Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
SLOPE STABILITY & STREAMBANK EROSION STUDY
900 MISSISSAUGA HEIGHTS DRIVE
MISSISSAUGA, ONTARIO

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Distribution

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1 INTRODUCTION

Terraprobe Inc. (Terraprobe) was retained by Ms. Jenny Chau c/o Mr. Norman Lee to conduct a geotechnical slope stability and streambank erosion study for the valley slope associated with the Credit River watershed situated on the east and south sides of the property at 900 Mississauga Heights Drive, in the City of Mississauga, Ontario.

This report encompasses the results of the slope stability analysis and borehole investigation carried out for the subject slope to determine the prevailing subsurface soil and ground water conditions, a detailed visual slope inspection to review the existing slope conditions and the results of a site specific slope stability and streambank erosion study conducted for the valley slope situated on east and south sides of the property to assess its long-term stability and streambank erosion risks. Based on the results of review and analysis, this report provides the Long-Term Stable Slope Crest (LTSSC) location to help facilitate the establishment of the development limit in the areas adjacent to the valley slope.

2 SITE AND PROJECT DESCRIPTION

The subject site is located in the southeast quadrant of the intersection of Dundas Street and Mavis Road, in the City of Mississauga. The municipal address of the property is 900 Mississauga Heights Drive, Mississauga. The general location of the site is shown on Figure 1.

The property is currently occupied by a one to two-storey residential dwelling (with a basement) with associated wooden decks, a detached garage, an in-ground swimming pool and a pool house, a patio, paved driveway/access routes, a tennis court and landscaping areas. The property at the north and east sides abuts a valley slope associated with the Credit River.

A drainage swale is situated at the toe of the north-easterly valley slope. The swale is about 1 to 3m wide with its base and banks lined with field stone gabion at some locations. The southerly valley slope position abuts a golf course (Mississauga Golf and Country Club). An asphalt trail is situated near the slope toe. The Credit River is located at a distance of greater than 15 m away from the southerly valley toe.

The valley slope within the study area is about 4 to 23 m high with inclination ranging from about 1.3 to 3.8 horizontal to 1.0 vertical. The southerly slope extending from the backyard and the portion of easterly slope approaching the dwelling are much higher and steeper than other portion. The slope is generally well vegetated with saplings, young and mature trees.

It is proposed to demolish the existing dwelling and associated structures to facilitate redevelopment of the property consisting of the severance and creation of eight (8) residential lots. Therefore, a site-specific slope stability and streambank erosion study is required to delineate the long-term stable slope crest location to help establish development limits in the areas abutting the valley slope.

3 INVESTIGATION PROCEDURE

The field investigation was conducted on February 1, 2018 and consisted of advancing a total of four (4) exploratory boreholes extending to about 4.6 m depth below grade. A significant portion of the tableland along the slope crest is densely vegetated with trees and not accessible to the drill rig, therefore the boreholes were advanced near the slope crest treeline (as close as possible to the slope crest), to obtain stratigraphic information comprising the subject slope. The approximate locations of the boreholes are shown on Figure 2.

The boreholes were drilled by a specialist drilling contractor using a track-mounted drill rig power auger. The borings were advanced using continuous flight solid stem augers, and were sampled at 0.75 m and 1.5 m intervals with a conventional 50 mm diameter split barrel samplers when the Standard Penetration Test (SPT) was carried out (ASTM D1586). The field work (drilling, sampling and testing) was observed and recorded by a member of our field engineering staff, who logged the borings and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into clean plastic jars, and transported to our geotechnical testing laboratory for detailed inspection and testing. The samples were examined (tactile) in detail by a geotechnical engineer, and classified according to visual and index properties. Laboratory tests consisted of water content determination on all samples; and a Sieve and Hydrometer analysis and Atterberg Limits tests on two (2) selected native soil samples (Borehole 1, Sample 3 and Borehole 3, Sample 4). The geotechnical laboratory testing results are plotted on the enclosed Borehole Logs at respective sampling depths, and the results of the Sieve and Hydrometer Analysis and Atterberg Limits tests are appended and summarized in section 4.5 of this report.

Standpipe type piezometers were installed in Boreholes 1, 2 and 4 to facilitate ground water level measurement. The standpipe comprised a 25 mm diameter PVC tubing, fitted with a sand filter and bentonite seal as shown on the accompanying Borehole Logs. Water levels were monitored in the open boreholes upon completion of drilling, and in the standpipe piezometers on February 9 and May 1, 2018. The results of the ground water monitoring are summarized in Section 4.6 of this report.

The borehole ground surface elevations were surveyed by Terraprobe using a Trimble R10 GNSS System. The Trimble R10 system uses the Global Navigation Satellite System and the Can-Net reference system to determine target location and elevation. The Trimble R10 system is reported to have an accuracy of up to 10 mm horizontally and up to 30 mm vertically.

It is should be noted that the elevations provided on the Borehole Log are approximate, for the purpose of relating soil stratigraphy and should not be used or relied on for other purposes.

4 SUBSURFACE CONDITIONS

The specific soil stratigraphy encountered at each borehole location is detailed on the enclosed Borehole Logs, with a brief summary of the general subsurface soil conditions provided below. This summary is intended to correlate this information to assist in the interpretation of the subsurface conditions encountered at the site.

It should be noted that the subsurface conditions are confirmed at the borehole locations only, and may vary between and beyond the borehole locations. The boundaries between the various strata as shown on the logs represent an inferred transition between the various strata, rather than a precise plane of geologic change.

4.1 Topsoil

A topsoil layer was encountered at the ground surface at each borehole location and ranged in thickness from about 100 to 150 mm.

The above topsoil thicknesses were measured from the borehole drilling and are approximate; and not adequate to estimate topsoil quantity and costs. We recommend that a shallow test pit investigation be carried out to determine a precise topsoil thickness across the site for quantity estimation and costing purposes, if required.

4.2 Earth Fill

Earth fill materials, primarily consisting of sandy silt to silty sand, with trace amounts of clay, gravel and organics was encountered beneath the surficial topsoil layer in each borehole and extended to depths of about 0.8 m (Borehole 2, Elev. 105.8 ± m; and Borehole 3, Elev. 105.1 ± m) to 2.3 m (Borehole 4, Elev. 101.2 ± m) below grade.

Standard Penetration Test (N-Values) obtained from the earth fill zone ranged from 5 to 11 blows per 300 mm of penetration, indicating a loose to compact relative density. The measured moisture contents of the earth fill samples ranged from 10 to 19 percent by mass, indicating a typically moist condition.

4.3 Clayey Silt Till

Undisturbed native clayey silt till deposit with trace to some sand gravel was encountered beneath the earth fill zone in each borehole and extended to depths of about 3 m (Borehole 1, Elev. 104.1 ± m; Borehole 2, Elev. 103.6 ± m; and Borehole 3, Elev. 102.9 ± m) to 4.6 m (Borehole 4, Elev. 98.9 ± m) below grade.

The N-values obtained from the undisturbed clayey silt till deposits ranged from 30 to 72 blows per 300mm of penetration to 50 blows per 125 to 150 mm of penetration, indicating a very stiff to hard (typically hard) consistency. The in-situ moisture contents of the undisturbed glacial till samples ranged from 10 to 17 percent by mass, indicating a typically moist condition.

It should be noted that the glacial till deposit may contain larger size particles (cobbles and boulders) that are not specifically identified in the boreholes. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples for the particles of this size.

4.4 Inferred Bedrock

The glacial till deposits graded into till-shale complex/weathered shale (inferred Bedrock of Georgian Bay Formation Formation) in each borehole at depths varying from about 3 m (Borehole 1, Elev. 104.1 ± m; Borehole 2, Elev. 103.6 ± m; and Borehole 3, Elev. 102.9 ± m) to about 4.6 m (Borehole 4, Elev. 98.9 ± m) below grade. Till-shale complex/weathered shale extended to the full depth of investigation.

The inferred bedrock beneath the site is expected to be of the Georgian Bay Formation, which is a deposit predominantly comprising thin to medium bedded grey shale of Ordovician age. The shale contains interbedded grey calcareous shale, limestone/dolostone and calcareous sandstone (conventionally grouped together as “limestone”) which are discontinuous and nominally 25 to 125 mm thick.

The augered borehole method used at this site is conventionally accepted investigative practice. However, the interval sampling method does not define the bedrock surface with precision, particularly where the surface of the rock is weathered, weaker and easily penetrated by auger. The auger refusal is generally indicative of a presence of a relatively less weathered/sound shale and/or limestone/dolostone layers. It should be noted that confirmation and characterization of the bedrock through rock coring was not included in our scope of work. Therefore, the bedrock surface elevations at the borehole locations, as noted on the borehole logs, could not be confirmed, and were inferred from the borehole augering, auger grinding, split barrel sampler refusal and bouncing. Auger grinding or sampler refusal in this case could either be inferred as bedrock or could be due to the presence of boulders/obstruction/limestone slabs which may be present within the overburden, therefore actual bedrock surface elevations may vary from the inferred elevations noted on the borehole logs and provided here. It must be noted that inference of bedrock level based on auger grinding and/or sampler refusal does not provide bedrock level accurately. Any variation in the design bedrock level and actual bedrock level may result in cost implications and project schedule delays. If an exact delineation of the bedrock and surface elevation and bedrock characterization is required then consideration should be given to bedrock coring.

4.5 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of natural water content determination for all samples, while Sieve and Hydrometer analysis were conducted on selected soil samples. The test results are plotted on the enclosed Borehole Logs at respective sampling depths. The results (graphs) of the Sieve and Hydrometer (grain size) analysis are appended and a summary of these test results is presented as follows:

Borehole No. Sample No.	Sampling Depth below Grade (m)	Percentage (by mass)				Descriptions (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 1, Sample 3	1.8	2	8	57	33	CLAYEY SILT trace sand, trace gravel
Borehole 3, Sample 4	2.4	18	18	47	17	SILT some clay, some sand, some gravel

Atterberg Limits Tests were also carried out on the above soil samples. The results were plotted on A-Line Graph (refer to enclosed Figure, Atterberg Limits Test Results) and summarized as follows:

Borehole No. Sample No.	Sampling Depth below Grade (m)	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)	Natural Moisture Content (%)	Plasticity
Borehole 1, Sample 3	1.8	40	23	17	14	Medium Plastic
Borehole 3, Sample 4	2.4	31	20	11	10	Slightly Plastic

4.6 Ground Water

Observations pertaining to the depth of water level and caving were made in the open boreholes immediately after completion of drilling, and are noted on the enclosed Borehole Logs. Stabilized ground water levels were measured on February 9 and May 1, 2018 in the standpipe piezometers installed in Boreholes 1, 2 and 4. The water levels measured in the open boreholes during the field investigation and in the standpipe piezometers during our subsequent site visits, are summarized below:

Borehole No.	Depth of Boring below Grade	Depth to Cave below Grade	Water Level Depth/Elevation at the Time of Drilling	Water Levels Depth/Elevation in Piezometers	
				February 9, 2018	May 1, 2018
Borehole 1	4.6 m	Open	Dry	4.2 m / 102.9 m	2.1 m / 105.0 m
Borehole 2	4.6 m	Open	Dry	4.3 m / 102.4 m	2.2 m / 104.4 m
Borehole 3	4.6 m	Open	Dry	Piezometer not installed	Piezometer not installed
Borehole 4	4.6 m	Open	Dry	4.4 m / 99.1 m	3.8 m / 99.7 m

The water levels noted above may fluctuate seasonally depending upon the precipitation and surface runoff. Water level measurements taken in the piezometers in the month of February indicate the normal and long-term ground water levels, while the water level readings collected in May represent temporary elevated ground water levels (spring thaw conditions)

5 DISCUSSIONS AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for use of the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards and guidelines of practice. If there are any changes to the site development features or there is any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

The easterly and southerly portions of the property abut Credit River valley land, regulated by Credit Valley Conservation (CVC) Authority. Therefore, due to proximity of the valley slope, a slope stability and streambank erosion risk assessment is required to delineate the Long-Term Stable Slope Crest (LTSSC) location to help establish the extent of erosion hazard zone for the proposed development.

5.1 Slope Inspection and Mapping

A detailed visual inspection of the slope area was conducted on January 24, 2018. General information pertaining to the existing slope features such as slope profile, slope drainage, vegetation cover and slope slide features, were obtained during this inspection. A brief summary of the results of the visual inspection is presented below. The general locations of the photographs taken are shown on the Borehole Location and Site Features Plan in Figure 2. The site photographs and descriptions are provided in Appendix C.

The property is currently occupied by a one to two storey residential dwelling (with a basement) associated wooden decks, a detached garage, an in-ground swimming pool with a pool house, paved driveway/access routes, a tennis court and, landscaping area. The tableland portion of the property is relatively flat and gently slopes towards the valley slope. The tableland approaching the slope crest is densely vegetated with trees. The valley slope abuts the southerly and easterly tableland of the project site, and therefore the valley slope is divided into two portions, i.e. southerly slope and easterly slope for the purpose of slope description.

The southerly valley slope abuts the Mississauga Golf and Country Club. An asphalt trail is situated near the slope toe separating the slope from the watercourse. The Credit River is located greater than 15 m away from the slope toe. The valley slope in this area (Section A-A') is about 19 to 23 m high with inclinations ranging from 1.3 to 1.5 horizontal to 1.0 vertical.

The easterly valley slope is about 3 m (westerly portion near Mississauga Heights Drive) and increases to about 19 m high as it extends in the southerly direction, with inclinations ranging from 1.4 to 3.8 horizontal to 1.0 vertical (Sections B-B', C-C', D-D', E-E' and F-F'). There is a drainage swale located at the slope toe before the slope rises again on the other side of this swale. The swale base and sides are lined with field stones and gabions (at some locations). The swale, at the time of our inspection appeared to be about 1 to 3 m wide with a shallow depth and minor water discharge.

The valley slope is generally vegetated with saplings, young and mature trees. The tree trunk growth is generally straight and upright. The slope does not exhibit any conspicuous signs of instability or erosion, and visually appears to be generally stable. There is no conspicuous sign of swale bank/slope toe erosion as the swale base and sides include a zone of field stone and/or gabion lining (at some locations).

5.2 Slope Stability Analysis

Boreholes 1 to 4 were advanced near the slope crest to obtain the subsurface soil and ground water information comprising the slope. The borehole data indicates that the valley slope consists of a surficial layer of the topsoil at ground surface and an earth fill zone extending to the depths of about 0.8 to 2.3 m below grade. The earth fill zone was underlain by undisturbed native clayey silt till deposit extending to the depths of about 3.0 to 4.6 m below grade, which graded into till-shale complex/weathered shale extending to the full depth of investigation.

The boreholes were dry and open upon the completion of drilling. The ground water level measurement taken in the piezometer installed in Borehole 1, 2 and 4 (on February 9 and May 1, 2018) indicated the ground water level ranged from about 2.1 to 4.4 m depth below grade.

Topographic information of the property and the slope (prepared by David B. Searles Surveying Ltd., OLS, Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, received on April 5, 2018) was provided by the client and is enclosed (Figure 2). Six (6) representative cross sections (Sections A-A', B-B', C-C', D-D', E-E' and F-F') were inferred from the topographic information and our field observations to prepare slope model for the long-term slope stability analysis. The cross sections were selected on the basis of the slope height and inclination to provide adequate site coverage and represent the critical slope conditions present within the study area. These sections included a portion of the tableland extending across the slope down to the slope toe and beyond. The locations of the slope cross sections are presented on Figure 2, and the details of the slope profiles on Figures 3A and 3B (see enclosed).

A detailed engineering analysis of slope stability was carried out for Sections A-A', B-B', C-C', D-D' and F-F' utilizing computer software SLIDE (version 7.0), developed by Rocscience Inc. The slope stability analysis is based on effective stress limit equilibrium method for analyzing slope stability using Morgenstern-Price, Bishop and Spencer methods. These methods of analysis allow the calculation of Factors of Safety for hypothetical or assumed failure surfaces through the slope. The analysis method is used to assess potential for movements of large masses (typically greater than 2 m thick) of soil over a specific failure surface which is often curved or circular. The analysis involves dividing the sliding mass into many thin slices and calculating the forces on each slice. The normal and shear forces acting on the sides and base of each slice are calculated. It is an iterative process that converges on a solution.

For a specific failure surface, the Factor of Safety is defined as the ratio of the available soil strength resisting movement, divided by the gravitational forces tending to cause movement. The Factor of Safety of 1.0 represents a "limiting equilibrium" condition where the slope is at a point of pending failure since the soil resistance is equal to forces tending to cause movement. It is usual to require a Factor of Safety of greater than one (1) to ensure slope stability. The typical Factor of Safety used for engineering design for slope stability ranges from 1.3 to 1.5 for structures situated close to the slope crest. The most common design guidelines, for “Active Land Use” are based on a 1.5 minimum Factor of Safety.

The analysis was carried out by preparing a model of the slope geometry and subsurface conditions; and analyzing numerous potential failure surfaces in search of the minimum or critical Factor of Safety for site-specific conditions. The pertinent data obtained from the topographic information, slope profile, slope mapping and the borehole information were input for the slope stability analysis. Many calculations were carried out to examine the Factors of Safety for potential failure surfaces. Based on the borehole results, and our previous investigations carried out in the area the following average soil properties were utilized for the soil strata in the slope stability analysis:

Stratum	Unit Weight kN/m^3	Angle of Internal Friction (degrees)	Cohesion (kPa)
Earth Fill	19.0	28	0
Clayey Silt Till	21.0	32	8
Shale Bedrock	26.0	NA*	NA*

*** Bedrock modeled as a non-penetrable material with respect to potential soil slope slides**

The above soil strength parameters are based on the effective stress analysis for long-term slope stability. It is noted that these soil properties are relatively conservative, and the site soils are actually stronger.

The soil stratigraphy as obtained from the site specific boreholes and ground water levels measured in the piezometers were incorporated into corresponding slope model section as follows:

Sections	Applicable Borehole	Applicable Ground Water Level
Sections A-A', B-B' and C-C'	Borehole 4	3.8 m/Elev. 99.7 m
Sections D-D'	Borehole 3	2.2 m/Elev. 104.4 m

Sections	Applicable Borehole	Applicable Ground Water Level
Sections E-E' and F-F'	Borehole 1	2.1 m/Elev. 105.0 m

Conservatively, the potential effect of pore pressure on the long-term stability of the site slope was also assessed by incorporating an assumed elevated ground water level (located within about 1 to 2 m of the ground surface) to simulate infrequent and elevated ground water level (temporary condition) due to the potential seasonal fluctuation in the ground water table.

Slope cross sections (Sections A-A', B-B', C-C', D-D' and F-F') representing the critical slope conditions for the existing condition were analyzed. The results of the slope stability analysis carried out are presented on the enclosed figures, and summarized as follows:

Sections	Average Slope Inclination	Minimum Factor of Safety for Potential Slope Slides	
		Normal Ground Water	Elevated Ground Water
Section A-A'	1.3 Horizontal : 1 Vertical	1.84	1.60
Section B-B'	1.4 Horizontal : 1 Vertical	3.33	2.89
Section C-C'	1.4 Horizontal : 1 Vertical	1.36	1.25
Section D-D'	1.7 Horizontal : 1 Vertical	3.24	3.11
Section F-F'	3.7 Horizontal : 1 Vertical	4.14	3.43

For active land development use, the MNR Policy Guidelines allow a minimum Factor of Safety of 1.3 to 1.5 for slope stability, as follows:

Type	Land-uses	Design Minimum Factor of Safety
A	PASSIVE: no buildings near slope; farm field, bush, forest, timberland, woods, wasteland, badlands, tundra	1.1
B	LIGHT: no habitable structures near slope; recreational parks, golf courses, buried small utilities, tile beds, barns, garages, swimming pools, sheds, satellite dishes, dog houses	1.20 to 1.30
C	ACTIVE: habitable or occupied structures near slopes; residential, commercial, and industrial buildings, retaining walls, storage/warehousing of non-hazardous substances	1.30 to 1.50
D	INFRASTRUCTURE and PUBLIC USE: public use structures and buildings (i.e. hospitals, schools, stadiums), cemeteries, bridges, high voltage power transmission lines, towers, storage/warehousing of hazardous materials, waste management areas	1.40 to 1.50

CVC *Slope Stability Definition & Determination Guideline* (Guideline) requires a minimum Factor of Safety of 1.5 for normal and 1.3 for the elevated temporary ground water condition.

The results of the analysis indicate that the existing slope has adequate Factor of Safety for both normal and elevated ground water conditions at Sections A-A', B-B', D-D' and F-F'. The relatively high Factors of Safety obtained for these Sections are representative of relatively than overburden thickness as most of the slope at these sections comprises shale bedrock. However, at Section C-C', the slope does not have adequate Factors of Safety for normal ground water condition and elevated ground water condition, as the inferred overburden at this location is about 5 m thick. Therefore, the slope at the Section C-C' is not considered to be stable in the long term in its current configuration.

The results of the slope stability analysis at Section C-C' indicate that slope stability failure would likely be limited within the earth fill zone under the current inclination, therefore a hypothetical slope profile of the earth fill zone with a flatter inclination of 2.5 horizontal to 1.0 vertical was analysed for both normal and elevated ground water conditions to determine the stable inclination units. A Factor of Safety of 1.5 for normal and 1.3 for temporary/elevated groundwater conditions. The detailed results of the analysis are presented in enclosed figures. The Factor of Safety under the normal ground and elevated ground water level conditions for the hypothetical slope surface are tabulated below:

Sections	**Hypothetical (Stable) Slope Inclination**	**Minimum Factor of Safety for Potential Slope Slides**	
		Normal Ground Water	**Elevated Ground Water**
Section C-C'	2.4 Horizontal : 1.0 Vertical (Earth Fill Zone)	1.50	1.32

Based on the slope stability analysis, an inclination of 2.5 horizontal to 1.0 vertical (or flatter) for the upper earth fill zone is required for the long-term stability at Section C-C' for the site slope.

5.3 Toe Erosion Allowance

In addition to a stability set-back, an erosion allowance is also recommended in areas where the watercourse position is within 15 m of the toe of the slope as per the *CVC Guideline*. The suggested design toe erosion allowance provided in the Guideline (where slope toe is located within 15m of the watercourse) is reproduced as follows:

Material at Chanel Bank or Bank Full/ Bank Condition	**Active Erosion of Bank**	**Erosion Currently not Evident**	**Existing Erosion Protection in Place and Maintained along Bank**
Limestone, Dolostone	2 m	1 m	0
Shale	5 m	2 m	0

Material at Chanel Bank or Bank Full/ Bank Condition	Active Erosion of Bank	Erosion Currently not Evident	Existing Erosion Protection in Place and Maintained along Bank
Cohesive Soils, Silty Clays, Clayey Silts	8 m	4 m	0
Cohesionless Soils, Silts, Sands	15 m	7 m	0

The above table provides recommended toe erosion allowance based on the watercourse characteristics, type and degree of slope toe erosion and the type of material comprising the slope toe.

As noted before, a relatively broad floodplain (the golf course) separates the southerly slope toe from Credit River (greater than 15 m). Therefore, a toe erosion allowance is not applicable for the southerly slope.

As noted before a drainage swale is located at the toe of the easterly slope before the slope rises again on the other side of the swale. The swale, at the time of inspection, appeared to be about 1 m to 3 m wide with about 0.2 to 0.4 m water depth. The swale base and sides include field stone lining as well as gabions as erosion protection measure. The borehole data indicate that the slope toe material is expected to consist of the shale bedrock. There is currently no evidence of active toe erosion, and therefore on the above considerations, a toe erosion allowance of 2 m was selected and applied at this site in conformance to the above *CVC Guideline* table.

5.4 Long Term Stable Slope Crest (LTSSC) Position

The result of the global stability analysis indicates the southerly slope (Section A-A') has adequate factor of safety against potential slope slides. The inclination of the slope in this area ranges from 1.3 to 3.8 horizontal to 1.0 vertical. The southerly slope predominantly consists of shale bedrock. The CVC Guideline recommends a stable slope inclination of 1.4 horizontal to 1 vertical for a shale slope without rock coring and characterization. Therefore, in conformance to the above, a stability setback of 1.4 horizontal to 1.0 vertical was applied to the slope at Section A-A'. As noted before, a toe erosion allowance is not applicable for this slope.

The result of the slope stability analysis indicates the easterly slope also has adequate Factors of Safety against potential slope slides and is thus stable except for Section C-C. A stability setback of 2.5 horizontal to 1.0 vertical was applied to the upper (fill portion of the) slope at Section C-C'. A toe erosion allowance of 2.0 m is applied to the easterly valley slope to account for potential toe erosion due to the presence of a drainage swale at the slope toe. The detailed results of the analysis are presented in Appendix D.

The location of the Long Term Stable Slope Crest (LTSSC) was determined based on the applicable stability and toe erosion setbacks for easterly slope in accordance with Long Term Stable Slope Crest

Model (Figure 4). The LTSSC location is shown on Figure 2 in the Plan. For planning purposes, the long term refers to a 100 year planning horizon.

5.5 Development Setback / Erosion Access Allowance

In addition to the stability setback and the toe erosion allowance, the MNR and CVC Guideline requires a Development Setback/Erosion Access Allowance to establish the Erosion Hazard Limit. The Erosion Hazard Limit consists of a combined setback based on the applicable stability, toe erosion and erosion access allowance. The policy guidelines require that the developments, dwellings, buildings or other structures should be further setback (erosion access allowance setback) from the greatest landward extent of the Physical Top of Bank, Staked Top of Bank and Long-Term Stable Slope Crest location. The erosion access allowance setback is usually required to facilitate access to the slope in case of an emergency/regular maintenance and to provide a buffer between the development and the valley system.

The erosion access setback requirements vary based on the policies and guidelines of individual authorities and site-specific conditions, and may vary, from 6 to 10 m based on MNR and individual Conservation Authority Guidelines. Structures may be allowed to be located closer if approved by applicable authorities and a qualified geotechnical engineer.

For new developments, the MNR Guidelines require a 6 m Erosion Access Allowance while CVC *Watershed Planning and Regulation Policies* (2010) require a 10 m setback. For existing developments and/or redevelopments, this allowance depends on several considerations including but not limited to the type and extent of existing development, existing and proposed land use, type of structure as well as site-specific and surrounding land developments.

5.6 Slope Protection and Maintenance Considerations

The following general slope maintenance as well as construction considerations and constraints are recommended to maintain and enhance the slope condition, and to help protect against surficial soil erosion, during the development phase as well as in the long-term horizon:

a. Site development and construction activities should be conducted in a manner which does not result in surface erosion of the slope. In particular, site grading and drainage should be designed to prevent direct concentrated or channelized surface runoff from flowing directly over the slope. Water drainage from down-spouts, sumps, road drainage, and the like should not be permitted to flow over the slope, but a minor sheet flow may be acceptable. In case, tableland/downspout drainage is designed to be drained towards the slope, and approved by regulatory agencies, such drainage should be contained in a drainage pipe to convey flow directly and safely to the bottom of the slope.

b. The configuration of the slope should not be altered without prior consultation with a geotechnical engineer and conservation authority approval. In particular, the slope should not be steepened and fill materials/stockpiles should not be placed on the slope or within about 5 m of the slope crest.

c. A silt fence must be erected prior to the commencement of the site works and maintained until the completion of work or as required by the applicable authorities.

d. All necessary approvals must be secured from applicable authorities prior to the commencement of the site works.

It is recommended that the final site grading plans be reviewed by Terraprobe to ensure that they are consistent with the above recommendations.

6 LIMITATIONS AND RISK

6.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained by Terraprobe.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

6.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

This report was prepared for the express use of Ms. Jenny Chau and her retained design consultants and is not for use by others. This report is copyright of Terraprobe Inc. and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc. and Ms. Jenny Chau, who are the authorized users.

It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

Yours truly,

Terraprobe Inc.

LICENSED PROFESSIONAL ENGINEER
L. ZHANG
100103585
2018-06-18
PROVINCE OF ONTARIO

Seth Zhang, M. Eng., M.Sc., P. Eng.
Associate

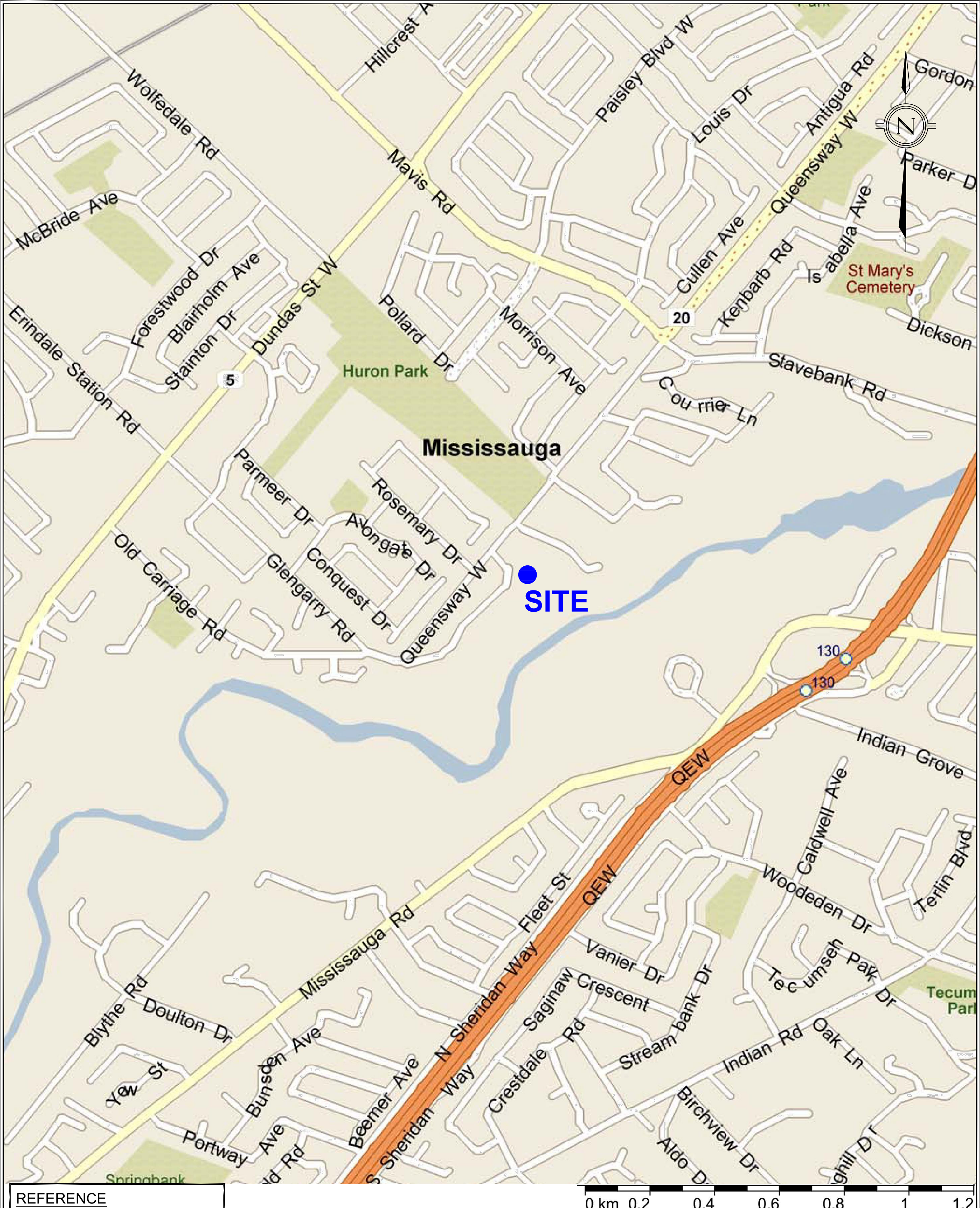
B. Singh, M.A.Sc., P. Eng.
Principal

ENCLOSURES

TERRAPROBE INC.

FIGURES

TERRAPROBE INC.



REFERENCE
Microsoft Streets & Trips 2012

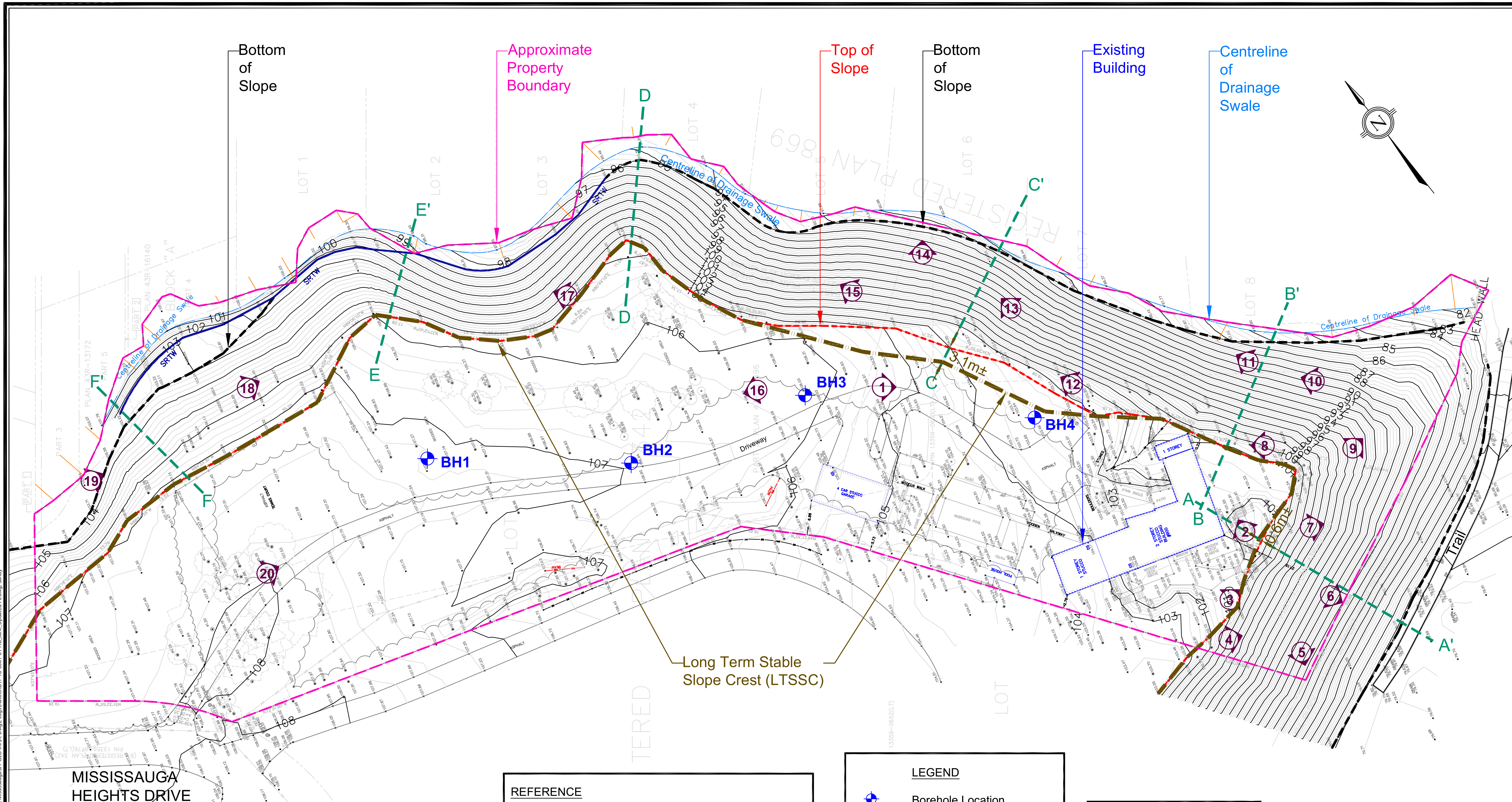
Terraprobe

11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: SITE LOCATION PLAN

File No. 1-18-0001-01

FIGURE : 1



REFERENCE

1. Topographic Plan
   Plan of Survey of Part of Lots 1 and 2 Registered Plan 342 City of Mississauga Regional Municipality of Peel
   File No.: 146-1-17, Drawing File: 146-1-17.dwg
   Dated: received April 5, 2018
   By: David B. Searles Surveying Ltd., OLS
2. Property Line Updated On Plan
   Digital file received June 13, 2018 from David B. Searles Surveying Ltd.

LEGEND

- Borehole Location
- Photo Location and Direction
- A-----A' Section Location

SCALE 1:750

10 8 6 4 2 0 10m

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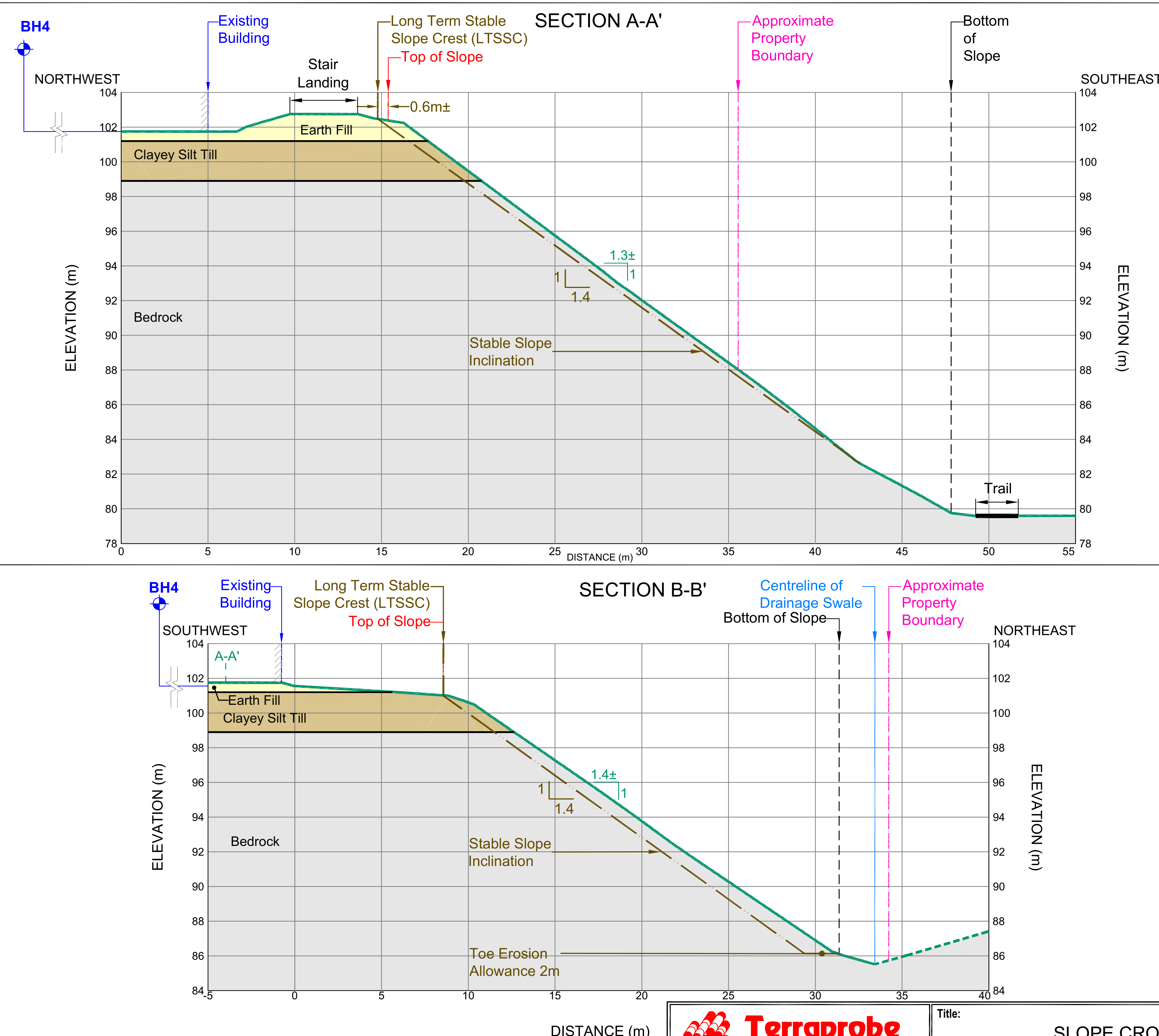
Tel: (905) 796-2650 Fax: (905) 796-2250

Title: BOREHOLE LOCATION AND SITE FEATURES PLAN

File No. 1-18-0001-01

FIGURE : 2



SCALE 1:250

2 1 0 5m

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Tel: (905) 796-2650 Fax: (905) 796-2250

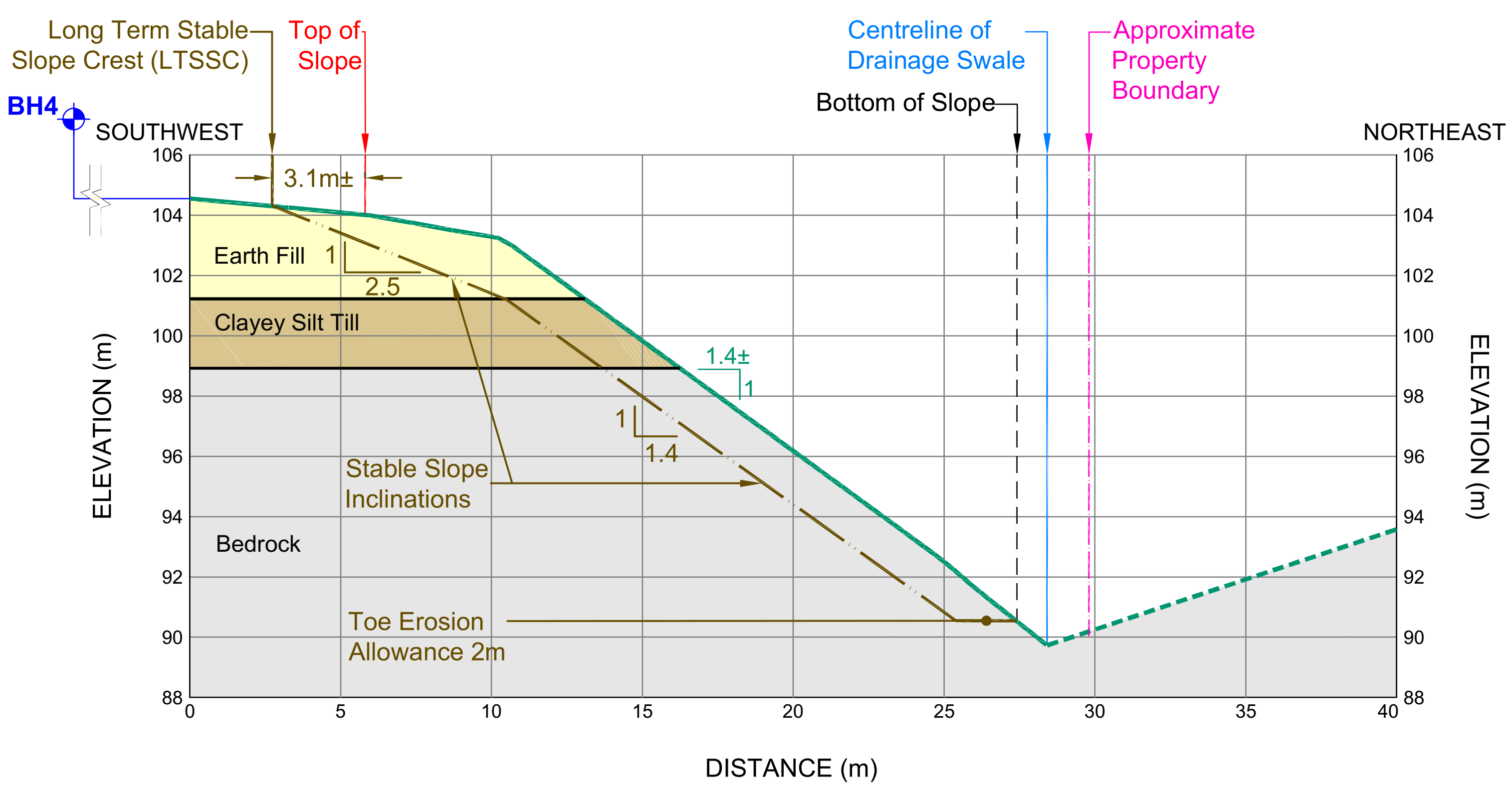
Title: SLOPE CROSS SECTIONS

File No. 1-18-0001-01

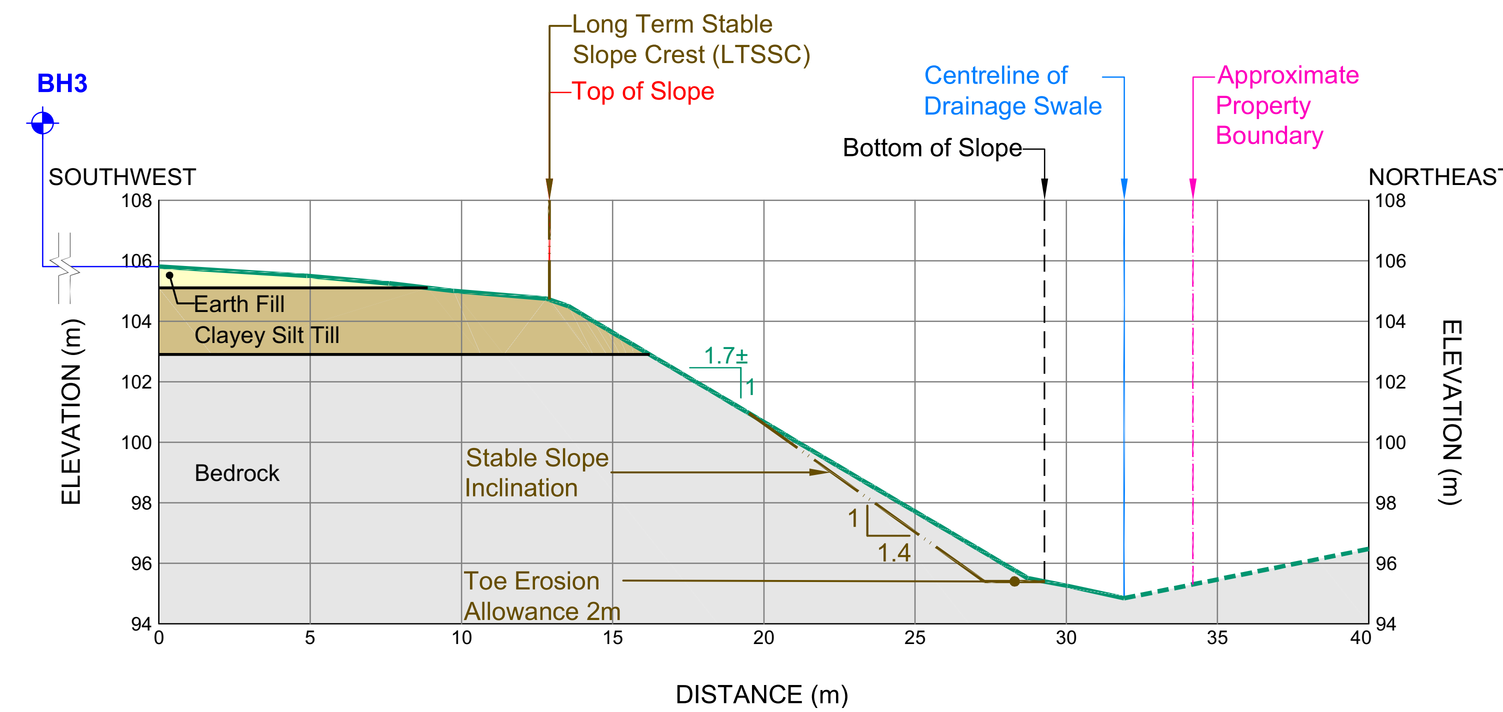
FIGURE : 3A

T:\1-Project Files\2018\1-18-0001 - 900 Mississauga Heights Dr, Mississauga\01-GEO Inv\A. Dwgs, Logs\AutoCAD\1-18-0001-01 FIG_June_Updated PL.dwg, Sandy

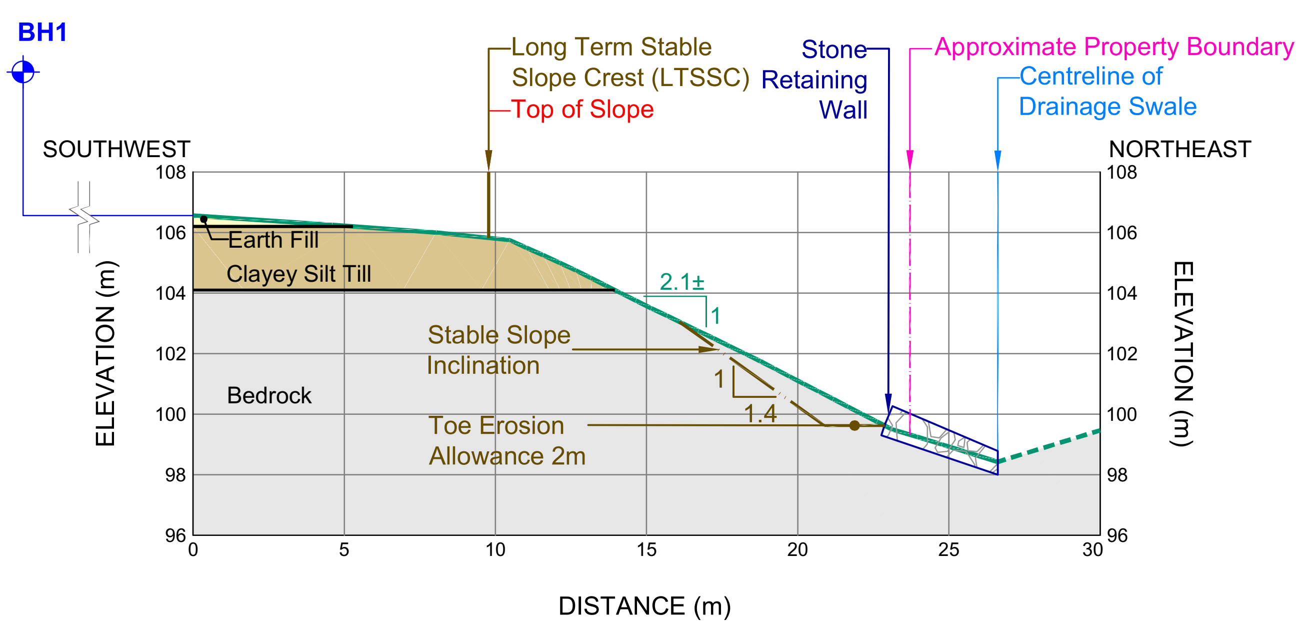
SECTION C-C'



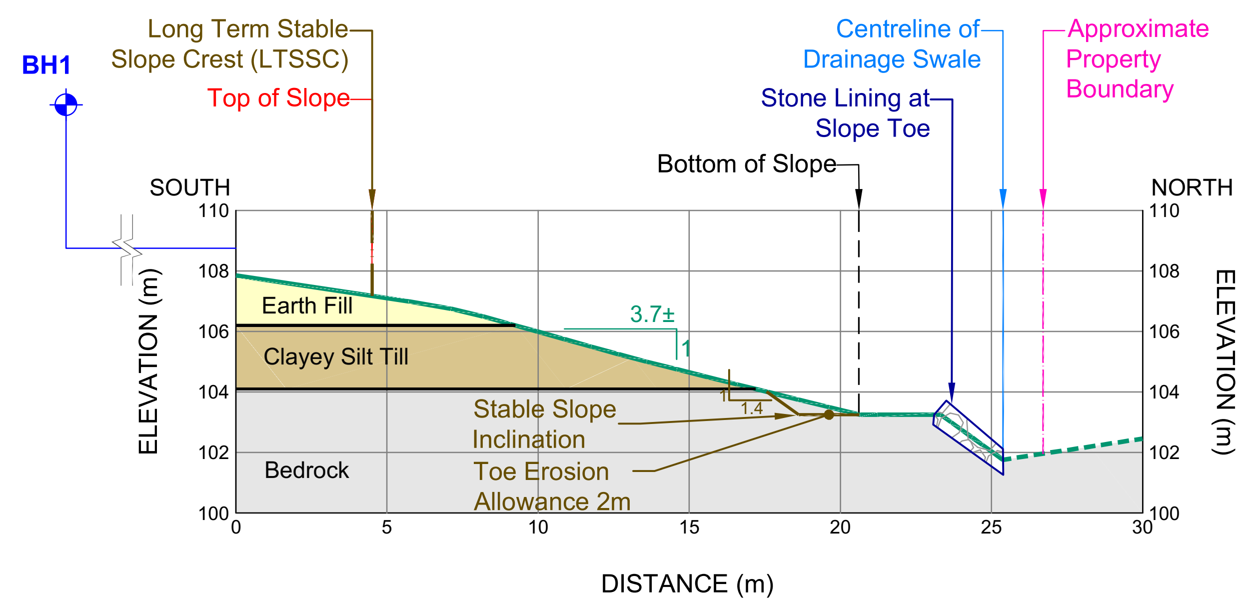
SECTION D-D'



SECTION E-E'



SECTION F-F'



SCALE 1:250

2 1 0 5m

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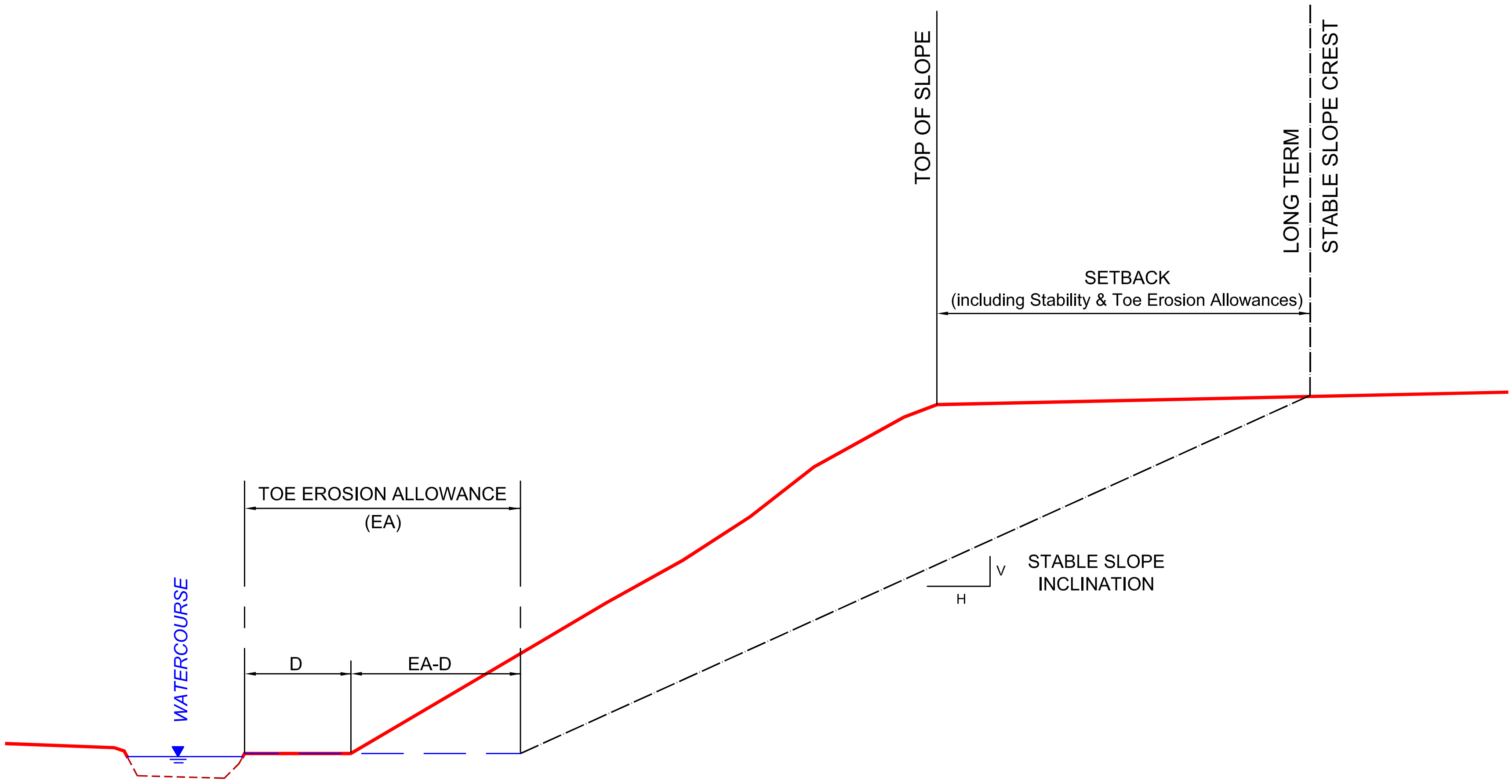
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:	FIGURE :
SLOPE CROSS SECTIONS	3B
File No. 1-18-0001-01	

T:\1-Project Files\2018\1-18-0001 - 900 Mississauga Heights Dr, Mississauga\01-GEO Inv\A. Dwgs, Logs\AutoCAD\1-18-0001-01 FIG_June_Updated PL.dwg, Sandy



LEGEND

D = Available Flood Plain Between Edge of Watercourse and Slope Toe

EA = Erosion Allowance

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Title:

LONG TERM STABLE SLOPE CREST MODEL

APPENDIX A

TERRAPROBE INC.

Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

AS	auger sample
CORE	cored sample
DP	direct push
FV	field vane
GS	grab sample
SS	split spoon
ST	shelby tube
WS	wash sample

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.)."

COHESIONLESS SOILS

Compactness	'N' value
very loose	< 4
loose	4 – 10
compact	10 – 30
dense	30 – 50
very dense	> 50

COHESIVE SOILS

Consistency	'N' value	Undrained Shear Strength (kPa)
very soft	< 2	< 12
soft	2 – 4	12 – 25
firm	4 – 8	25 – 50
stiff	8 – 15	50 – 100
very stiff	15 – 30	100 – 200
hard	> 30	> 200

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
silty	20 – 35
sand *and* silt	> 35

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
G_s	specific gravity
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index
c_v	coefficient of consolidation
m_v	coefficient of compressibility
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Damp	refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.
Moist	refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at or close to plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

LOG OF BOREHOLE 1

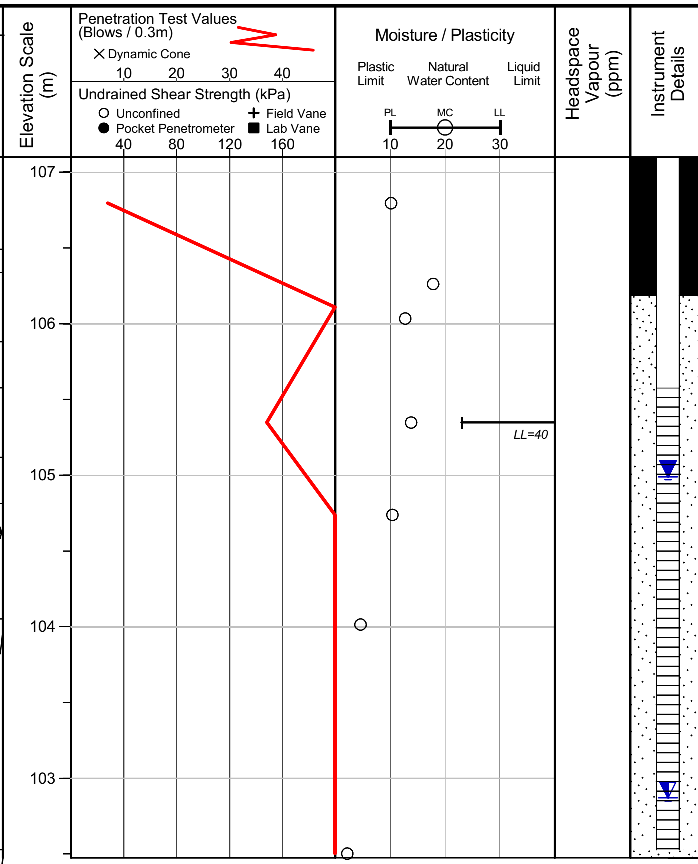
Terraprobe

Project No. : 1-18-0001-01	Client : Norman Lee & Associates Ltd.	Originated by : SM
Date started : February 1, 2018	Project : 900 Mississauga Heights Drive	Compiled by : NNA
Sheet No. : 1 of 1	Location : Mississauga, ON	Checked by : SZ

Position : E: 610815, N: 4823281 (UTM 17T) Elevation Datum : Geodetic

Rig type : Track-mounted Drilling Method : Solid stem augers

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Lab Data and Comments
107.1		**GROUND SURFACE**				
106.9	0.2	150mm **TOPSOIL**				
		FILL, silty sand, trace clay, trace gravel, trace organics, loose, brown, moist	1	SS	7	
106.2	0.9	**CLAYEY SILT**, trace to some sand, trace gravel, hard, greyish brown, moist (GLACIAL TILL)	2A			
			2B	SS	70	
			3	SS	37	Grain size (GR SA SI CL): 2 8 57 33; LL=40
						auger grinding
			4	SS	50 / 150mm	
104.1	3.0	**INFERRED BEDROCK** (GEORGIAN BAY FORMATION)	5	SS	50 / 75mm	
102.5	4.6		6	SS	50 / 50mm	



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

25 mm dia. piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 9, 2018	4.2	102.9
May 1, 2018	2.1	105.0

Terraprobe

LOG OF BOREHOLE 2

Project No. : 1-18-0001-01
Client : Norman Lee & Associates Ltd.
Originated by : SM

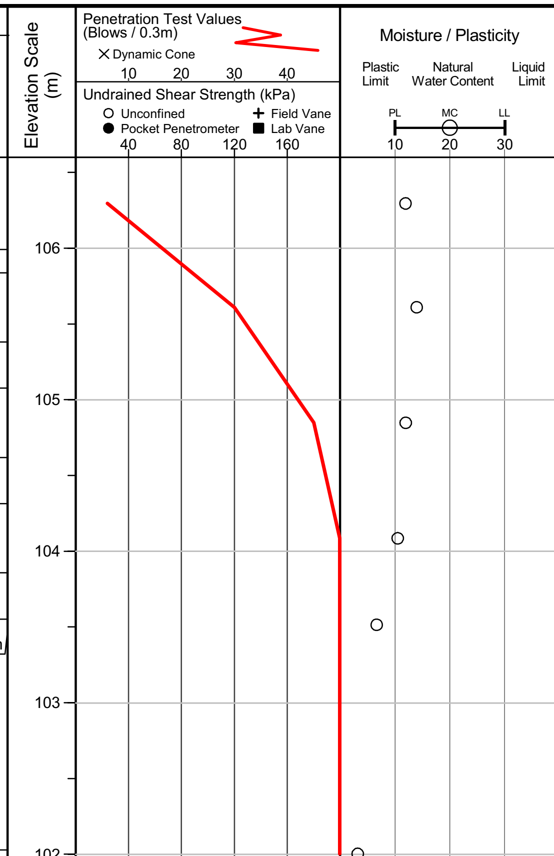
Date started : February 1, 2018
Project : 900 Mississauga Heights Drive
Compiled by : NNA

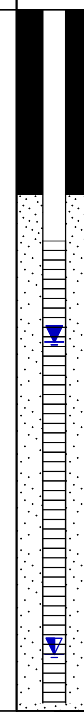
Sheet No. : 1 of 1
Location : Mississauga, ON
Checked by : SZ

Position : E: 610847, N: 4823256 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Solid stem augers

Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Lab Data and Comments
106.6	**GROUND SURFACE**				
	100mm **TOPSOIL**				
	FILL, silty sand, trace clay, trace gravel, trace organics, loose, brown, moist	1	SS	6	
105.8 / 0.8	**CLAYEY SILT**, trace to some sand, trace gravel, hard, greyish brown, moist (GLACIAL TILL)	2	SS	30	
		3	SS	45	
		4	SS	72	
103.6 / 3.0	**INFERRED BEDROCK** (GEORGIAN BAY FORMATION)	5	SS	50 / 75mm	auger grinding
102.0 / 4.6		6	SS	50 / 50mm	auger grinding





END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

25 mm dia. piezometer installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 9, 2018	4.3	102.4
May 1, 2018	2.2	104.4

file: 1-18-0001-01 bh logs.gpj

LOG OF BOREHOLE 3

Terraprobe

Project No. : 1-18-0001-01	Client : Norman Lee & Associates Ltd.	Originated by : SM
Date started : February 1, 2018	Project : 900 Mississauga Heights Drive	Compiled by : NNA
Sheet No. : 1 of 1	Location : Mississauga, ON	Checked by : SZ

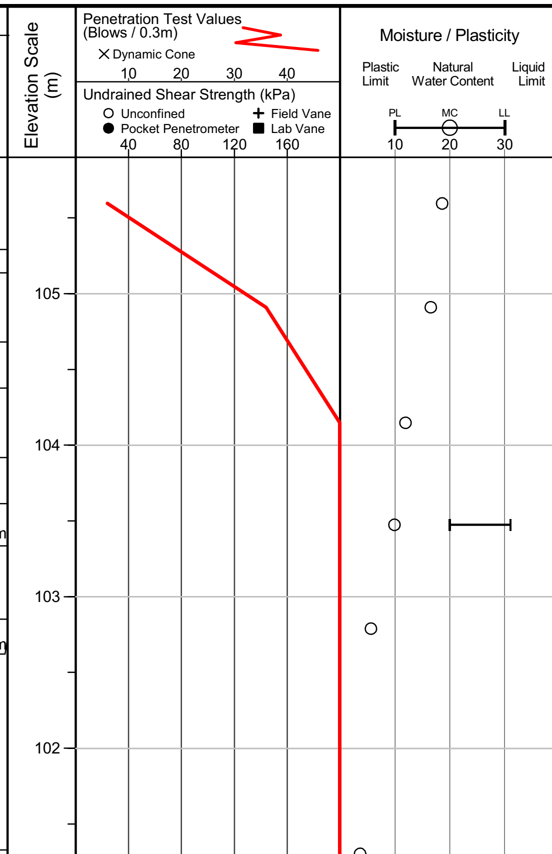
Position : E: 610882, N: 4823244 (UTM 17T)	Elevation Datum : Geodetic
Rig type : Track-mounted	Drilling Method : Solid stem augers

SOIL PROFILE

Depth Scale (m)	Elev / Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Lab Data and Comments (GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL)
0	105.9	**GROUND SURFACE**				
		100mm **TOPSOIL**				
		FILL, silty sand, trace clay, trace gravel, trace organics, loose, brown, moist	1	SS	6	
	105.1 / 0.8	**CLAYEY SILT**, trace to some sand, trace gravel, hard, greyish brown, moist (GLACIAL TILL)	2	SS	36	
			3	SS	68	
			4	SS	50 / 125mm	18 18 47 17
3	102.9 / 3.0	**INFERRED BEDROCK** (GEORGIAN BAY FORMATION)	5	SS	50 / 125mm	auger grinding
	101.3 / 4.6		6	SS	50 / 50mm	

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.



file: 1-18-0001-01 bh logs.gpj

LOG OF BOREHOLE 4

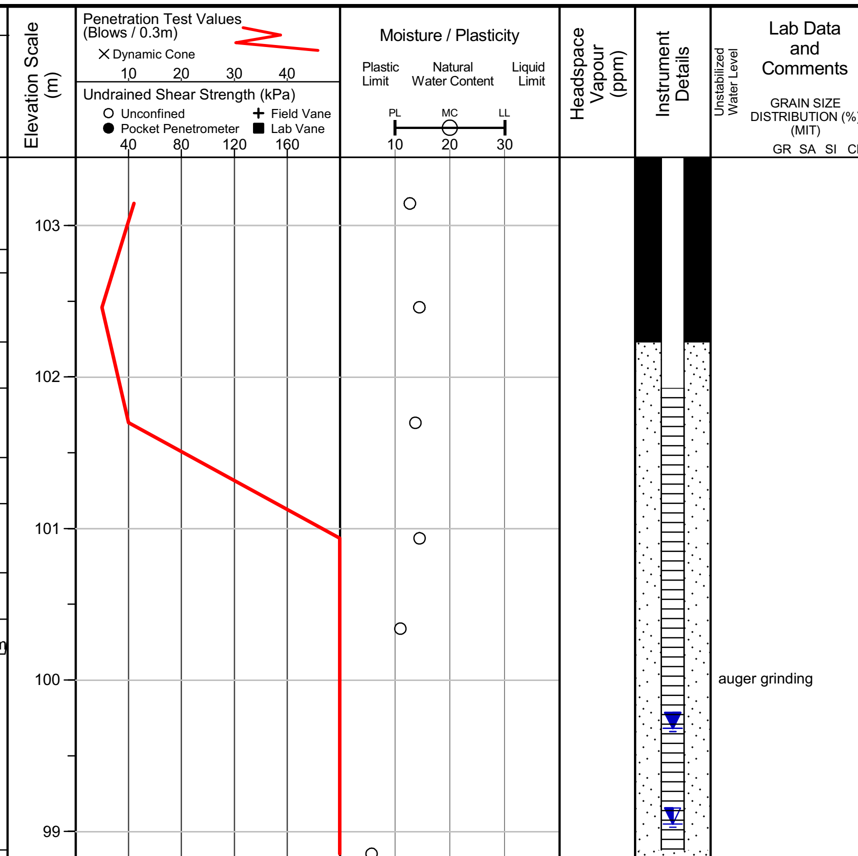
Terraprobe

Project No. : 1-18-0001-01	Client : Norman Lee & Associates Ltd.	Originated by : SM
Date started : February 1, 2018	Project : 900 Mississauga Heights Drive	Compiled by : NNA
Sheet No. : 1 of 1	Location : Mississauga, ON	Checked by : SZ

Position : E: 610915, N: 4823212 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Solid stem augers

SOIL PROFILE / SAMPLES

Elev (m)	Depth (m)	Description	Sample Number	Type	SPT 'N' Value	Lab Data and Comments
103.5	0	**GROUND SURFACE**				
103.3	0.2	150mm **TOPSOIL**				
		FILL, sandy silt to silty sand, trace clay, trace gravel, trace organics, loose to compact, brown, moist	1	SS	11	
			2	SS	5	
			3	SS	10	
101.2	2.3	**CLAYEY SILT**, trace to some sand, trace gravel, hard, greyish brown, moist (GLACIAL TILL)	4	SS	57	
			5	SS	50 / 125mm	
						auger grinding
98.9	4.6	**INFERRED BEDROCK** (GEORGIAN BAY FORMATION)	6	SS	50 / 50mm	



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

25 mm dia. piezometer installed.

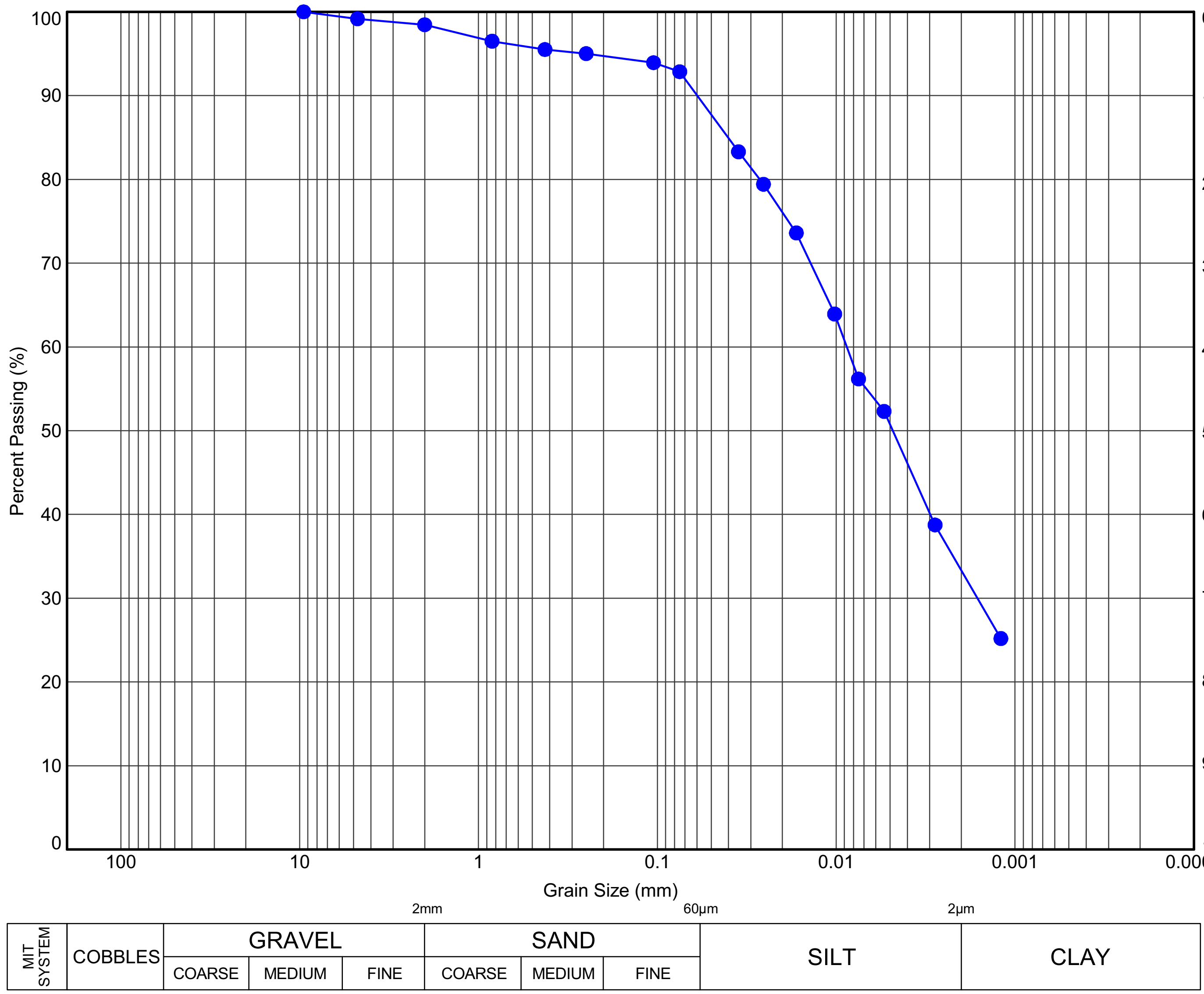
WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Feb 9, 2018	4.4	99.1
May 1, 2018	3.8	99.7

file: 1-18-0001-01 bh logs.gpj

APPENDIX B

TERRAPROBE INC.



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**1**	SS3	1.8	105.3	2	8	57	33	

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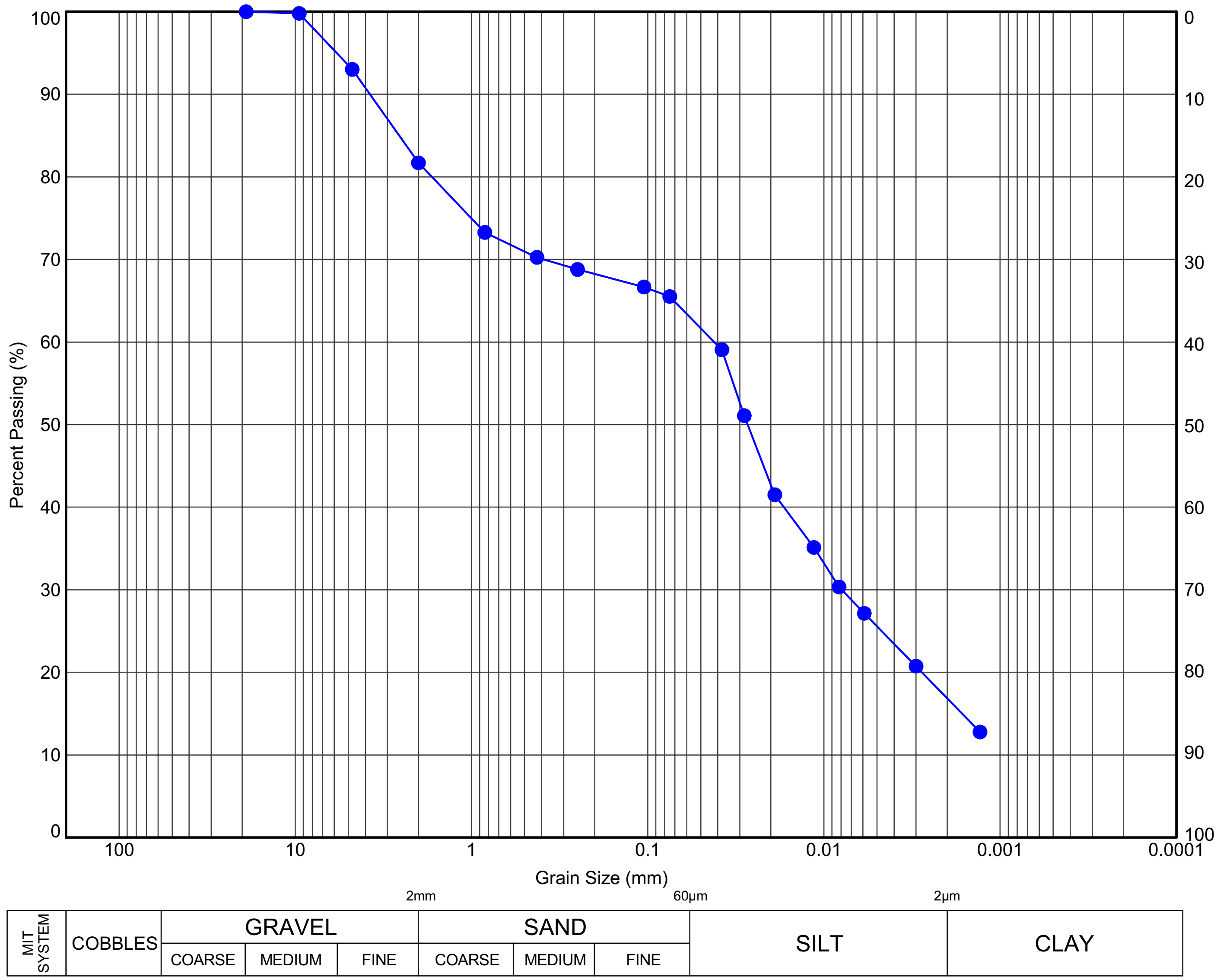
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, TRACE SAND, TRACE GRAVEL

File No.: **1-18-0001-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**3**	SS4	2.4	101.1	18	18	47	17	

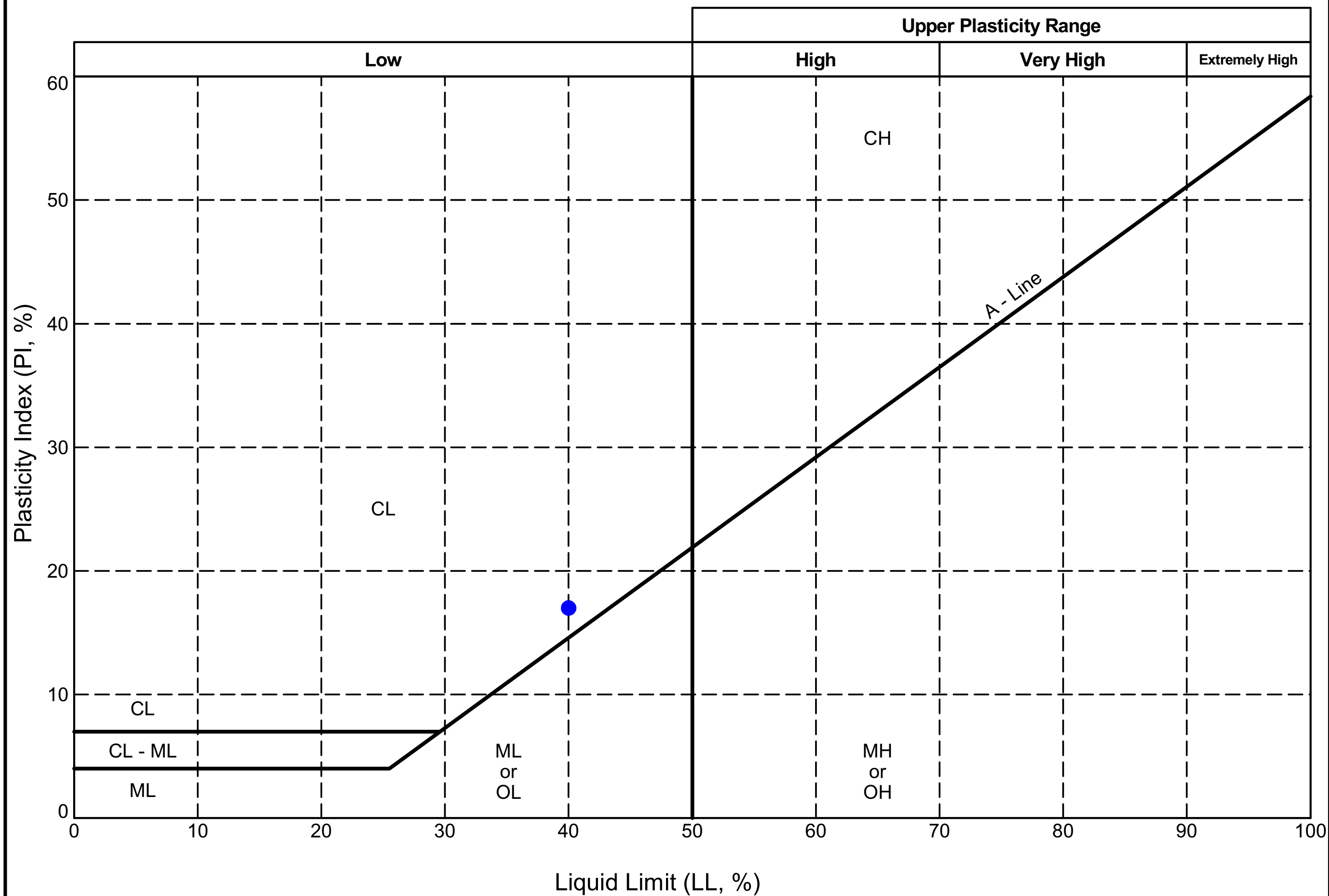
Terraprobe

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

Title:

GRAIN SIZE DISTRIBUTION
SILT, SOME CLAY, SOME SAND, SOME GRAVEL

File No.: **1-18-0001-01**



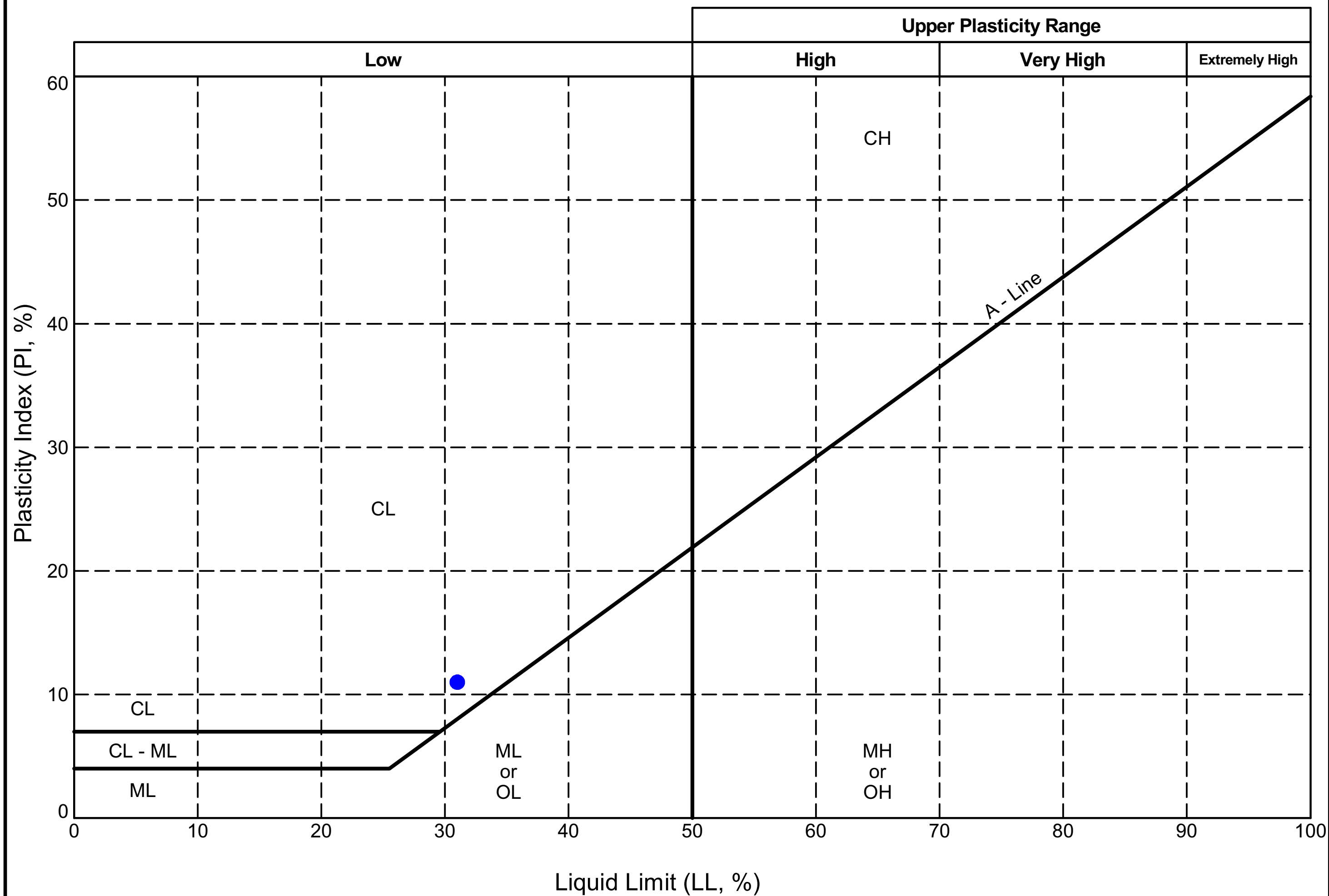
	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)	Description
●	1	SS3	1.8	105.3	40	23	17	MEDIUM PLASTIC

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

Title:

ATTERBERG LIMITS CHART

File No.: **1-18-0001-01**



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)	Description
●	3	SS4	2.4	103.5	31	20	11	SLIGHTLY PLASTIC

Terraprobe
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(905) 796-2650

Title:

ATTERBERG LIMITS CHART

File No.: **1-18-0001-01**

APPENDIX C

TERRAPROBE INC.

PHOTOGRAPH 1. Looking southeast, a view of the front yard tableland. The tableland is relatively flat and consists of landscaped areas and asphalt paved driveway. A residential dwelling situated on the tableland is visible in background.

PHOTOGRAPH 2. Looking north, a view of backyard tableland. A gently grassed sloping ground backyard is located between the house and the slope crest.

PHOTOGRAPH 3. Looking northeast, a view of slope crest and slope. A series of concrete steps is located at the slope crest. The slope is leaf littered and vegetated with saplings and mature trees. The tree trunk growth is generally straight and upright.

PHOTOGRAPH 4. Looking east, a view of the ravine slope, leaf littered and well vegetated with mature trees and saplings. Credit River located at a significant distance away from the slope toe is visible in the background.

PHOTOGRAPH 5. Looking southwest, another view of the lower portion of the slope. The watercourse is separated from the slope toe by a broad floodplain.

PHOTOGRAPH 6. Looking south, a view of the slope toe and floodplain. An asphalt trail is situated near the slope toe. Credit River, located more than 15 m away from the slope toe is visible in the background.

PHOTOGRAPH 7. Looking east, another view of the ravine slope with the floodplain.

PHOTOGRAPH 8. Looking northwest, another view of the vegetated slope crest. The house located near the slope crest is visible in the background.

PHOTOGRAPH 9. Looking east, another view of ravine slope. A small drainage swale is located on the slope.

PHOTOGRAPH 10. Looking northwest, general view of the well vegetated ravine slope. Tree trunk growth is generally straight and upright.

PHOTOGRAPH 11. Looking north, a view of the slope toe. A relatively shallow drainage swale is situated at the slope toe before the slope rise again on the other side of the swale.

PHOTOGRAPH 12. Looking north, another view of the tableland and slope crest. The slope is vegetated with mature trees and saplings

PHOTOGRAPH 13. Looking north, another view of the leaf littered vegetated ravine slope and the drainage swale. The tree trunk growth is generally straight and upright.

PHOTOGRAPH 14. Looking northeast, a view of the slope toe and drainage swale. The swale surface is covered with numerous field stone and cobbles. No evidence of bank erosion.

PHOTOGRAPH 15. Looking north, another view of the vegetated slope. No evidence of slope instability (i.e. scarp, slump, tension crack etc.

PHOTOGRAPH 16. Looking northwest, another view of the tableland and slope crest vegetated with grass, saplings and mature trees.

PHOTOGRAPH 17. Looking northwest, another view of the vegetated ravine slope. No conspicuous evidence of slope instability and toe erosion.

PHOTOGRAPH 18. Looking southeast, another view of the ravine slope and drainage swale. The swale bank includes field stone/gabion stone lining. No evidence of the slope toe/swale bank erosion.

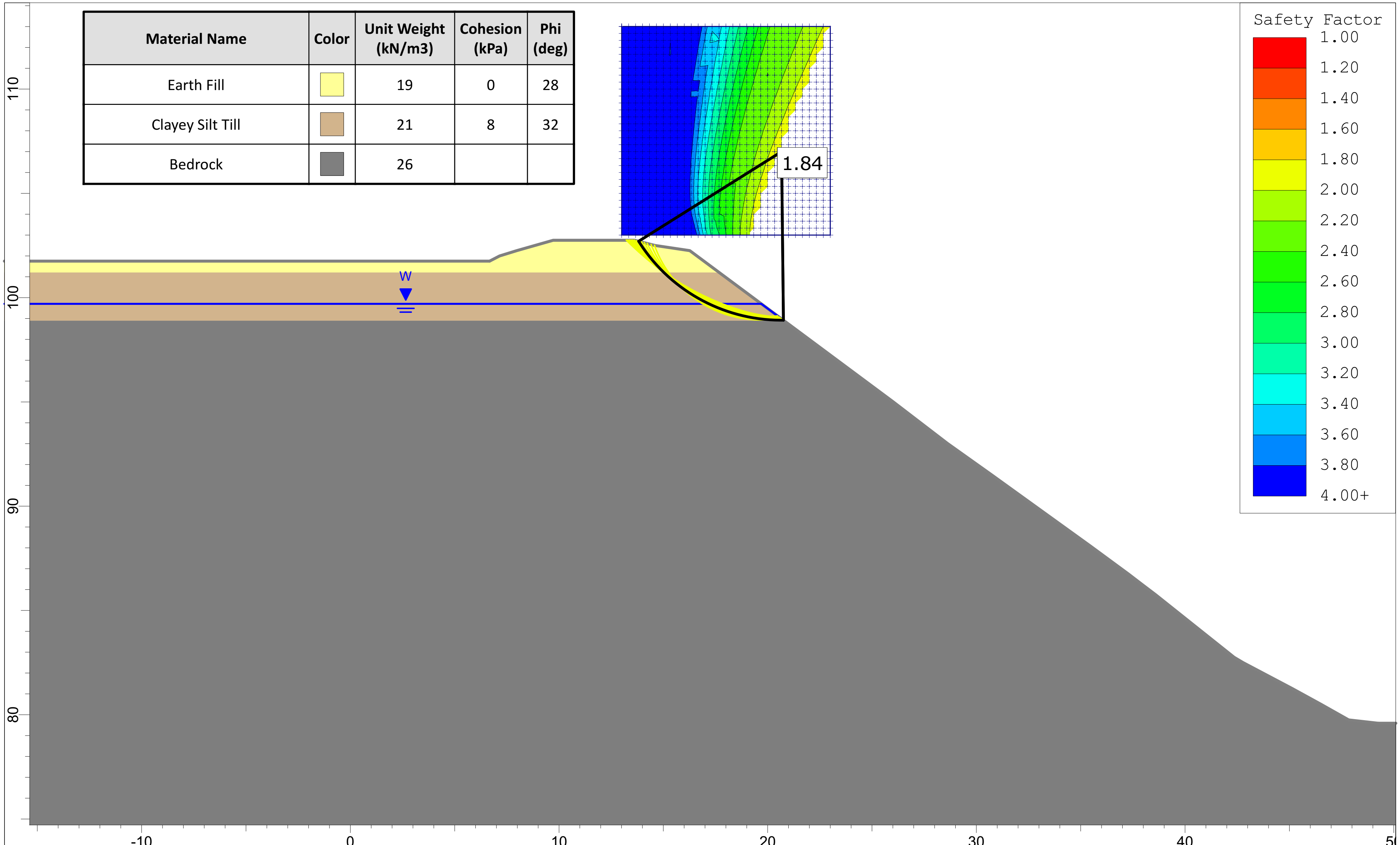
PHOTOGRAPH 19. Looking southeast, a view of the slope toe and drainage swale. The swale bank incudes field stone/gabion lining.

PHOTOGRAPH 20. Looking southeast, another view of the tableland. A tennis court is visible in the foreground.

APPENDIX D

TERRAPROBE INC.

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		



Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

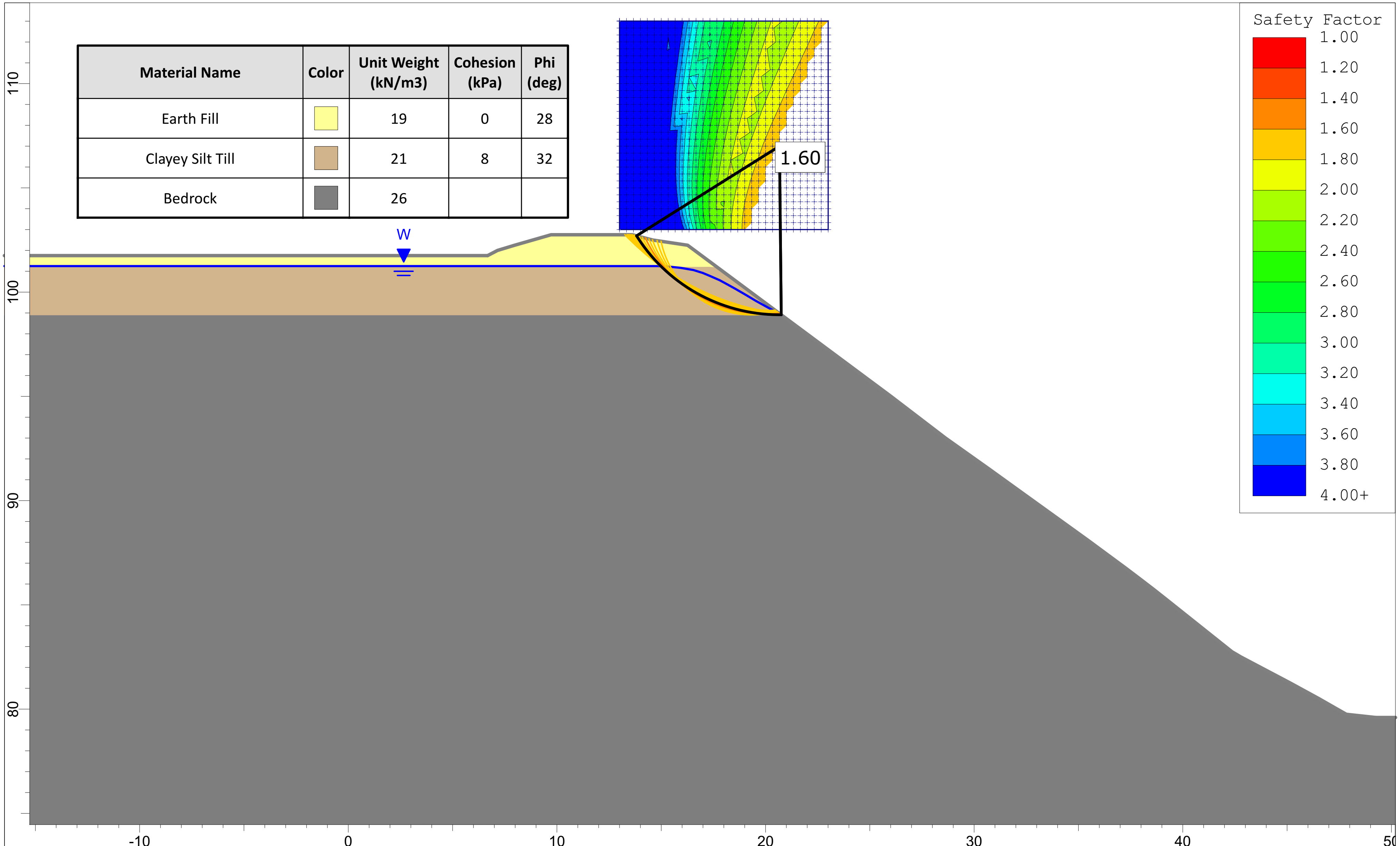
Project: **900 Mississauga Heights Dr., Mississauga, ON**

Analysis: Slope Stability: : Section A-A', Normal Water Level

Date	Scale	File
5/14/2018	1:250	1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

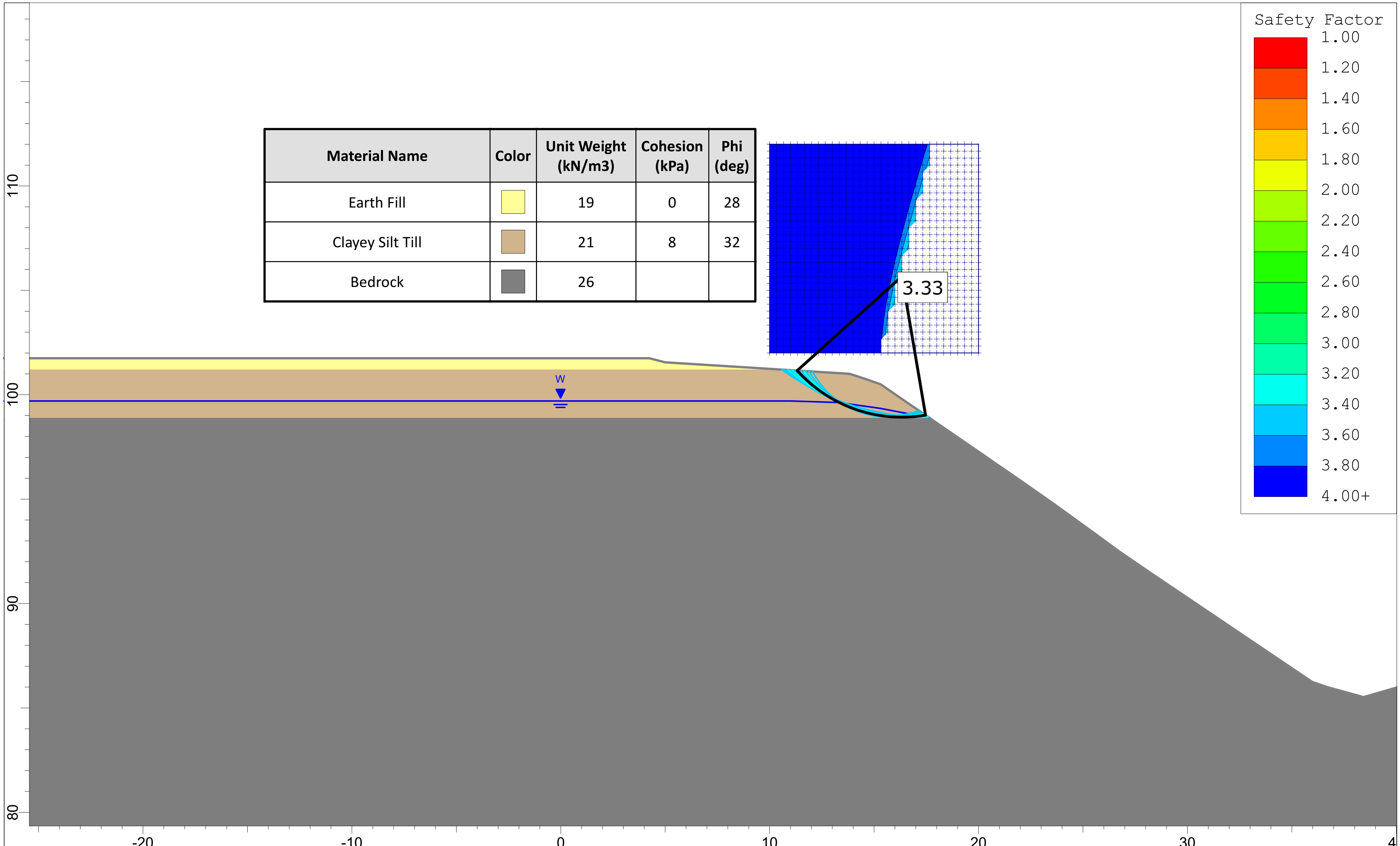
Project: **900 Mississauga Heights Dr., Mississauga, ON**

Analysis: Slope Stability: : Section A-A', High Water Level

Date	Scale	File
5/14/2018	1:250	1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

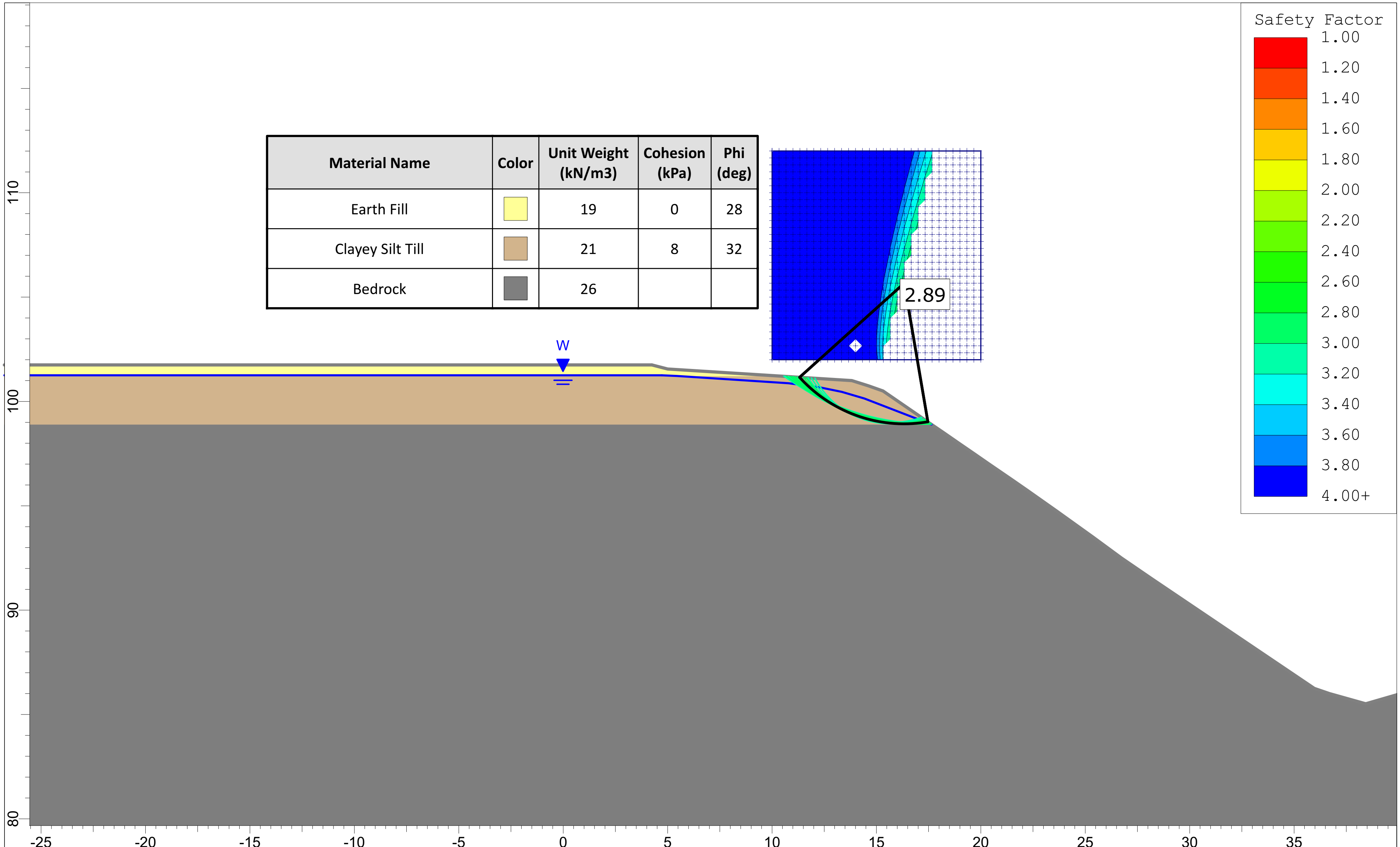
Project
900 Mississauga Heights Dr., Mississauga, ON

Analysis
Slope Stability: : Section B-B', Normal Water Level

Date	Scale	File
5/14/2018	1:250	1-18-0001-01.slmd

By Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	(light yellow)	19	0	28
Clayey Silt Till	(tan)	21	8	32
Bedrock	(grey)	26		

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes

Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project: **900 Mississauga Heights Dr., Mississauga, ON**

Analysis: Slope Stability: : Section B-B', High Water Level

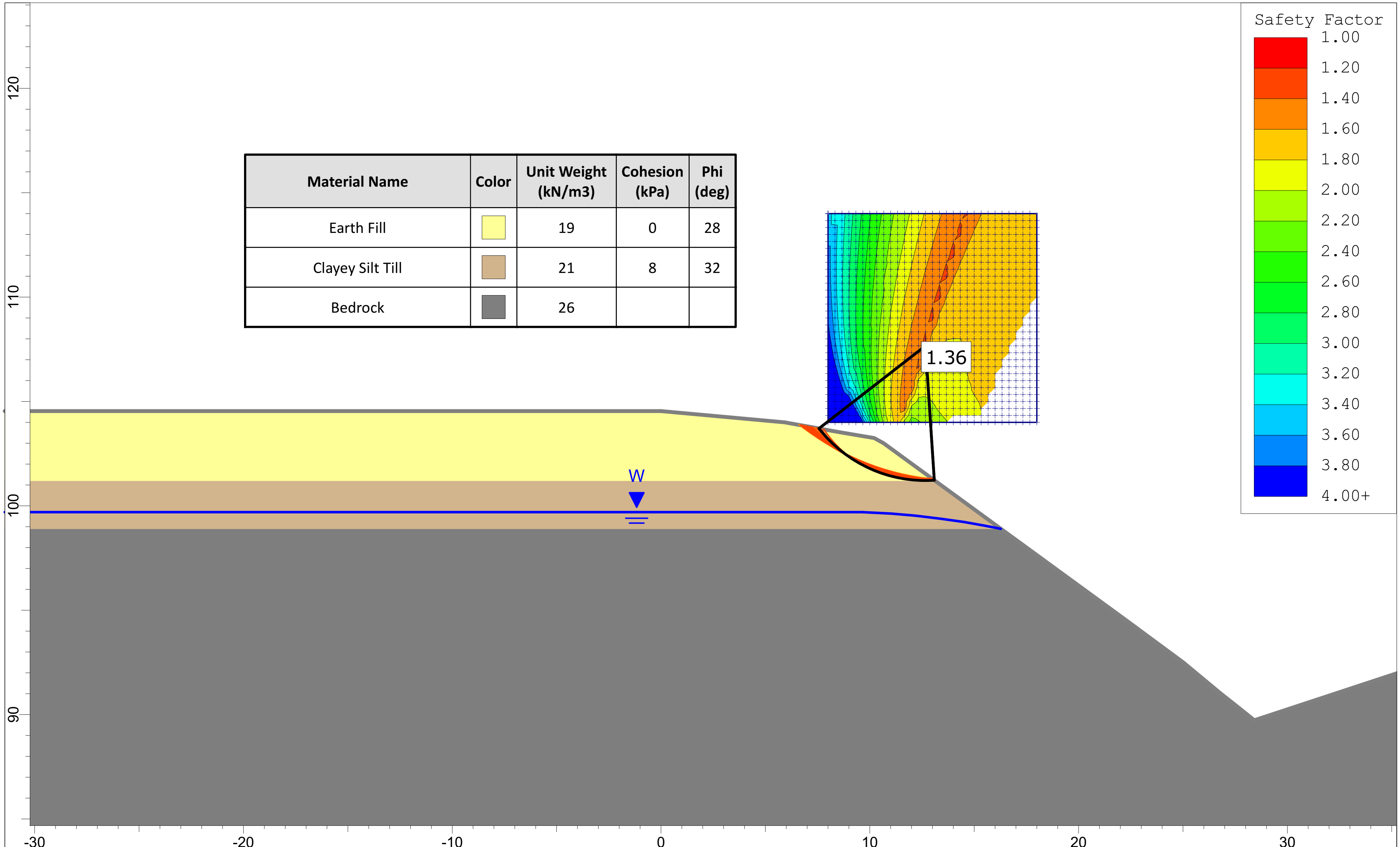
Date: 5/14/2018

Scale: 1:250

File: 1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

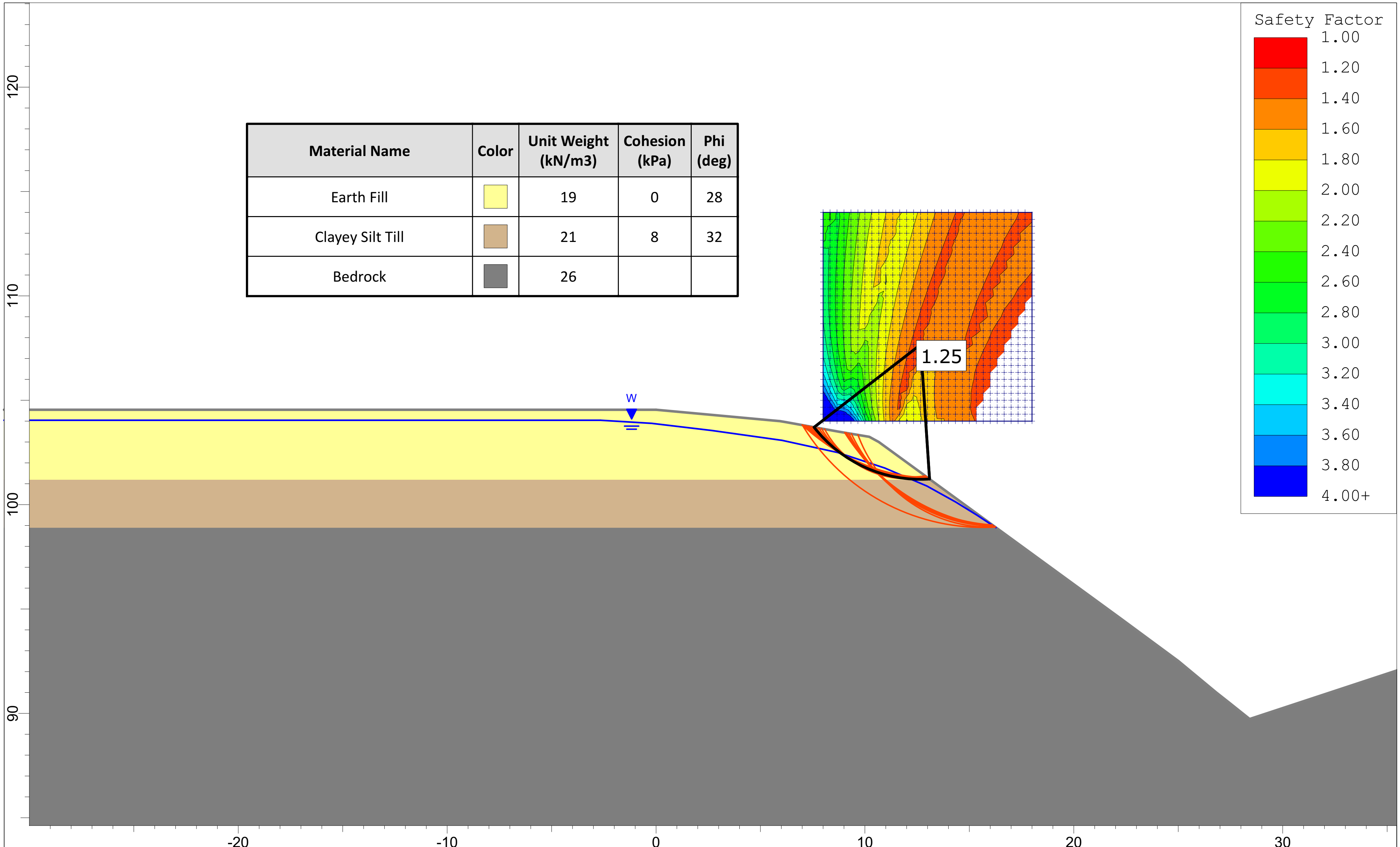
Project
900 Mississauga Heights Dr., Mississauga, ON

Analysis
Slope Stability: : Section C-C', Normal Water Level

Date	Scale	File
5/14/2018	1:250	1-18-0001-01.slmd

By Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

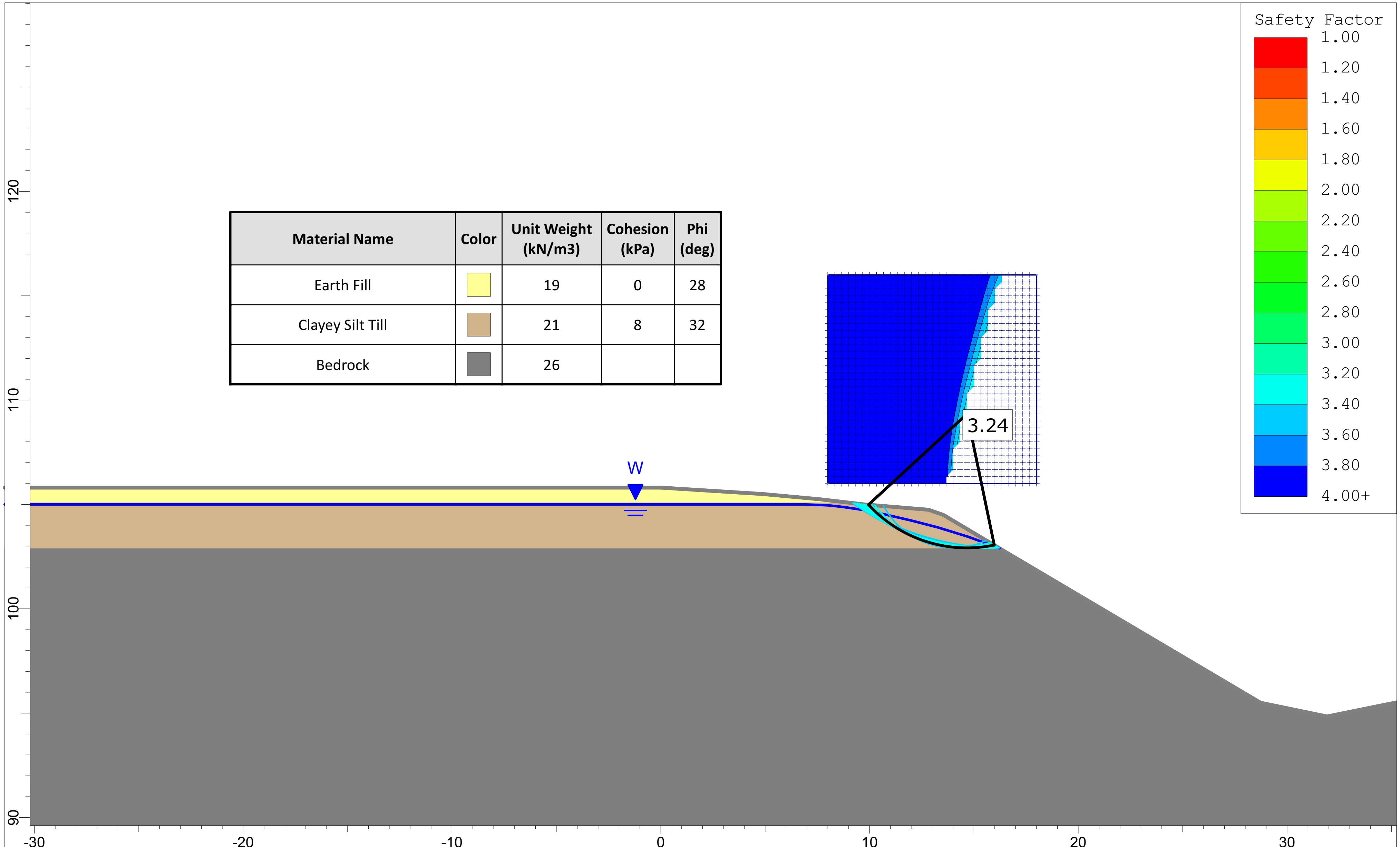
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project
900 Mississauga Heights Dr., Mississauga, ON

Analysis
Slope Stability: : Section C-C', High Water Level

Date 5/14/2018 | Scale 1:250 | File 1-18-0001-01.slmd

By Naemeh Naghavi | Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



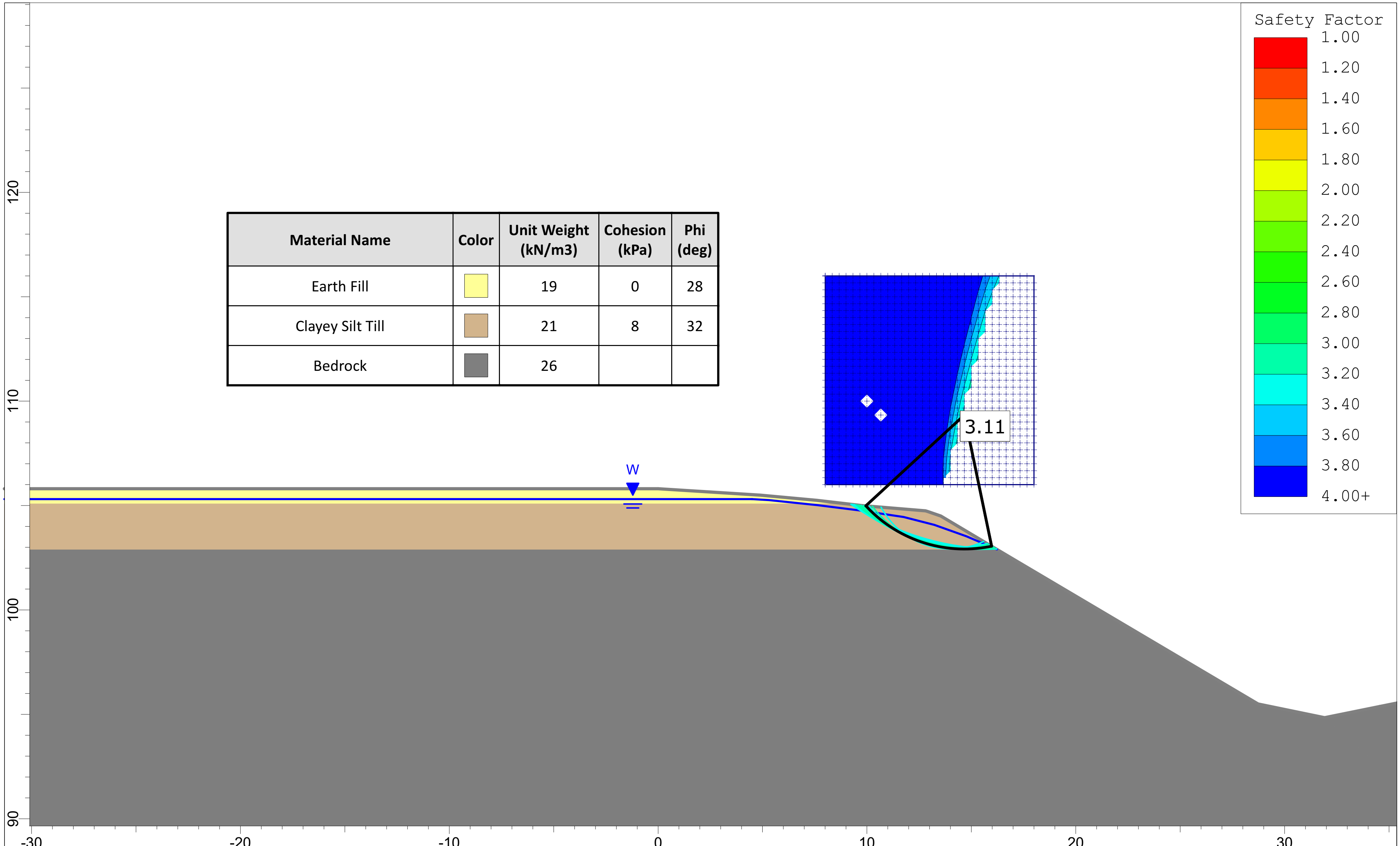
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project	900 Mississauga Heights Dr., Mississauga, ON
Analysis	Slope Stability: : Section D-D', Normal Water Level
Date	5/14/2018
Scale	1:250
File	1-18-0001-01.slmd
By	Naemeh Naghavi
Ref.	Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

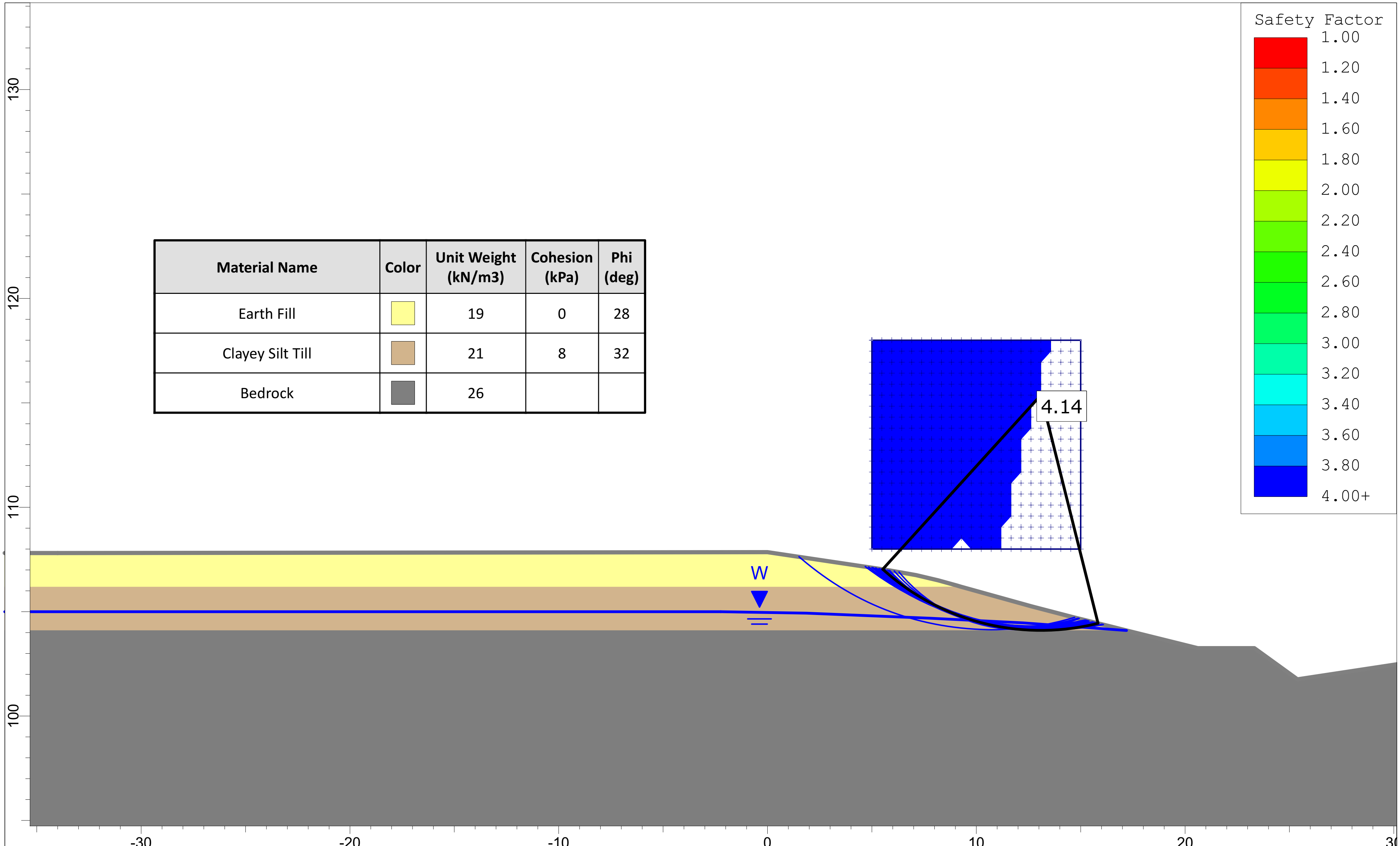
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project
900 Mississauga Heights Dr., Mississauga, ON

Analysis
Slope Stability: : Section D-D', High Water Level

Date 5/14/2018
Scale 1:250
File 1-18-0001-01.slmd
By Naemeh Naghavi
Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		



Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

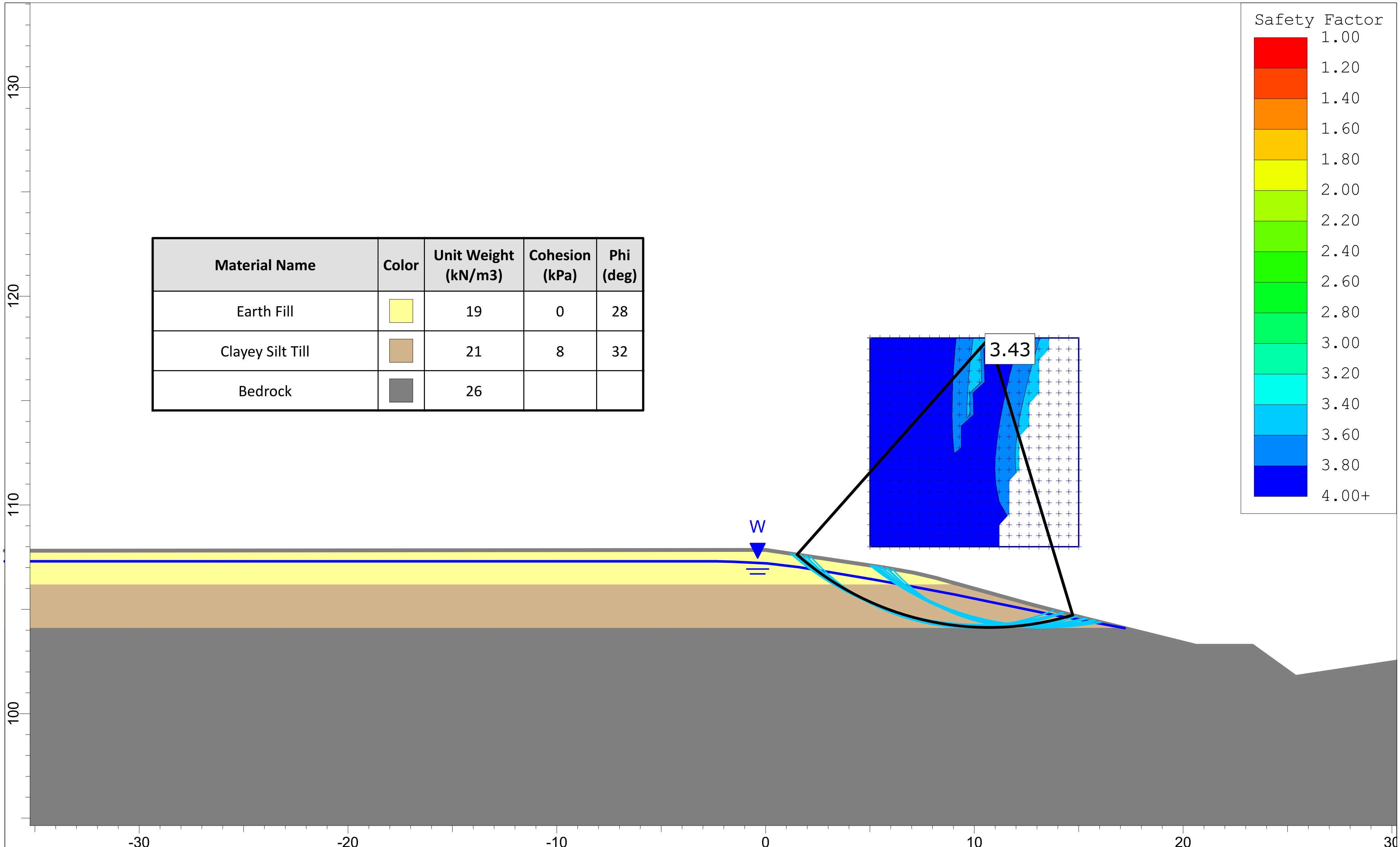
Project: **900 Mississauga Heights Dr., Mississauga, ON**

Analysis: Slope Stability: : Section F-F', Normal Water Level

Date: 5/14/2018 | Scale: 1:250 | File: 1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.031

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project: **900 Mississauga Heights Dr., Mississauga, ON**

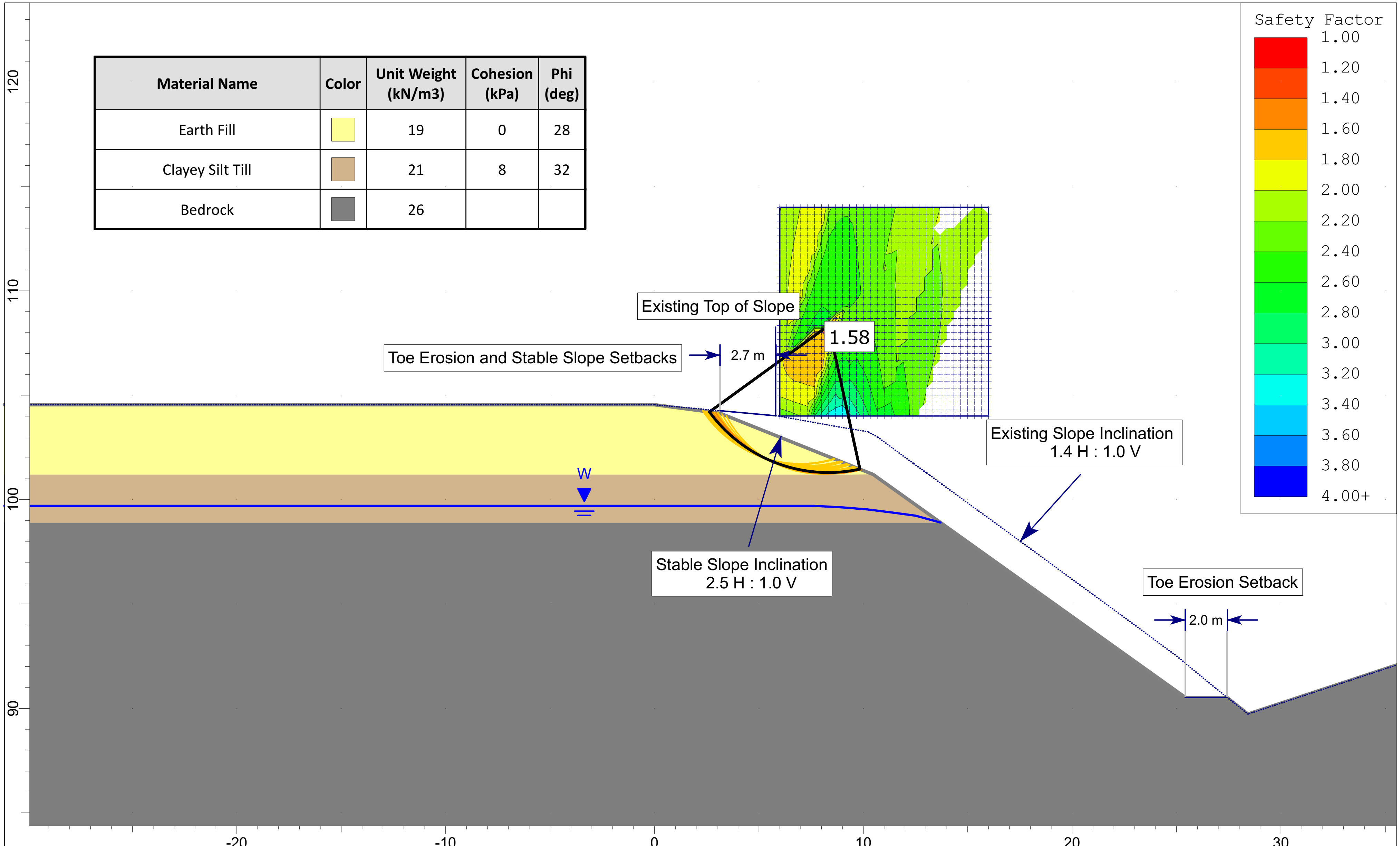
Analysis: Slope Stability: : Section F-F', High Water Level

Date: 5/14/2018 | Scale: 1:250 | File: 1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		



Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.013

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

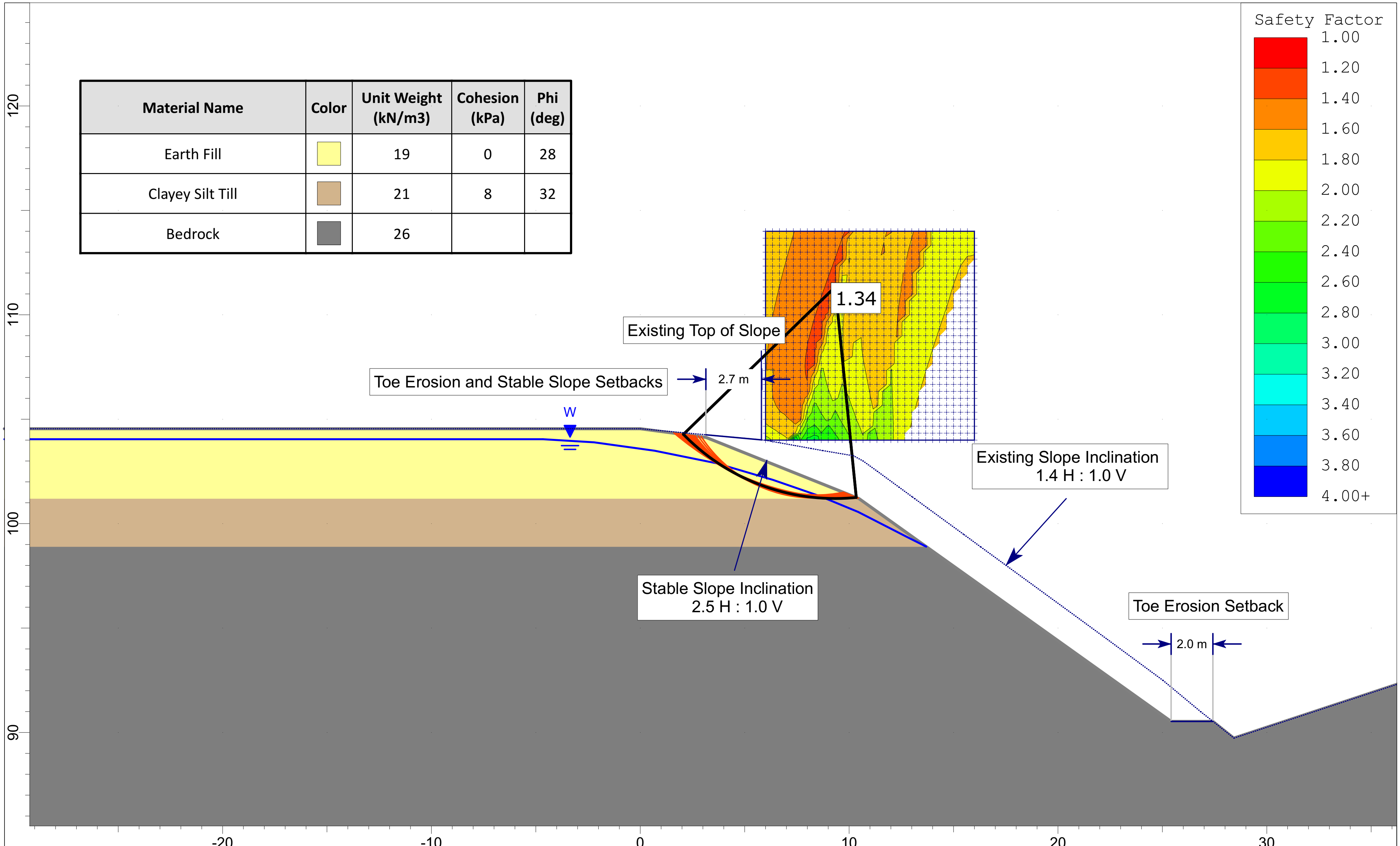
Project
900 Mississauga Heights Dr., Mississauga, ON

Analysis
Slope Stability: : Section C-C' Stable Slope with Erosion Setback, Normal Water Level

Date 6/4/2018 | Scale 1:250 | File 1-18-0001-01.slmd

By Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill		19	0	28
Clayey Silt Till		21	8	32
Bedrock		26		

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.013

Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project: **900 Mississauga Heights Dr., Mississauga, ON**

Analysis: Slope Stability: : Section C-C' Stable Slope with Erosion Setback, High Water Level

Date: 6/4/2018 | Scale: 1:250 | File: 1-18-0001-01.slmd

By: Naemeh Naghavi

Ref. Plan of Survey of Part of Lots 1 and 2, Registered Plan 342 City of Mississauga, Regional Municipality of Peel, File No.: 146-1-17, By: David B. Searles Surveying Ltd., OLS, Dated: received April 5, 2018