (with stamp).dwg



Hwy. 9 at Station 14+680 - Looking East - January 07, 2022




Hwy. 9 at Station 14+580 - Looking West - January 07, 2022



Hwy. 9 at Station 14+570 - Looking East - January 07, 2022



Top of Existing Cut Slope North Side of Hwy. 9 at Station 14+675 - Looking West - January 07, 2022

<div>  Terraprobe <small>Consulting Geotechnical & Environmental Engineering Construction Materials, Inspection & Testing</small> <small>11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650</small> </div>		<div> HWY 9 & GORE ROAD INTERSECTION Town Of Caledon </div>	
G.W.P. No. 2072-17-00		DATE: July 29, 2022	
SUBM'D: SD		CHKD: RA	
Project No: 1-20-0088		Figure: 3	

APPENDIX A

Record of Borehole Sheets



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{u} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J 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.

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 (RQD), 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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

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_r	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 9

1 of 1

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271335.9 N:4868862.3 (MTM) ORIGINATED BY SM
 DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2022-2-1 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)										WATER CONTENT (%)		
								20	40	60	80	100						○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE X LAB VANE	20
323.0	GROUND SURFACE																GR SA SI CL			
322.1 0.9	850mm FILL, gravelly sand, trace to some silt, very dense, brown, moist		1	SS	86												0 87 11 2			
	SAND, trace to some silt, trace gravel, trace clay, compact to very dense, brown, dry to moist		2	SS	59															
			3	SS	21															
			4	SS	33															
			5	SS	38															
			6	SS	72															
318.6 4.4	GRAVELLY SAND, trace to some silt, trace clay, dense to very dense, brown, dry to 5.6m, wet below		7	SS	130												21 57 18 4			
315.9 7.1	SAND, some silt, dense, brown, wet		8	SS	32												Sampler wet at 6.1m			
314.9			9	SS	40															

END OF BOREHOLE

Unstabilized water level measured at 7.0 m below ground surface; borehole was open upon completion of drilling.

Piezometer installation consists of a 50mm diameter PVC pipe with a 3.0m long slotted screen

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 23, 2022	6.8	316.2
Mar 17, 2022	5.9	317.1
Jun 3, 2022	5.8	317.2

RECORD OF BOREHOLE No 10

1 of 1

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271386.9 N:4868875.3 (MTM) ORIGINATED BY SM
 DIST _____ HWY 9 _____ BOREHOLE TYPE SOLID STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2022-1-31 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)					WATER CONTENT (%)				
								20 40 60 80 100					w _p w w _L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE									
323.5	GROUND SURFACE																
322.7 0.8	800mm FILL, gravelly sand, trace to some silt, very dense, brown, moist		1	SS	76		323										
	SAND, some silt to silty, trace to some gravel, trace clay, dense to very dense, brown, dry to 5.5m, wet below		2	SS	64												
			3	SS	31		322										
			4	SS	53		321										
			5	SS	57		320										
			6	SS	55		319										
			7	SS	115												
			8	SS	72		317										
316.4 7.1	CLAYEY SILT, some sand, hard, brown, wet						318										
							</										

END OF BOREHOLE

Unstabilized water level measured at
6.7 m below ground surface; borehole
caved to 6.7 m below ground surface
upon completion of drilling.

RECORD OF BOREHOLE No 11

1 of 1

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271437.6 N:4868889.1 (MTM) ORIGINATED BY SM
 DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2022-1-31 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100												
								SHEAR STRENGTH (kPa)												
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE												
								w _p w w _L												
								WATER CONTENT (%)												
323.5	GROUND SURFACE														GR SA SI CL					
322.8	700mm FILL, gravelly sand, some silt, trace clay, very dense, brown, moist		1	SS	98							○			30 54 13 3					
0.7	SILT, some sand to sandy, trace clay, trace gravel, compact to very dense, brown, moist to wet		2	SS	70															
			3	SS	29							○								
			4	SS	45															
			5	SS	45								○							
			6	SS	62															
			7	SS	62								○							
316.4																				
			8	SS	49										Sampler wet at 6.1m					
7.1	SAND, some silt, very dense, brown, wet																			
315.4			9	SS	52							○								

END OF BOREHOLE

Unstabilized water level measured at 7.0 m below ground surface; borehole was open upon completion of drilling.

Piezometer installation consists of a 50 mm diameter PVC pipe with a 3.0m long slotted screen.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 23, 2022	6.6	316.9
Mar 6, 2022	6.4	317.1

RECORD OF BOREHOLE No 12

1 of 2

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271350.1 N:4868891.0 (MTM) ORIGINATED BY DH
DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
DATUM GEODETIC DATE 2022-2-15 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
329.1	GROUND SURFACE																
328.4	140mm TOPSOIL		1	SS	12												
0.7	FILL , sand and silt, trace clay, trace gravel, trace organics, compact, brown, moist		2	SS	16												
	SANDY SILT to SILT AND SAND , trace to some clay, trace gravel, compact to very dense, brown, moist to wet		3	SS	31												
			4	SS	35												
			5	SS	38												
			6	SS	29												
			7	SS	38												
			8	SS	51												
323.2	SAND , some silt to silty, trace gravel, trace clay, very dense, brown, moist		9	SS	61											0 20 77 3	
5.9			10	SS	51												
			11	SS	100 / 240mm											2 78 18 2	
319.0	GRAVELLY SAND , some silt, trace clay, very dense, brown, dry to 11.6m, wet below		12	SS	100 / 275mm												
10.1			13	SS	29												
316.8	CLAYEY SILT , some sand to sandy, very stiff, brown, wet		14	SS	30												
12.3																	
315.9	SAND , some silt, compact to dense, brown, wet																
13.2																	
314.9																	
14.2																	
	END OF BOREHOLE															Sampler wet at 13.7m	

Continued Next Page

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

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RECORD OF BOREHOLE No 12

2 of 2

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271350.1 N:4868891 (MTM) ORIGINATED BY DH
 DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2022-2-15 CHECKED BY RA

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT NUMBER	TYPE			SHEAR STRENGTH (kPa)		W _p	W	W _L	γ	
						20 40 60 80 100						
						○ UNCONFINED + FIELD VANE						
						● QUICK TRIAXIAL × LAB VANE						
						20 40 60 80 100		10 20 30			kN/m ³	GR SA SI CL

Unstabilized water level measured at
12.8 m below ground surface;
borehole caved at 13.4 m below
ground surface upon completion of
drilling.

Piezometer installation consists of a
50 mm diameter PVC pipe with a 3.0m
long slotted screen.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 23, 2022	12.2	316.9
Mar 6, 2022	12.0	317.1

RECORD OF BOREHOLE No 13

1 of 1

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271397.5 N:4868906.6 (MTM) ORIGINATED BY LB
DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
DATUM GEODETIC DATE 2022-2-14 CHECKED BY RA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			SPT 'N' VALUE	SHEAR STRENGTH (kPa)					WATER CONTENT (%)			
						20	40	60	80	100	W _p	W	W _L			
328.9	GROUND SURFACE															
328.6	300mm TOPSOIL		1	SS	7										0 54 40 6	
0.3	FILL, sand and silt, trace clay, loose, brown, wet															
328.2			2	SS	12											
0.7	SAND AND SILT, trace gravel, trace clay, compact, brown, moist															
327.5			3	SS	16											
1.4	SILT, some sand to sandy, trace to some clay, compact, brown, moist to wet															
			4	SS	21											
			5	SS	13										0 10 81 9	
			6	SS	15											
			7	SS	21											
323.7			8	SS	21											
5.2	SILTY SAND to SAND AND SILT, trace to some clay, trace gravel, compact, brown, moist to 11.7m, wet below															
			9	SS	17										2 74 22 2	
			10	SS	20											
			11	SS	22										0 66 31 3	
			12	SS	28											
			13	SS	19											
			14	SS	23										Sampler wet at 12.2m	
314.7	END OF BOREHOLE															
14.2	Unstabilized water level measured at 13.9m below ground surface; borehole was open upon completion of drilling.															

file: 1-20-0088 bh logs.pdf

RECORD OF BOREHOLE No 14

1 of 1

METRIC

G.W.P. _____ LOCATION _____ Coords: E:271440.0 N:4868915.1 (MTM) ORIGINATED BY DH
 DIST _____ HWY 9 _____ BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2022-2-16 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100										
								SHEAR STRENGTH (kPa)										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
								20 40 60 80 100					WATER CONTENT (%)					
328.1	GROUND SURFACE																	
327.9	180mm TOPSOIL						328											
0.2	FILL, sand and silt, trace clay, trace gravel, loose, brown, moist		1	SS	8													
327.4																		
0.7	SAND AND SILT, trace gravel, trace clay, compact, brown, wet		2	SS	14		327						○			1 54 36 9		
326.7																		
1.4	SILT, some sand to sandy, some clay, trace gravel, compact, brown, moist		3	SS	16		326											
326.0																		
2.1	SAND, trace to some gravel, trace to some silt, compact, brown, dry to moist		4	SS	20		325						○					
			5	SS	17													
			6	SS	22		324						○			0 91 8 1		
			7	SS	21													
			8	SS	25		323						○					
322.2																		
5.9	SANDY SILT, trace clay, trace gravel, compact, brown, wet		9	SS	18		322						○			1 35 58 6		
321.0							321											
7.1	SAND, trace to some silt, trace clay, compact to dense, brown, moist to wet		10	SS	23		320											
			11	SS	26		319						○			0 90 9 1		
							318											
			12	SS	32		317									Sampler wet at 10.7m		
							316											
			13	SS	40								○					
315.5																		

END OF BOREHOLE

Unstabilized water level measured at 11.9m below ground surface; borehole was open upon completion of drilling.

Piezometre installation of a 50mm diameter PVC pipe with a 3.0m long slotted screen.

WATER LEVEL READINGS

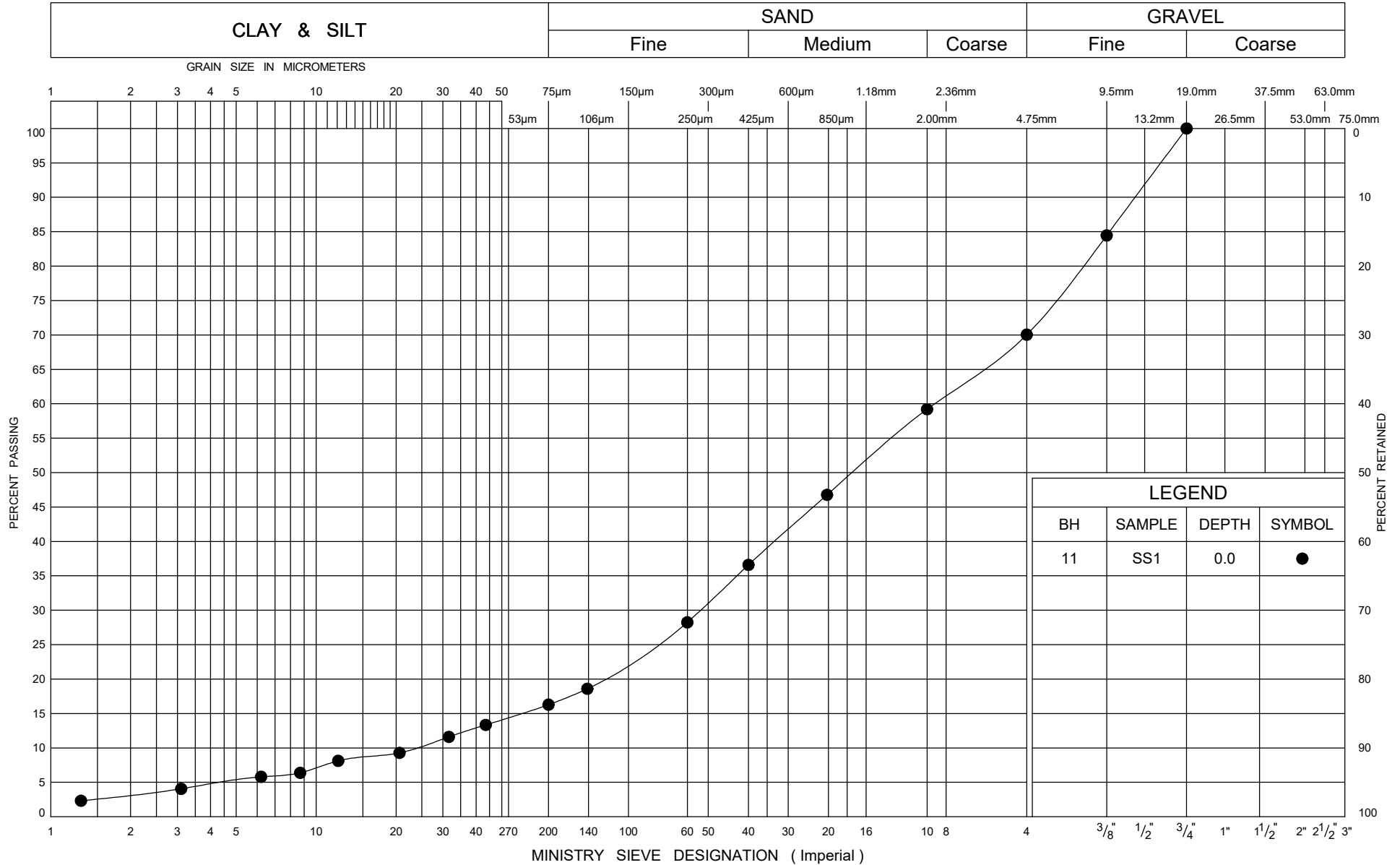
Date	Water Depth (m)	Elevation (m)
Feb 23, 2022	11.5	316.6
Mar 6, 2022	11.3	316.8

APPENDIX B

Field & Laboratory Test Results



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

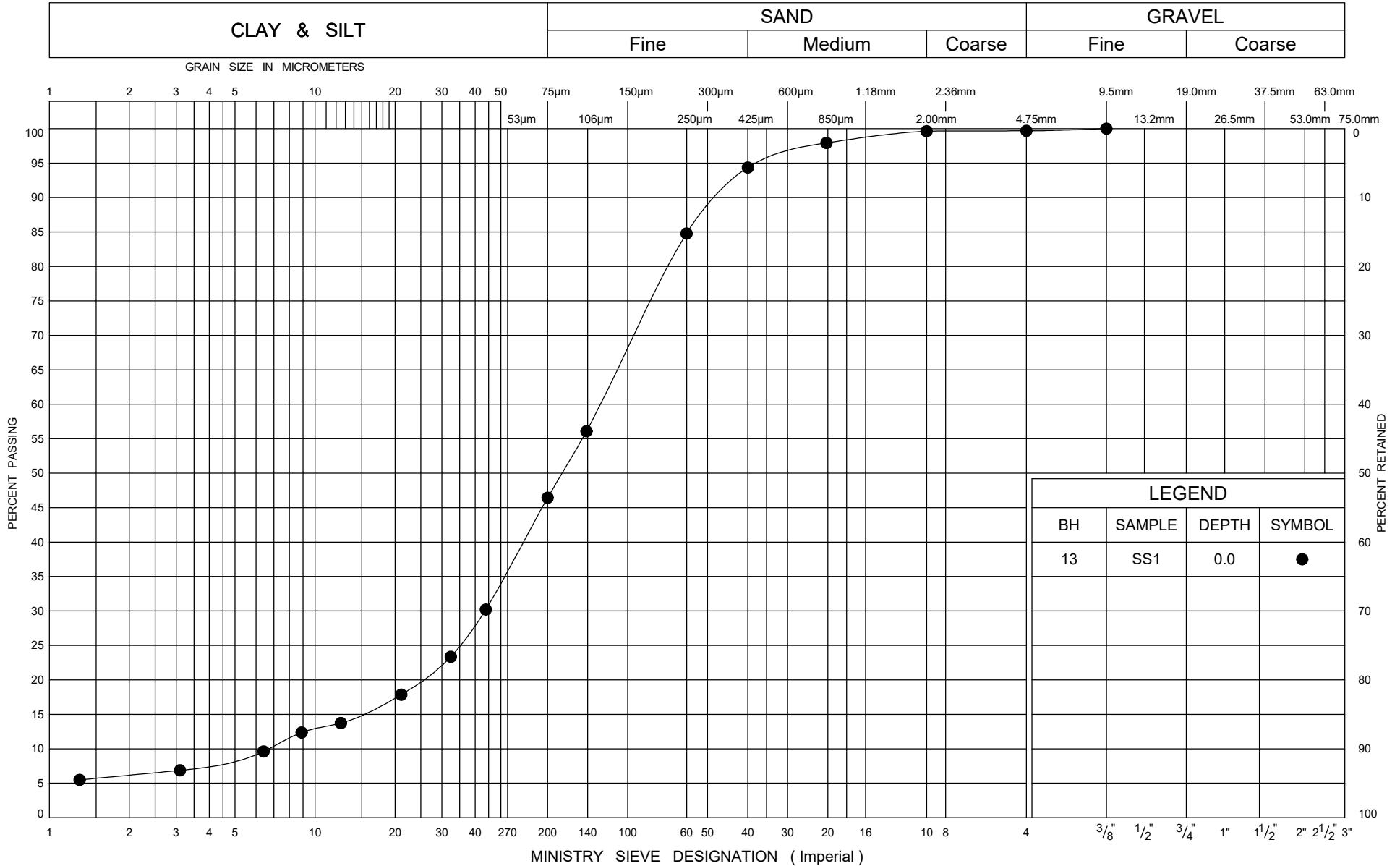
GRAIN SIZE DISTRIBUTION FILL - GRAVELLY SAND

FIG No B1

G W P

Hwy. 9 and The Gore Road, Caledon,
Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

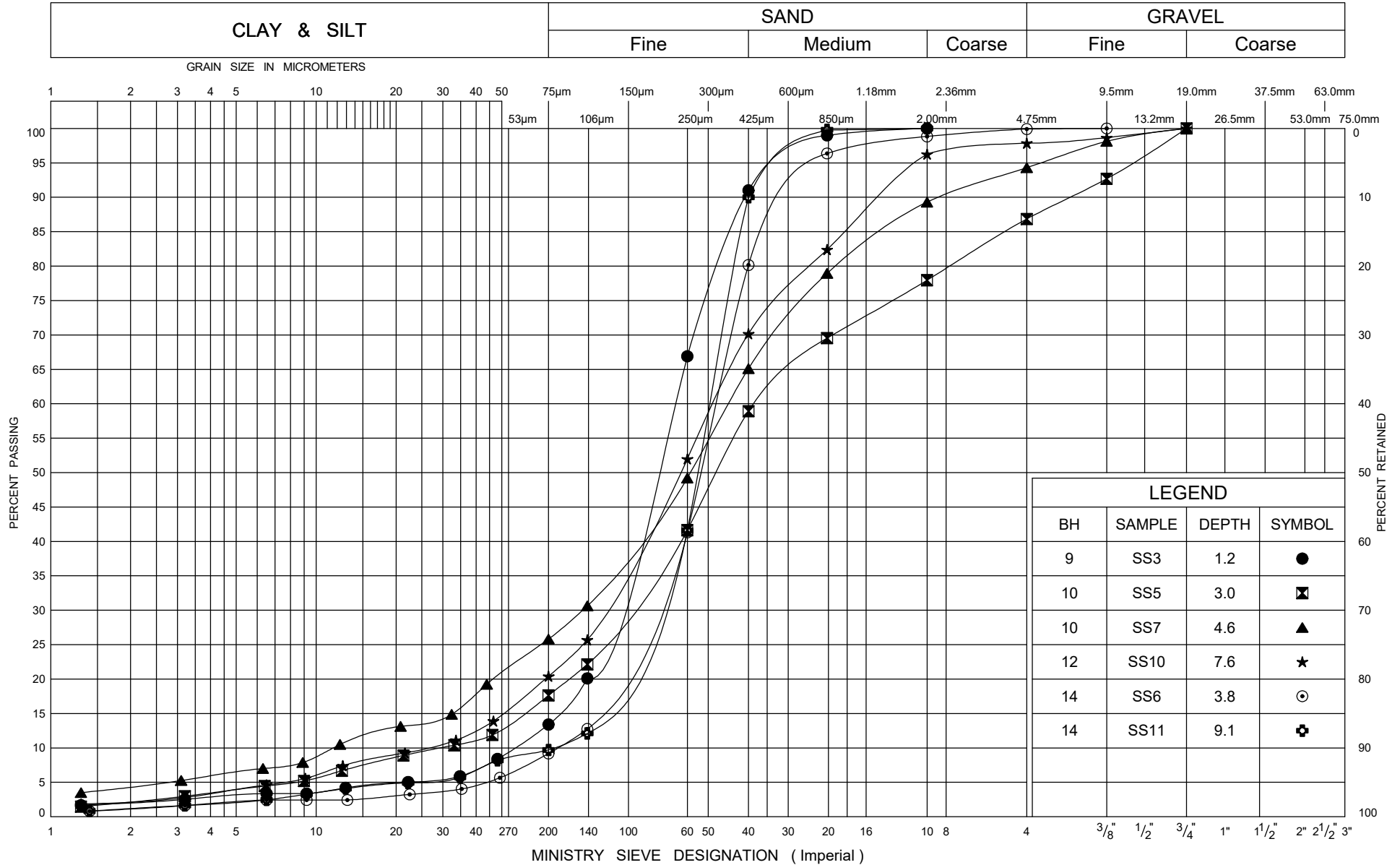
GRAIN SIZE DISTRIBUTION FILL - SAND AND SILT

FIG No B2

G W P

Hwy. 9 and The Gore Road, Caledon,
Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION SAND

FIG No B3

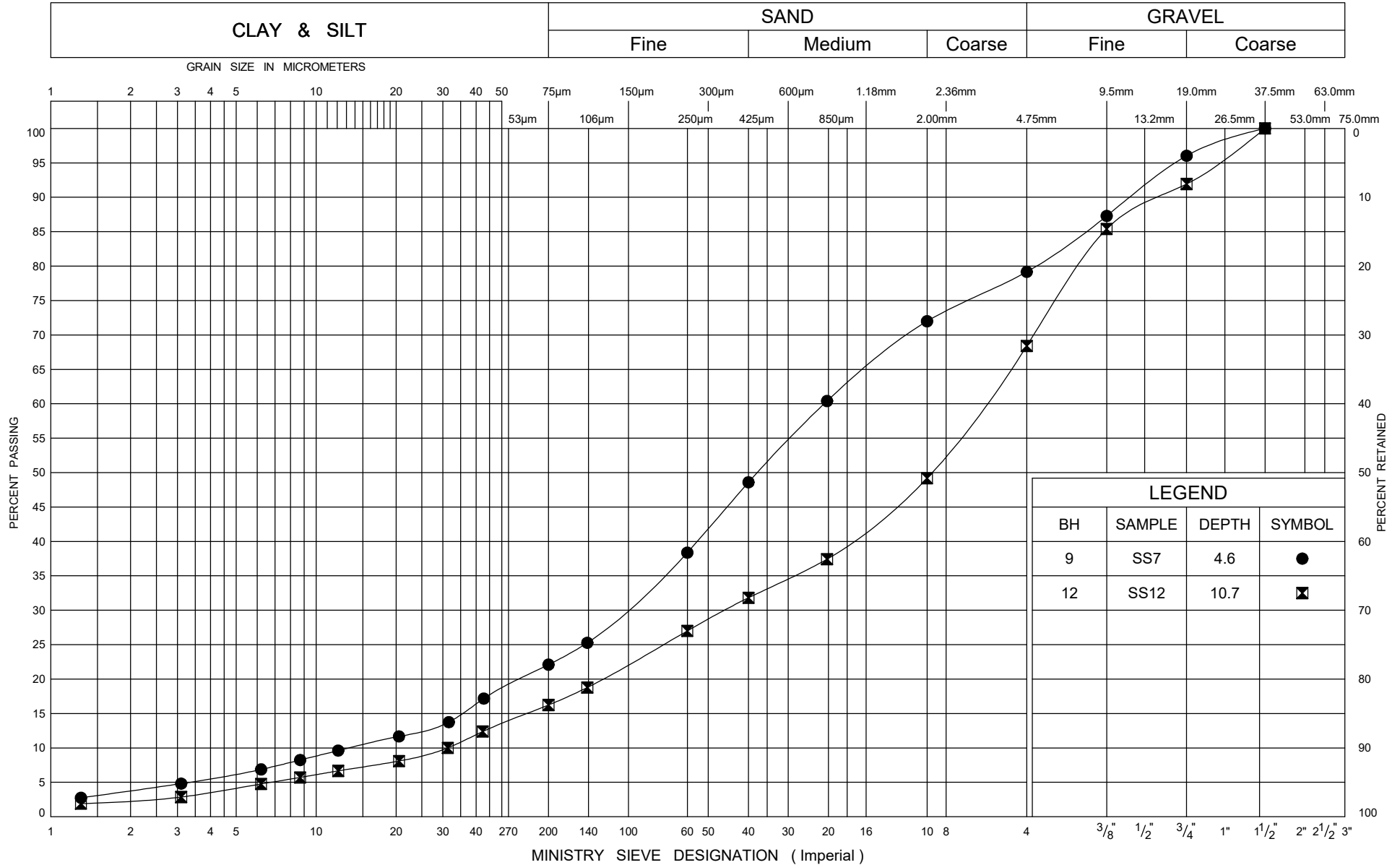
G W P

Hwy. 9 and The Gore Road, Caledon, Ontario



Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

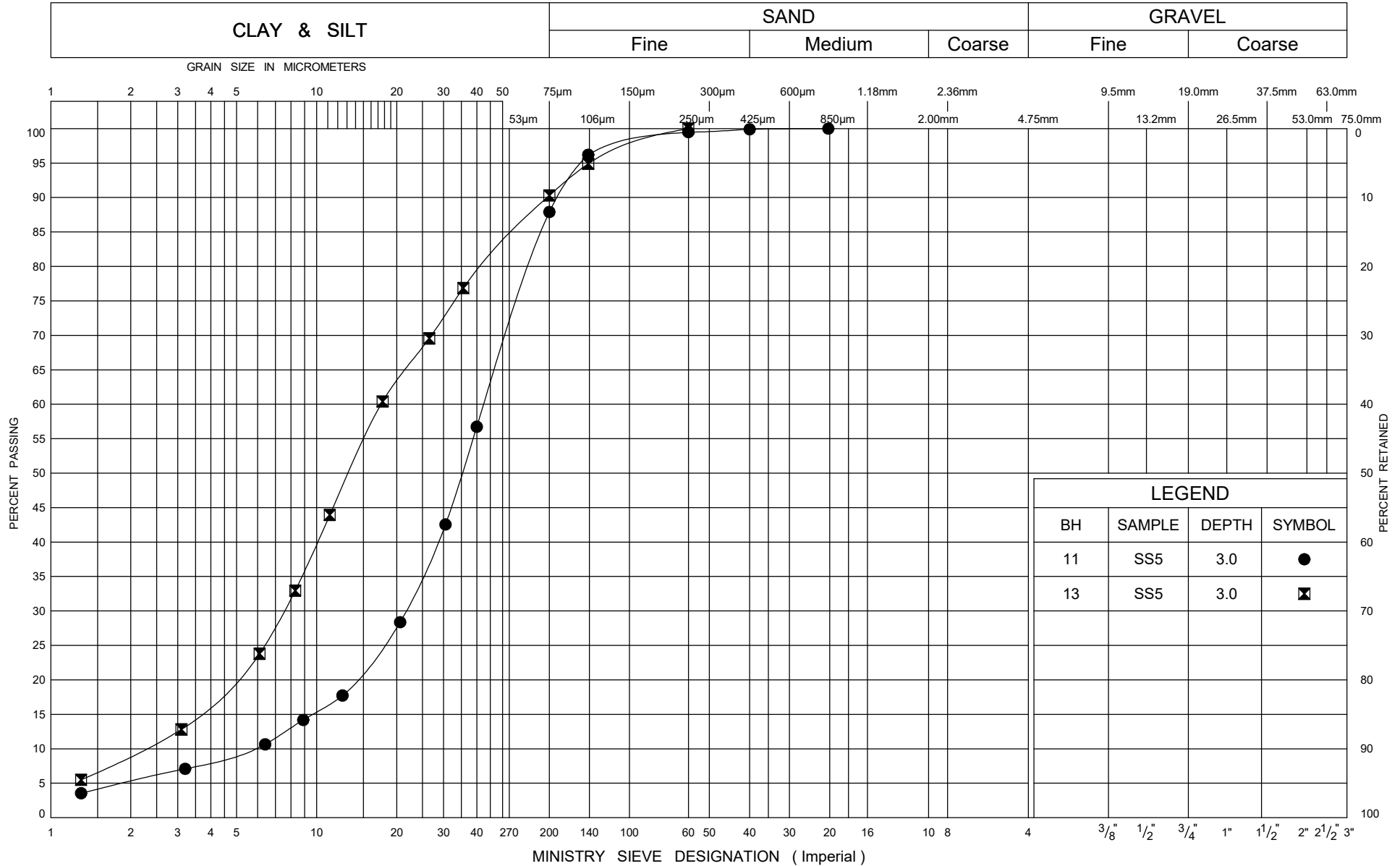
GRAIN SIZE DISTRIBUTION GRAVELLY SAND

FIG No B4

G W P

Hwy. 9 and The Gore Road, Caledon,
Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

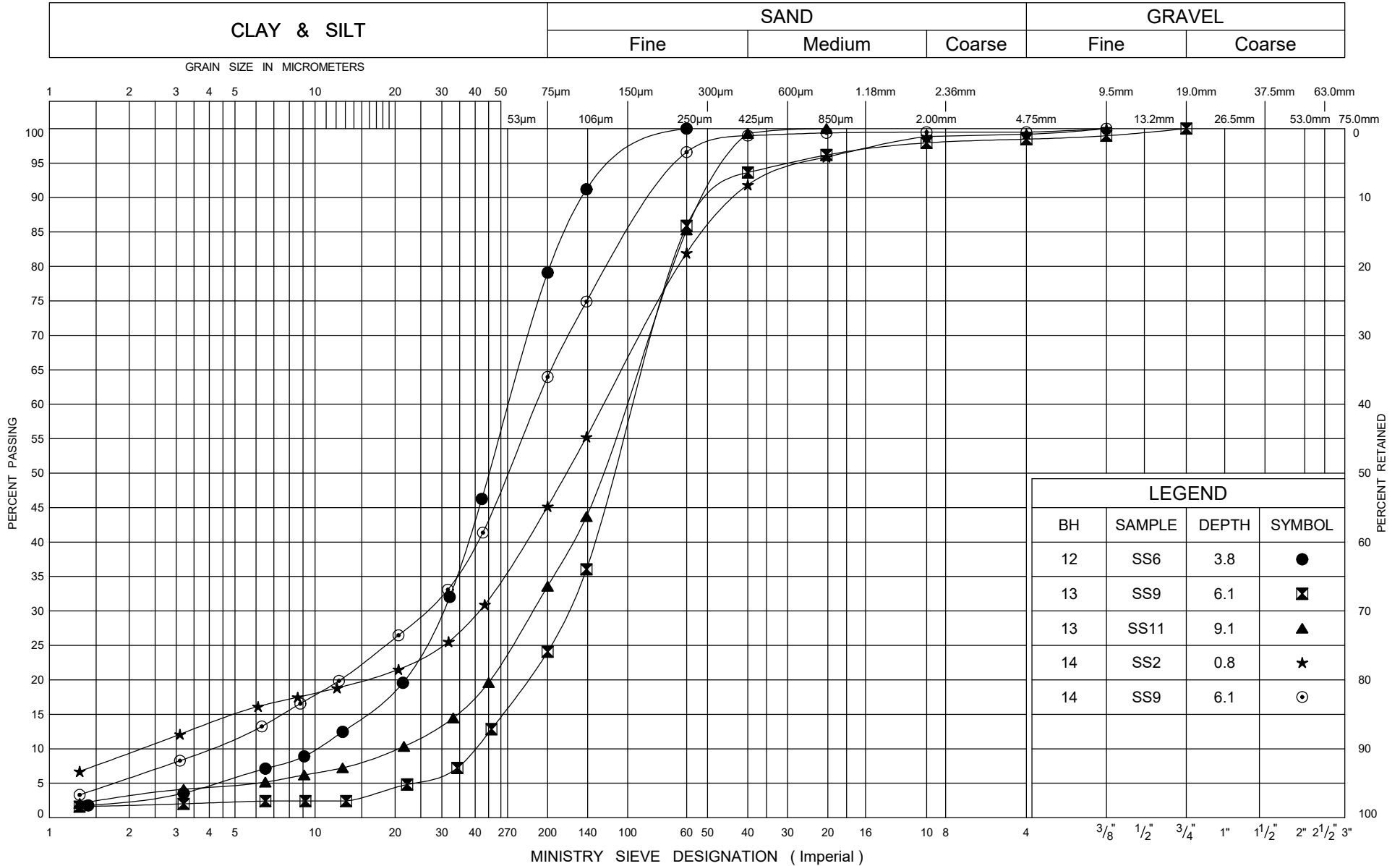
GRAIN SIZE DISTRIBUTION SILT

FIG No B5

G W P

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Ontario

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT

FIG No B6

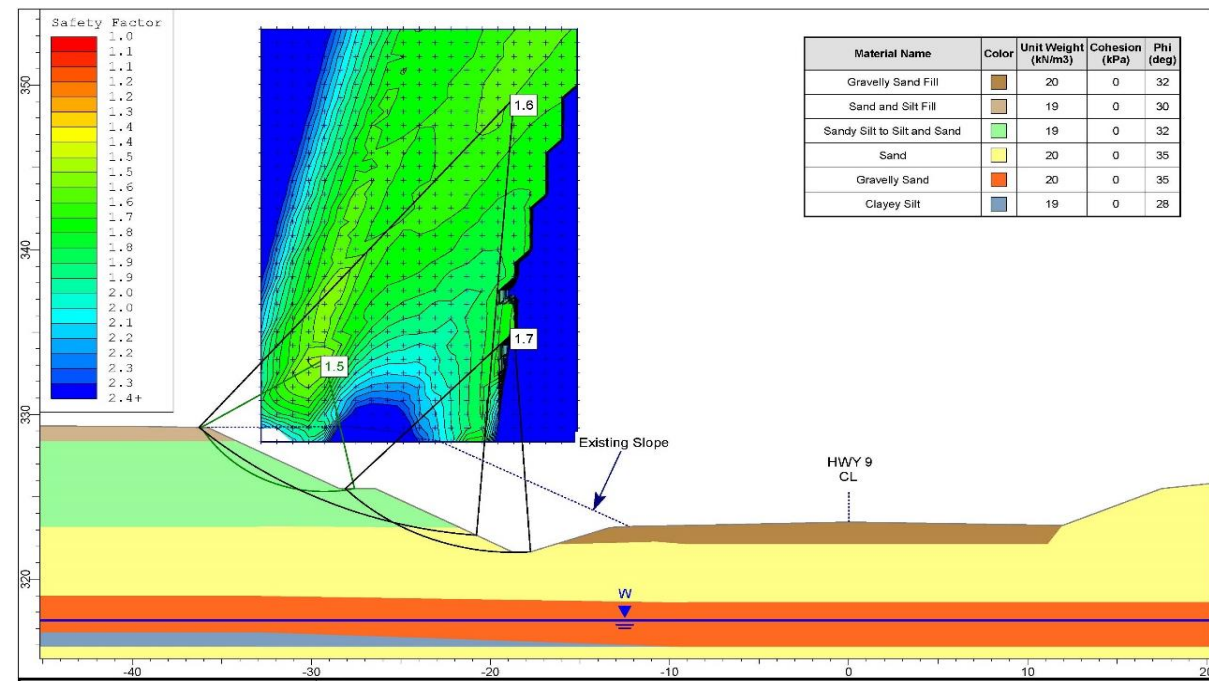
G W P

Hwy. 9 and The Gore Road, Caledon,
Ontario

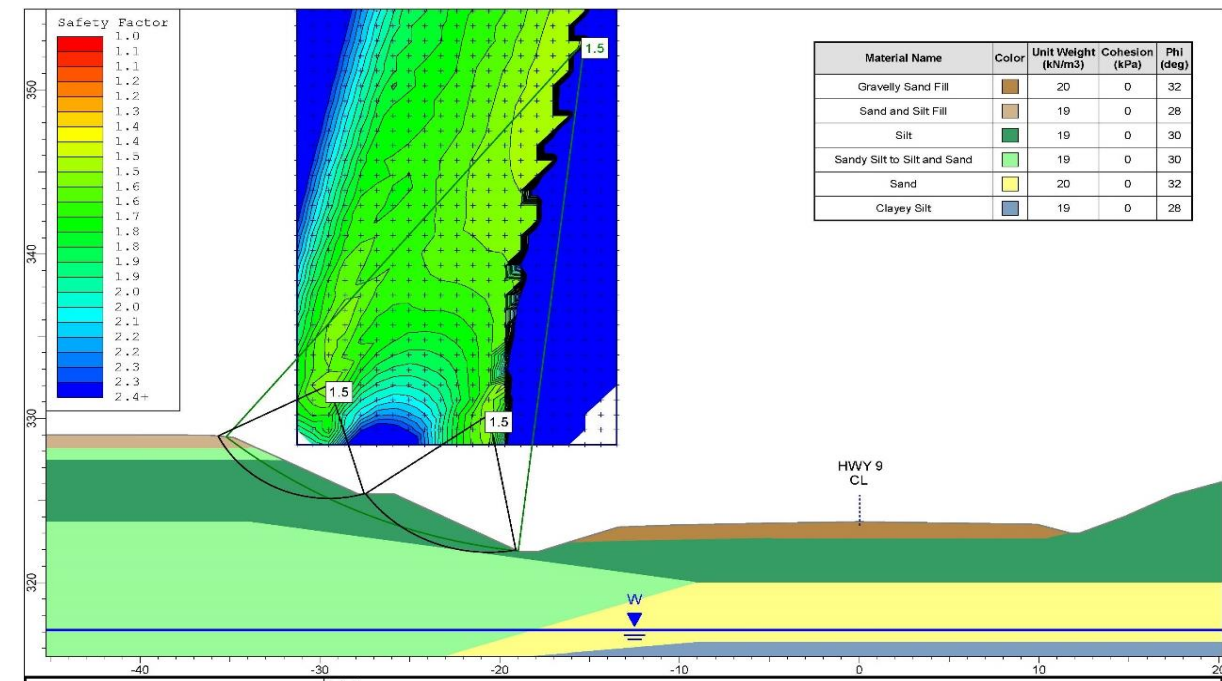
APPENDIX C

Slope Stability Models & Results

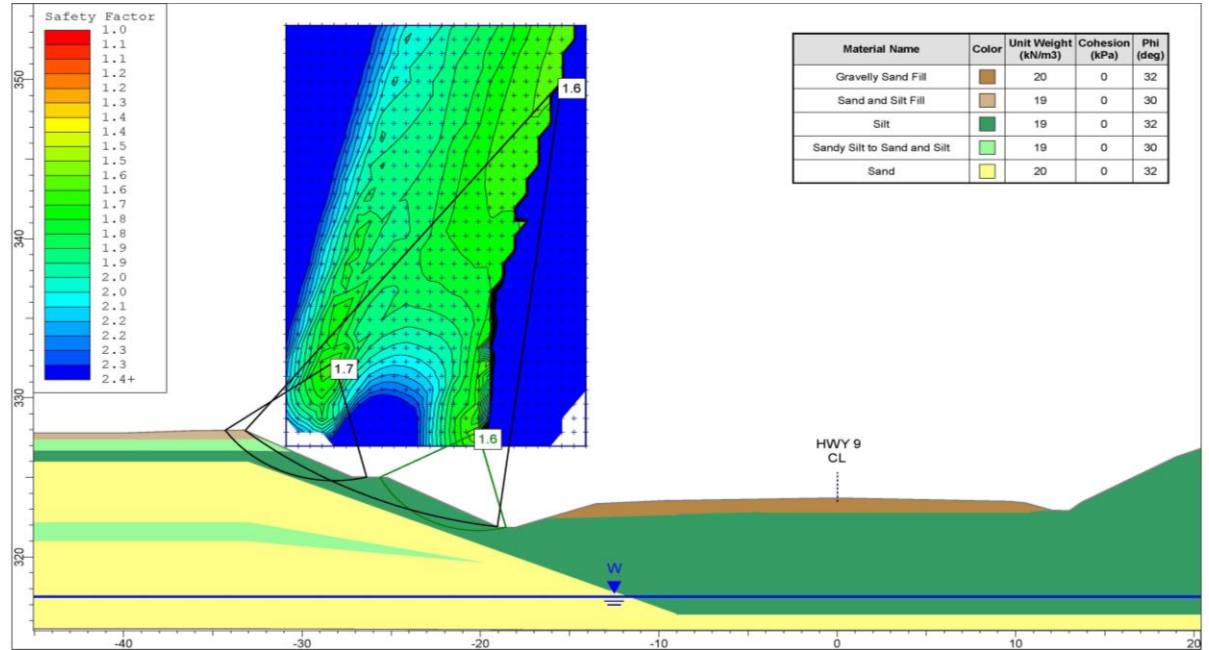




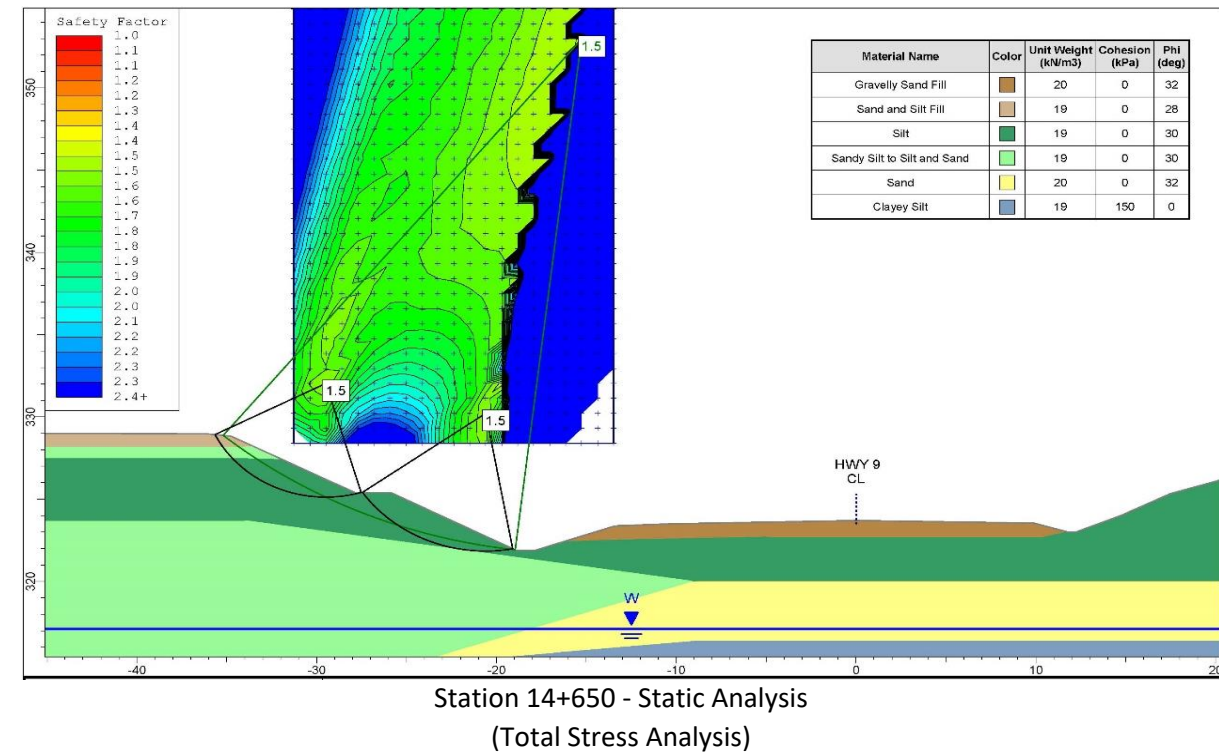
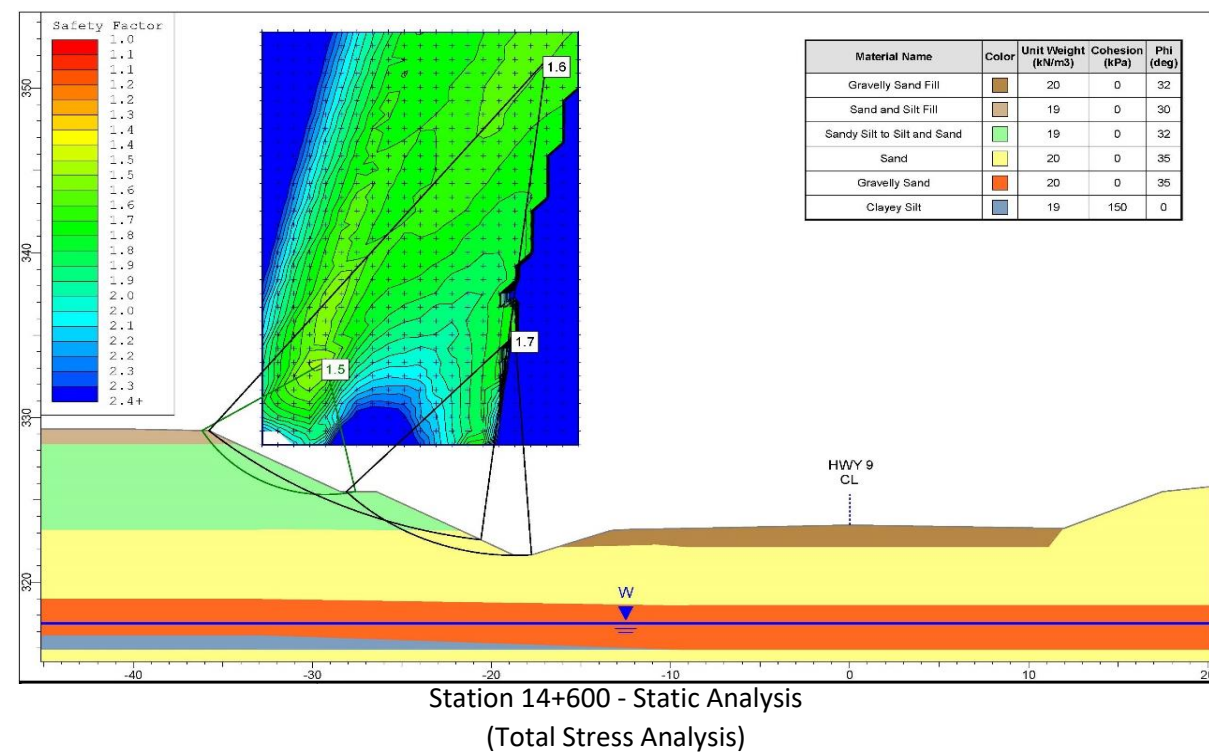
Station 14+600 - Static Analysis
(Effective Stress Analysis)

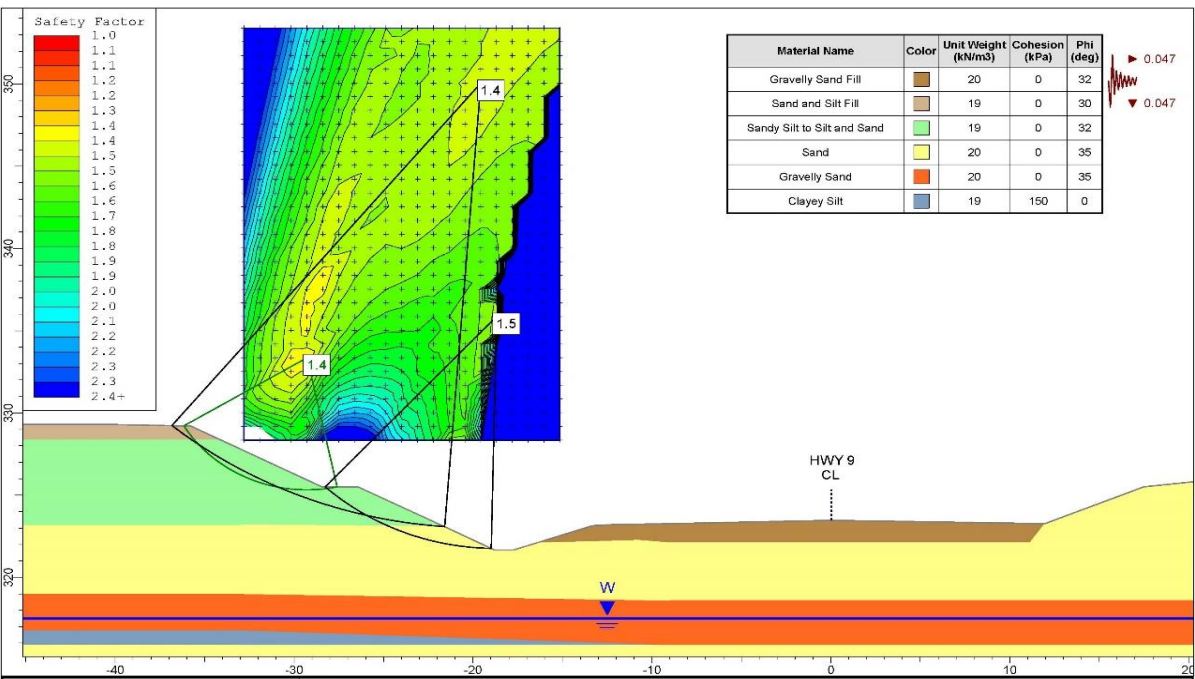


Station 14+650 - Static Analysis
(Effective Stress Analysis)

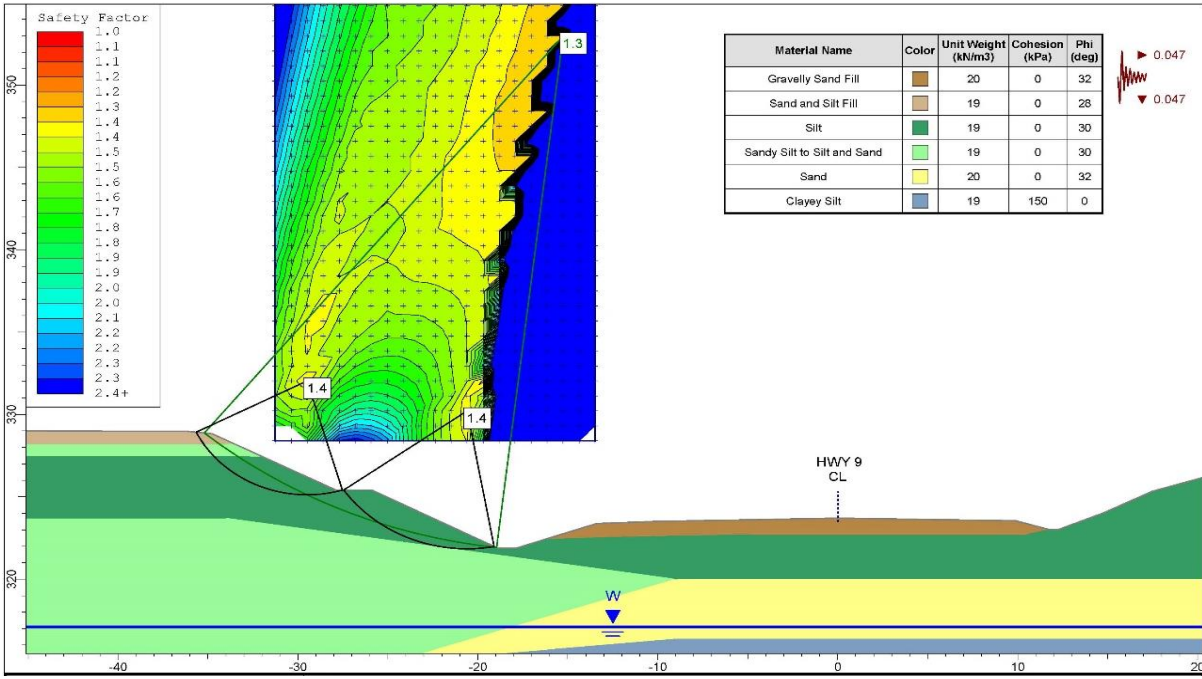


Station 14+700 - Static Analysis
(Effective Stress Analysis)

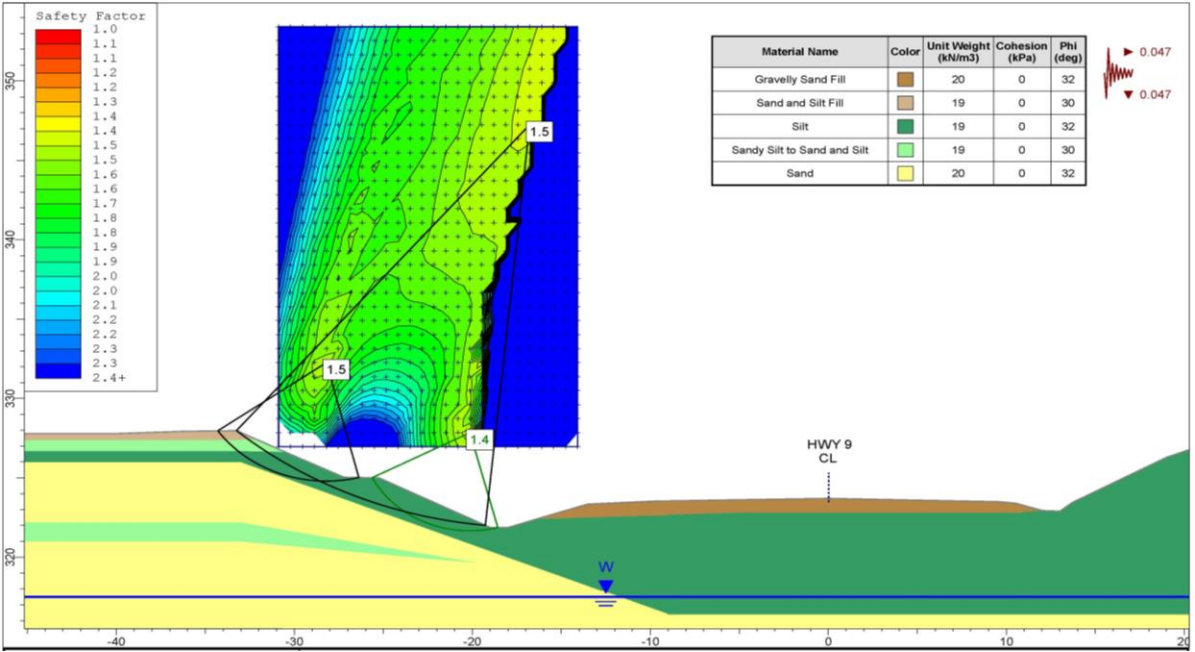




Station 14+600 - Seismic Analysis



Station 14+650 - Seismic Analysis



Station 14+700 - Seismic Analysis