THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION AND DESIGN REPORT
DEEP CUTS
APPROXIMATE STATIONS 12+585 TO 12+750
HIGHWAY 400 NEAR SUNNIDALE ROAD
CITY OF BARRIE, ONTARIO
G.W.P. 2445-15-00

GEOCRES NO. 31D-770

Latitude: 44.392898
Longitude: -79.703493

Report

to

McIntosh Perry

Date: October 20, 2021
File: 22424

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed deep cuts along Highway 400 on the east side of the northbound lanes (NBL) and the west side of the southbound lanes (SBL), just to the north and south of Sunnidale Road in the City of Barrie, Ontario.

The purpose of this investigation was to explore the subsurface conditions in the vicinity the proposed deep cuts, and based on the data obtained, to provide borehole location and soil strata drawings, records of boreholes, laboratory test results, and a written description of the subsurface conditions. A model of the subsurface conditions was developed for the site, based on data obtained from the present investigation and selected data from previous investigations by Thurber and others, to describe the geotechnical conditions influencing design and construction of the deep cuts.

Thurber was retained by McIntosh Perry (MP) to carry out this foundation investigation under the Ministry of Transportation Ontario (MTO) Assignment Number 2017-E-0032. The overall assignment includes replacement of three underpass structures on Highway 400; at Dunlop Street, at Anne Street and at Sunnidale Road. It also includes reconstruction of the Highway 400 and Dunlop Street interchange, noise barrier and retaining walls, pavement rehabilitation, culvert replacements, drainage improvements (sewers and stormwater management ponds) and illumination (high mast lighting). This report addresses the proposed deep cuts in the vicinity of Sunnidale Road.

In preparation of this report, reference has been made to information on subsurface conditions contained in previous foundation reports prepared by Thurber and others for this site. The titles of these reports are:

- Foundation Investigation Report for Sunnidale Road Underpass, Highway 400, City of Barrie, Ontario, Site 30-173, G.W.P. 2445-15-00, prepared by Thurber Engineering Ltd., dated August 31, 2020 (Reference 1).

- Pre-Draft Foundation Investigation and Design Report for Proposed Sunnidale Road Watermain Crossing, Highway 400, City of Barrie, Ontario, PML Ref. 19BF005, Pre-Draft Report 1, prepared by Peto McCallum Ltd., dated August 7, 2019 (Reference 2).

2. PROJECT AND SITE DESCRIPTION

The proposed deep cuts are located along Highway 400 on the east side of NBL and west side of SBL, from approximately 65 m south to 100 m north of Sunnidale Road in the City of Barrie, Ontario.

The general locations of the proposed deep cuts along Highway 400 on the north and south sides of Sunnidale, are shown on the Borehole Location Plan drawing in Appendix F.

The deep cuts are required for the proposed widening of Highway 400 and for the replacement of the existing underpass structure at Sunnidale Road, and will extend from approximate Stations 12+585 to 12+750. This is a part of the overall scheme to accommodate 10-lane configuration in the future. The maximum depths of the cuts are about 14 m below the original ground surface (plateau) on the west side, and up to about 6 m on the east side.

It is understood that the relocation of some existing underground utilities in the area will be required due to the highway widening. Two new watermains will be installed within a casing on the north side of the underpass. This work is being designed by others and will involve construction of launching and exit shafts on either side of Highway 400, and trenchless crossing of the casing under the highway. The currently proposed location of the west shaft is only several metres away from the slope surface of the proposed cut. Preliminary assessment of this shaft on cut slope stability is included in this report. A detail assessment cannot be made at this time until information on the proposed shaft design, construction methodology and sequence are made known to McIntosh Perry and Thurber.

Available information indicates that underground utilities (825 mm diameter storm sewer pipe and 300 mm diameter sanitary sewer pipe) will be installed at the west plateau some 25 m away from the crest of the proposed cut, running in a north-south direction, and approximately 3.5 m to 4.0 m below ground surface.

Beyond the highway cut, the overall surface topography in the vicinity of the site is relatively flat and consists of residential and commercial properties to the east and west of Highway 400. Sunnidale Park occupies the lands on the northwest side of Highway 400 and Sunnidale Road underpass. These lands are generally covered with grass, bushes, trees and other vegetation. A gravel walkway runs along the top of the cut, parallel to Highway 400. The width is approximately 2.0 m.

At the existing Sunnidale Road underpass, Highway 400 was constructed in a cut of up to approximately 8.5 m deep, with side slopes of 2H : 1V. The existing grade of Highway 400 is at approximate Elevation 248.5. The Sunnidale Road grade rises from approximate Elevations 254.0 to 257.6, east to west.

Selected photographs of the site are presented in Appendix E.

Based on published geological mapping, the study area is located within the Simcoe Lowlands physiographic region. This region borders Georgian Bay and Lake Simcoe and can generally be separated into two major divisions: the Nottawasaga basin to the west, consisting of plains draining into Nottawasaga Bay, and the Lake Simcoe basin to the east, consisting of the lowlands which surround Lake Simcoe. These two basins are connected at Barrie by a flat-floored valley. The Simcoe Lowlands region is generally comprised of sand, silt and clay deposits of deltaic and lacustrine origin.

2.1 Site Reconnaissance Visit

Observations made on the slopes during our site reconnaissance visit and during our borehole investigation are summarized below.

- The existing slopes on the west and east sides of Highway 400, within the area of investigation, are generally well vegetated and in good condition, and do not show any visible signs of instability or seepage zones.
- A treed zone was noted along the top of the slope, immediately southwest of the existing Sunnidale Road underpass. There were a few fallen trees amongst the generally upright trees.

- Some trees were noted along the slope at the northwest side of the Sunnidale Road underpass.
- On the northeast side, the slope is covered by tall grass with a few trees near its toe.

Selected photographs of the site are attached in Appendix E.

3. SITE INVESTIGATION AND FIELD TESTING

The borehole investigation and field testing program for this project was carried out from December 3, 2020 to January 26, 2021, and consisted of drilling and sampling four (4) boreholes (numbered NBL 12+685, SBL 12+725, SBL 12+685 and SBL 12+595) at selected locations within the proposed east and west deep cuts. Boreholes SBL 12+725, SBL 12+685 and SBL 12+595 were drilled along the west side of Highway 400 SBL to depths ranging from 18.6 m to 18.9 m (Elevations 236.7 to 239.0) below existing grade. Borehole NBL 12+685 was drilled within the proposed deep cut on the northeast side of Highway 400 and Sunnidale Road underpass, and terminated at 15.8 m depth (Elevation 238.0). The record of borehole sheets of the present investigation are provided in Appendix A.

It is important to note that the following boreholes were relocated due to various reasons including sloping ground, thick vegetation and proximity of existing boreholes etc.

Borehole Designation	Actual Location
SBL 12+595	SBL 12+613
SBL 12+685	SBL 12+691
NBL 12+685	NBL 12+678

Reference has been made to four boreholes (numbered SUN-01 and SUN-03 to SUN-05), drilled during a previous investigation (Reference 1) for the proposed replacement of the Sunnidale Road underpass at Highway 400. Boreholes SUN-01 and SUN-05 were drilled near the locations of the proposed foundation elements (abutments) and were terminated at 24.7 m depth (Elevations 227.9 and 232.7). Boreholes (SUN-03 and SUN-04) were drilled for the immediate approaches and terminated at 9.5 m to 9.8 m depths (Elevations 244.6 and 247.9). The Record of Borehole sheets are included in Appendix C.

Boreholes 101 and 102 drilled by others for the proposed trenchless watermain crossing to the north of the bridge were incorporated in this report (Reference 2). Boreholes 101 and 102

were terminated at 20.3 m depth (Elevations 238.2 and 230.9). The Record of Borehole sheets of Boreholes 101 and 102 are included in Appendix D.

The approximate locations of the previous and current boreholes are shown on the Borehole Locations Plan and Soil Strata Drawing in Appendix F.

Shoulder closures with traffic control were implemented during drilling of the boreholes for the investigation. Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The boreholes were advanced using a track-mounted drill rig with hollow stem augers. Soil samples were obtained at selected intervals using a 50 mm outside diameter split-spoon sampler driven in conjunction with the Standard Penetration Test (SPT) in general accordance with ASTM D1586.

Thurber obtained the borehole coordinates in the field using an in-house GPS unit, and McIntosh Perry provided the ground surface elevations. The coordinates and elevations are referenced to MTM Zone 10 NAD 83 (Original) and the Canadian Geodetic Vertical Datum (CGVD 1928: 1978 Adjustment).

The field investigation was supervised on a full-time basis by a member of Thurber's technical staff who marked the boreholes in the field, arranged for the clearance of subsurface utilities, supervised the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Three standpipe piezometers (25 mm diameter) and one piezometer (31.75 mm) were installed with the screened portion enclosed in a filter sand column in Boreholes NBL 12+685, SBL 12+595 and SBL 12+725 during the present investigation. As per the request of McIntosh Perry, one monitoring well (50 mm diameter) was installed with the screened portion enclosed in a filter sand column in Borehole SBL 12+595. It is understood that this monitoring well was installed to facilitate environmental groundwater sampling to be carried out by others. Details of the piezometer and monitoring well installations are shown in Table 3.1.

Table 3.1 – Piezometer and Monitoring Well Details

Borehole	Borehole Depth / Base Elevation (m)	Piezometer / Monitoring Well Tip Depth / Elevation (m)	Completion Details
NBL 12+685	15.8 / 238.0	15.2 / 238.6	Piezometer with 3 m slotted screen installed within sand filter from 15.8 m to 11.6 m, bentonite holeplug from 11.6 m to 10.9 m, grout from 10.9 m to ground surface.
SBL 12+595[(1)] MW	18.9 / 236.7	17.2 / 238.4	Monitoring well with 3 m slotted screen installed within sand filter from 18.9 m to 13.7 m, bentonite holeplug from 13.7 m to 10.7 m, filter sand from 10.7 m to 5.9 m, holeplug from 5.9 m to 4.8 m, then holeplug and auger cuttings to ground surface.
SBL 12+595	18.9 / 236.7	9.8 / 245.8	Piezometer with sand filter from 18.9 m to 13.7m, bentonite holeplug from 13.7 m to 10.7m, 3 m slotted screen installed within filter sand from 10.7 m to 5.9 m, holeplug from 5.9 m to 4.8, then holeplug and auger cuttings to ground surface.
SBL 12+725	18.6 / 239.0	18.3 / 239.3	Piezometer with 3 m slotted screen installed within sand filter from 18.6 m to 14.6 m, bentonite holeplug from 14.6 m to 14.0 m, grout from 14.0 m to ground surface.
SBL 12+685[(2)] Piezo	9.9 / 246.4	9.9 / 246.4	Piezometer with 3 m slotted screen installed within sand filter from 9.9 m to 6.4 m, bentonite holeplug from 6.4 m to ground surface.

(1) 50-mm diameter monitoring well

(2) Piezometer (31.75-mm diameter) installed approximately 4.5 m west of Borehole SBL 12+685

Borehole SBL 12+685 without piezometer installation was backfilled upon completion of drilling in general conformance with O.Reg. 903 as amended by O.Reg.128/03. The installed piezometers and monitoring well will be decommissioned once groundwater level monitoring is completed as per the terms of reference.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and

Atterberg Limits testing. All the laboratory tests were carried out in accordance to MTO and/or ASTM Standards, as appropriate. Geotechnical laboratory testing results for the present investigation are summarized on the Record of Borehole sheets included in Appendix A and are presented on the figures included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A. A general 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. It must be recognized and anticipated that soil conditions may vary between and beyond the borehole locations.

In general, the soil stratigraphy encountered in Boreholes NBL 12+685, SBL 12+725, SBL 12+685 and SBL 12+595 drilled during the present investigation, and Boreholes 101 and 102 drilled during the previous investigation (Reference 2), along the proposed deep cuts, consists of topsoil overlying loose to dense sand to sand and silt fill and firm to stiff clayey silt to silty clay fill. Underlying the fill, native soils were encountered typically comprising of interlayered compact to very dense silty sand to silt, compact to very dense silty sand / sand and silt till. The site is generally underlain at depth by a deposit of compact to very dense sand. Within the cohesionless deposits, there are some embedded layers or lenses of firm to hard silty clay/clayey silt to silty clay/clayey silt till. On the east side of Highway 400, measured groundwater levels ranged from about 7 m to 10 m depths below existing grade. On the west side of Highway 400, measured groundwater levels ranged from about 10.5 m to 11.5 m depths.

More detailed descriptions of the stratigraphy are presented below.

5.1 Topsoil

Topsoil was encountered surficially in the four boreholes drilled during the present investigation for the proposed deep cuts. The thickness of the topsoil ranged from 75 mm to 100 mm.

The topsoil thickness may vary between and beyond the borehole locations, and the data is not intended for the purpose of estimating quantities.

5.2 Fill

Fill was encountered underlying the topsoil in Borehole NBL 12+685 of the current investigation. The fill consisted of brown sand containing some silt and occasional clay pockets. The thickness of the fill was 2.4 m.

Boreholes 101 and 102 drilled by others (Reference 2) revealed the presence of surficial firm clayey silt and loose sand/sandy silt fill. The thickness of the fill was 1.4 m.

The depth to the base of the sand fill encountered in Borehole NBL 12+685 was at 2.5 m (Elevation 251.3).

The SPT 'N' values recorded in this fill during the present investigation were 1 and 3 blows per 0.3 m of penetration indicating a very loose condition. The natural moisture contents measured on samples of the fill were 13 percent and 25 percent.

5.3 Silty Sand to Sandy Silt

An upper layer of native brown silty sand containing trace to some clay, trace gravel, occasional clay pockets and occasional roots was contacted below the topsoil in Boreholes SBL 12+685 and SBL 12+725. A layer of sandy silt was encountered at 14.7 m depth in Borehole SBL 12+725. The thickness of the upper silty sand layer was 1.3 m and 2.2 m.

The depth to the base of the silty sand was at 1.4 m and 2.3 m (Elevations 255.5 and 255.3) in Boreholes SBL 12+685 and SBL 12+725, respectively. Borehole SBL 12+725 was terminated within the sandy silt at 18.6 m depth (Elevation 239.0).

In Boreholes 101 and 102 drilled by others (Reference 2), layers of native compact to very dense silty sand and compact silt were encountered below the fill at 1.4 m depth. The thickness of the silty sand to silt were 0.8 m to 1.5 m.

The SPT 'N' values recorded in the surficial silty sand during the present investigation varied from 8 to 13 blows per 0.3 m of penetration, indicating a loose to compact state. SPT 'N' values greater than 100 blows for less than 0.3 m of penetration were measured in the lower sandy silt layer, indicating a very dense condition. The natural moisture contents measured on samples of the silty sand to sandy silt in the present investigation ranged from 10 percent to 19 percent.

The results of grain size distribution analyses carried out during the present investigation on a sample of the sandy silt are presented on Record of Borehole Sheets in Appendix A and on

Figure B1 in Appendix B. The results of the laboratory gradation test are summarized as follows:

Soil Particle	Sandy Silt (Percent)
Gravel	0
Sand	31
Silt	69
Clay	0

5.4 Silty Sand to Sand and Silt Till

Brown silty sand to sand and silt till containing trace gravel, trace clay and occasional cobbles were encountered below the fill at 2.5 m depth in Borehole NBL 12+685, and below the surficial sand, silty sand and silty clay till at depths ranging from 0.5 m to 3.0 m in the three SBL boreholes. The thickness of the silty sand to sand and silt till typically varied from 4.9 m to 7.0 m, except in Borehole SBL 12+595 where it was 12.8 m.

The depth to base of the silty sand to sand and silt till ranged from 7.2 m to 13.3 m (Elevations 242.3 to 250.4).

Compact to very dense silty sand till was contacted in Boreholes 101 and 102 at 2.9 m and 2.2 m depth during the previous investigation (Reference 2), with a thickness of 10.1 m and 7.9 m.

SPT ‘N’ values recorded in the silty sand to sand and silt till during the present investigation ranged from 17 to 98 blows per 0.3 m penetration, indicating a compact to very dense state. An SPT ‘N’ value of 5 blows per 0.3 m of penetration, indicating a loose zone, was measured in Borehole NBL 12+685 just below the fill. SPT ‘N’ values greater than 100 blows for less than 0.3 m of penetration were measured in Boreholes NBL 12+685 and SBL 12+685 near 8.0 m to 9.5m depths, respectively. The grinding of augers and these high blow counts at several locations are indicative of the possible presence of cobbles and boulders. The measured moisture contents of samples of these cohesionless tills ranged from 5 percent to 16 percent.

Grain size distribution results for silty sand to sand and silt till samples carried out during the present investigation are presented on the Record of Borehole sheets in Appendix A and on Figure B2 Appendix B. The results of the laboratory gradation test are summarized as follows:

Soil Particles	Silty Sand to Sand and Silt Till Percentage (%)
Gravel	1 to 8
Sand	45 to 62
Silt	26 to 40
Clay	8 to 13

The results of Atterberg Limits tests conducted on a silty sand till sample are presented on the Record of Borehole sheets in Appendix A, and illustrated in Figure B5 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	13
Plasticity Index	2

The results of the Atterberg Limits testing indicate that the silty sand till is non-plastic with a group symbol of ML.

Glacial tills inherently contain cobbles and boulders.

5.5 Silty Clay to Clayey Silt Till

Brown silty clay till with sand containing trace gravel was contacted below the silty sand at 1.4 m depth in Borehole SBL 12+685. A lower layer of brown clayey sandy silt till containing occasional cobbles and boulders was contacted at 10.0 m below the silty sand till in Borehole SBL 12+685. The thickness of two silty clay to clayey silt till layers were 1.6 m and 1.7 m.

The depths to the base of the silty clay to clayey silt till were at 3.0 m and 11.7 m (Elevations 253.9 and 245.2), respectively.

Measured SPT 'N' values in the silty clay till were 8 and 28 blows per 0.3 m of penetration indicating a stiff to very stiff consistency. An SPT 'N' value of 100 blows for less than 0.3 m of penetration was measured in the lower clayey silt till, indicating a hard consistency. Moisture contents measured in the silty clay to clayey silt till during the present investigation were 15 percent and 19 percent.

The results of grain size distribution analyses carried out on samples of the silty clay till and clayey silt till are presented on the Record of Borehole sheets included in Appendix A. Grain

size distribution curves of the samples tested are presented on Figure B3 in Appendix B. The results of the grain size distribution analyses are summarized below:

Soil Particle	Silty Clay to Clayey Silt Till (Percent)
Gravel	0
Sand	24 to 30
Silt	40 to 55
Clay	21 to 30

The results of Atterberg Limits tests conducted on silty clay to clayey silt till samples are presented on the Record of Borehole sheets in Appendix A, and illustrated in Figure B6 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	15 to 19
Plasticity Index	4 to 8

The results of the Atterberg Limits testing indicate that the silty clay to clayey silt till have low to slight plasticity with a group symbol of CL-ML.

Glacial tills inherently contain cobbles and boulders.

5.6 Sand

An extensive deposit of native brown sand containing trace to some silt and trace clay were contacted below the cohesionless and cohesive tills at depths ranging from 7.2 m to 13.3 m in boreholes drilled during the present investigation. An upper 400 mm thick layer of sand was also contacted below the topsoil in Borehole SBL 12+595. The thickness of the sand was 7.5 m in Borehole SBL 12+725.

The depth to the base of the sand was at 14.7 m (Elevations 242.9) in Borehole SBL 12+725. Boreholes NBL 12+685, SBL 12+595 and SBL 12+685 were terminated within the sand at depths ranging from 15.8 m to 18.9 m (Elevations 236.7 to 238.2).

During the previous investigation (Reference 2), a 1.4 m thick layer of very dense sand was encountered in Borehole 102 at 10.1 m depth. In Borehole 101, dense to very dense sand

was contacted at 13.0 m depth. Borehole 101 was terminated within the sand at 20.3 m depth (Elevation 238.2).

SPT 'N' values recorded in the sand deposit during the present investigation typically ranged from 13 blows to 89 blows per 0.3 m penetration indicating compact to very dense conditions. SPT 'N' values of 100 blows and greater for less than 0.3 m of penetration, indicating a very dense state, were measured in Boreholes SBL 12+685 and SBL 12+725. An SPT 'N' value of 4 blows per 0.3 m of penetration was measured in the surficial sand layer in Borehole SBL 12+595 indicating a loose state. The measured moisture contents of the sand varied between 3 percent and 20 percent.

The results of grain size distribution analyses carried out on sand samples from the present investigation are presented on Record of Borehole Sheets in Appendix A and on Figure B4 in Appendix B. The results of laboratory gradation tests are summarized as follows:

Soil Particle	Sand (Percent)
Gravel	0 to 2
Sand	77 to 89
Silt	10 to 17
Clay	0 to 6

5.7 Clayey Silt

A layer of grey clayey silt was contacted below the sand, at 11.5 m depth, in Borehole 102 drilled during the previous investigation (Reference 2). The clayey silt was described as hard in consistency with SPT 'N' values ranging from 34 to 74 blows per 0.3 m of penetration.

Borehole 102 was terminated within the clayey silt at 20.3 m (Elevations 230.9).

5.8 Groundwater Levels

The groundwater levels in the open boreholes were observed and noted during and upon completion of drilling. The water levels measured in the open boreholes are summarized in Table 5.1.

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Table 5.1 - Observed Groundwater Levels

Location Relative to Highway 400	Borehole	Date	Groundwater Level		Comments
			Depth (m)	Elev. (m)	
East side of Hwy 400 NBL	NBL 12+685	January 6, 2021	8.5	245.3	Piezometer
		March 4, 2021	7.8	246.0	
		April 19, 2021	7.6	246.2	
		April 30, 2021	7.6	246.2	
		May 18, 2021	7.6	246.2	
	SUN-03	July 4, 2019	Dry	-	Open borehole
	SUN-05	July 20, 2019	-	-	Open borehole (caved to 12.2 m)
		August 27, 2019	9.5	243.1	Piezometer
		March 4, 2021	10.2	242.4	
		April 19, 2021	9.9	242.7	
		April 30, 2021	9.9	242.7	
		June 22, 2021	9.9	242.7	
	102	April 25, 2019	6.9	244.3	Monitoring well
		August 6, 2019	7.0	244.2	
West side of Hwy 400 SBL	SBL 12+595 MW	February 10, 2021	Dry	-	Monitoring well
		March 4, 2021	Dry	-	
		April 19, 2021	Dry	-	
		April 30, 2021	Dry	-	
	SBL 12+595	February 10, 2021	11.3	244.3	Piezometer
		March 4, 2021	11.4	244.2	
		April 19, 2021	11.1	244.5	
		April 30, 2021	11.1	244.5	
	SBL 12+685	December 3, 2020	11.5	245.4	Open borehole
	SBL 12+685 Piezo	April 30, 2021	9.7	246.6	Piezometer
	SBL 12+725	January 6, 2021	10.5	247.1	Piezometer
		March 4, 2021	10.7	246.9	
		April 19, 2021	10.4	247.2	
		April 30, 2021	10.3	247.3	
		May 18, 2021	11.3	246.3	

Table 5.1 - Observed Groundwater Levels

Location Relative to Highway 400	Borehole	Date	Groundwater Level		Comments
			Depth (m)	Elev. (m)	
West side of Hwy 400 SBL	SUN-01	June 18, 2019	-	-	Open borehole (caved to 18.3 m)
		July 4, 2019	10.6	246.8	Piezometer
		August 27, 2019	10.9	246.5	
		March 4, 2021	11.2	246.2	
		April 19, 2021	10.9	246.5	
		April 30, 2021	10.9	246.5	
		June 22, 2021	11.0	246.4	
	SUN-04	July 4, 2019	Dry	-	Open borehole
	101	April 25, 2019	11.3	247.2	Monitoring well
		August 6, 2019	11.4	247.1	

Based on the above readings, it is apparent that the groundwater level decreases from west to east across the site.

The values shown in Table 5.1 are short-term readings, and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant or prolonged precipitation.

6. MISCELLANEOUS

Thurber marked the borehole locations in the field and obtained utility clearances prior to drilling. McIntosh Perry surveyed the boreholes in the field and provided to Thurber the borehole coordinates and ground surface elevations.

Altech Drilling and Investigative Services from Cambridge, Ontario and Walker Drilling of Utopia, Ontario supplied and operated the drill rigs to carry out the drilling, sampling and in-situ testing operations for the boreholes.

The field operations were supervised on a full-time basis by Mr. Amir Fereidouni, Mr. Greg Forrest and Mr. George Azzopardi, C.Tech. of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO approved laboratory. Overall supervision of the field program was carried out by Mr. Stephane Loranger, C.E.T.

Interpretation of the field data and preparation of the report were carried out by Ms. Rocio Palomeque Reyna, P.Eng. The report was reviewed by Dr. Sydney Pang, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report provides interpretation of the geotechnical data presented in the factual information section and provides foundation recommendations for the detailed design of the proposed deep cuts along Highway 400 on the east side of northbound lanes (NBL) and the west side of southbound lanes (SBL), just north and south of Sunnidale Road in the City of Barrie, Ontario.

The deep cuts are required for the proposed widening of Highway 400 to the east and west sides, and for the replacement (lengthening and widening) of the existing underpass structure at Sunnidale Road. It is understood that this widening will accommodate 10-lane configuration along this stretch of the highway. The proposed deep cuts will extend between approximate Stations 12+585 and 12+750. It is anticipated that the existing Highway 400 grade at about Elevation 248.5 will remain. On the west side of Highway 400, the base of cut will be up to 13.8 m in depth below the original ground surface (slope crest), and on the east side up to 6.0 m depth.

It is understood that due to the proposed Highway 400 widening and bridge replacement, relocation of existing underground utilities in the area will be required. Available information indicates that installation of two new 300 mm and 500 mm diameter watermains is proposed under Highway 400, approximately 30 m to 40 m north of the existing Highway 400 and Sunnidale Road underpass, near Station 12+685. This work is currently being designed by others for the City of Barrie and in conjunction with MTO. Existing information provided by McIntosh Perry indicates that launch and exit shafts are proposed at each end of the watermains to be installed inside one casing which is proposed to have a diameter in the order of 1.5 m. It is understood that micro-tunnelling techniques will be used to install the

casing under Highway 400. The proposed west shaft will have an outside diameter of about 7 m with its perimeter less than 5 m behind the proposed face of the west cut. The proposed east shaft will have an outside diameter of about 9 m with its perimeter greater than 10 m behind the proposed face of the east cut. The base of the shafts will be at approximate Elevation 242.2. It is understood that both shafts will be backfilled to reinstate the original ground surface after the watermains are installed and prior to bulk excavation for the proposed deep cuts. In addition, underground utilities (825 mm diameter storm sewer pipe and 300 mm diameter sanitary sewer pipe) will be installed along the top of the west plateau, running in a north-south direction, and approximately 4 m to 4.5 m below the ground surface. In plan, the sewers will be located some 11 m to 12 m to the west of the proposed cut slope face.

For the purpose of this report, preliminary analyses will be carried out to assess the potential impact of the shafts on the stability of the proposed permanent cuts. It is expected that more detail information such as methodology for constructing and backfilling of the shafts will be provided.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation and McIntosh Perry, and shall not be used or relied upon for any other purposes or by any other parties including the construction 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 factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

Information on the proposed locations and configuration of the deep cuts was provided to Thurber by McIntosh Perry. The discussion and recommendations presented in this report are based on this information and on the factual data obtained during the current and previous investigations.

8. ENGINEERING AND ANALYSIS METHODOLOGY

Subsurface conditions were established from current and previous boreholes to assess cut slope stability and determine safe long term slope configurations, and to identify construction issues that may affect the design. Analyses were carried out based on cut slope geometry and existing subsurface conditions (see Section 5). Geotechnical factors governing design of deep cuts include the following:

- Cut slope geometry including slope angle and requirements for benches
- Temporary and long-term drainage requirements and erosion control
- Construction procedures

For the purpose of preparing the geotechnical design recommendations, a number of assumptions have been made that are consistent with MTO's standard highway design practices:

- Permanent earth cuts will not be steeper than 2H : 1V
- Earth cuts with depths of 8 m or greater will be provided with a 2 m wide mid-height bench
- Permanent drainage and erosion protection will be provided for all earth cuts.

The Canadian Highway Bridge Design Code (2019) and Commentary have been referenced where applicable.

In general, the soil stratigraphy encountered along the proposed deep cuts consists of topsoil overlying loose to dense sand to sand and silt fill and firm to stiff clayey silt to silty clay fill. Underlying the fill, native soils were encountered typically comprising of interlayered compact to very dense silty sand to silt, compact to very dense silty sand / sand and silt till. The site is generally underlain at depth by a deposit of compact to very dense sand. Within the cohesionless deposits, there are some embedded layers or lenses of firm to hard silty clay/clayey silt to silty clay/clayey silt till. On the east side of Highway 400, measured groundwater levels ranged from about 7 m to 10 m depths below existing grade. On the west side of Highway 400, measured groundwater levels ranged from about 10.5 m to 11.5 m depths. Observations during and upon completion of drilling, and in a shallow piezometer, indicate that there is no free water within the upper slope. However, it is possible that perched water is present within the upper slope.

9. DEEP CUTS

9.1 Global Stability

Global stability analyses were carried out for the proposed deep cuts at the southwest, northwest and northeast quadrants, with maximum cut heights at 13.8 m, 10.8 m and 6.0 m, respectively.

The analyses were carried out utilizing the commercially available slope stability analysis program Slope/W (Version 2020) 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. Only drained conditions were analyzed since the subsurface at this site contains predominantly cohesionless soils.

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 to date from standpipe piezometers and observations during drilling. The stability of the embankment was also checked under seismic loading assuming a peak horizontal acceleration of 0.064g.

Analyses of global stability was conducted for cut slope configurations near the west and east abutments assuming existing very loose sand fill, firm clayey silt fill, compact silty sand, stiff to very stiff silty clay till, dense to very dense silty sand to sand and silt till, overlying compact to very dense sand with 2H : 1V slope inclinations. A 2 m wide mid-height bench was provided for the deep cuts exceeding 8 m depth on the west side.

Selected graphical output for the stability analysis results are presented on Figures G1 to G16 in Appendix G. The results are also summarized in Table 9.1 below.

This set of analyses applies to the southwest and northeast cut slopes, and the northwest cut slopes where there is no construction shaft. Preliminary analyses of the localized scenario where a backfilled shaft would be located close to the slope face prior to formation of the cut are presented in the following Section 9.2.

THURBER

Table 9.1 - Computed Factors of Safety

Condition	Factor of Safety	Figure (Appendix G)
NE side of Hwy 400 and Sunnidale Road Underpass Approx. 6.0 m, 2H : 1V, Station 12+680		
Static Drained	1.5	G1
Seismic (PGA 0.064g)	1.3	G2
SW side of Hwy 400 and Sunnidale Road Underpass Approx. 13.8 m, 2H : 1V or flatter (upper), Station 12+620		
Static Drained	1.9	G3
Seismic (PGA 0.064g)	1.6	G4
Upper Slope 2H : 1V Static Drained	1.4	G5
Upper Slope 2H : 1V Seismic (PGA 0.064g)	1.2	G6
Upper Slope 2.5H : 1V Static Drained	1.6	G7
Upper Slope 2.5H : 1V Seismic (PGA 0.064g)	1.3	G8
Lower Slope 2H : 1V Static Drained	1.6	G9
Lower Slope 2H : 1V Seismic (PGA 0.064g)	1.4	G10
NW side of Hwy 400 and Sunnidale Rd. Underpass Approx. 10.8 m, 2H : 1V or flatter (upper), Station 12+685		
Static Drained	1.8	G11
Seismic (PGA 0.064g)	1.5	G12
Upper Slope 2H : 1V Static Drained	1.3	G13
Upper Slope 2H : 1V Seismic (PGA 0.064g)	1.1	G14
Upper Slope 2.5H : 1V Static Drained	1.6	G15
Upper Slope 2.5H : 1V Seismic (PGA 0.064g)	1.3	G16

As per typical MTO requirements, a Factor of Safety (F.S.) of 1.3 is acceptable for short term and total stress (undrained) conditions. A F.S. of 1.5 is acceptable for long term and effective

stress (drained) conditions. The above results show that the deep cuts with a 2H : 1V inclination would achieve global stability at the northeast side of Highway 400 and Sunnidale Road underpass. For the deep cuts on the west side of Highway 400, an overall slope with 2H : 1V at both tiers and a mid-height bench would also satisfy global stability requirements.

The F.S. values of 1.4 and 1.3 (static conditions) were obtained for the upper slopes (above the mid-height berm) at the northwest and southwest sides for an inclination of 2H : 1V. By flattening the upper slope to 2.5 H : 1V, a resulting F.S. of 1.6 would be achieved (see Section 9.2 Cut Slope Design below).

9.2 Cut Slope Design

Based on the design information currently available and the results of the analyses discussed above, it is recommended that the permanent deep cut slopes be formed at inclinations not steeper than 2H : 1V with a 2 m wide mid-height bench where the overall slope height exceeds 8 m. It is our understanding from discussions with the MTO Foundations Office that the upper slopes would be acceptable at an inclination of 2H : 1V as long as the F.S. is at least 1.3.

Adequate drainage must be provided to the cut sections (see Section 10). An interceptor ditch should be provided at the top of the cut adjacent to the slope crest as per OPSD 200.020.

The native soils within the earth cuts will typically consist of dense to very dense sands and silts with interlayers of very stiff to hard clayey silt to silty clay. Erodibility of these soils is considered to be moderate to high. On the exposed slopes, temporary drainage and erosion protection must be provided during construction. During construction, consideration may be given to mid-height benches to enhance temporary stability on the west side, especially where the cut heights exceed 11 m.

It is anticipated that the base of the cut will consist of the dense to very dense silty sand to sand and silt till, which are considered to be stable against basal heave upon exposure.

Vegetative cover should be established on all exposed earth cut slopes to protect against surficial erosion in accordance with current MTO practice with reference to OPSS.PROV 804.

Erosion protection measures must be provided for the slopes. Surface runoff and precipitation must be prevented from flowing perpendicularly down any slope surface.

Temporary protection (shoring) may be required at some locations during construction. Recommendations for temporary protection are presented in Section 12 of this report.

9.3 Stability of Northwest Slope near Shaft

Launch and exit shafts are to be designed by others on both sides of Highway 400 for the watermain crossing to be carried out by trenchless methods. Preliminary information available indicates that these shafts will be backfilled and decommissioned after the watermain is installed, and prior to formation of the main highway cut. The following is a summary of some shaft design information provided to us by McIntosh Perry.

	West Tunnelling Shaft	East Tunnelling Shaft
Inside diameter	5.0 m	7.0 m
Outside diameter	7.0 m	9.0 m
Top of shaft elevation	254.5	252.0
Bottom of shaft (invert level) elevation	242.2	242.2

Excavation for the west shaft will extend approximately 15 m below existing grade (west slope crest), and about 12 m depth (below east slope crest) for the east shaft. There is currently no confirmation on the construction methodology and decommissioning plan for these shafts. It is assumed that temporary protection (shoring) such as sheet piling and/or augered soldier pile and lagging in conjunction with ring beams would be used. It is understood that vertical shaft sinking methods utilizing concrete ring supports may also be considered. Given that the proposed shaft base is several metres below the groundwater level, effective dewatering will be required to construct the shaft. The impact of these construction activities on the permanent cut slopes cannot be assessed until more detail information is available.

Preliminary global stability analyses were carried out for the west shaft to assess potential impact of the shaft on slope stability. Several assumptions were made including that the shaft would consist of vertically sided and shored excavation sidewalls, and would be adequately backfilled with compacted granular material to reinstate the original ground level (west slope crest).

Selected graphical output for the stability analysis results are presented on Figures G17 to G22 in Appendix G. The results are also summarized in Table 9.2 below. The measured groundwater level to date (excluding perched water) is at approximate Elevation 247.2. In order to simulate a possible scenario where the granular backfill to the shaft acts as a conduit to recharge the slope, resulting in the overall rise of the groundwater level behind the proposed

cut slope, selected analyses were carried out for an assumed groundwater level at Elevation 255.0.

Table 9.2 - Computed Factors of Safety with Shaft

Condition	Factor of Safety	Figure (Appendix G)
NW side of Hwy 400 and Sunnidale Rd. Underpass Approx. 10.8 m, 2H : 1V with bench and shaft, Station 12+685		
Groundwater level at Elevation 247.2 (measured)		
Overall Slope 2H : 1V Static Drained	1.80	G17
Overall Slope 2H : 1V Seismic (PGA 0.064g)	1.52	G18
Upper Slope 2H : 1V Static Drained	1.27	G19
Upper Slope 2H : 1V Seismic (PGA 0.064g)	1.16	G20
Groundwater level at Elevation 255.0 (assumed)		
Upper Slope 2H : 1V Static Drained	1.25	G21
Overall Slope 2H : 1V Static Drained	1.25	G22

The above results appear to indicate that the proposed cut slope would remain stable with the currently measured groundwater level. If the groundwater level rises to a certain elevation, the F.S. will decrease to below 1.3 for the overall slope. The decrease of the F.S. for the upper slope would be relatively modest.

It has been suggested to the City that unshrinkable fill / lean concrete should be considered for use to backfill the shaft all the way up to just below the existing ground surface. It is anticipated that the use of a less pervious cementitious backfill material would reduce the risk of a rising groundwater level behind the cut slope.

It is noted that the above analyses must be considered as preliminary since they are based on assumptions. Once more details on the shaft design and construction methodology are available, the analyses will be updated to reflect the likely scenarios. In particular, potential disturbance of the soils surrounding the shaft and its implication on cut slope stability will be assessed.

The latest information provided by MP indicates that the MTO has agreed that further detailed assessment of the implications of shaft construction and abandonment on cut slope stability can be addressed in a separate context as part of an additional scope of work once more information is available.

10. EXCAVATION AND WATER CONTROL

Deep earth cuts, extending to approximately Elevation 248.5 (Highway 400 grade), are required for the proposed widening of Highway 400 on the north and south sides of the Sunnidale Road underpass. The cuts will be formed through the surficial very loose sand and silt fill, stiff to very stiff clayey silt to silty clay till and loose to compact silty sand, into an extensive deposit of typically dense to very dense silty sand to sand and silt till. Cobble and boulders are to be expected within the glacial tills.

All earth cuts must be carried out in accordance with OPSS.PROV 902 and the Occupational Health and Safety Act (OHSA). For the purposes of assessing temporary excavation slope requirements in compliance with the OHSA, the dense to very dense silty sand to sand and silt till is classified as Type 2 soils above the groundwater level, and Type 4 soils below the groundwater level. The fills, surficial sands and silts, and stiff to very stiff clayey silt to silty clay till are classified as Type 3 soils.

Cobbles and boulders may be encountered during excavation of the cut slopes. Provisions must be made for the removal of cobbles and boulders.

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. It is anticipated that the excavations be inspected periodically to confirm stability at all stages. 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. Suggested wording for an NSSP in this regard is included in Appendix H.

Where required, construction will need to be carried out in conjunction with temporary protection (shoring) which is discussed in more detail in Section 12.

The deep cut excavation is generally expected to be above the main groundwater table. During construction, perimeter ditches and pumping from filtered sumps are expected to be adequate to remove the water accumulated at the excavation base. Surface runoff and precipitation must be diverted away from the excavations. Flow of perched groundwater from the fill and surficial soils into the excavations should also be expected. Drainage will be

required to remove water originating from storm runoff and seepage from the sides of the cut and cohesionless soils.

Soil stockpiling close to the cut slopes should be avoided. Should temporary soil stockpiling be required at the site as part of the deep cut operations, it is recommended that the stockpiles be located away from all drainage systems, traffic routes and edge of slopes. A minimum setback distance of 5 m from the crest of any slope should be implemented. The maximum height of a stockpile should be limited to 3 m at any given time. The setback distance and height must be reviewed and confirmed on site during construction. Stockpile management should incorporate measures to minimize erosion and sediment transport as well as installation of perimeter controls such as silt fences, straw bale barriers, sand bags, etc. as necessary.

Permanent drainage will be required to remove water originating from surface runoff, precipitation and seepage from the sides of the cut and cohesionless soils. It is recommended that the water be controlled by means of surface ditching and permanent sub-drains incorporated, where required, within the corridor widening design.

An interceptor ditch should be provided at the top of the cut as per OPSD 200.020.

The design of a dewatering system that may be required during construction is the responsibility of the Contractor, and the Contract Documents must alert him to this responsibility. Filtered sumps must be properly designed to control loss of fines and ground loss.

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), and OPSS.PROV 902 and NSSP FOUN0003. A design engineer with a minimum five years relevant experience will be required to design and implement a dewatering system. It is recommended that pre-construction condition survey be carried out on existing structures within 50 m of the proposed deep cuts. As a pre-construction survey is required at this site, the Designer Fill-In ** in SP FOUN0003 should be “Yes”. The radius of influence for dewatering will be in the order of 30 m.

11. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site class is based on the soil conditions encountered in the upper 30 m of the stratigraphic profile. In general, the

subsurface stratigraphy encountered at the site consists of a pavement structure overlying fill which is underlain by compact to very dense silty sands and silts, and typically dense to very dense silty sand to sand and silt till overlying compact to very dense sand. There are embedded layers of firm to hard silty clay to clayey silt till within the tills.

As per Table 4.1, Clause 4.4.3.2 of the CHBDC (2019), the site may be classified as Seismic Site Class C.

Based on the National Building Code of Canada (NBCC 2015), the peak horizontal ground acceleration (PGA), corresponding to a design earthquake having a 2 percent probability of being exceeded in 50 years (i.e. 2,475 year return period) is 0.064 g at the site. Based on the site class and the PGA, the Site Coefficient is determined to be 1.00.

Based on review of the SPT data, seismically induced liquefaction of foundation soils is not anticipated under the design earthquake

12. TEMPORARY PROTECTION SYSTEMS

Temporary protection (shoring) systems may be required to maintain live traffic lanes during deep cut excavations.

An item titled “Temporary Protection System” as per OPSS.PROV 539 and SP105S09 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 temporary protection be specified on the contract drawings.

The selection and design of the temporary protection systems is the responsibility of the contractor. The design of such systems must incorporate traffic loading and surcharge loading due to the construction equipment and operations. It is anticipated that the protection system will need to be extended predominantly through the existing fill into the underlying native compact to very dense cohesionless soils to develop the required toe resistance. Installation of temporary protection should consider that the existing fill and native tills may contain obstructions, cobbles and boulders.

For conceptual planning and costing purposes, an augered soldier pile and lagging wall is considered suitable for temporary protection at this site. Sheetpile walls are also an alternative, however, due to the presence of very dense soils at shallow depths, it might present some difficulties during installation. These shoring walls may be designed using

the geotechnical parameters given below:

Soil Bulk Unit Weight	γ	=	20 kN/m^3
Soil Submerged Unit Weight (below gwl)	γ'	=	10 kN/m^3
Coefficient of Active Pressure	K_a	=	0.33 (fill)
		=	0.31 (native sands and silts, tills)
		=	0.32 (native silty clay/clayey silt)
Coefficient of Passive Pressure	K_p	=	3.0 (fill)
		=	3.2 (native sands and silts, tills)
		=	3.1 (native silty clay/clayey silt)

It is recommended that lateral earth pressures acting on the wall be computed in accordance with the CHBDC 2019. The surcharge should include soil loadings above the top of the pile and other loadings adjacent to the wall. A properly designed and constructed soldier pile and lagging wall will be permeable and therefore water pressure acting on the retained height may be set to zero. Filter fabric should be placed behind the lagging boards to minimize migration of fines. Full hydrostatic pressure will need to be incorporated for design of sheetpile walls if this type of protection system is used.

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.

In order to avoid disturbance of the soils adjacent the proposed deep cuts, it is recommended that the temporary protection (shaft support) be left in place upon completion of shaft installation and abandonment.

13. ADJACENT STRUCTURES AND BURIED UTILITIES

It is understood that relocation of existing underground utilities will be required at this site. The new watermain installation discussed previously is to be carried out as an advance contract. The potential presence of other underground utilities at the site should be confirmed prior to construction. It is recommended that the exact locations and elevations of any utilities be established by the designer, and compared with the extent of the potential work zones.

Underground utilities should not be undermined or damaged during deep cut excavations.

14. CONSTRUCTION CONCERNS

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

- The existing fills and native tills may contain obstructions. The Contractor must be equipped and prepared to remove, penetrate or otherwise handle these obstructions during construction.
- Deep/earth cuts will typically be carried out above the groundwater level. Seepage and perched groundwater may be encountered within the embankment fill. Sump pumping, diversion of surface runoff, precipitation and other forms of temporary dewatering may be required to maintain a reasonably dry excavation during construction.
- The permanent cut slopes should be inspected after construction for surficial disturbance. Where necessary, remedial measures such as re-vegetation and/or placement of gravel sheeting may be required.
- Effective long term erosion protection should be provided to the final cut slopes.
- Details of shaft installation/construction, proposed excavation sequence, backfilling and dewatering should be confirmed and evaluated once this information is available. These issues will be assessed in separate context under an additional scope of work.
- An instrumentation and monitoring program should be implemented during and after the construction and backfilling/abandonment of the shaft and associated trenches. The monitoring program should consist of visual observations and survey monitoring of instruments to identify any signs of distress, ground movement and groundwater levels. Details of this program can be provided in separate context under an additional scope of work once more information on the construction works is available.

15. CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Ms. R. Palomeque Reyna, P.Eng. The report was reviewed by Dr. Sydney Pang, P.Eng and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

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Appendix A

Record of Borehole Sheets

Present Investigation

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

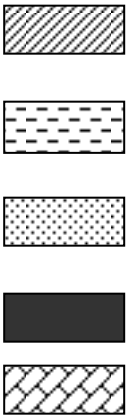
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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

THURBER

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No NBL 12+685 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 916 978.5 E 288 615.7 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.11 - 2020.12.11 LATITUDE 44.392633 LONGITUDE -79.703148 CHECKED BY RPR

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
253.8	GROUND SURFACE						
0.0	**TOPSOIL:** (100mm)						
0.1	**SAND**, some silt Very Loose Brown Moist (FILL)	1	SS	3	253		
		2	SS	1	252		
	Occasional clay pockets						
251.3		3	SS	5	251		
2.5	Silty **SAND**, trace gravel, trace clay, occasional cobbles Loose to Dense Brown Moist (TILL)	4	SS	35	250		
	Augers grinding at 2.9m						
		5	SS	46	249		8 58 26 8
248.0					248		
5.8	Augers grinding from 5.5m to 6.1m	6	SS	55	247		
	Very Dense						
	Augers grinding from 7.0m to 8.2m	7	SS	100/ 0.275	246		
245.0					245		
8.8	**SAND**, some silt, trace clay Compact Brown Wet	8	SS	22			
					244		

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

GROUND WATER CONDITIONS

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NBL 12+685 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 916 978.5 E 288 615.7 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.11 - 2020.12.11 LATITUDE 44.392633 LONGITUDE -79.703148 CHECKED BY RPR

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
	Continued From Previous Page										
	SAND, some silt, trace clay Compact to Dense Brown Wet										
			9	SS	29		243		○		0 77 17 6
							242				
			10	SS	35				○		
							241				
			11	SS	33		240		○		0 89 10 1
							239				
238.0	Very Dense		12	SS	52		238		○		
15.8	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2021.01.06	8.5	245.3
2021.03.04	7.8	246.0
2021.04.19	7.6	246.2
2021.04.30	7.6	246.2
2021.05.18	7.6	246.2

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

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THURBER

RECORD OF BOREHOLE No SBL 12+595 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 916 959.3 E 288 519.3 ORIGINATED BY GA

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2021.01.26 - 2020.01.26 LATITUDE 44.392457 LONGITUDE -79.704358 CHECKED BY RPR

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
255.6	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1			1	SS	4				○		
255.1	**SAND**, trace silt, trace clay Loose Brown Moist						255				
0.5			2	SS	17				○		
	SAND and **SILT**, some clay, trace gravel Compact to Dense Brown Moist (TILL)										
			3	SS	18		254		○		
			4	SS	30		253		○		2 45 40 13
			5	SS	41				○		
							252				
			6	SS	98		251		○		
	Very Dense										
250.1							250				
5.5	Silty **SAND**, some clay, trace gravel Very Dense Brown Moist (TILL)		7	SS	81				○		3 57 28 12
	Slow augering from 6.1m to 7.6m Occasional clay pockets						249				
							248		○		
							247				
			8	SS	91						
			9	SS	28		246		○		
	Compact										

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+595 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 916 959.3 E 288 519.3 ORIGINATED BY GA

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2021.01.26 - 2020.01.26 LATITUDE 44.392457 LONGITUDE -79.704358 CHECKED BY RPR

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
	Continued From Previous Page										
	Silty **SAND**, some clay, trace gravel Compact to Very Dense Brown Moist (TILL)						245				
			10	SS	21				○		1 62 27 10
							244				
			11	SS	76				○		
242.3							243				
13.3	**SAND**, some silt, trace clay Compact to Dense Brown Wet										
			12	SS	13		242		○		
							241				
			13	SS	28		240		○		0 87 12 1
							239				
			14	SS	24				○		
							238				
			15	SS	50		237		○		
236.7											
18.9	END OF BOREHOLE AT 18.9m. A monitoring well of 50mm diameter and a piezometer of 25mm diameter were installed at this borehole. Both consist of Schedule 40 PVC pipes with 3.05m slotted length.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No SBL 12+595 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 916 959.3 E 288 519.3 ORIGINATED BY GA

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2021.01.26 - 2020.01.26 LATITUDE 44.392457 LONGITUDE -79.704358 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	25mm Piezometer Readings:										
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.02.10 Dry - 2021.03.04 Dry - 2021.04.19 Dry - 2021.04.30 Dry -										
	50mm Monitoring Well Readings										
	WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2021.02.10 11.3 244.3 2021.03.04 11.4 244.2 2021.04.19 11.1 244.5 2021.04.30 11.1 244.5										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+685 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 028.6 E 288 555.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 LATITUDE 44.392457 LONGITUDE -79.704358 CHECKED BY RPR

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
256.9	GROUND SURFACE										
0.0 / 0.1	**TOPSOIL:** (75mm)										
	Silty **SAND**, some clay, occasional roots and rootlets Compact Brown Moist		1	SS	13		256				
255.5 / 1.4	Silty **CLAY**, with sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		2	SS	8		255				
			3	SS	28						0 30 40 30
253.9 / 3.0	Silty **SAND**, trace gravel, trace clay, occasional cobbles and boulders Dense to Very Dense Brown Moist (TILL)		4	SS	35		254				
			5	SS	92		253				
			6	SS	92		252				
			7	SS	70		251				
			8	SS	100/ 0.100		250				
246.9							249				
							248				
							247				

Continued Next Page

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+685 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 028.6 E 288 555.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.03 - 2020.12.03 LATITUDE 44.392457 LONGITUDE -79.704358 CHECKED BY RPR

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
	Continued From Previous Page										
10.0	Clayey **SILT**, some sand to sandy, occasional cobbles and boulders Hard Brown Moist (TILL)		9	SS	100/ 0.100	▽	246		H		0 24 55 21
245.2											
11.7	**SAND**, some silt Very Dense Brown Wet		10	SS	100/ 0.275		245		○		
							244				
			11	SS	100/ 0.225		243		○		0 88 12 0
							242				
			12	SS	100/ 0.200				○		
							241				
			13	SS	59		240		○		
							239				
238.2			14	SS	100/ 0.275				○		
18.7	END OF BOREHOLE AT 18.72m. WATER LEVEL AT 11.53m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+685 Piezo1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 030.7 E 288 551.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Tripod/Casing COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.20 LATITUDE 44.393101 LONGITUDE -79.703954 CHECKED BY RPR

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
256.3	GROUND SURFACE										
0.0	Borehole augered to 9.9m depth below ground surface for Piezometer installation. No soil samples collected. For soils conditions refer to Borehole SBL 12+685.						256				
							255				
							254				
							253				
							252				
							251				
							250				
							249				
							248				
							247				
246.4											

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+685 Piezo2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 030.7 E 288 551.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Tripod/Casing COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.20 LATITUDE 44.393101 LONGITUDE -79.703954 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
9.9	Piezometer installation consists of 31.75mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.04.30 9.7 246.6										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+685 Piezo1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 030.7 E 288 551.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Tripod/Casing COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.20 LATITUDE 44.393101 LONGITUDE -79.703954 CHECKED BY RPR

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
256.3	GROUND SURFACE										
0.0	Borehole augered to 9.9m depth below ground surface for Piezometer installation. No soil samples collected. For soils conditions refer to Borehole SBL 12+685.						256				
							255				
							254				
							253				
							252				
							251				
							250				
							249				
							248				
							247				
246.4											

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

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THURBER

RECORD OF BOREHOLE No SBL 12+685 Piezo2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 030.7 E 288 551.6 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Tripod/Casing COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.20 LATITUDE 44.393101 LONGITUDE -79.703954 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
9.9	Piezometer installation consists of 31.75mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.04.30 9.7 246.6										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+725 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 061.6 E 288 556.2 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.04 - 2020.12.04 LATITUDE 44.393379 LONGITUDE -79.703898 CHECKED BY RPR

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.6	GROUND SURFACE										
0.0 / 0.1	**TOPSOIL:** (75mm)										
	Silty **SAND**, trace gravel, trace clay, occasional roots Loose to Compact Brown Moist		1	SS	8		257		○		
	Occasional clay pockets		2	SS	12		256		○		
255.3 / 2.3	Silty **SAND**, trace clay, trace gravel, occasional cobbles Dense to Very Dense Brown Moist (TILL)		3	SS	44		255		○		
			4	SS	64		254		○		4 59 29 8
			5	SS	67		253		○		
			6	SS	63		252		○		
250.4 / 7.2	**SAND**, trace to some silt, trace gravel Very Dense Brown Moist		7	SS	100/ 0.175		251				
			8	SS	131/ 0.275		250		○		
							249				
							248		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

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Ontario

THURBER

RECORD OF BOREHOLE No SBL 12+725 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 061.6 E 288 556.2 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.04 - 2020.12.04 LATITUDE 44.393379 LONGITUDE -79.703898 CHECKED BY RPR

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace to some silt, trace gravel Very Dense Brown Moist										
			9	SS	89		247				2 81 17 0
							246				
			10	SS	100/ 0.275		245				
							244				
242.9			11	SS	100/ 0.250		243				
14.7	Sandy **SILT** Very Dense Brown Wet										
			12	SS	100/ 0.225		242				0 31 69 0
							241				
							240				
239.0			13	SS	146/ 0.275						
18.6	END OF BOREHOLE AT 18.57m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.01.06 10.5 247.1 2021.03.04 10.7 246.9										

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 SBL 12+725 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Deep Cut at Sunnidale Road N 4 917 061.6 E 288 556.2 ORIGINATED BY AF

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2020.12.04 - 2020.12.04 LATITUDE 44.393379 LONGITUDE -79.703898 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	2021.04.19 10.4 247.2										
	2021.04.30 10.3 247.3										
	2021.05.18 11.3 246.3										

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

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

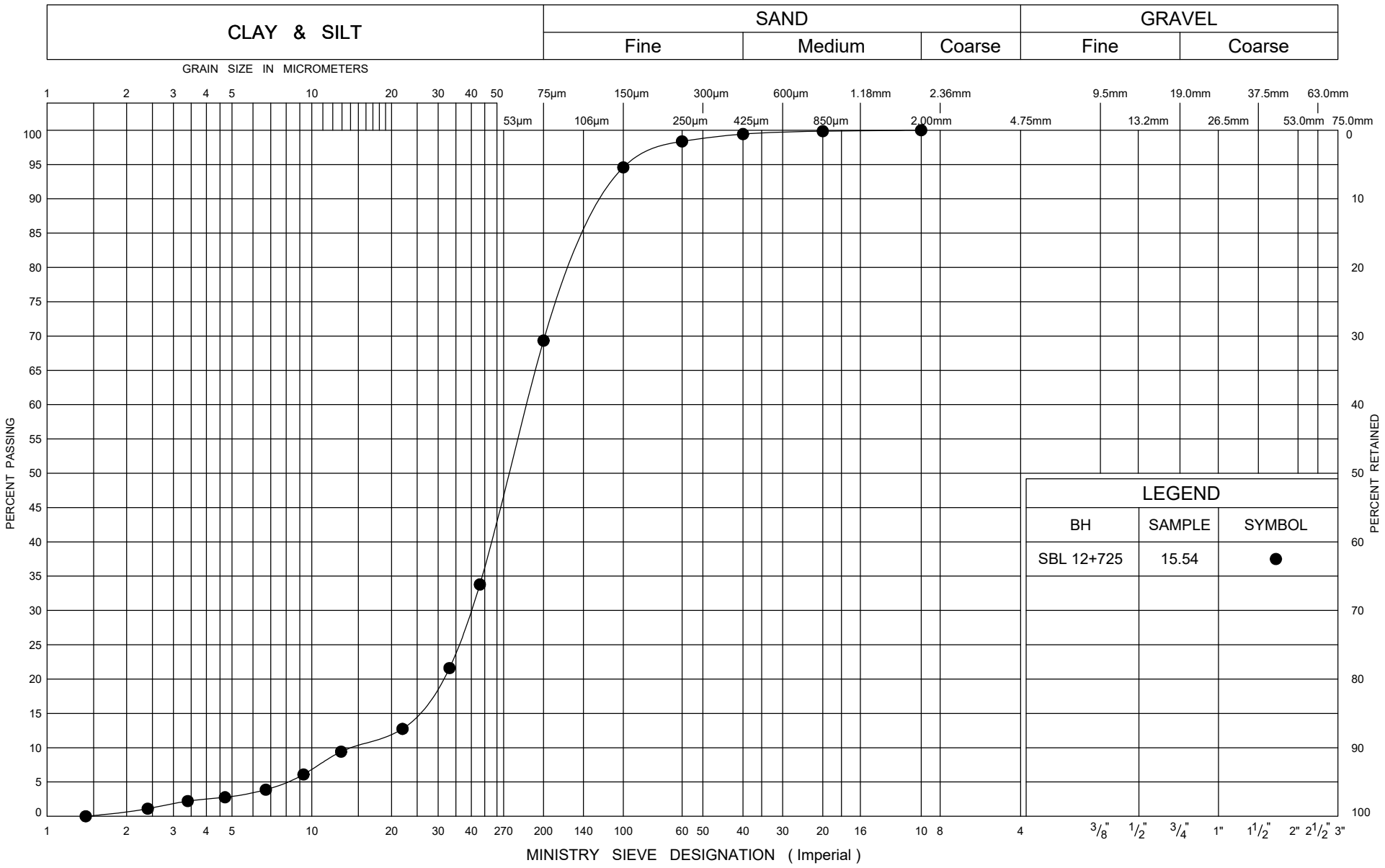
ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

THURBER

Appendix B

Geotechnical Laboratory Test Results

Present Investigation



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

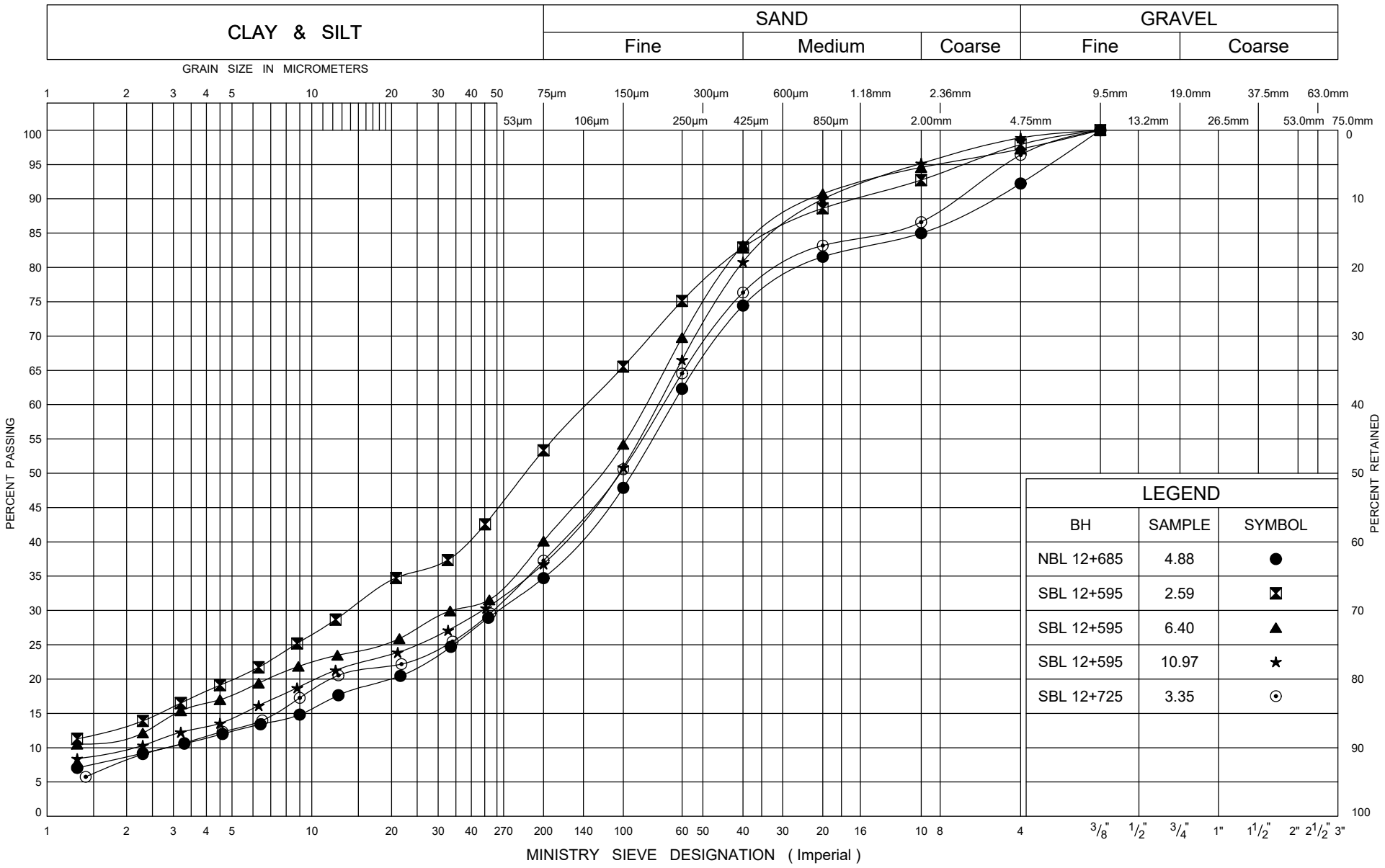
Sandy SILT

FIG No B1

W P 2445-15-00

Deep Cut at Sunnidale Road

ONTARIO MOT GRAIN SIZE 3 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21



ONTARIO MOT GRAIN SIZE 3 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21

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Ontario

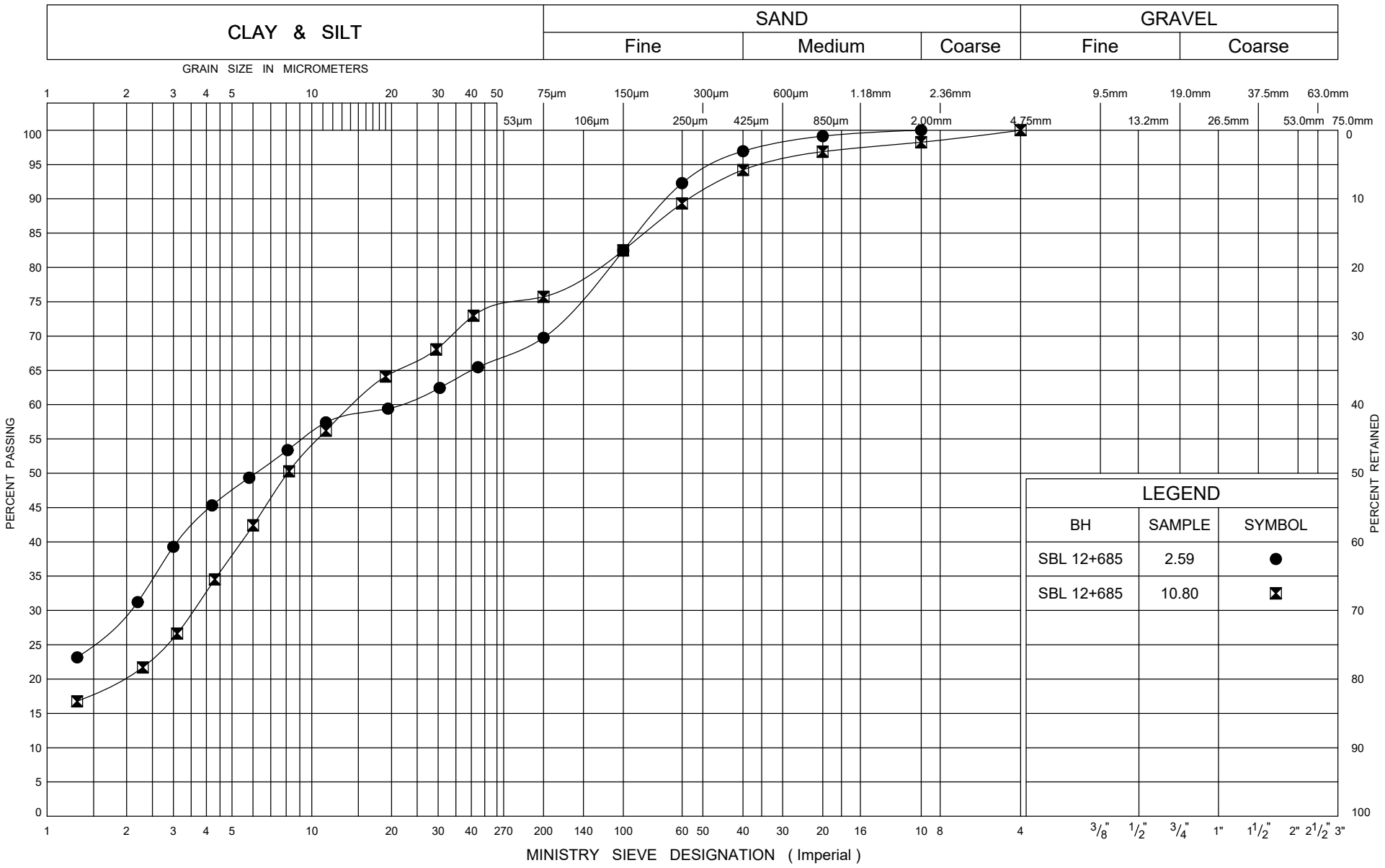
GRAIN SIZE DISTRIBUTION

Silty SAND TILL/SAND and SILT TILL

FIG No B2

W P 2445-15-00

Deep Cut at Sunnidale Road



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GRAIN SIZE DISTRIBUTION

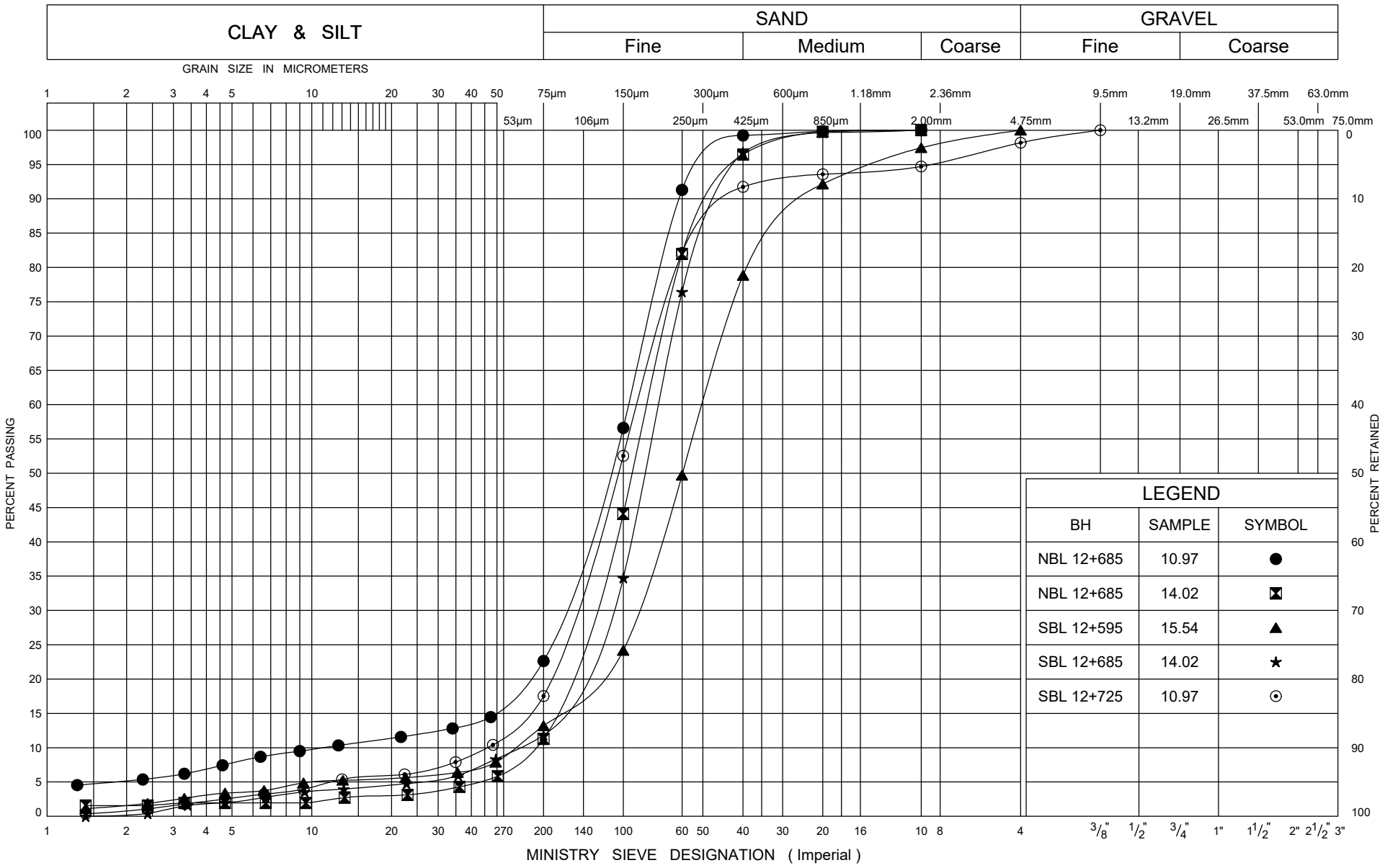
Silty CLAY TILL/Clayey SILT TILL

FIG No B3

W P 2445-15-00

Deep Cut at Sunnidale Road

ONTARIO MOT GRAIN SIZE 3 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21



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GRAIN SIZE DISTRIBUTION

SAND

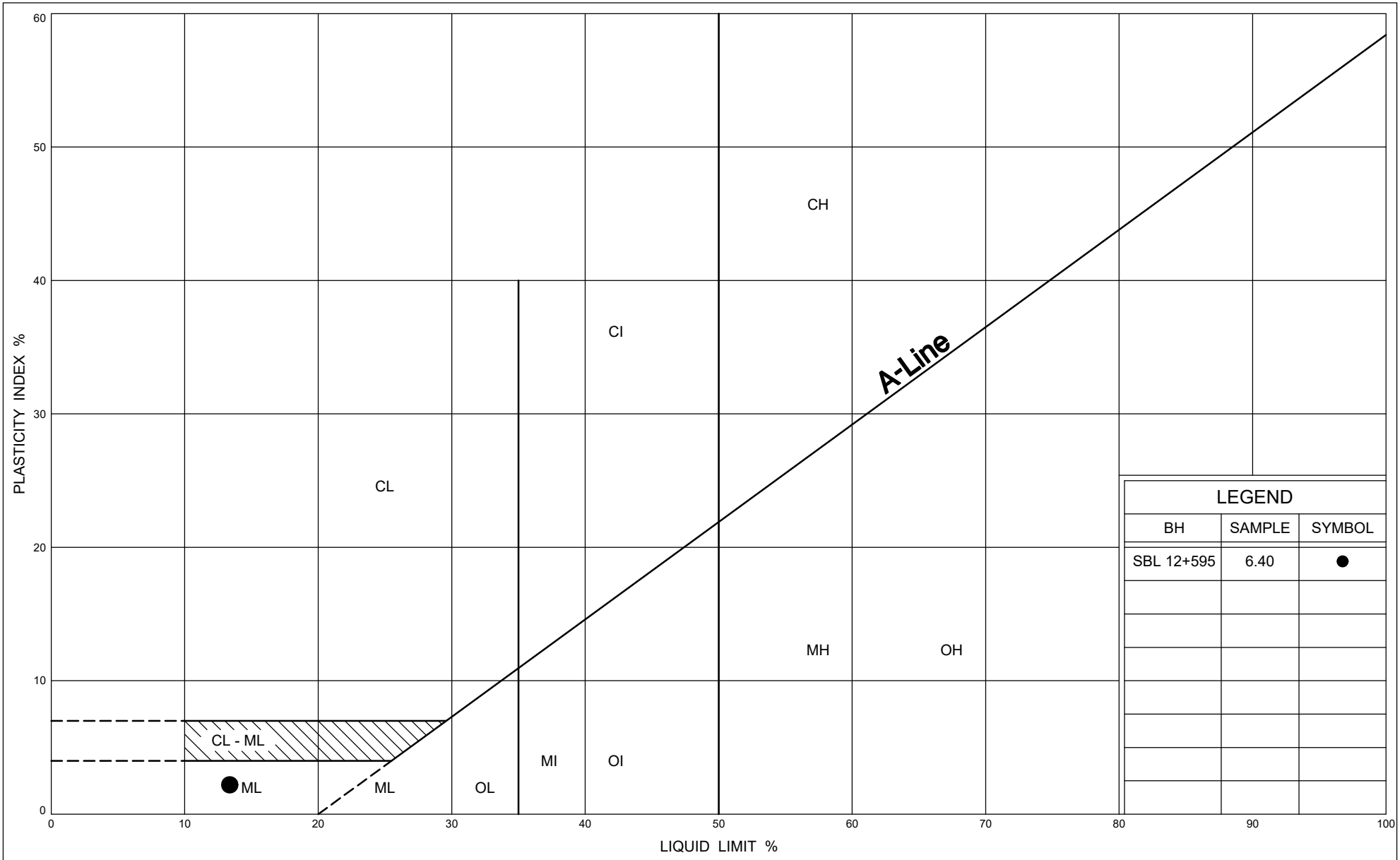
FIG No B4

W P 2445-15-00

Deep Cut at Sunnidale Road

ONTARIO MOT GRAIN SIZE 3 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21

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Ontario

PLASTICITY CHART

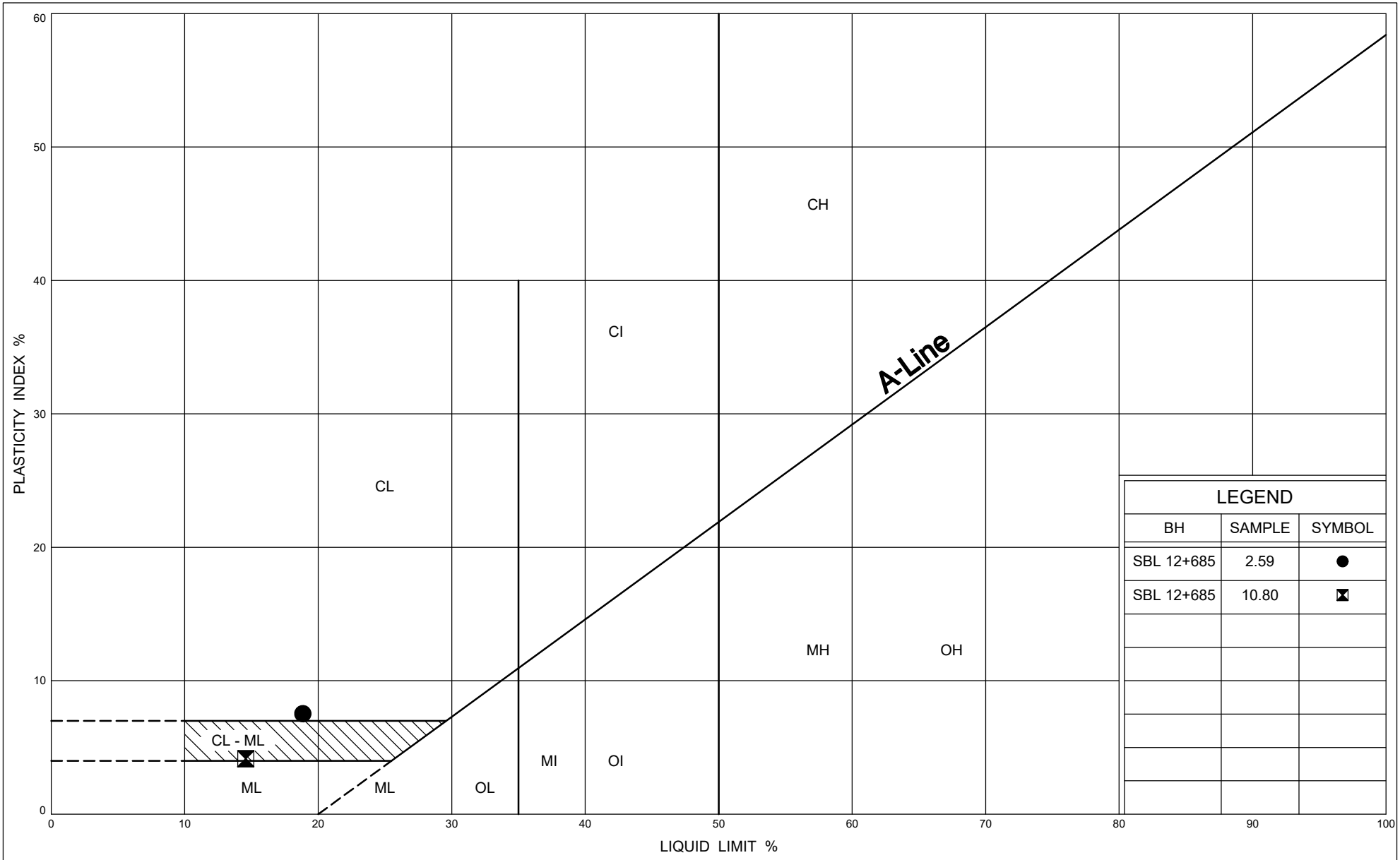
Silty SAND TILL

FIG No B5

W P 2445-15-00

Deep Cut at Sunnidale Road

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-22424.GPJ ONTARIO MOT.GDT 2/22/21

Ministry of Transportation
Ontario

PLASTICITY CHART

Silty CLAY TILL/Clayey SILT TILL

FIG No B6

W P 2445-15-00

Deep Cut at Sunnidale Road

THURBER

Appendix C

Record of Borehole Sheets

Previous Investigation by Thurber

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-01 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
257.4	GROUND SURFACE										
0.0	**TOPSOIL**, some silt and sand, trace gravel, occasional organics Compact Dark Brown		1	SS	11		257	○	○		
256.8	Moist										
0.7	**SAND** and **SILT**, trace gravel, some clay Compact to Dense Brown Moist (FILL) Clayey silt layer at 1.2m (200mm)		2	SS	15		256		○ ○		
			3	SS	28				○		
			4	SS	30		255		○		1 45 40 14
			5	SS	49		254		○		
253.3											
4.1	Silty **SAND**, trace gravel, trace clay, occasional cobbles Very Dense Brown Moist (TILL)		6	SS	100		253		○		Augers grinding at 4.6m
			7	SS	100/ 0.050		252				Augers grinding at 6.0m Switch to Tricone Spoon bouncing No recovery
	Occasional cobbles from 6.9m to 7.2m		8	SS	100/ 0.225		251		○		7 58 26 9
			9	SS	100/ 0.225		250		○		
			10	SS	100/ 0.075		249		○		
247.5							248				

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 SUN-01 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 CHECKED BY GRL

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
	Continued From Previous Page										
9.9	**SAND** and **SILT**, trace gravel, trace clay Very Dense Brown Moist to Wet (TILL)		11	SS	58	▼	247 246	○	○		4 59 34 3
245.3											
12.2	Gravelly **SAND** Very Dense Brown Wet		12	SS	100/ 0.225		245	○ ○			
244.4											
13.0	**SAND** and **SILT**, trace gravel, trace clay Very Dense Brown Moist (TILL)		13	SS	100/ 0.100		244 243 242	○	○		
241.1											
16.3	**SAND**, trace to some gravel, trace to some silt Very Dense Brown Wet		14	SS	100/ 0.275		241 240		○		
			15	SS	100/ 0.250		239 238		○		

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-01 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 997.6 E 288 541.5 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers and Tricone COMPILED BY AN

DATUM Geodetic DATE 2019.06.17 - 2019.06.18 LATITUDE 44.392803 LONGITUDE -79.704080 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 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
	Continued From Previous Page										
	SAND, trace to some gravel, trace to some silt Very Dense Brown to Grey Wet		16	SS	100/ 0.250		237				
236.6											
20.9	Silty **SAND**, trace to some gravel, trace clay Very Dense Brown Moist (TILL)		17	SS	100/ 0.275		236				
235.0							235				
22.4	**SAND**, trace to some silt, trace clay Very Dense Brown Wet		18	SS	100/ 0.275		234				0 84 13 3
233.4											
24.0	Silty **SAND**, trace clay Very Dense Brown Moist (TILL)		19	SS	100/ 0.175		233				
232.7											
24.7	END OF BOREHOLE AT 24.7m. BOREHOLE CAVED TO 18.3m AND WATER LEVEL NOT OBSERVED. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2019.07.04	10.6	246.8
2019.08.27	10.9	246.5
2021.03.04	11.2	246.2
2021.04.19	10.9	246.5
2021.04.30	10.9	246.5

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-03 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 957.8 E 288 605.2 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392447 LONGITUDE -79.703280 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 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
254.0	GROUND SURFACE						254				
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL** Loose Brown Moist (FILL)		1	GS					○		
252.9			1	SS	8		253		○		
1.1	Silty **CLAY**, some sand, trace gravel, occasional cobbles Firm to Stiff Brown Moist (FILL)		2	SS	11				○		
251.8							252				
2.2	**SAND** and **SILT**, trace gravel, trace clay, occasional cobbles Dense to Very Dense Brown Moist (TILL)		3	SS	39				○		4 50 39 7
			4	SS	32		251		○		
			5	SS	70		250		○		
			6	SS	87		249		○		
246.9							248				
7.2	Silty **SAND**, trace clay Very Dense Brown Moist		7	SS	72		247		○		
							246				
244.6			8	SS	100/0.175		245		○		0 76 22 2
9.5	END OF BOREHOLE AT 9.5m. BOREHOLE OPEN AND DRY UPON COMPLETION.										

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 SUN-03 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 957.8 E 288 605.2 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392447 LONGITUDE -79.703280 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 2/17/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-04 1 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 985.9 E 288 533.3 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392697 LONGITUDE -79.704182 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 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
257.6	GROUND SURFACE										
0.0	**ASPHALT:** (125mm)										
0.1	**SAND** and **GRAVEL** Dense Brown Moist (FILL)		1	GS			257				
256.5			1	SS	34						
1.1	**SAND**, some gravel, trace to some silt and clay Compact Brown Moist (FILL)		2	SS	21		256				12 75 13 (SI+CL)
254.7			3	SS	23		255				
3.0	**SAND**, trace silt, trace clay Compact to Dense Brown Moist		4	SS	29		254				
252.0			5	SS	36		253				
5.6	Silty **SAND**, trace gravel, trace clay, occasional stains Very Dense Brown Moist (TILL)		6	SS	94		252				
			7	SS	96		251				
			8	SS	73		250				
247.9							249				
9.8	END OF BOREHOLE AT 9.8m.						248				

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 2/17/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-04 2 OF 2 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 985.9 E 288 533.3 ORIGINATED BY KK

DIST Central HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.04 - 2019.07.04 LATITUDE 44.392697 LONGITUDE -79.704182 CHECKED BY GRL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.125m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 2/17/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-05 1 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
252.6	GROUND SURFACE										
0.0	**TOPSOIL** (200mm)										
0.2	Silty **SAND**, trace gravel, trace to some clay Loose to Compact Brown Moist (TILL)		1	SS	6		252				
			2	SS	17						
			3	SS	19		251				
			4	SS	24		250				7 56 28 9
	Occasional cobbles from 3.0m to 3.7m Very Dense		5	SS	75		249				
248.6											
4.0	Silty **SAND**, trace gravel, trace clay Dense to Very Dense Brown Moist		6	SS	30		248				
			7	SS	41		247				
			8	SS	60		246				
244.0							245				0 76 22 2
8.7	Silty **CLAY**, trace sand Hard Grey to Brown Moist		9	SS	37		244				
							243				0 1 50 49 Tricone

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 SUN-05 2 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 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										
	Silty **CLAY**, trace sand Hard Grey to Brown Moist						242				
			10	SS	49						
							241				
240.3											
12.3	Silty **SAND**, trace clay Compact to Very Dense Brown Moist to Wet		11	SS	13		240				
							239				
			12	SS	67						0 65 32 3
	Wet						238				
			13	SS	100/ 0.275		237				
236.4											
16.2	**SAND**, trace silt, trace clay Very Dense Brown Moist to Wet						236				
			14	SS	100/ 0.250						
							235				
			15	SS	100/ 0.275		234				
							233				

Continued Next Page

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

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

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SUN-05 3 OF 3 METRIC

GWP# 2445-15-00 LOCATION Sunnidale Road N 4 916 945.5 E 288 599.7 ORIGINATED BY BL

DIST Central HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2019.07.19 - 2019.07.20 LATITUDE 44.392336 LONGITUDE -79.703348 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										
	SAND, trace silt, trace clay Very Dense Brown Moist to Wet		16	SS	100/ 0.225		232		○		
			17	SS	100/ 0.225		231		○		
			18	SS	100/ 0.250		230		○		0 90 7 3
							229				
227.9			19	SS	100/ 0.200		228		○		
24.7	END OF BOREHOLE AT 24.7m. BOREHOLE CAVED TO 12.2m AND WATER LEVEL NOT OBSERVED UPON COMPLETION. Piezometer installation consists of 30mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2019.08.27 9.5 243.1 2021.03.04 10.2 242.4 2021.04.19 9.9 242.7 2021.04.30 9.9 242.7										

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

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-22424.GPJ 2017TEMPLATE(MTO).GDT 5/27/21

THURBER

Appendix D

Record of Borehole Sheets

Previous Investigation by Others

RECORD OF BOREHOLE No 101

1 OF 2

METRIC

G.W.P. _____ LOCATION Co-ordinates: 4 916 364.6 N; 603 199.3 E ORIGINATED BY DP

DIST Central HWY 400 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY RB

DATUM Geodetic DATE 2019.04.19 LATITUDE 44.39322 LONGITUDE -79.70423 CHECKED BY GW

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
258.5	GROUND SURFACE										
0.0	CLAYEY SILT, trace sand, trace gravel, trace organics Firm Brown Moist (FILL)		1	SS	4		258				
			2	SS	5						
257.1							257				1 10 73 16
1.4	SILT, some clay, trace sand, trace gravel Compact Brown Moist		3	SS	21						
256.4							256				
2.1	SILTY SAND, trace gravel Very dense Brown Moist		4	SS	60						
255.6							255				
2.9	SILTY SAND, trace to some gravel, trace to some clay, occasional cobbles and boulders Dense to very dense, Brown to grey, Moist (TILL)		5	SS	41						
			6	SS	50		254				
			7	SS	79		253				5 57 29 9
			8	SS	50/75mm		252				
			9	SS	50		251				
			10	SS	50/125mm		250				
			11	SS	67		249				
245.5							248				13 68 17 2
13.0	SAND, trace silt Dense Brown to Grey Wet		12	SS	50		247				
							246				
							245				
							244				

Continued Next Page

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

RECORD OF BOREHOLE No 101

2 OF 2

METRIC

G.W.P. _____ LOCATION Co-ordinates: 4 916 364.6 N; 603 199.3 E ORIGINATED BY DP

DIST Central HWY 400 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY RB

DATUM Geodetic DATE 2019.04.19 LATITUDE 44.39322 LONGITUDE -79.70423 CHECKED BY GW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR	SA SI CL
243.5	SAND, trace silt Dense Brown to Grey Wet *(Cont.d)*		13	SS	95	▽	243		○			
			14	SS	50/125mm		242		○		0	95 5 0
			15	SS	78		241		○			
238.2			16	SS	42		240		○			
20.3	BOREHOLE TERMINATED AT 20.3 m						239					

Notes:

First water strike noted at 15.3 m during drilling.

Water measured in well on April 25, 2019 at 11.3 m.

Water measured in well on August 6, 2019 at 11.4 m.

Monitoring well installed prior to extraction of the augers.

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

RECORD OF BOREHOLE No 102

1 OF 2

METRIC

G.W.P. _____ LOCATION Co-ordinates: 4 916 306.9 N; 603 324.7 E ORIGINATED BY DP

DIST Central HWY 400 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY RB

DATUM Geodetic DATE 2019.04.08 LATITUDE 44.39268 LONGITUDE -79.70266 CHECKED BY GW

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
251.2	GROUND SURFACE						251				
0.0 / 250.6	SAND, trace to some silt, trace organics Dark brown, Moist (FILL)		1	SS	4						
0.6 / 249.7	SANDY SILT, trace clay, trace gravel Light grey to brown, Moist to very moist (FILL)		2	SS	9		250				
1.4 / 249.0	SILTY SAND, trace clay, trace gravel Compact, light grey to brown, Moist to very moist		3	SS	11		249				
2.2	SILTY SAND, trace to some gravel, trace to some clay, occasional cobbles and boulders Compact to very dense, Brown to grey, Moist to wet (TILL)		4	SS	26		248				
			5	SS	39		247				
			6	SS	58		246				19 53 21 7
			7	SS	36		245				
			8	SS	50/125mm		244				
			9	SS	50/100mm		243				
241.1 / 10.1 / 239.7	SAND, trace gravel, trace silt Very dense, Light brown, Wet		10	SS	50		242				4 93 3 0
11.5	CLAYEY SILT, trace sand Hard, Grey, Moist		11	SS	67		241				0 2 66 32
			12	SS	61		240				0 1 54 45
							239				
							238				
							237				

Continued Next Page

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

RECORD OF BOREHOLE No 102

2 OF 2 **METRIC**

G.W.P. _____ LOCATION Co-ordinates: 4 916 306.9 N; 603 324.7 E ORIGINATED BY DP

DIST Central HWY 400 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY RB

DATUM Geodetic DATE 2019.04.08 LATITUDE 44.39268 LONGITUDE -79.70266 CHECKED BY GW

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
236.2	CLAYEY SILT, trace sand Hard, Grey, Moist *(Cont.d)*		13	SS	74		236				0 1 59 40
			14	SS	34		235				
			15	SS	51		234				0 0 60 40
230.9			16	SS	45		233				
20.3	BOREHOLE TERMINATED AT 20.3 m						232				
	Notes: First water strike noted at 10.7 m during drilling. Water measured in wells on April 25, 2019 at 6.9 m. Water measured in well on August 6, 2019 at 7.0 m. Monitoring well installed prior to extraction of the augers.						231				

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

THURBER

Appendix E

Selected Site Photographs

Photo 1. – Southwest side of Highway 400 and Sunnidale Road Underpass

Photo 2. – Southwest side of Highway 400 and Sunnidale Road Underpass

Photo 3. – Northwest side of Highway 400 and Sunnidale Road Underpass

Photo 4. – Northwest side of Highway 400 and Sunnidale Road Underpass, (May 18, 2021)

Photo 5. – Northeast side of Highway 400 and Sunnidale Road Underpass

THURBER

Appendix F

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 2445-15-00

SHEET

HWY 400 & SUNNIDALE RD. DEEP CUTS
APPROX. STA. 12+585 TO 12+750
BOREHOLE LOCATIONS PLAN

McINTOSH PERRY

THURBER ENGINEERING LTD.

KEYPLAN

A
B
C
C'
D
D'
A'
B'

SBL 12+725
PROP. RELOCATION OF UNDERGROUND UTILITIES
EX. MTO ROW
PROP. EDGE OF PAVEMENT OF HWY 400
EDGE OF CUT
FUTURE MTO ROW
101
SBL 12+685 PIEZO
SBL 12+685 (ACTUAL STA. 12+691)
PROP. WEST SHAFT (CONFIGURATION TO BE DEFINED)
PROP. CONC. VALVE CHAMBER
#79
#80
SUN-01
SUN-04
SUN-03
SUN-05
SBL 12+595 (ACTUAL STA. 12+613)
HIGHWAY 400SBL
HIGHWAY 400 NBL
SUNNIDALE ROAD
TO TORONTO
TO BARRIE
R=190
12+700
10+000
10+038
10+052
10+057
10+075
N 4 917 000
E 288 500
E 288 600
257.00
256.00
255.00
254.00
253.00
252.00
251.00
250.00
NBL 12+685 (ACTUAL STA. 12+678)
EX. MTO ROW
PROP. EDGE OF PAVEMENT OF HWY 400
EDGE OF CUT
FUTURE MTO ROW
102
PROP. EAST SHAFT (CONFIGURATION TO BE DEFINED)
#53
#54
PROP. CONC. VALVE CHAMBER

PLAN

10 0 10 20m
SCALE 1:500

LEGEND

●	Borehole (By Thurber)
⊕	Borehole (By Other)
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
101	258.5	4 917 043.7	288 530.2
102	251.2	4 916 983.7	288 654.5
NBL 12+685	253.8	4 916 978.5	288 615.7
SBL 12+595	255.6	4 916 959.3	288 519.3
SBL 12+685	256.9	4 917 028.6	288 555.6
SBL 12+685 PIEZO	256.3	4 917 030.7	288 551.6
SBL 12+725	257.6	4 917 061.6	288 556.2
SUN-01	257.4	4 916 997.6	288 541.5
SUN-03	254.0	4 916 957.8	288 605.2
SUN-04	257.6	4 916 985.9	288 533.3
SUN-05	252.6	4 916 945.5	288 599.7

-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. 31D-770

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
10/20/2021
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S. PANG
35314509
10/20/2021
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

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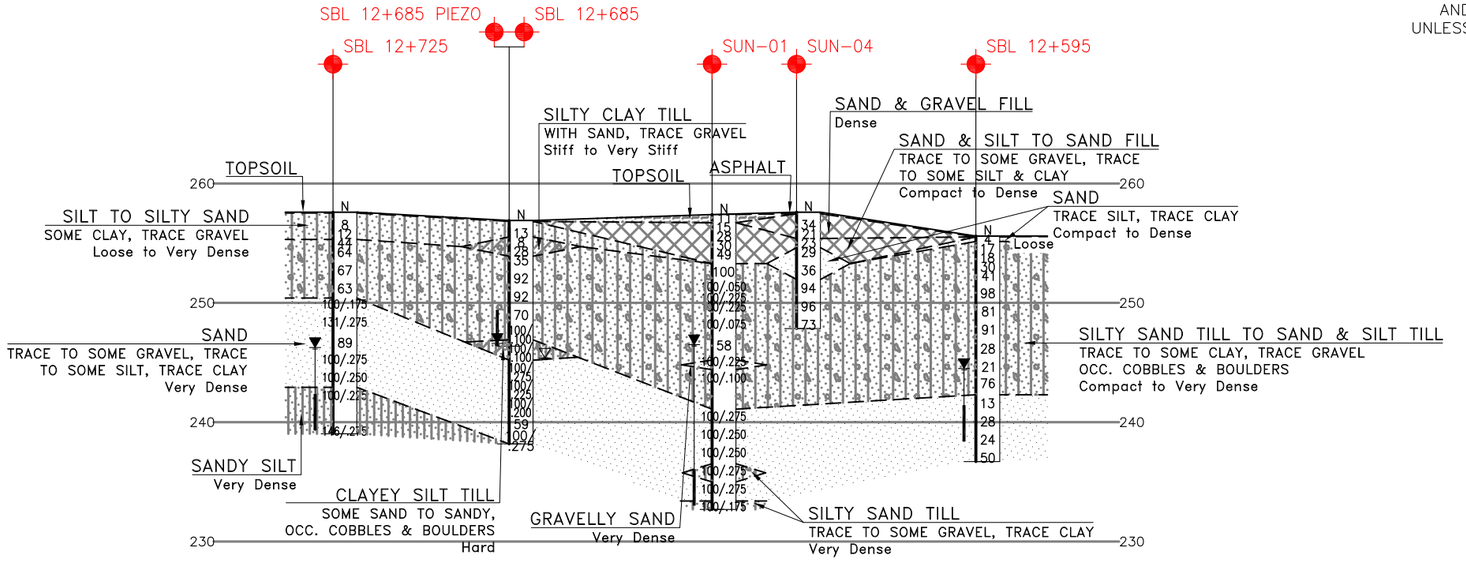
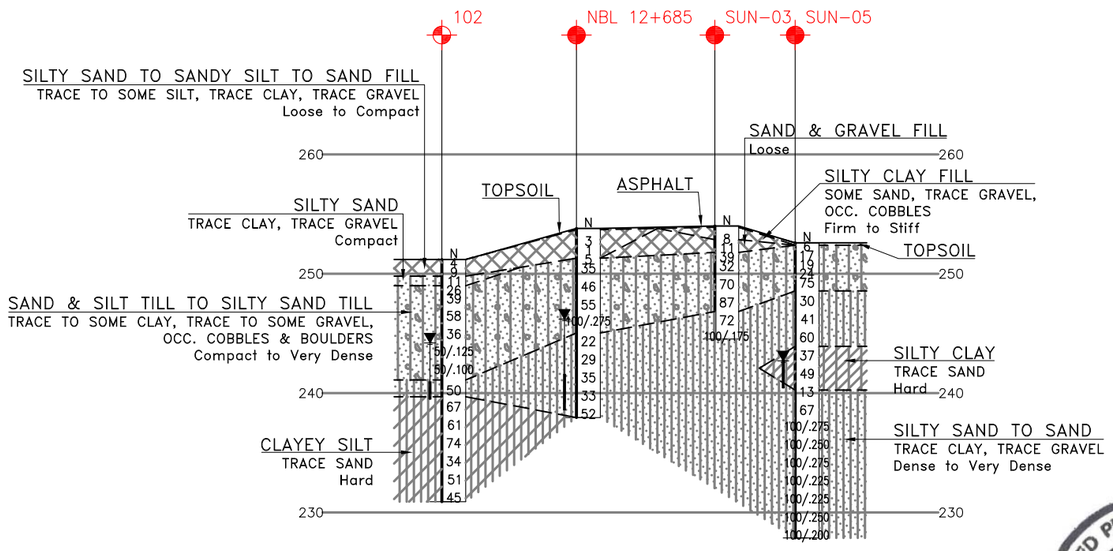


SECTION ALONG A–A'



SECTION ALONG B–B'

20 0 20 40m H 1:1000

20 0 10 10m V 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 2445-15-00

HWY 400 & SUNNIDALE RD. DEEP CUTS
APPROX. STA. 12+585 TO 12+750
BOREHOLE LOCATIONS PROFILES

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (By Other)
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
101	258.5	4 917 043.7	288 530.2
102	251.2	4 916 983.7	288 654.5
NBL 12+685	253.8	4 916 978.5	288 615.7
SBL 12+595	255.6	4 916 959.3	288 519.3
SBL 12+685	256.9	4 917 028.6	288 555.6
SBL 12+685 PIEZO	256.3	4 917 030.7	288 551.6
SBL 12+725	257.6	4 917 061.6	288 556.2
SUN-01	257.4	4 916 997.6	288 541.5
SUN-03	254.0	4 916 957.8	288 605.2
SUN-04	257.6	4 916 985.9	288 533.3
SUN-05	252.6	4 916 945.5	288 599.7

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REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	SKP	CODE		LOAD	DATE OCT 2021
DRAWN	AN	CHK	RPR	SITE	C-78	STRUCT	DWG 2

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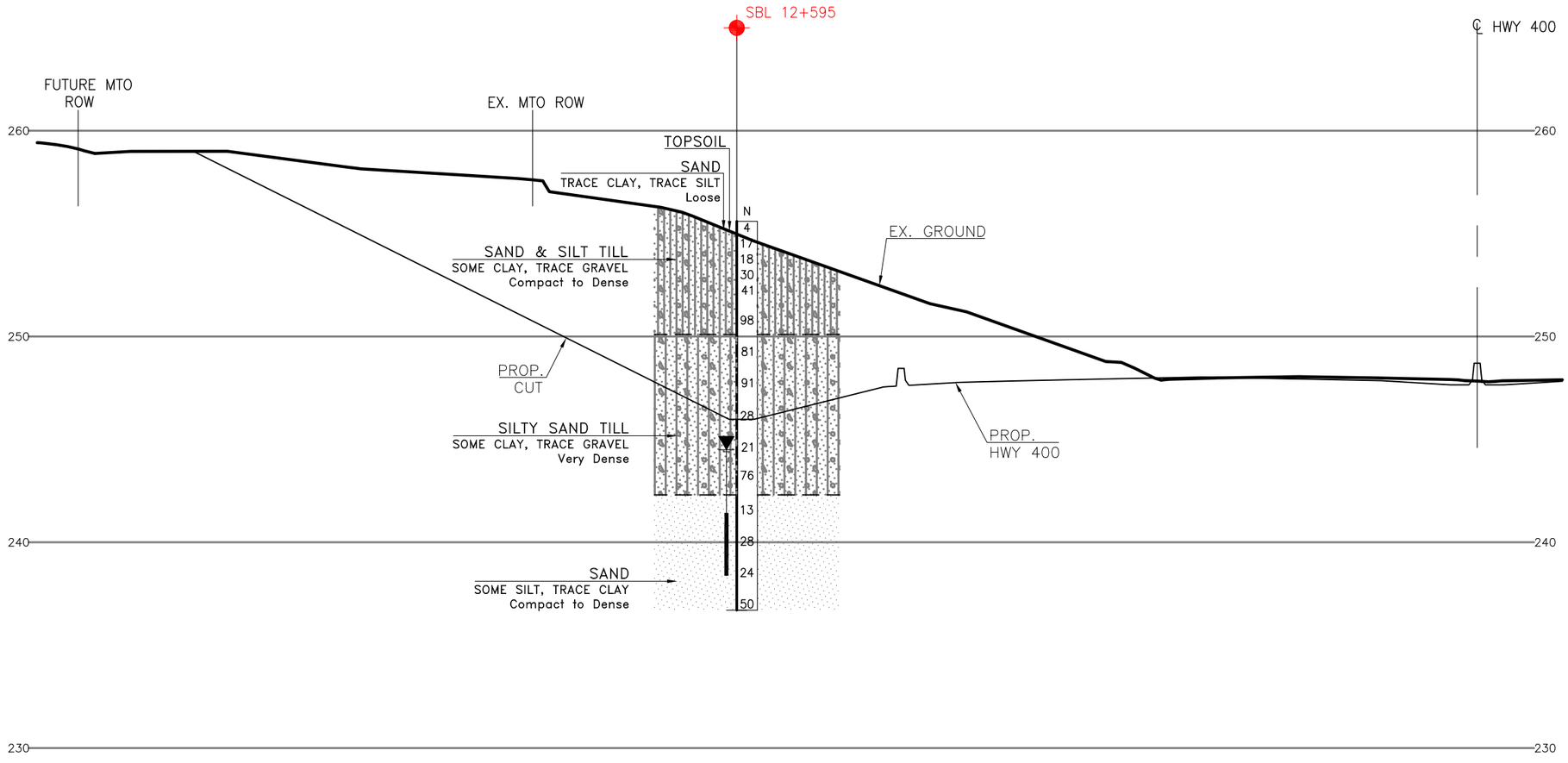
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



SECTION ALONG C–C' WEST SIDE
(APPROX. STA. 12+608.3)

5 0 5 10m

SCALE 1:250

CONT No
GWP No 2445-15-00

HWY 400 & SUNNIDALE RD.
DEEP CUTS
APPROX. STA. 12+585 TO 12+750
BOREHOLE LOCATIONS SECTIONS

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

●	Borehole (By Thurber)
⊕	Borehole (By Other)
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
101	258.5	4 917 043.7	288 530.2
102	251.2	4 916 983.7	288 654.5
NBL 12+685	253.8	4 916 978.5	288 615.7
SBL 12+595	255.6	4 916 959.3	288 519.3
SBL 12+685	256.9	4 917 028.6	288 555.6
SBL 12+685 PIEZO	256.3	4 917 030.7	288 551.6
SBL 12+725	257.6	4 917 061.6	288 556.2
SUN-01	257.4	4 916 997.6	288 541.5
SUN-03	254.0	4 916 957.8	288 605.2
SUN-04	257.6	4 916 985.9	288 533.3
SUN-05	252.6	4 916 945.5	288 599.7

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REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK SKP	CODE	LOAD	DATE OCT 2021
DRAWN	AN	CHK RPR	SITE C-78	STRUCT	DWG 3

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PLOTDATE: 10/21/2021 9:53 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

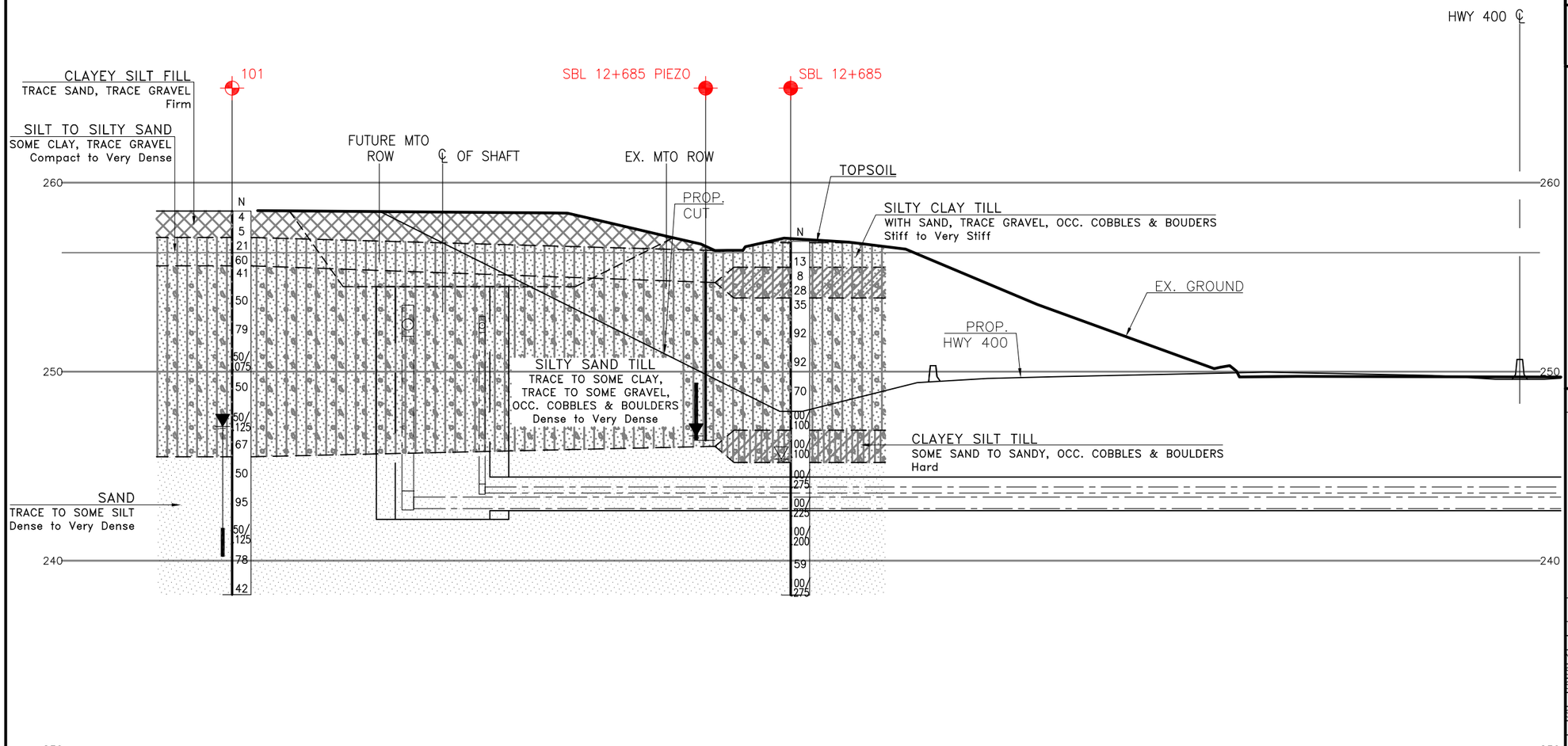
CONT No
GWP No 2445-15-00

HWY 400 & SUNNIDALE RD. DEEP CUTS
APPROX. STA. 12+585 TO 12+750
BOREHOLE LOCATIONS SECTIONS

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD.



SECTION ALONG D-D' WEST SIDE
(APPROX. STA. 12+686.2)

5 0 5 10m
SCALE 1:250

KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (By Other)
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
101	258.5	4 917 043.7	288 530.2
102	251.2	4 916 983.7	288 654.5
NBL 12+685	253.8	4 916 978.5	288 615.7
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10/20/2021
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	SKP	CODE		LOAD	DATE OCT 2021
DRAWN	AN	CHK	RPR	SITE	C-78	STRUCT	DWG 4

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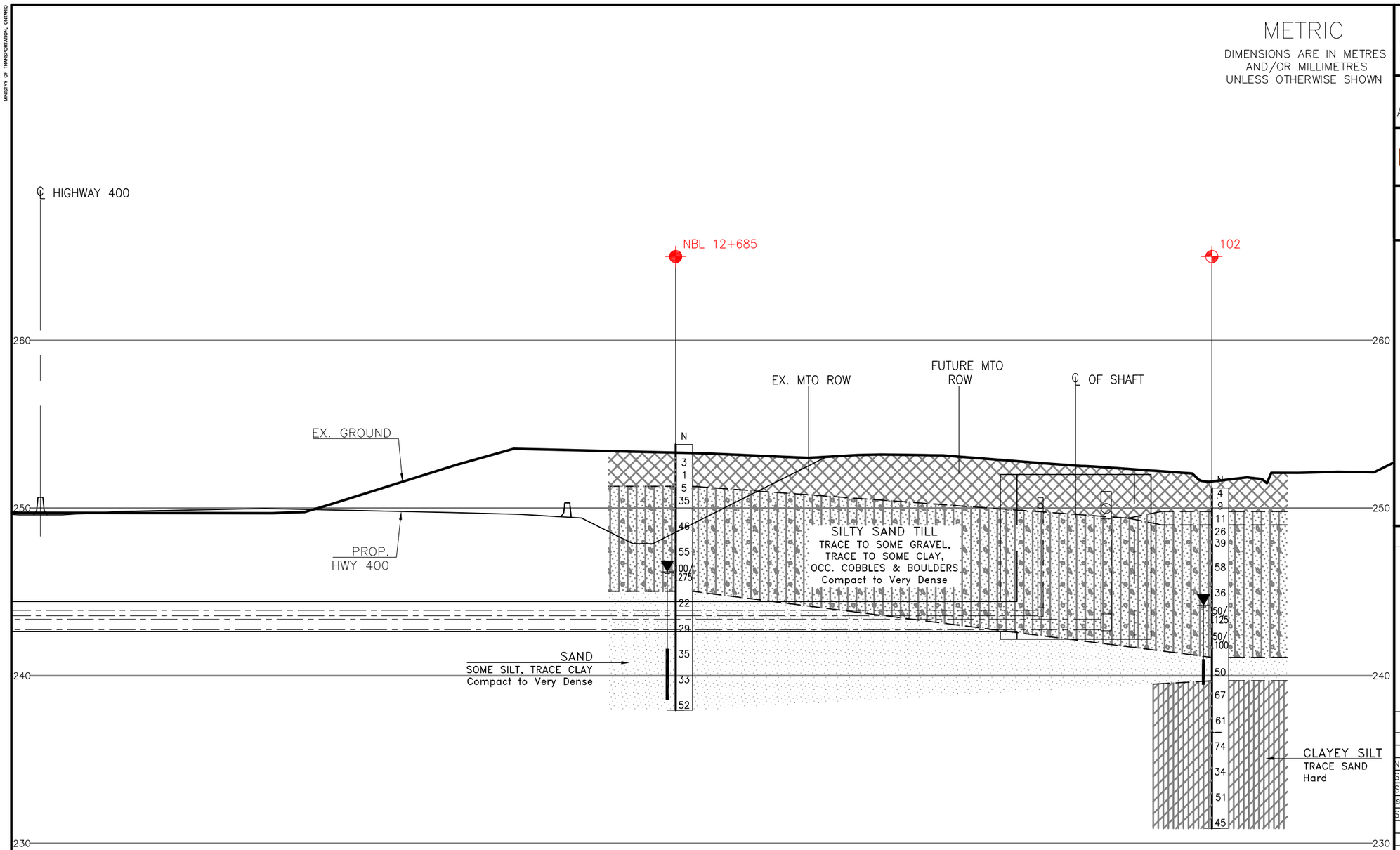
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



SECTION ALONG D–D' EAST SIDE
(APPROX. STA. 12+686.2)

5 0 5 10m

SCALE 1:250

CONT No
GWP No 2445-15-00

HWY 400 & SUNNIDALE RD. DEEP CUTS
APPROX. STA. 12+585 TO 12+750
BOREHOLE LOCATIONS SECTIONS

SHEET

McINTOSH PERRY

THURBER ENGINEERING LTD.

KEYPLAN

LEGEND

	Borehole (By Thurber)
	Borehole (By Other)
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
101	258.5	4 917 043.7	288 530.2
102	251.2	4 916 983.7	288 654.5
NBL 12+685	253.8	4 916 978.5	288 615.7
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10/20/2021
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35314509
10/20/2021
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK	SKP	CODE		LOAD	DATE OCT 2021
DRAWN	AN	CHK	RPR	SITE	C-78	STRUCT	DWG 5

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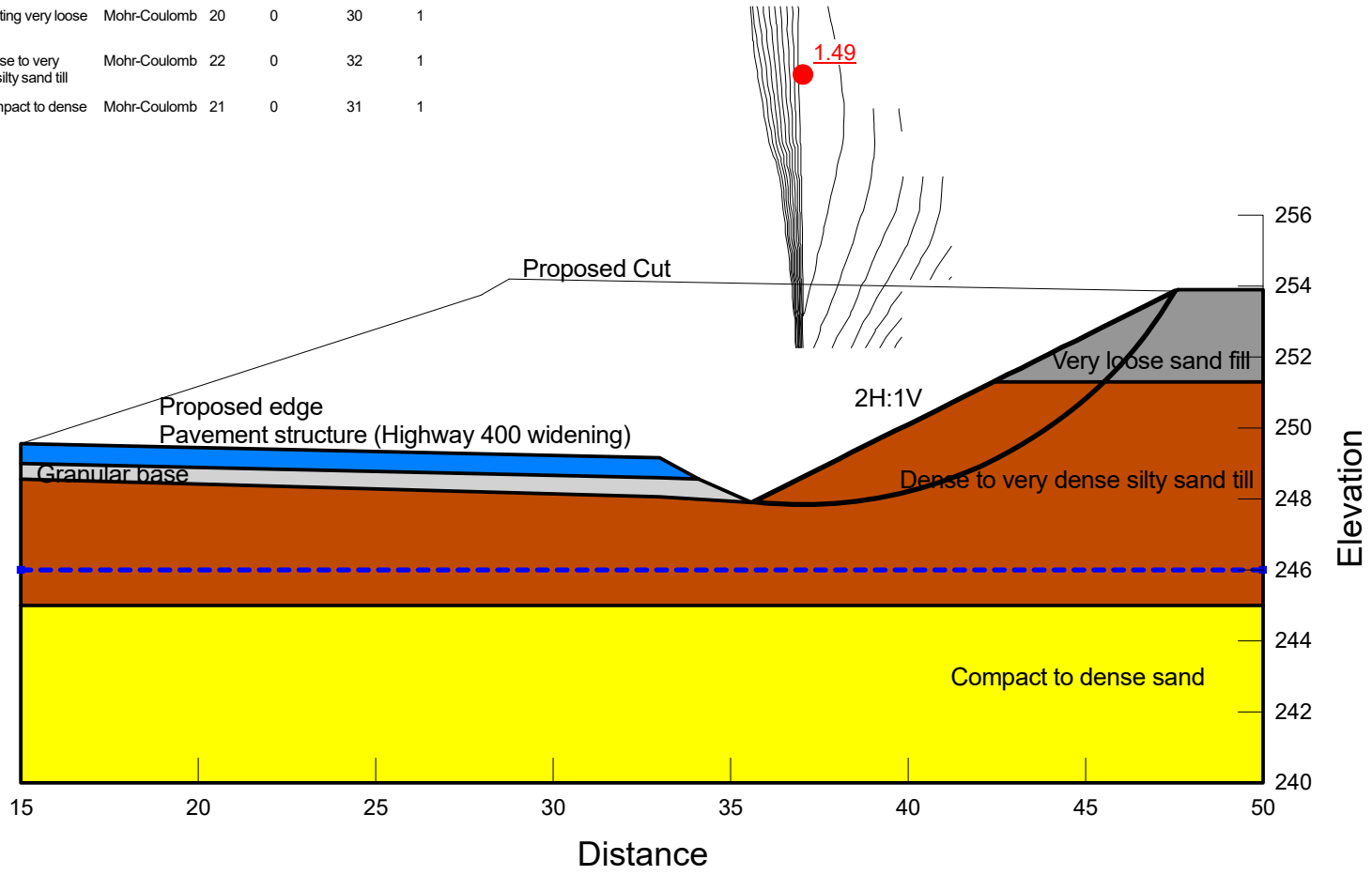
PLOTDATE: 10/21/2021 9:54 AM

THURBER

Appendix G

Slope Stability Analysis Results

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular Fill	Mohr-Coulomb	22	0	35	1
	02-Existing very loose sand fill	Mohr-Coulomb	20	0	30	1
	04-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Compact to dense sand	Mohr-Coulomb	21	0	31	1



THURBER

Project
22424- Hwy 400 NBL & Sunnidale Rd - Deep Cuts

Analysis
Drained Analysis -NE side

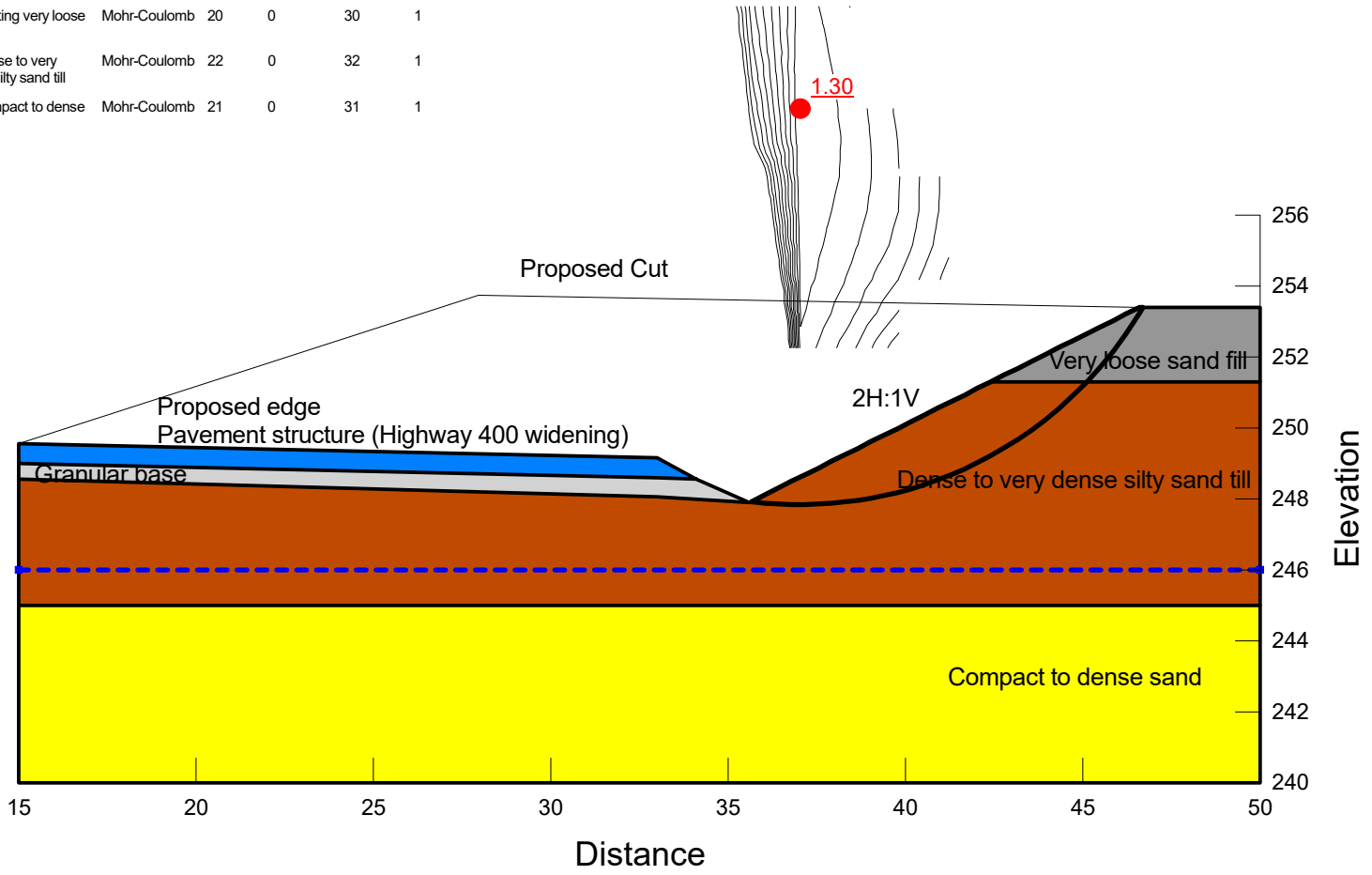
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,05:17:53 AM	1:200

Additional Details
Name: Hwy 400 & Sunnidale Rd. - NBL Deep Cuts
Comments: Northeast side of Hwy 400 & Sunnidale Rd. Underpasss
Approx. Height 6.0 m
Approx. Station12+680
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 246.0

Figure G1

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular Fill	Mohr-Coulomb	22	0	35	1
	02-Existing very loose sand fill	Mohr-Coulomb	20	0	30	1
	04-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Compact to dense sand	Mohr-Coulomb	21	0	31	1



THURBER

Project
22424- Hwy 400 NBL & Sunnidale Rd - Deep Cuts

Analysis
Seismic Analysis - NE side

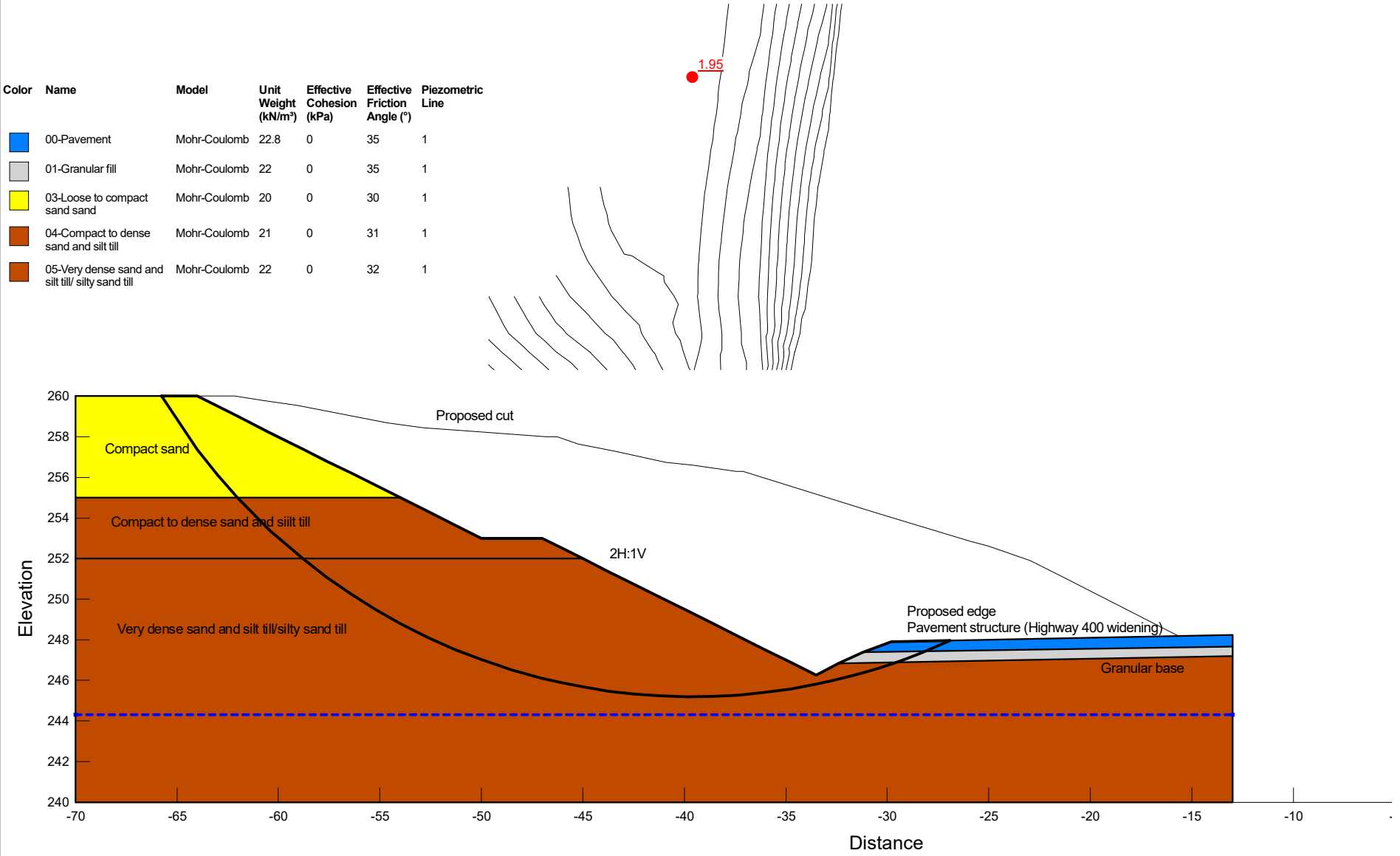
Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,05:20:56 AM	1:200

Additional Details
Name: Hwy 400 & Sunnidale Rd. - NBL Deep Cuts
Comments: Northeast side of Hwy 400 & Sunnidale Rd. Underpass
Approx. Height 6.0 m
Approx. Station12+680
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 246.0

Figure G2

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

Analysis
Drained Analysis - SW side

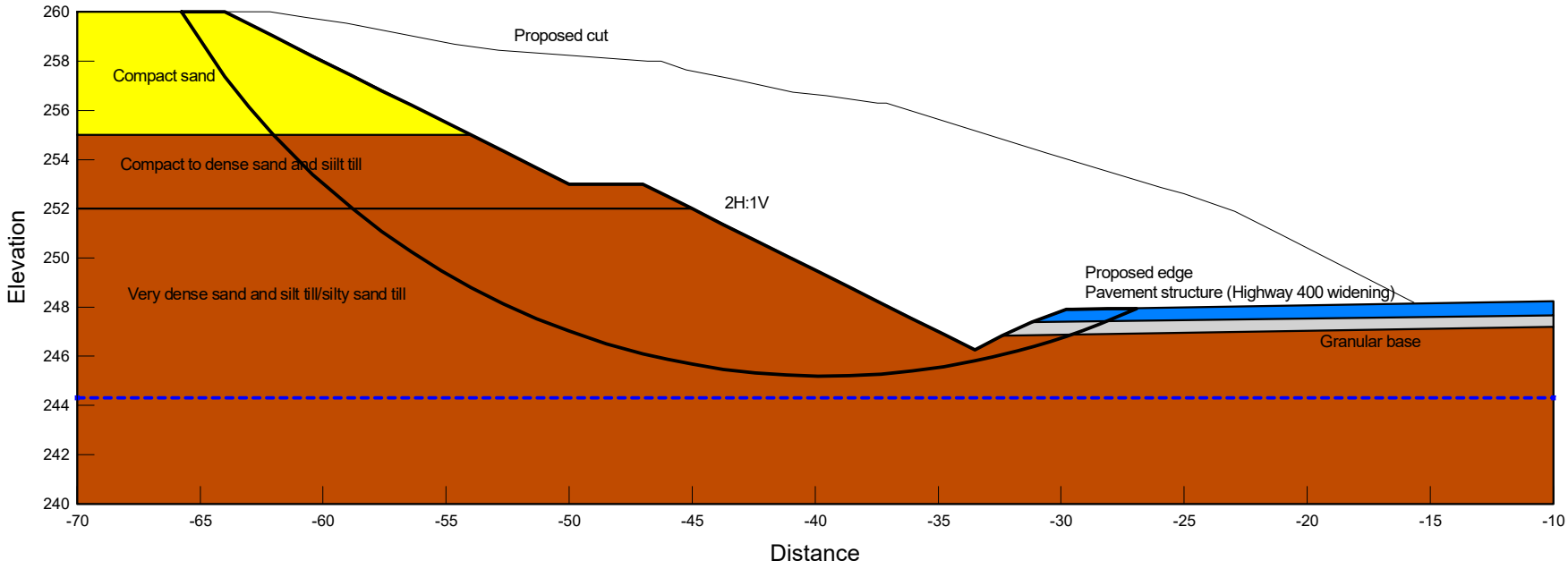
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,05:24:58 AM	1:275

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G3

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424-Hwy 400 SBL & Sunnidale Rd - Deep Cuts

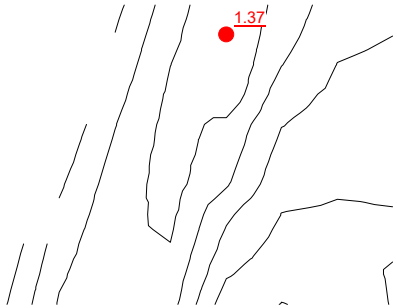
Analysis
Drained Analysis - SW side

Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,05:57:40 AM	1:275

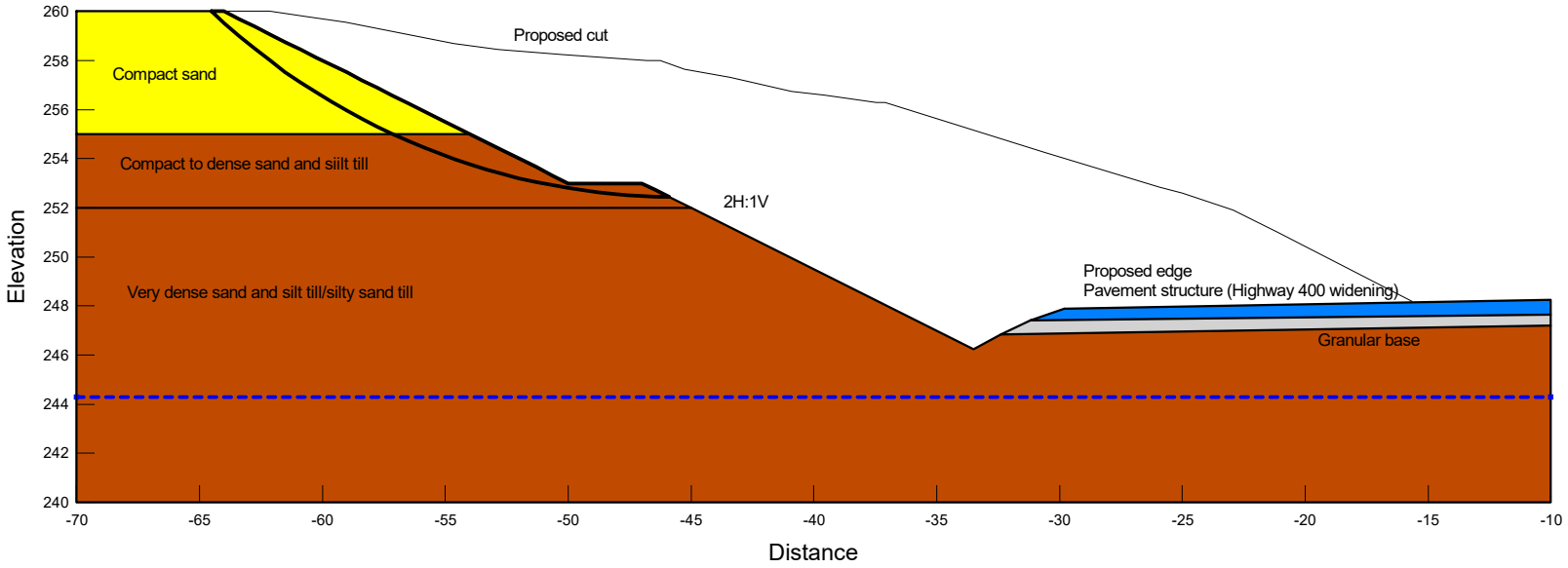
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G4



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424-Hwy 400 SBL & Sunnidale Rd - Deep Cuts

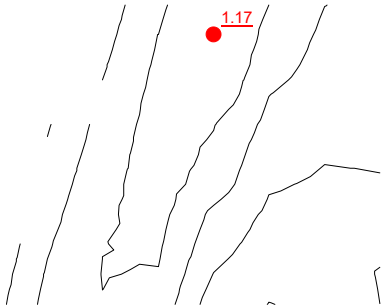
Analysis
Drained Analysis - SW side -Upper slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,05:58:57 AM	1:300

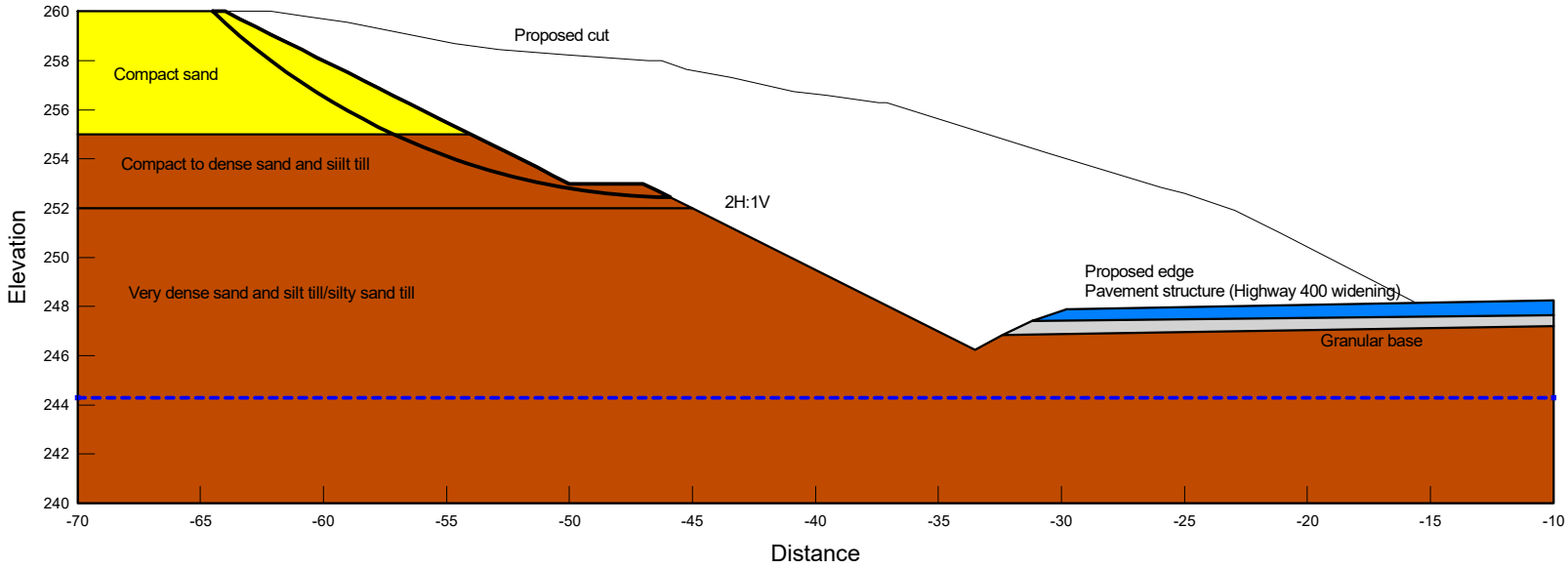
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G5



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424-Hwy 400 SBL & Sunnidale Rd - Deep Cuts

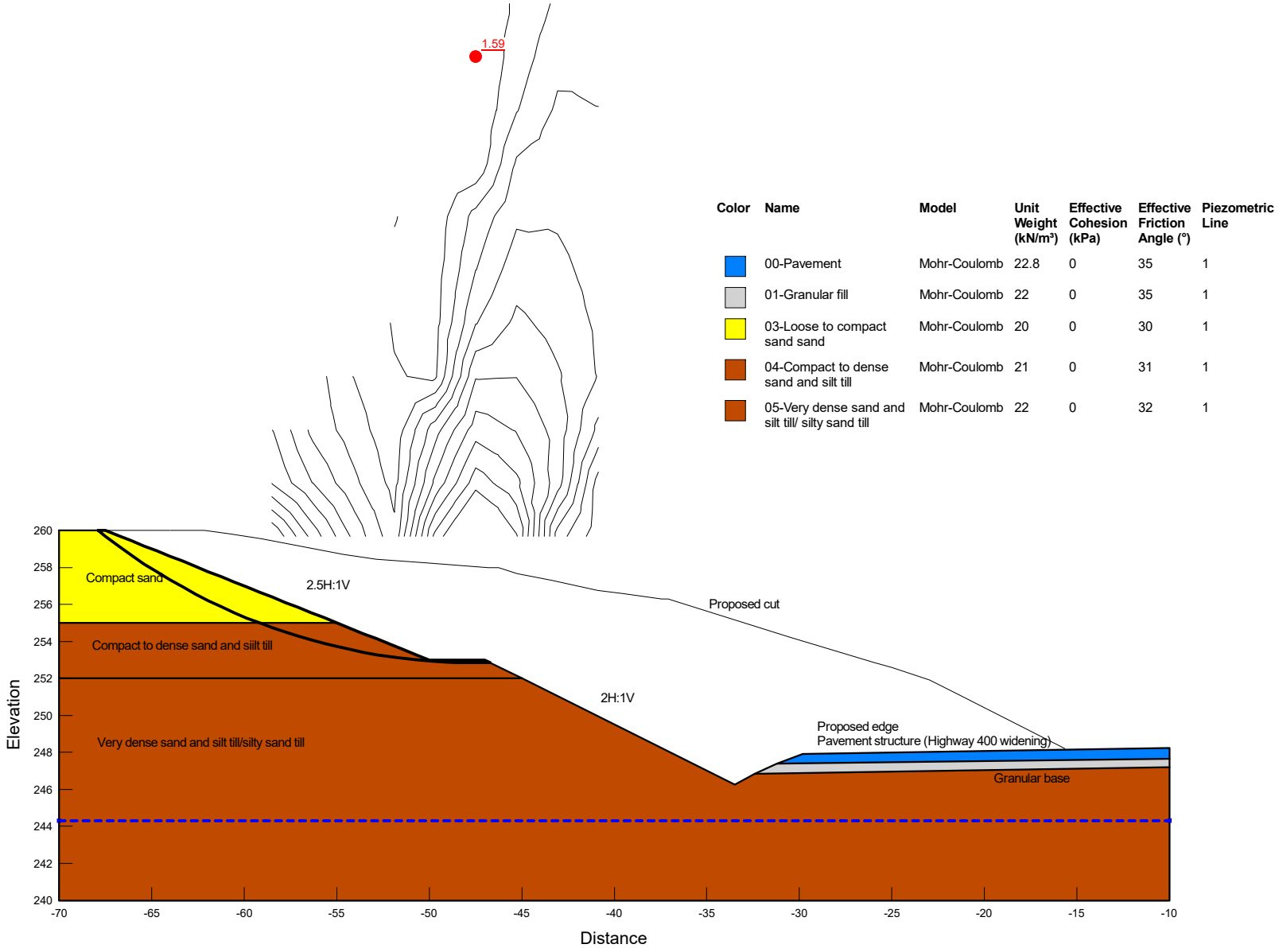
Analysis
Seismic Analysis - SW side - Upper slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,06:01:11 AM	1:300

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G6



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

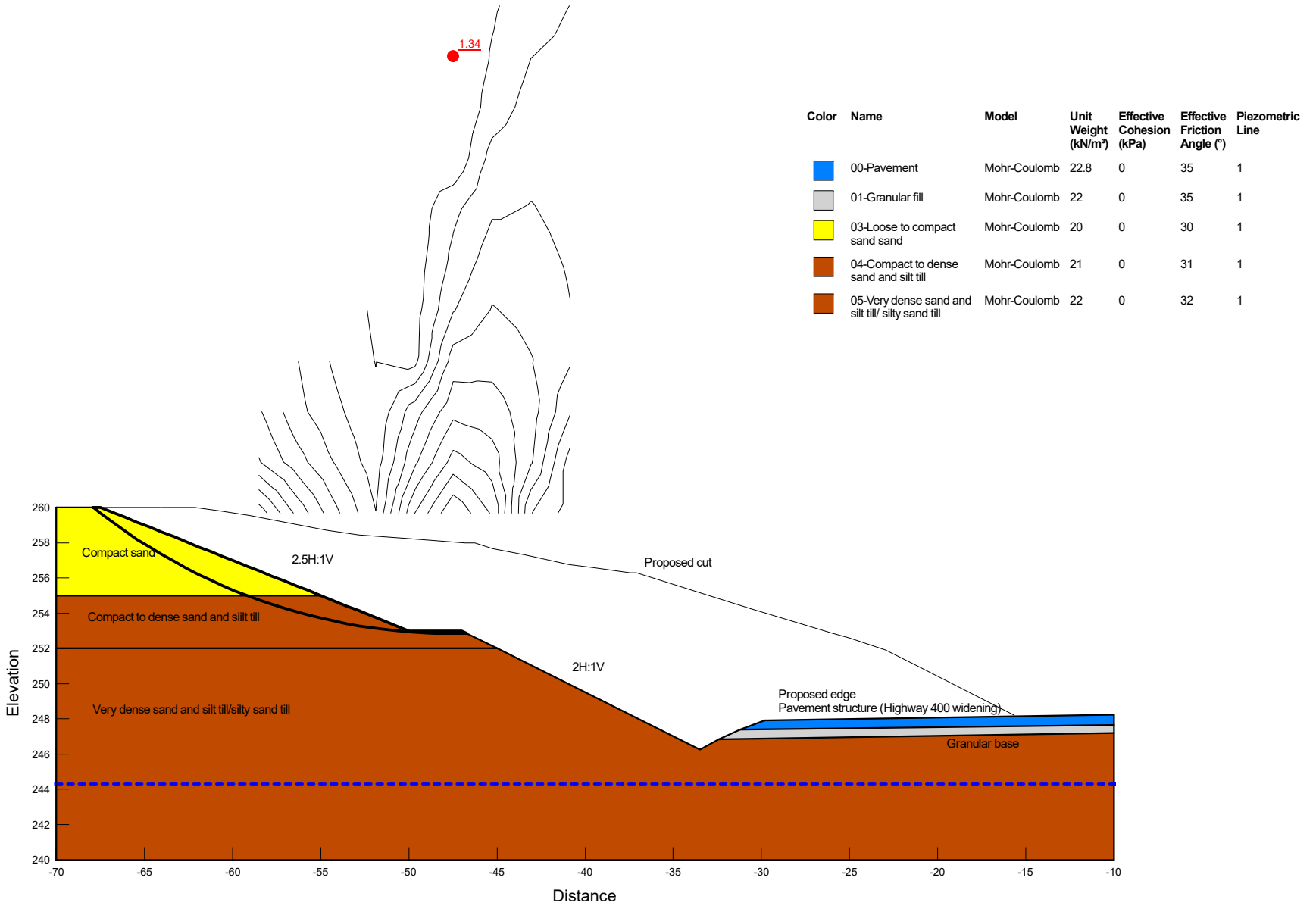
Analysis
Drained Analysis - SW side - Upper Slope 2.5H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,06:03:06 AM	1:325

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G7



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

Analysis
Seismic Analysis - SW side - Upper Slope 2.5H:1V

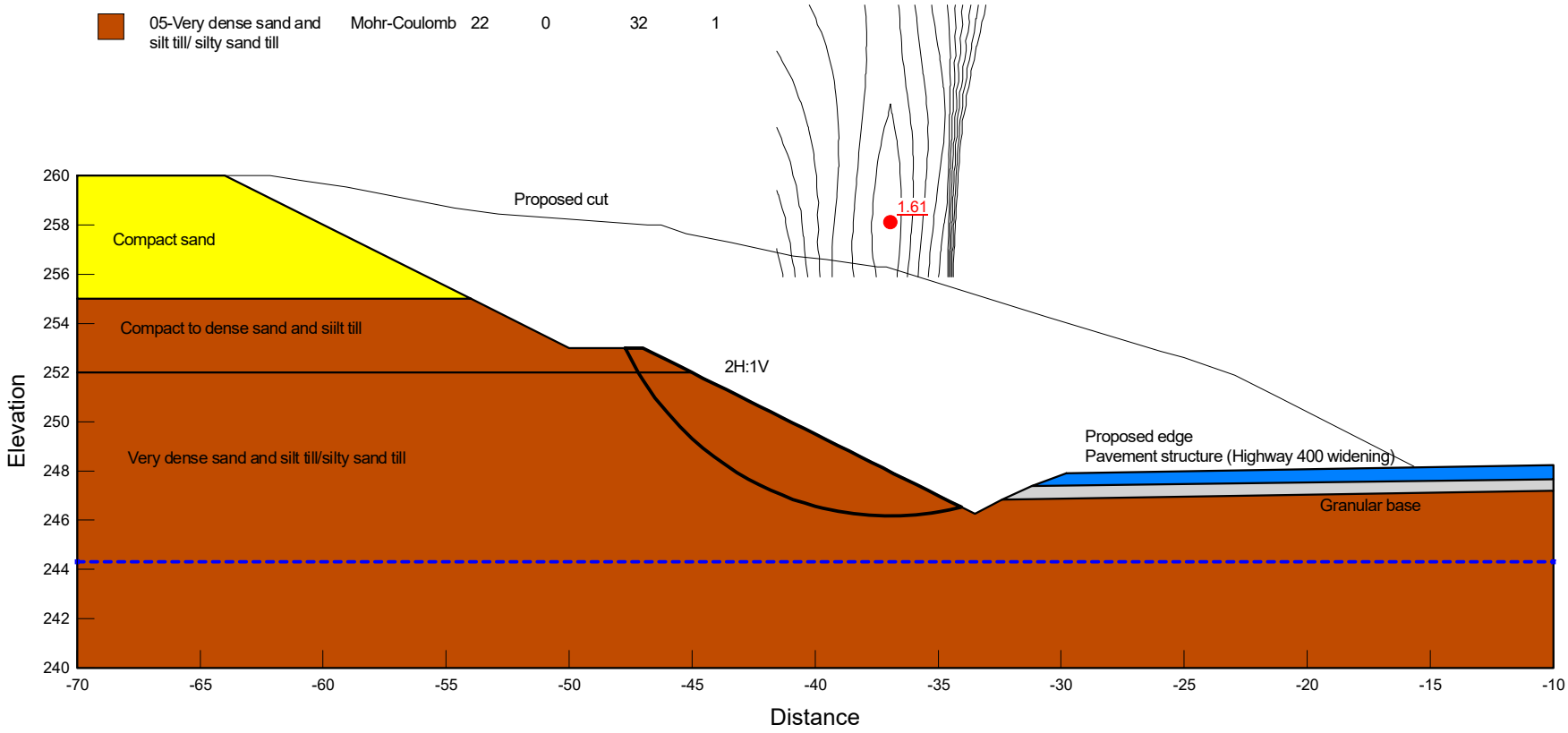
Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,06:04:49 AM	1:325

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G8

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

Analysis
Drained Analysis - SW side - Lower Slope 2H:1V

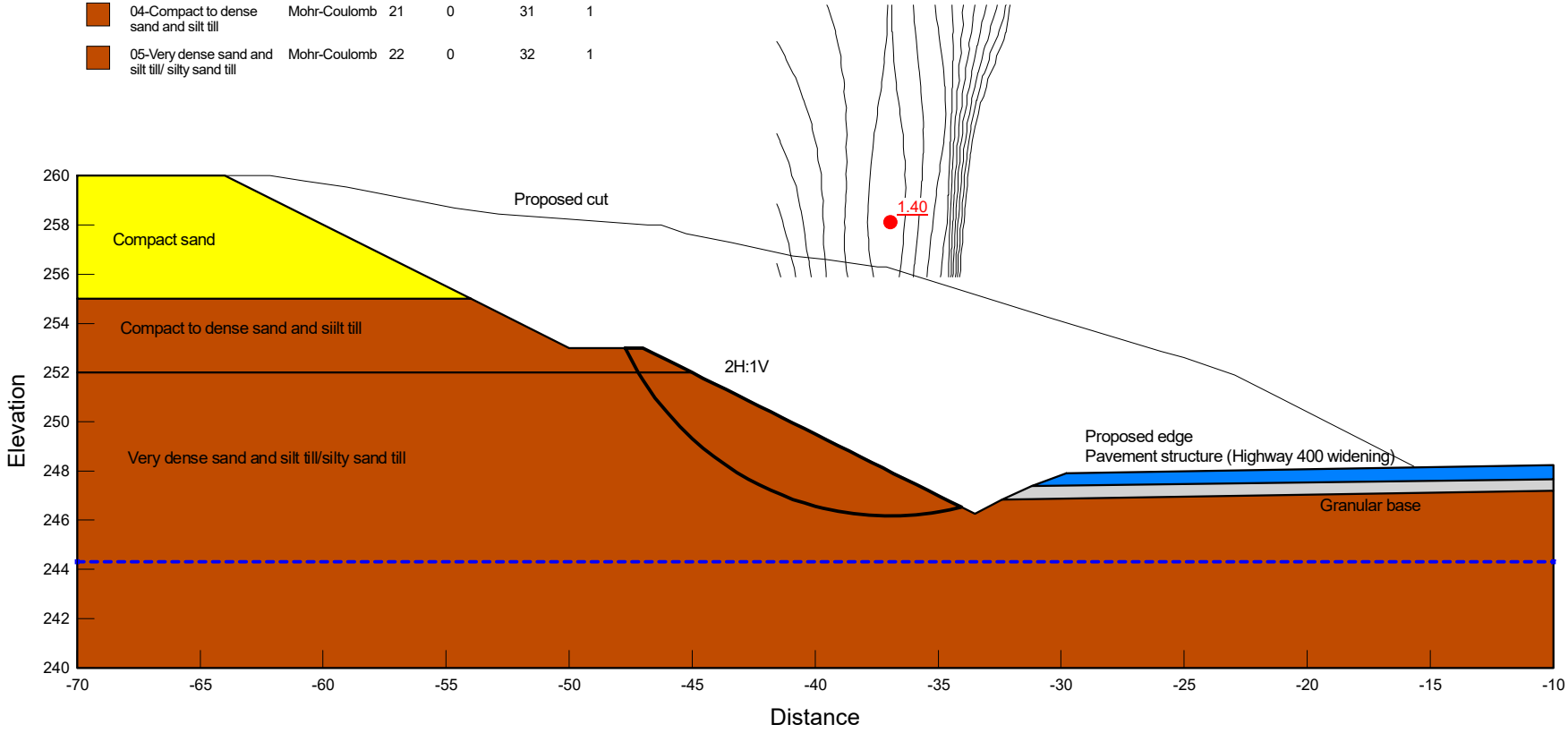
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,05:54:42 AM	1:275

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope Height 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G9

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03-Loose to compact sand sand	Mohr-Coulomb	20	0	30	1
	04-Compact to dense sand and silt till	Mohr-Coulomb	21	0	31	1
	05-Very dense sand and silt till/ silty sand till	Mohr-Coulomb	22	0	32	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

Analysis
Seismic Analysis- SW side - Lower Slope 2H:1V

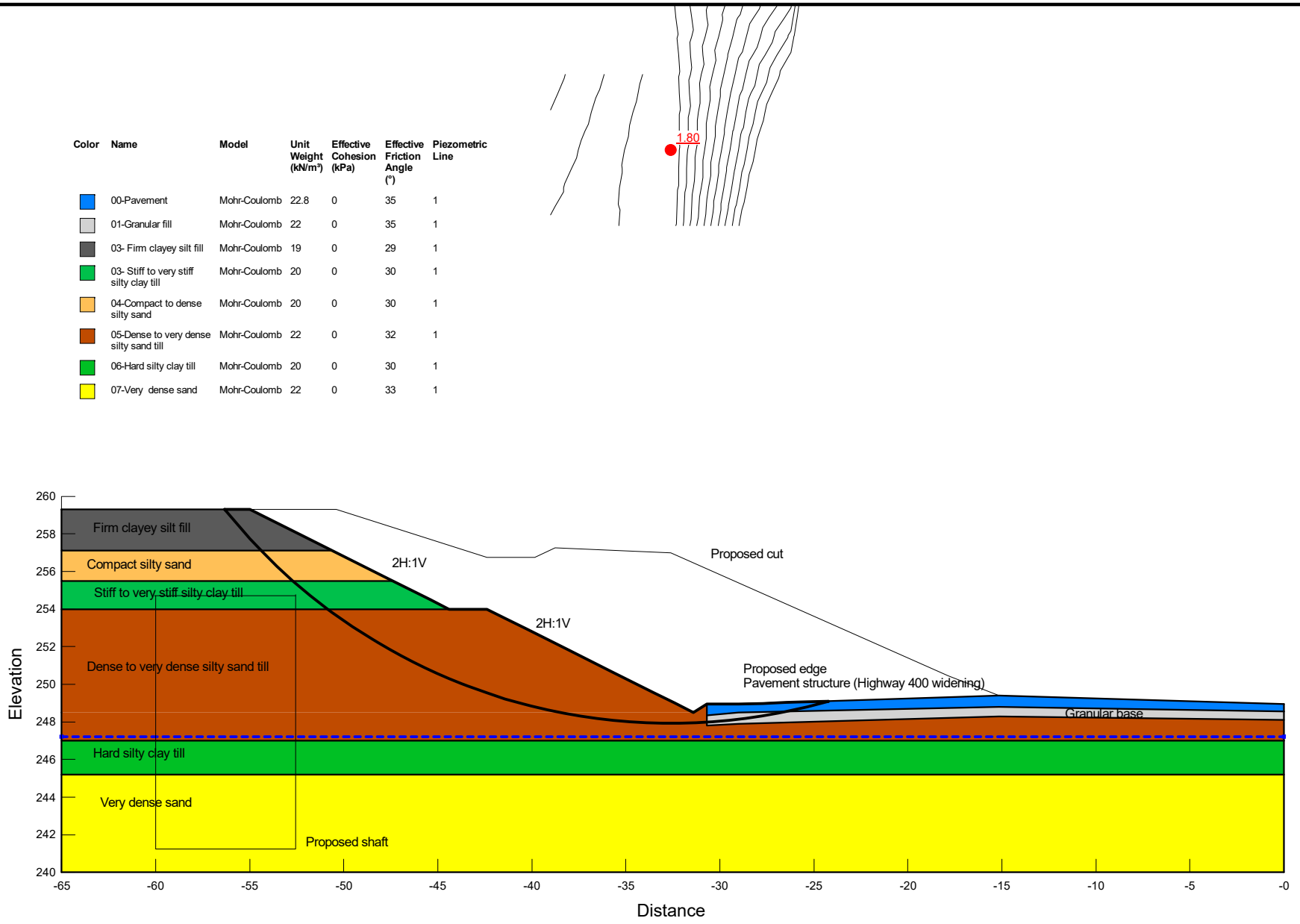
Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,06:08:18 AM	1:275

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Southwest side of Sunnidale Road Underpass
Approx. Total height 13.8 m, Lower Slope Height 6.8 m, Upper Slope Height 7.0 m
Approx. Station12+620
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 244.3

Figure G10

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

Analysis
Drained Analysis - NW side

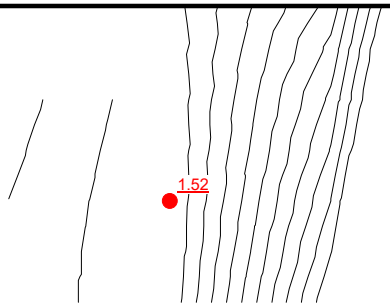
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,06:18:12 AM	1:300

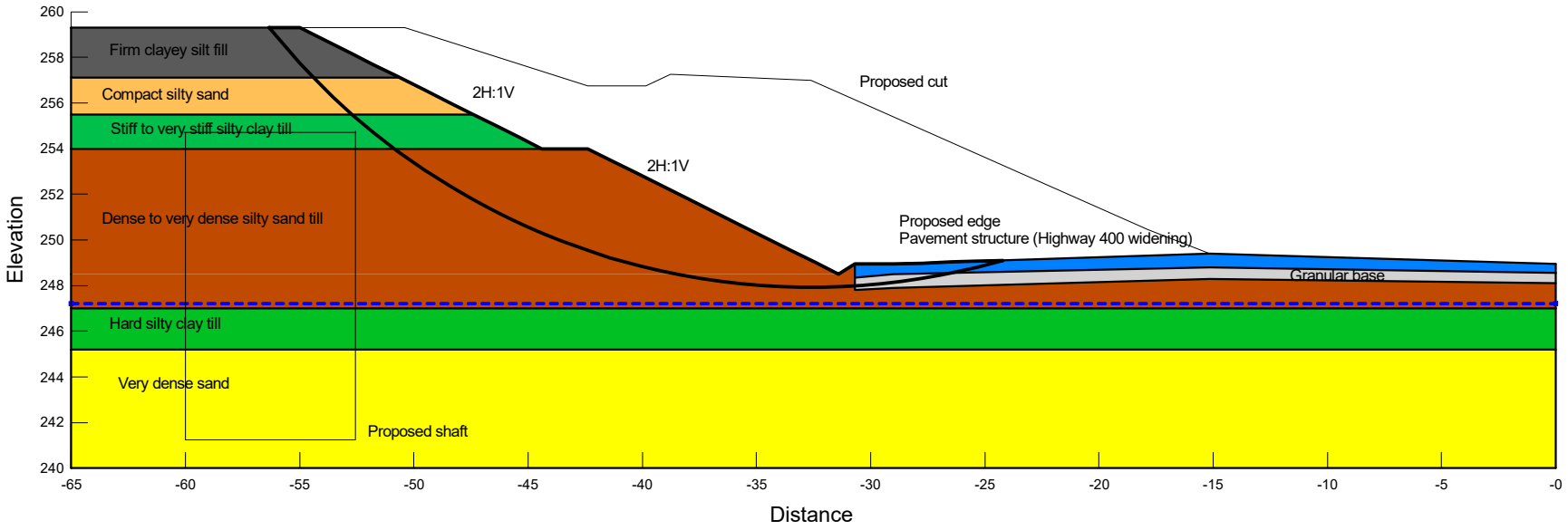
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Northwest side of Hwy 400 and Sunnidale Rd. Underpass
Approx. Height 10.8 m
Approx. Station 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G11

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1





THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

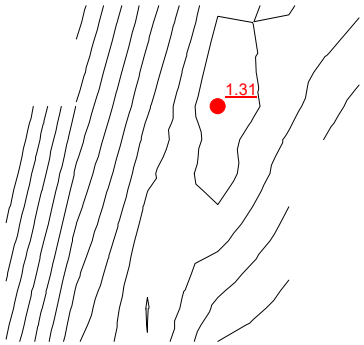
Analysis
Seismic Analysis - NW side

Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,06:46:15 AM	1:300

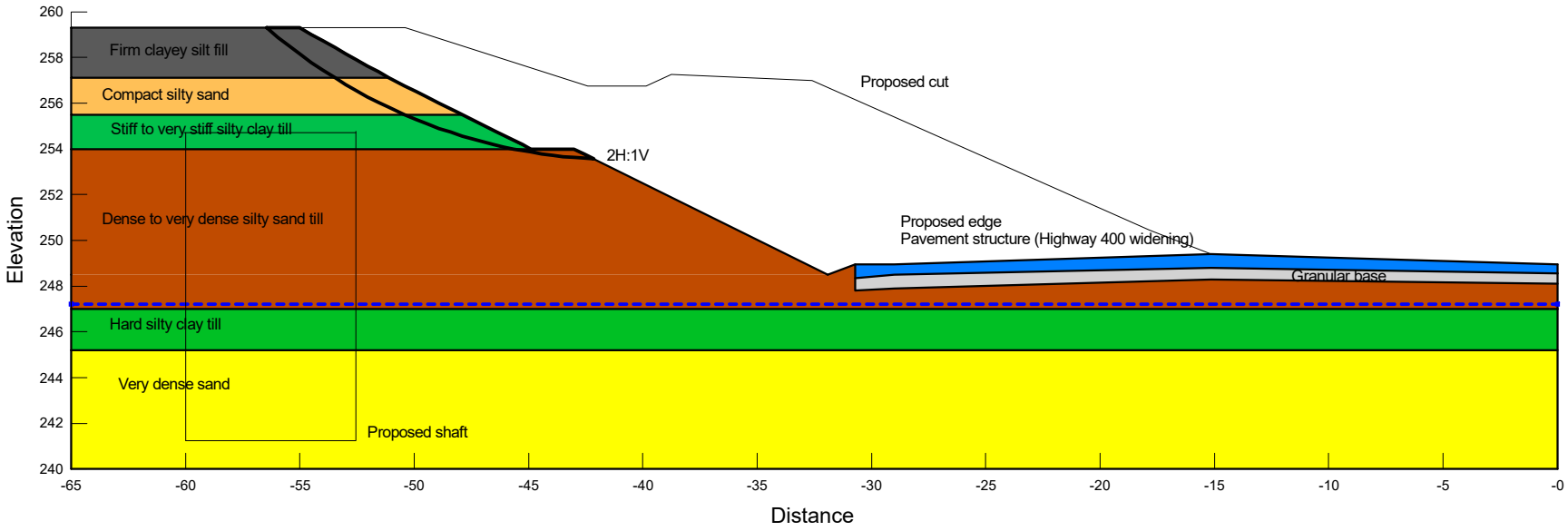
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Hwy 400 and Sunnidale Rd. Underpass
Approx. Height 10.8 m
Approx. Station 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G12



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piez Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

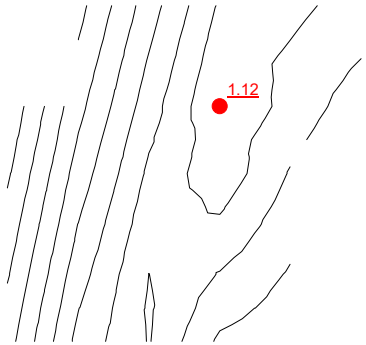
Analysis
Drained Analysis - NW side - Upper Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,06:47:03 AM	1:300

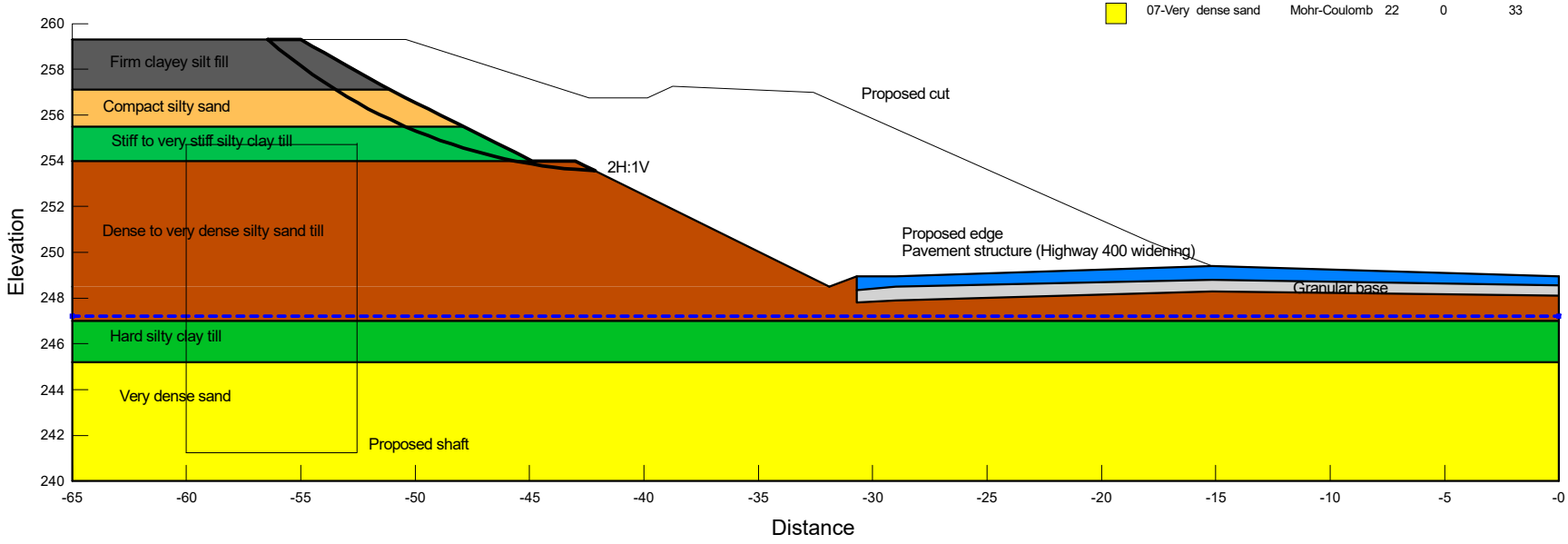
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Northwest side of Hwy 400 and Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G13



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometr Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

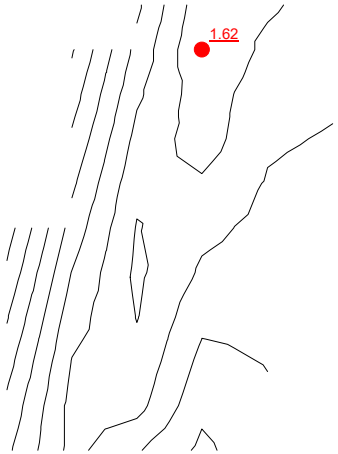
Analysis
Seismic Analysis - NW side - Upper Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-05,06:32:24 AM	1:300

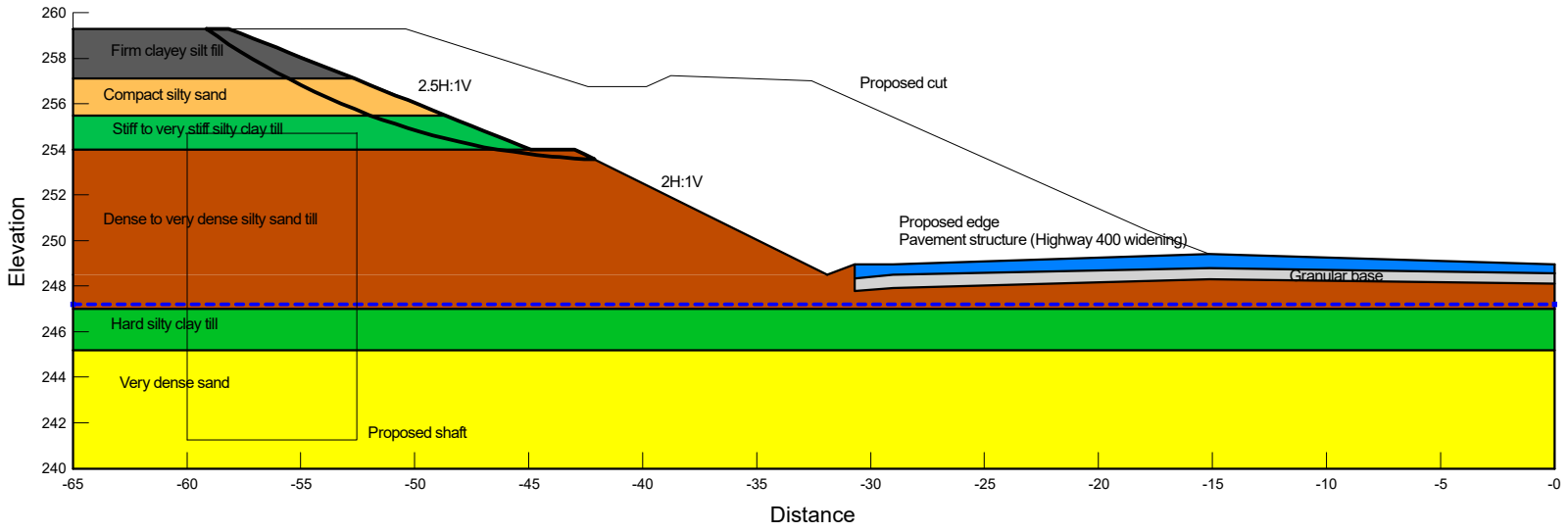
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Northwest side of Hwy 400 and Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G14



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1



THURBER

Project
22424- Hwy 400 SBL & Sunnidale Rd - Deep Cuts

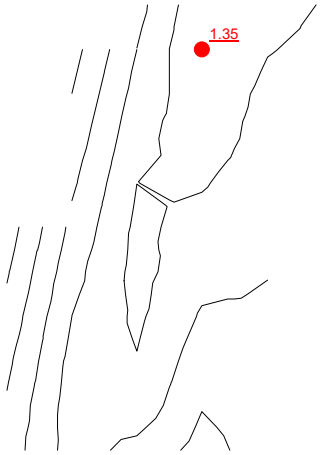
Analysis
Drained Analysis - NW side - Upper Slope 2.5H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-05,06:44:17 AM	1:325

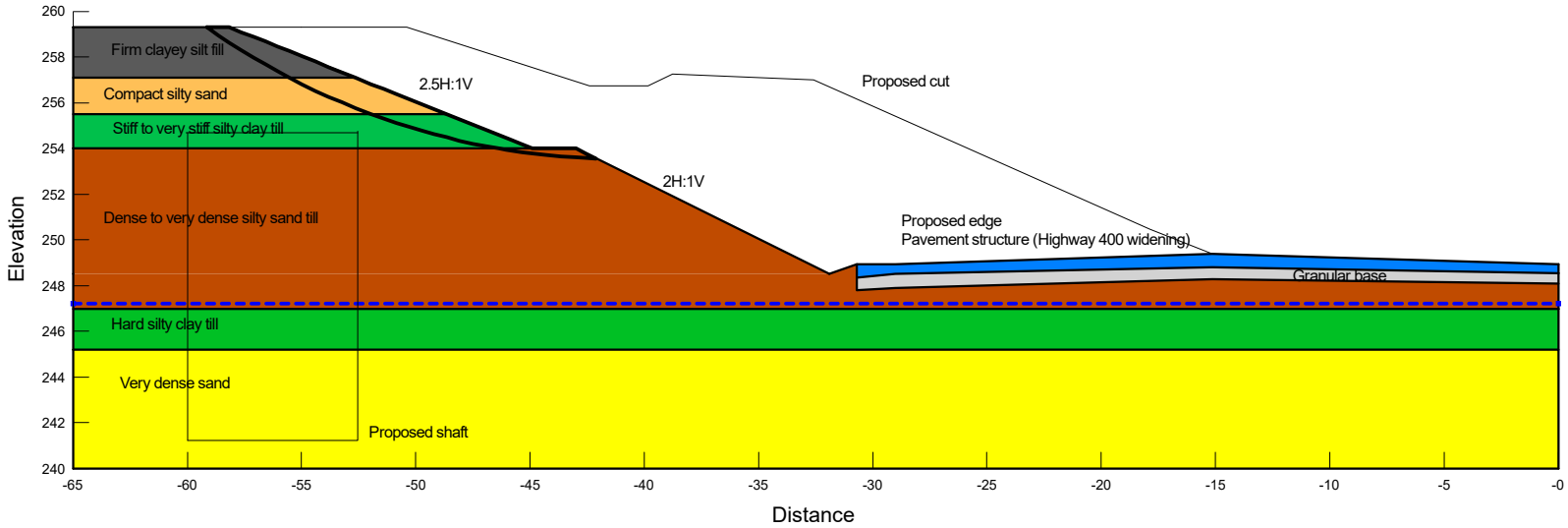
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Northwest side of Highway 400 & Sunnidale underpass
Approx. Height 10.8 m
Approx. 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G15



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1



THURBER

Project
22424-Hwy 400 SBL & Sunnidale Rd - Deep Cuts

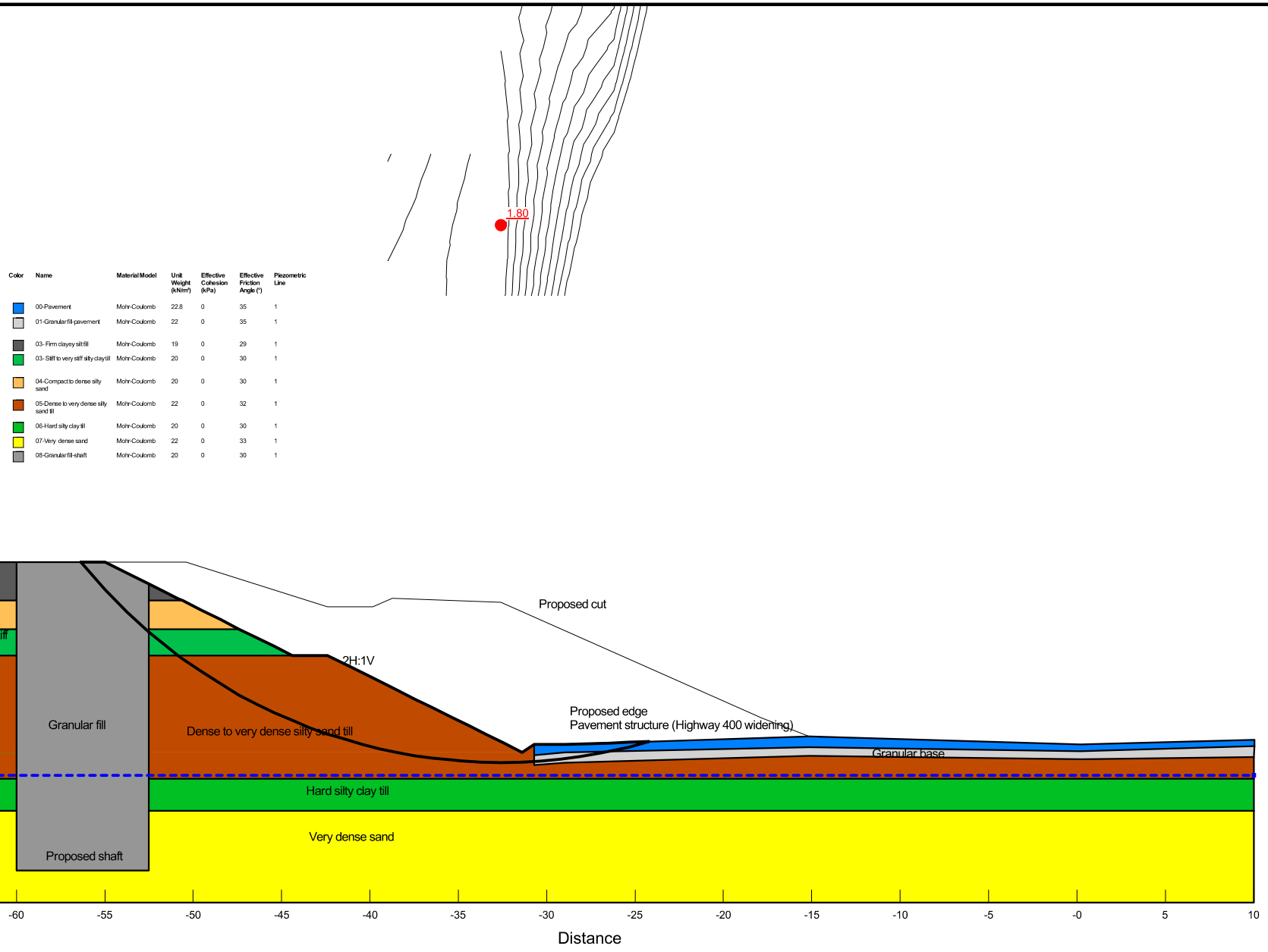
Analysis
Seismic Analysis - NW side - Upper Slope 2.5H:1V

Seismic Coefficient	Last Run	Scale
H: 0.065g, V: 0g	2021-03-05,06:52:22 AM	1:325

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments: Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station 12+685
Method: Morgenstern-Price, Half-Sine

GWL- Elevation 247.2

Figure G16



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

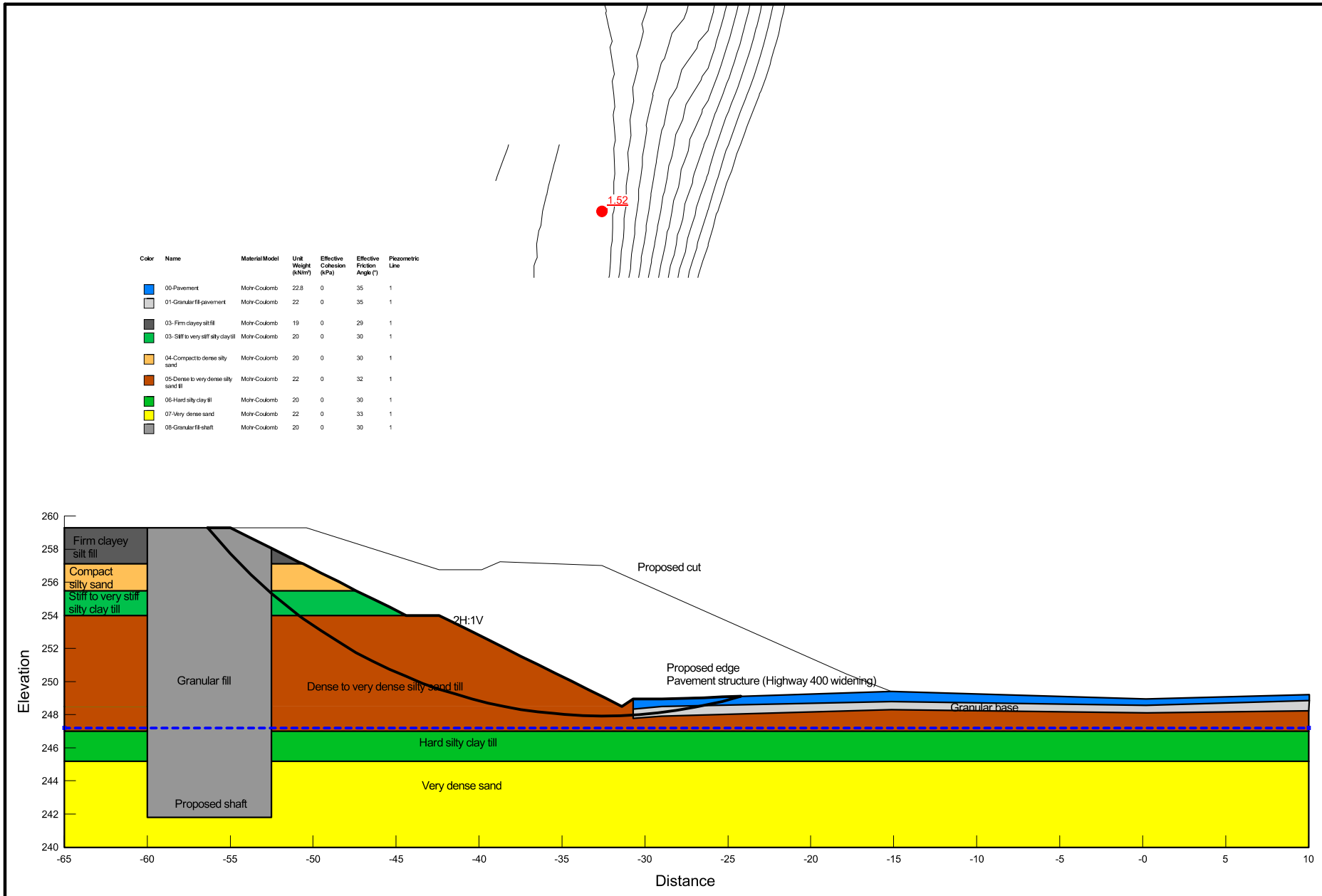
Analysis
Drained Analysis - NW side

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-18,05:11:00 PM	1:325

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 247.2

Figure G17



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

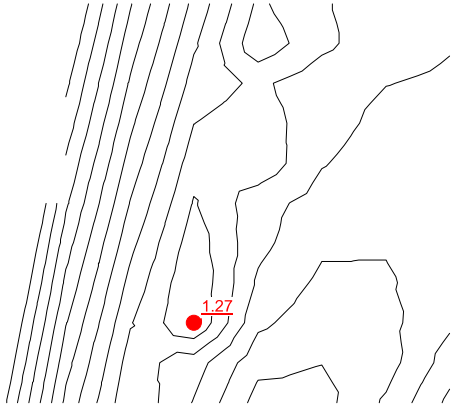
Analysis
Seismic Analysis - NW side- Upper Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-18,05:12:11 PM	1:325

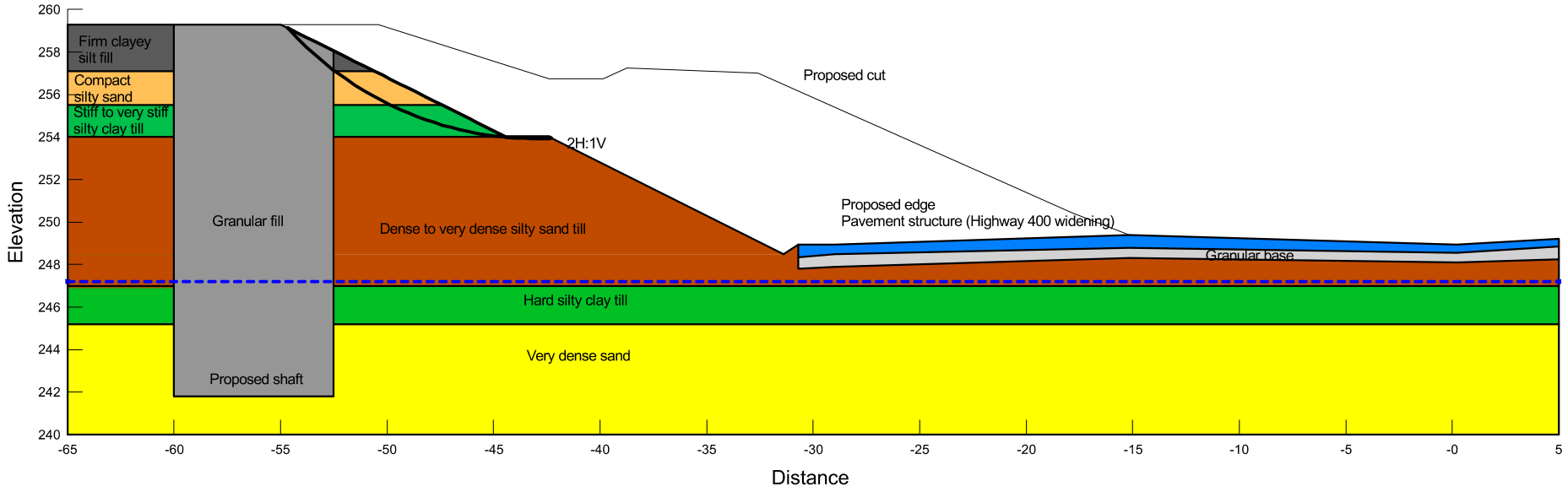
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 247.2

Figure G18



Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill-pavement	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1
	08-Granular fill-shaft	Mohr-Coulomb	20	0	30	1



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

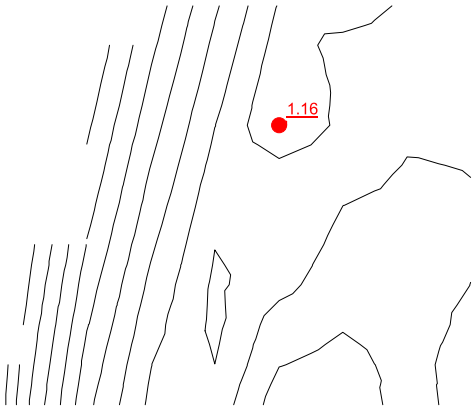
Analysis
Drained Analysis - NW side- Upper Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-03-18,05:13:17 PM	1:300

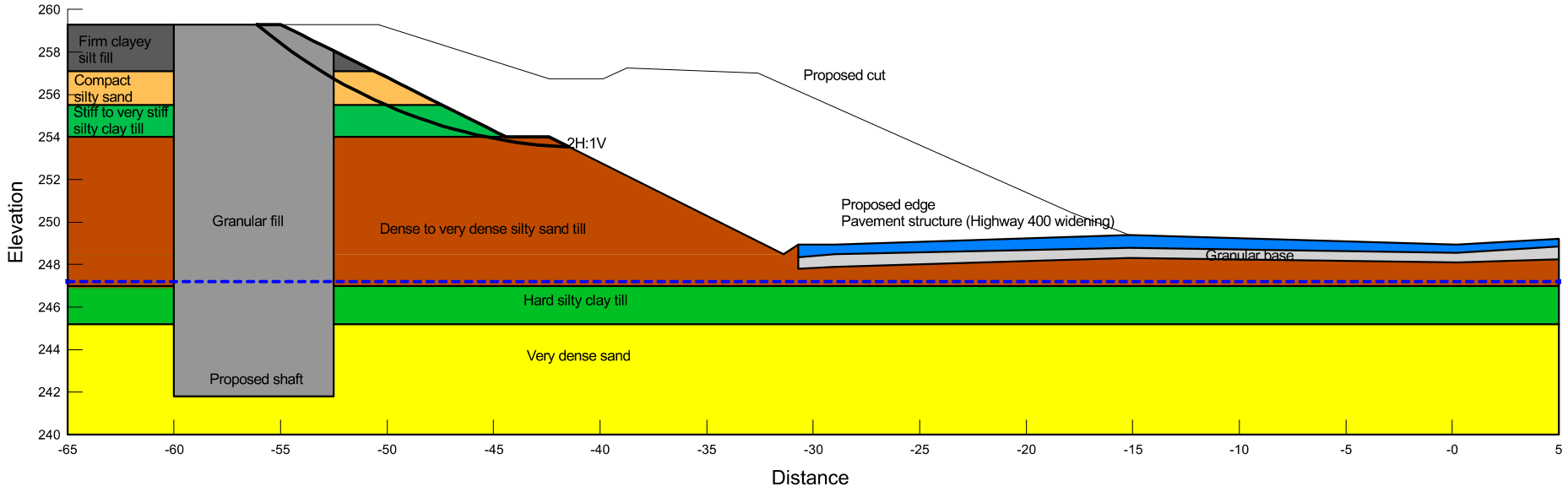
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 247.2

Figure G19



Color	Name	Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill-pavement	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1
	08-Granular fill-shaft	Mohr-Coulomb	20	0	30	1



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

Analysis
Seismic Analysis - NW side- Upper Slope 2H:1V

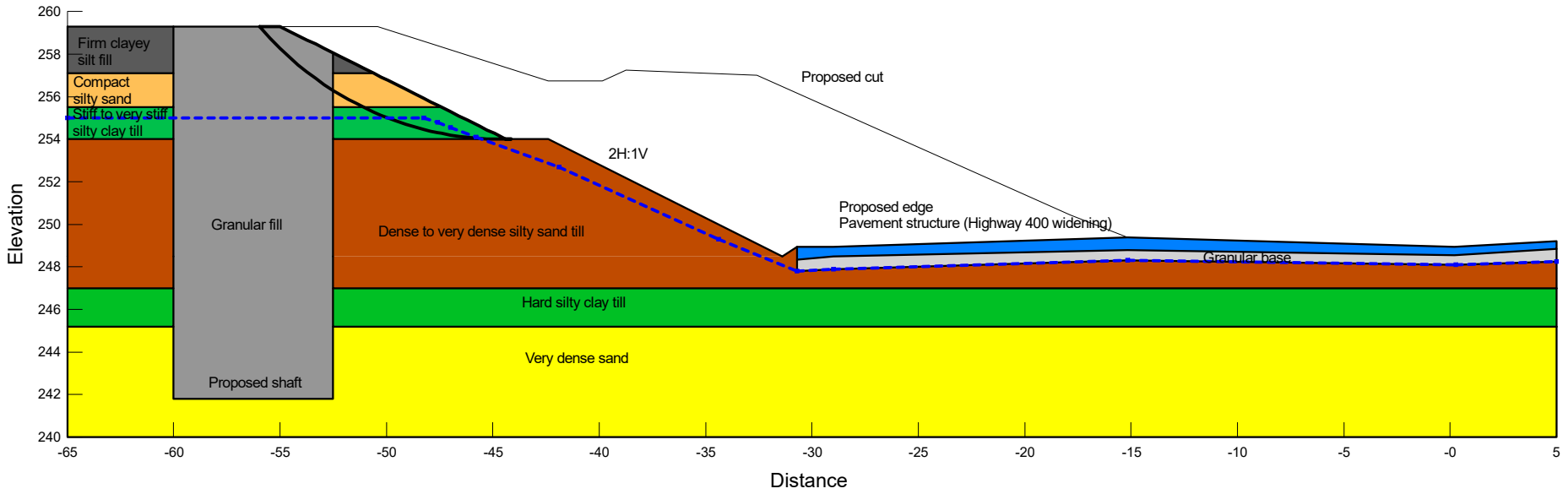
Seismic Coefficient	Last Run	Scale
H: 0.064g, V: 0g	2021-03-18,05:14:42 PM	1:300

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 247.2

Figure G20

Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill-pavement	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1
	08-Granular fill-shaft	Mohr-Coulomb	20	0	30	1



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

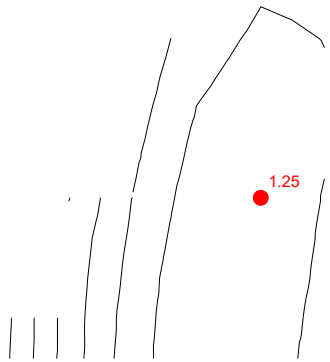
Analysis
Drained Analysis - NW side-Upper Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-10-14,03:39:14 PM	1:300

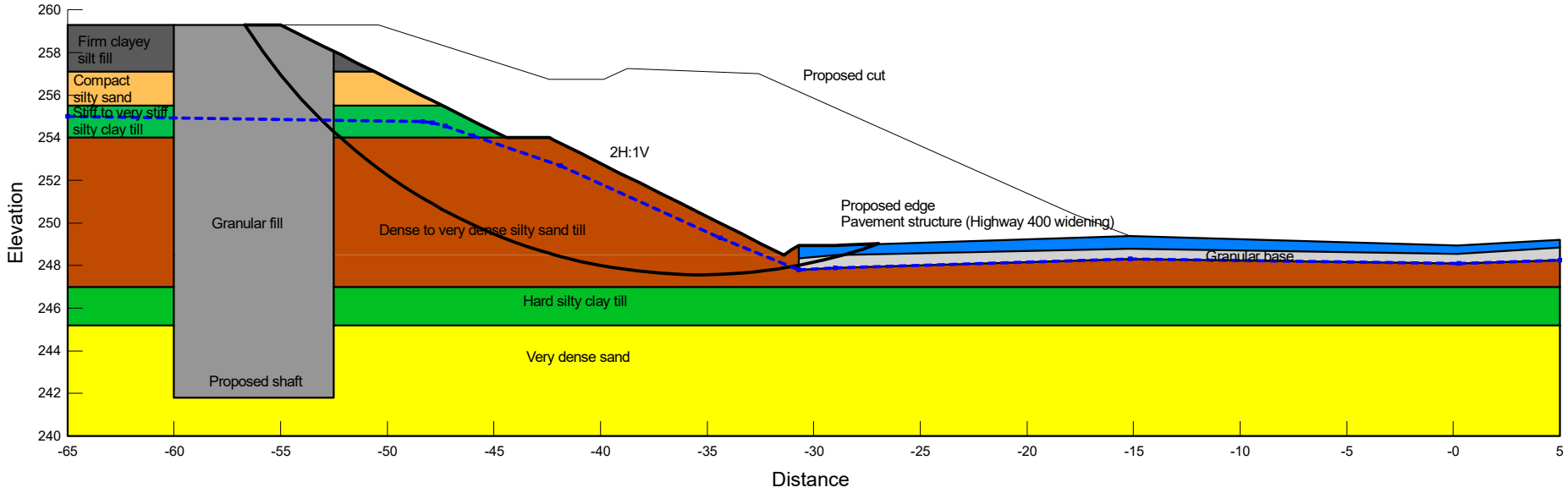
Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 255.0

Figure G21



Color	Name	Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Line
	00-Pavement	Mohr-Coulomb	22.8	0	35	1
	01-Granular fill-pavement	Mohr-Coulomb	22	0	35	1
	03- Firm clayey silt fill	Mohr-Coulomb	19	0	29	1
	03- Stiff to very stiff silty clay till	Mohr-Coulomb	20	0	30	1
	04-Compact to dense silty sand	Mohr-Coulomb	20	0	30	1
	05-Dense to very dense silty sand till	Mohr-Coulomb	22	0	32	1
	06-Hard silty clay till	Mohr-Coulomb	20	0	30	1
	07-Very dense sand	Mohr-Coulomb	22	0	33	1
	08-Granular fill-shaft	Mohr-Coulomb	20	0	30	1



THURBER

Project
22424- Hwy 400 S BL & Sunnidale Rd - Deep cuts

Analysis
Drained Analysis - NW side- Slope 2H:1V

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	2021-10-14,02:26:55 PM	1:300

Additional Details
Name: Hwy 400 & Sunnidale Rd. - SBL Deep Cuts
Comments:Northwest side of Highway 400 & Sunnidale Underpass
Approx. Height 10.8 m
Approx. Station12+685
Method: Morgenstern-Price, Half-Sine

GWL- 255.0

Figure G22

THURBER

Appendix H

List of Special Provisions

And

Suggested Text for NSSP

THURBER

1. List of Special Provisions Referenced in this Report

-	OPSS.PROV 517	Construction specification for dewatering
-	SP 517F01	Amendment to OPSS 517
-	OPSS PROV 539	Construction specification for temporary protection systems
-	OPSS PROV 804	Construction specification for seed and cover
-	OPSS PROV 902	Construction specification for excavating and backfilling – Structures
-	OPSD 200.20	Earth/Shale Grading

2. Suggested Text for NSSP on Groundwater Control

The deep cuts are expected above the groundwater level. However, permeable soils are present at this site. Water inflow/seepage should be anticipated from the embankment fill and underlying native sands and silts, and surface runoff and precipitation will accumulate within the excavation. Groundwater control measures such as perimeter ditches and pumping from filtered sumps will need to be employed to remove any accumulation of water from the excavation base.

At the proposed east and west shafts, excavation will extend below the groundwater level. Excavation into the wet cohesionless soils below the water level will encounter sloughing of unsupported excavation sidewalls, caving and subgrade loosening/softening. The Contractor must implement effective dewatering measures during construction and prior to excavating below the water level. Effective dewatering shall be designed and provided by the Contractor. A combination of interlocking sheetpiles , surface water diversion, vacuum well-points where required, and pumping from filtered sumps may be warranted. The dewatering system must remain operational and effective until the shaft is constructed.

Filtered sumps must be designed properly so that construction drainage water containing eroded soil and fines do not flow onto the existing roadways. It is also important to minimize disturbance of the exposed sand fill surfaces by limiting construction traffic.

The Contractor shall be responsible to retain a dewatering specialist/consultant for designing, installing and operating any dewatering / groundwater control systems that may be required as outlined above.

3. Suggested text for a NSSP on “Excavation within the Glacial Tills”

The Contractor is alerted that there are risks of encountering cobbles and boulders within the glacial tills, and as such, the Contractor shall be equipped to handle, penetrate and/or remove such obstructions during earth cut excavations.