**Terraprobe**

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

# GEOTECHNICAL SLOPE STABILITY
# AND STREAMBANK EROSION STUDY
# LONG TERM STABLE SLOPE CREST UPDATE
# 1300 BRONTE ROAD
# OAKVILLE, ONTARIO

**Prepared for:** Bronte River LP
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**Attention:** Mr. Julian Pompeo

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## 1. INTRODUCTION

Terraprobe Inc. was retained by Bronte River LP to conduct a geotechnical slope stability and streambank erosion analysis update for the valley slope situated to the west of the properties generally located around 1300 Bronte Road, in the Town of Oakville, Ontario.

This report encompasses the results of a site specific detailed slope stability and streambank erosion analysis based on a borehole investigation, conducted to assess the long-term stability and erosion risks of the subject slope. The report provides an update to the previous Terraprobe Report (File No. 1-16-0035-01, dated May 19, 2016) as well as extending the study area further south along the slope crest; including geotechnical engineering recommendations for the long-term stability of the site slope and delineates the updated Long-Term Stable Slope Crest (LTSSC) location for the entire site based on the applicable stability and erosion setbacks.

## 2. SITE AND PROJECT DESCRIPTION

The subject site, is located on the west side of Bronte Road, at a short distance north of Queen Elizabeth Way (QEW), in the Town of Oakville, Ontario. For site description purposes, Bronte Road is assumed to be aligned in a north-south direction. The municipal address of the property is 1300 Bronte Road, while the legal description is Part of Lot 31, Concession 2, S.D.S, Geographic Township of Trafalgar, Town of Oakville, Regional Municipality of Halton. The general location of the subject property and portions of the adjacent lands are shown on the enclosed Site Location Plan (Figure 1) and Borehole Location and Site Features Plan (Figure 2).

The property is bounded by Bronte Road to the East (front), residential properties to the north, wood lot to the south and valley slope associated with Bronte Creek to the west (rear). The geotechnical study area currently includes a two-storey brick dwelling and a detached garage situated within the relatively wider (rear) portion of the property (#1300 Bronte Road) as well as adjacent land to the south. There is a relatively large man made pond situated to the east side of the existing dwelling and garage. The westerly tableland portion of the geotechnical study area is relatively flat and gently slopes towards the Bronte Creek valley slope. The slope within the study area is about 30 to 32 m high with inclination varying from about 0.6 to 2.1 horiz. to 1 vert. The watercourse (Bronte Creek) meanders within a well defined and deeply incised valley base. The creek meanders towards the subject slope as it progresses downstream with a relatively broad floodplain.

A geotechnical slope stability and streambank erosion study is required as the property abuts the valley land regulated by Conservation Halton. The study included an assessment of the long-term stability and erosion risks for the valley slope and delineation of the Long-term Stable Slope Crest (LTSSC) location for the subject site.

## 3. FIELD PROCEDURE

The field investigation was conducted on October 25 & 26, and November 3 to 5, 2021 and consisted of drilling and sampling a total of two (2) exploratory boreholes near the slope crest extending to depths of about 19.9 m (Borehole 21-1) and 27.5 m (Borehole 21-2) below existing ground surface.

The boreholes were staked out in the field by Terraprobe Inc. at approximate locations shown on the enclosed Borehole Location and Site Features Plan (Figure 2). Boreholes were located in a relatively close proximity of the slope crest to determine subsurface soil and ground water conditions comprising the valley slope. The ground surface elevations at the borehole locations were inferred from the topographic survey information (prepared by J.D. Barnes Limited, OLS, Reference No. 20-30-555-01, dated November 22, 2021) provided by the client, and are referenced to the Geodetic datum.

Utility agencies were contacted by Terraprobe to locate underground public utility lines present within the work area and to clear the borehole locations prior to drilling. The borings were drilled by a specialist drilling subcontractor using a track-mounted drill rig power auger. The boreholes were advanced using continuous flight hollow stem augers and mud-rotary, and were sampled at 0.75 m (up to 3.0 m below grade) and 1.5 m (below 3.0 m depth) intervals with a conventional 50 mm diameter split barrel sampler when the Standard Penetration Test (SPT) was carried out (ASTM D 1586). The field work (drilling, sampling and testing) was observed and recorded by a member of our field engineering staff, who logged the boring and examined the soil samples as they were obtained. All samples obtained during the field investigation were sealed into plastic jars, and transported to our laboratory for detailed inspection and testing. Borehole soil samples were examined (tactile) in detail by a geotechnical engineer, and classified according to visual and index properties. Laboratory testing consisted of water content determination on all samples, and a Sieve and Hydrometer analysis on two (2) selected native soil samples (Borehole 21-1, Sample 3 and Borehole 21-2, Sample 6). Atterberg Limits tests was also conducted on one (1) selected native soil sample (Borehole 21-1, Sample 3). The results of the geotechnical laboratory testing are plotted on the enclosed Borehole Logs at respective sampling depths. The results of the Sieve and Hydrometer analysis as well as Atterberg Limits tests are summarized in Section 4.6 of this report, and appended.

Ground water levels were monitored in the boreholes upon completion of drilling. Monitoring wells consisting of 51 mm diameter PVC tubing were installed in both boreholes to facilitate ground water level measurement. The PVC tubing was fitted with a bentonite clay seal as shown on the enclosed Borehole Logs. Water levels in the monitoring wells were measured on November 30, 2021, about three weeks following the installation. The results of ground water level monitoring are summarized in Section 4.7 of this report.

# 4. SUBSURFACE CONDITIONS

The results of the individual boreholes are summarized below and recorded on the accompanying Borehole Logs. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions encountered at the site. Refer to enclosed Borehole Logs for stratigraphic details.

It should be noted that the soil conditions are confirmed at the borehole locations only and may vary between and beyond the boreholes. The stratigraphic boundaries between the various strata as shown on the borehole logs are based on a non-continuous sampling. The stratigraphic boundaries as shown on the Borehole Logs represent an inferred transition between the various strata, rather than a precise plane of geologic change.

In summary, the subsurface soil conditions encountered in the boreholes advanced across the site were fairly consistent. The 2021 Terraprobe boreholes encountered a topsoil layer at the ground surface underlain by weathered/disturbed native soil which was in turn underlain by undisturbed native soil deposit. The undisturbed native soil deposit was further underlain by weathered shale (inferred Bedrock of Queenston Formation) at both borehole locations.

## 4.1 Topsoil

A layer of topsoil was encountered at the ground surface in all boreholes, with thicknesses of about 150 mm (Borehole 21-1) and 200 mm (Borehole 21-2). The topsoil was dark brown in colour and predominantly consisted of a silt matrix.

The topsoil thicknesses were estimated from the borings and are approximate, and may vary between and beyond the boreholes. The topsoil thickness noted on the Borehole Logs refers to the distinct topsoil layer present at the borehole location, however, organic inclusions extended deeper than the topsoil thickness layer noted on the Borehole Logs. The topsoil thickness to be removed/stripped for the site development may differ from the topsoil thickness noted on the Borehole Logs. Therefore, this information is not sufficient for estimating topsoil quantities and/or associated costs. Consideration should be given to conduct a shallow test pit investigation to obtain a more precise topsoil thickness, if required.

## 4.2 Weathered/Disturbed Soil

A zone of weathered/disturbed soil was encountered in both boreholes beneath the surficial topsoil layer and extended to depths of about 0.8 m (Borehole 21-1) and 1.2 m (Borehole 21-2) below grade. The weathered/disturbed soils predominantly consisted of clayey silt with variable sand (some sand to sandy), and trace gravel.

The Standard Penetration Test results ('N' Values) obtained from the weathered/disturbed soil varied from 2 to 6 blows per 300 mm of penetration, indicating a soft to firm consistency.

Measured moisture contents of weathered/disturbed soil samples ranged from 15 to 23 percent by weight, indicating a typically moist condition. The relatively high moisture contents of some of the weathered/disturbed soil samples are likely due the presence of topsoil or organics.

## 4.3 Native Soils

Undisturbed native soil deposit was encountered in all boreholes beneath the zone weathered/disturbed soil and extended to depths of about 19.8 m (Borehole 21-1) to 25.9 m (Borehole 21-2) below existing grade. The native soils are generally brown/reddish brown in colour and become grey at deeper depths.

Undisturbed native glacial clayey silt till with variable sand (some sand to sandy) and trace amounts of gravel was encountered in both boreholes at depths of about 0.8 m (Borehole 21-1) and 1.2 m (Borehole 21-2) and extended to depths of about 4.6 m and 2.4 m below grade, respectively.

The Standard Penetration Test results ('N' Values) obtained from clayey silt till deposit varied from 21 to 36 blows per 300 mm of penetration and 88 blows per 250 mm of penetration, indicating a very stiff to hard (typically hard) consistency.

Measured moisture contents of the native till soil samples varied form 8 to 12 percent by weight, indicating a moist condition.

A layer of silty sand with varying amounts of gravel (some gravel to gravelly) and trace amounts clay was encountered in Borehole 21-2 beneath the clayey silt till at a depth of about 2.3 m below grade, and extended to a depth of about 6.1 m below grade.

The Standard Penetration Test results ('N' Values) obtained from the silty sand layer were greater than 50 blows per 300 mm of penetration, indicating a very dense relative density.

The measured moisture content of these soil samples ranged from 9 to 10 percent by weight, indicating a generally moist condition.

A layer of sandy gravel to sand and gravel with some silt and trace amounts of clay was encountered in both boreholes beneath the clayey silt till deposit (Borehole 21-1) and below the silty sand deposit (Borehole 21-2) at depths of about 4.6 m and 6.1 m below grade, and extended to depths of about 12.2 and 25.9 m below grade, respectively.

The Standard Penetration Test results ('N' Values) obtained from these soil samples varied from 39 to 95 blows per 300 mm to 50 blows per 75 mm to 125 mm of penetration, indicating a dense to very dense (generally very dense) relative density.

The measured moisture content of these soil samples ranged from 6 to 19 percent by weight, indicating a moist to wet condition.

A layer of sand with some silt and trace amounts gravel was encountered in Borehole 21-1 beneath the sandy gravel to sand and gravel at a depth of about 12.2 m below grade, and extended to a depth of about 19.8 m below grade.

The Standard Penetration Test results ('N' Values) obtained from the sand layer varied from 25 to 32 blows per 300 mm of penetration, indicating a compact to dense relative density.

The measured moisture content of these soil samples ranged from 18 to 21 percent by weight, indicating a generally wet condition.

The glacial till and sandy gravel to sand and gravel deposits are likely to contain larger 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 particles of this size.

## 4.4 Shale

Shale (inferred Bedrock of Queenston Formation) was encountered in all boreholes beneath the native soil (overburden) at depths of about 19.8 m (Borehole 21-1) and 25.9 m (Borehole 21-2) below grade. The shale (Bedrock of Queenston Formation) is a deposit predominantly comprising thin to medium bedded reddish brown calcareous shale with intermittent grey/green bands of 'harder' sandstone/dolostone/limestone stringers. Experience in larger excavations suggests that these limestone layers are discontinuous and nominally 50 to 300 mm thick. Thicker beds of limestone may also be encountered in some areas. The shale is typically of low strength while the 'harder' limestone layers are generally of medium strength.

The tri-cone borehole method used at this site is conventionally accepted investigative practice. However, the tri-cone and 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 the tri-cone. It should be noted that confirmation and characterization of the bedrock through rock coring was not included in our scope of work. The bedrock surface elevations at the borehole locations, as noted on the borehole logs, were inferred from the spoon samples, sampling spoon refusal and bouncing, therefore actual bedrock surface elevations may vary from the inferred elevations noted on the borehole logs and as summarized below.

The following table summarizes the inferred bedrock elevations interpreted from the borehole data:

| Borehole No. | Borehole Surface Elevation (m) | Inferred Bedrock Elevation (m) | Depth of Inferred Bedrock Below Grade (m) |
|---|---|---|---|
| 21-1 | 128.0 | 108.2 | 19.8 |
| 21-2 | 126.0 | 100.1 | 25.9 |

The coring and detailed characterization of the bedrock was beyond the current scope of our work.

## 4.5 Previous Boreholes

In Summary, the subsurface soil conditions encountered in the 2016 Terraprobe boreholes advanced across the site were fairly consistent. The boreholes encountered a topsoil layer at the ground surface underlain by a zone of earth fill material which was in trun underlain by undisturbed native soil deposit. The undisturbed native soil deposit was in turn underlain by weathered shale (inferred Bedrock of Queenston Formation) at all borehole locations. The detailed borehole descriptions can be found in the 2016 report (File No. 1-16-0035-01) and the borehole logs have been appended to this report.

## 4.6 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of water content determination on all samples, while a Sieve and Hydrometer analysis and Atterberg Limits tests on selected native soil samples. The laboratory test results are plotted on the enclosed Borehole Logs at respective sampling depths, and the results of the Sieve and Hydrometer analysis are appended and summarized as follows:

| Borehole No. Sample No. | Sampling Depth below Grade (m) | Percentage (by weight) | | | | Description (MIT System) |
|---|---|---|---|---|---|---|
| | | Gravel | Sand | Silt | Clay | |
| Borehole 21-1<br>Sample 3 | 1.8 | 3 | 27 | 46 | 24 | CLAYEY SILT, sandy, trace gravel |

| Borehole No. Sample No. | Sampling Depth below Grade (m) | Percentage (by weight) | | | | Description (MIT System) |
|---|---|---|---|---|---|---|
| | | Gravel | Sand | Silt | Clay | |
| Borehole 21-2<br>Sample 6 | 4.7 | 22 | 49 | 21 | 8 | SILTY GRAVELY SAND, trace clay |

The results of the Atterberg Limits test were plotted on A-Line Graph (refer to enclosed figure, Atterberg Limits Test Results). The following table presents a summary of the Atterberg Limits test results:

| Borehole No. Sample No. | Sampling Depth below Grade (m) | Liquid Limit ($W_L$) % | Plastic Limit ($W_P$) % | Plasticity Index ($I_P$) % | Natural Water Content ($W_N$) % | Plasticity |
|---|---|---|---|---|---|---|
| Borehole 1<br>Sample 3 | 1.8 | 27 | 16 | 11 | 12 | Slightly Plastic |

## 4.7 Ground Water

Observations pertaining to the depth of water level and borehole caving were made in the boreholes immediately after the completion of drilling, and are noted on the enclosed Borehole Logs. Monitoring wells consisting of 50 mm diameter PVC tubing were installed in both boreholes to facilitate ground water level monitoring. The details of the well installations are shown on the enclosed Borehole Logs. Ground water level measurements in the wells/piezometers were taken on November 30, 2021, (about three weeks following the installation) and are noted on the enclosed Borehole Logs. A summary of the measured ground water levels is provided as follows:

| Borehole No. | Depth of Boring below Grade (m) | Depth to Cave below Grade (m) | Water Level Depth / Elevation at the time of drilling (m) | Water Level Depth/Elevation November 30, 2021 (m) |
|---|---|---|---|---|
| 21-1 | 19.9 | N/A | N/A | 12.8/115.2 |
| 21-2 | 27.5 | N/A | N/A | 16.5/109.5 |

N/A = Not Measurable due to drilling mud and casing.

It should be noted that the ground water levels may fluctuate seasonally depending on the amount of precipitation and surface runoff. Wet soils may be encountered to about 0.6 m higher than the water levels due to capillary rise in fine cohesionless silt/sand soils (where present).

# 5. DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from the investigations in 2016 & 2021 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 geotechnical engineering 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.

## 5.1 Slope Stability

A detailed site specific slope stability and streambank erosion analysis was carried out based on the borehole investigation conducted for the site to assess the long-term stability and erosion risks of the subject valley slope. The study included a visual inspection of the site slope to assess existing slope conditions with respect to any obvious signs of instability and erosion concerns, as well as a detailed slope stability analysis by preparing slope models and using a computer software. This study extends the area assessed in the 2016 report and the additional area to the south of 2016 Study Area.

### 5.1.1 Slope Inspection and Mapping

A visual inspection of the slope was conducted on October 19, 2021. General information pertaining to existing slope features such as slope profile, slope drainage, watercourse features, vegetation cover, structures in the vicinity of the slope, as well as erosion and slope slide features, was obtained during the inspection. A brief summary of the results of the visual inspection as well as site topographic information is presented below.

The topographic survey of the property (prepared by J.D. Barnes Limited, OLS, Reference No. 20-30-555-01, dated November 22, 2021) and base maps of the adjacent slope area including the creek (Drawing Name: OAK023-1991 Format and OAK024-1991 Format) were provided by the client. A composite topographic map was inferred/prepared based on the above noted information and is enclosed as Figure 2 (Borehole Location and Site Features Plan). A total of three (3) slope cross-sections (Sections E-E', F-F', and G-G') were derived from the topographic information and our slope inspection for slope stability analysis in addition to the four cross sections derived in the previous report. The cross-section locations were selected on the basis of slope height and inclination to represent the critical slope conditions present within the study area, and to obtain sufficient coverage of the subject slope. These sections extended through the tableland, across the slope surface extending down to the Bronte Creek floodplain and to the watercourse. The locations of the slope cross-sections are presented on Figure 2 (in plan), and the details of the slope profiles along with the floodplain (where applicable) and watercourse, are presented on Figures 3A to 3C.

The property abuts the valley slope associated with Bronte Creek. The tableland is followed by the prominent valley slope extending down to the bottom of the deeply incised valley associated with the Bronte Creek watershed. The tableland is relatively flat and gently slopes toward the valley slope.

The slope within the study area is about 30 to 32 m high with inclinations varying from about 0.6 to 2.1 horiz. (with locally steeper or flatter inclinations). A near vertical bare scarp was noted at the central portion of the slope (refer to Photographs 6 and 7) which extended upward from the slope toe/water edge covering approximately three-quarters of the slope height (refer to the attached Figure 2 for the approximate extent of the scarp). The near vertical bare scarp is likely created by slope toe/creek bank erosion due to the presence of the creek at the slope toe. This erosion results in an oversteepened slope which is then subjected to progressive slumping. The slope surface outside of the scarp area is generally vegetated with numerous young to mature trees and saplings (refer to Photographs 1 to 4 & 9 to 16) . The slope surface (outside of the scarp area) was noted to be leaf littered at the time of our inspection. The tree trunk growth was generally straight and upright except for a few leaning and fallen trees. There were no obvious signs of any slope instability such as tension cracks, slump or scarp zones outside of the scarp area. Further, there was no evidence of any significant surface or rill erosion outside of the scarp area (refer to the enclosed photographs and Figure 2 for photo locations). There is a small ravine/galley (about 1 to 6 m deep) within the southerly portion of the site that extends from the slope crest to the floodplain and Bronte Creek (refer to photographs 11, 12 and 15).

There is a 11 to 50 m wide vegetated flood plain located between a tributary of Bronte Creek and the slope toe within the northerly and southerly portions of the slope (refer to Section A-A', B-B', F-F' and G-G' locations) within the study area. There was no evidence of active slope toe erosion and/or undercutting within the northerly or southerly portions of the slope toe. However, the creek takes a sharp meander towards the subject slope within the central portion of the site and flows at the slope toe resulting in active toe erosion at the central portion of the slope. No significant/noticeable changes to the slope condition from 2016 were noted in the 2021 inspection.

### 5.1.2 Slope Stability Analysis

The boreholes were advanced on the tableland, in a relatively close proximity of the slope crest, to determine the subsurface soil and ground water conditions comprising the subject slope. The borehole data indicates that the subject slope consists of a relatively thin layer (about 0.8 to 1.2 m) of weathered/disturbed soil underlain by native soil deposits which was further underlain by inferred shale bedrock (Queenston Formation).

A detailed engineering analysis of slope stability was carried out for the selected slope cross-sections (Section E-E' and Section G-G') utilizing computer software Slide (version 7.036, developed by Rocscience) and several standard methods of limit equilibrium analysis (Bishop's, Janbu, and Spencer). 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 of soil (typically more than 2 m slip circle thickness) 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 the forces tending to cause movement. It is usual to require a Factor of Safety greater than one (1) to ensure stability of the slope. The typical Factors of Safety used for engineering design of slopes for stability, ranges from about 1.3 to 1.5 for developments situated close to the slope crest. The most common design guidelines 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 through the slope in search of the minimum or critical Factor of Safety for site specific conditions. The pertinent data obtained from the topographic and borehole information were input into the slope stability analysis. Many calculations were carried out to examine the Factors of Safety for varying depths for potential failure surfaces.

Based on the borehole results, the following average soil properties were utilized for the overburden soil strata in the slope stability analysis:

| Stratum | Unit Weight ($kN/m^3$) | Angle of internal friction $\phi$ (degree) | Cohesion c (kPa) |
|---|---|---|---|
| Clayey Silt Till | 21.0 | 32 | 6 |
| Silty Sand | 20.0 | 35 | 0 |
| Sandy Gravel to Sand and Gravel | 21.5 | 36 | 0 |

| | | | |
|---|---|---|---|
| Sand | 20.0 | 35 | 0 |

The above soil strength parameters are based on the effective stress analysis for long-term slope stability. It is noted that the above soil parameters are conservative and actual site soils are stronger. The ground water levels as measured in the monitoring wells installed in Boreholes 21-1 and 21-2 were also incorporated in the slope stability analysis.

The bedrock was encountered in both boreholes at depths of about 19.8 m to 25.9 m below grade. Based on the overburden soil type comprising the slope and the slope configuration, the formation of high pore water pressure (elevated water table) within the overburden soils is unlikely. However, conservatively, the effect of a hypothetical elevated water level (water level assumed to be within about 1 to 2 m of the ground surface) on the slope stability was also analyzed to simulate short-term, temporary and infrequent ground water level condition.

The results of the slope stability analyses are presented on the enclosed figures and are summarized below:

| Section | Approximate Slope Inclination | Minimum Factor of Safety for Potential Slope Slides | | Type of Slope Slide |
|---|---|---|---|---|
| | | Normal Ground Water | Elevated Ground Water | |
| Section E-E’ | ±0.9 H : 1 V | 1.02 | * | Overburden Slope Slide |
| Section G-G’ | ±0.7 H : 1 V Upper<br>±1.3 H : 1 V Lower | 1.01 | * | Overburden Slope Slide |

* The minimum Factors of Safety for both sections for normal ground water level are lower than a 1.30 Factor of Safety which is required for elevated ground water condition, therefore, these sections were not analyzed for elevated (temporary) ground water condition as the slope at these locations is considered to be unstable even at normal ground water level condition.

The minimum factors of safety for Sections E-E’ and G-G’ were 1.02 and 1.01 for normal ground water level condition. As noted above both sections were not analysed for high/elevated ground water level condition as the Factors of Safety obtained from the normal ground water level condition were lower than the required Factor of Safety, and therefore, these slopes are considered to be unstable in the long-term.

For an active land used, the MNR Policy Guidelines allow a minimum Factor of Safety range 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 |

Conservation Halton’s Policies, procedures and guidelines (based on the MNR Guidelines) require a 1.5 minimum Factor of Safety for slope stability for land development and planning over the long-term. A minimum factor of safety of 1.5 is required for normal ground water condition and a minimum factor of safety of 1.3 is required for elevated, short term and infrequent ground water condition.

The minimum factors of safety for Sections E-E’ and G-G’ were 1.02 and 1.01 for normal ground water level condition. Therefore, the minimum factors of safety obtained for both sections for the existing slope condition are lower than the minimum required factors of safety, and therefore are not considered adequate with respect to the long-term stability of the site slope.

Therefore, a number of representative trial profiles of the slope with flatter inclinations and similar slope height and subsurface conditions as those of Sections E-E’ and G-G’ were analyzed to obtain the minimum factors of safety in conformance to the policy guidelines. These two sections were selected to represent the most critical overburden slope conditions within the extended study area.

The results of the slope stability analysis conducted for a hypothetical slope profile with a flatter inclination of 1.8 horizontal to 1.0 vertical through the native soils for the subject slope with similar slope height and sub-surface conditions as those of Sections E-E’ and G-G’, for both normal and elevated ground water conditions, are presented on the enclosed figures, and summarized below:

| Section | Stable Slope Inclination | Minimum Factor of Safety for Potential Slope Slides | Type of Slope Slide |
|---|---|---|---|

| | | **Normal Ground Water** | **Elevated Ground Water** | |
|---|---|---|---|---|
| Section E-E’ | Native Soils 1.8 H : 1 V | 1.53 | 1.34 | Overburden Slope Slide |
| Section G-G’ | Native Soils 1.8 H : 1 V | 1.67 | 1.32 | Overburden Slope Slide |

The above computed minium factors of safety were 1.53 and 1.67 for long term (normal ground water condition) and 1.34 and 1.32 for temporary and infrequent condition (elevated ground water level) for Sections E-E’ and G-G’, respectively, which are considered to be adequate, and are in conformance to the Conservation Halton’s Policies, procedures and guidelines and industry standards.

Therefore, a slope inclination of 1.8 to 1.0 (horizontal to vertical) or flatter is required for the long-term stability of the native overburden portion. It is noted that the calculated long-term stable slope inclination for this site is consistent with our previous studies conducted at this site (File No. 1-16-0035-01) and the general area which is about 1.8 to 1.0 (horizontal to vertical) for the native overburden in the general area. As there were no significant/noticeable changes to the slope condition between the 2016 and 2021 inspections, the LTSSC from the 2016 report requires no changes at this time and is still considered to be valid for the 2016 Study Area.

The *Credit Valley Conservation - Slope Stability Definition and Determination Guidelines, February 2014* recommend a stable slope inclination of 1.4 horizontal to 1 vertical (Generalized Stability Setback Guidelines) for shale bedrock without rock coring and characterization. The topographic information indicates that the lower portion of the slope comprising shale is currently slightly steeper than the recommended stable slope inclination (for Section E-E’). Therefore, a stability setback should be applied to the slope by extending a line at 1.4 horz. to 1 vert. inclination through the shale portion of the slope, at 1.8 horz. to 1 vert. (stable) inclination through the native overburden soil. The stability setback line shall extend from the applicable toe erosion allowance (erosion component, see Section 5.2).

## 5.2 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 slope toe. A guideline table (MNR) recommended for estimating the toe erosion allowance is presented as follows:

## Guideline Table

**MINIMUM TOE EROSION ALLOWANCE - River within 15 m of Slope Toe ***

| Type of Material<br>Native Soil Structure | Evidence of Active Erosion** or<br>Bankfull Flow Velocity > Competent Flow Velocity*** | No evidence of Active Erosion** or<br>Flow Velocity << Competent Flow Velocity*** | | |
|---|---|---|---|---|
| | | Bankfull Width | | |
| | | <5 m | 5 - 30 m | > 30 m |
| 1. Hard Rock (granite) | 0 - 2 m | 0 m | 0 m | 1 m |
| 2. Soft Rock (shale, limestone)<br>Cobbles, Boulders | 2 - 5 m | 0 m | 1 m | 2 m |
| 3. Stiff/Hard Cohesive Soil (clays, clayey silt)<br>Coarse Granular (gravels)<br>Tills | 5 - 8 m | 1 m | 2 m | 4 m |
| 4. Soft/Firm Cohesive Soil<br>Fine Granular (sand, silt)<br>Fill | 8 - 15 m | 1-2 m | 5 m | 7 m |

* If a valley floor is > 15m width, still may require study or inclusion of a toe erosion allowance.

** Active Erosion is defined as: bank material is bare and exposed directly to stream flow under normal or flood flow conditions and, where undercutting, over steepening, slumping of a bank or high down stream sediment loading is occurring. An area may be exposed to river flow but may not display “active erosion” (i.e. is not bare or undercut) either as a result of well rooted vegetation or as a result of shifting of the channel or because flows are relatively low velocity. The toe erosion allowances presented in the right half of Table 2 are suggested for sites with this condition.

*** Competent Flow velocity; the flow velocity that the bed material in the stream can support without resulting in erosion or scour. Consideration must also be given to potential future meandering of the watercourse channel.

Source: Ontario Ministry of Natural Resources (2002), “Technical Guide River & Stream Systems: Erosion Hazard Limit, pp38

The MNR Guidelines “Geotechnical Principles for Stable Slopes” recommend an erosion setback where a watercourse is located within 15 m of the slope toe. The Guideline Table recommends different ranges of erosion setbacks based on the native soil structure comprising the slope, degree of erosion, and watercourse characteristics.

At this site the slope toe consists of shale bedrock. At the southerly portion of the site (Sections F-F’ and G-G’) of the slope toe is separated by a vegetated floodplain of about 20 to 50 m wide and there was no obvious evidence of active slope toe erosion in this area. However, at the central portion of the slope (Section E-E’), the creek is in direct contact with the valley wall resulting in active slope toe erosion. The MNR Guidelines require a toe erosion allowance of 2 to 5 m for a slope toe comprising shale for an active erosion condition.

Conservatively, a toe erosion setback of 5 m is recommended at this site (as per the MNR Guidelines) to be applied for the entire site slope within the study area, as applicable.

Therefore, the long-term stable slope crest location at this site can be determined by applying a toe erosion setback of 5 m at the slope toe (as applicable), and extending a stability setback line from the toe erosion setback drawn at 1.4 horz. to 1 vert. inclination through the shale (where applicable), at 1.8 horz. to 1 vert. inclination through the native overburden portion of the slope. The location of the estimated Long-term Stable Slope crest is shown on Figure 2 in plan, and Figures 3A to 3C in sections, respectively. For planning purposes the long-term refers to a 100 year planning horizon.

## 6. SUMMARY

The borehole data indicates that the site slope consists of a surficial layer of topsoil, underlain by a layer of earth fill materials/weathered/disturbed soil which was further underlain by undisturbed native soil overburden which graded into shale (inferred Bedrock of Queenston Formation) at depths of about 19.8 to 25.9 m below grade.

As noted before, the slope is relatively steep (about 0.6 to 2.1 horiz. to 1 vert). Therefore, a stability setback of 1.4 horz. to 1 vert. is recommended for the slope portion comprising shale and 1.8 horz. to 1 vert. for the native soil overburden at this site. The slope toe within the study area, consists of shale and evident of active toe erosion was noted at the slope toe within the central portion of the slope as the watercourse is located at the slope toe in this area. Conservatively a toe erosion setback (Erosion Component) of 5 m is recommended for the site slope.

Therefore, the location of the Long-Term Stable Slope Crest (LTSSC) was calculated (according to the appended Long-Term Stable Slope Crest Model) by applying a toe erosion allowance of 5 m at the slope toe (where applicable) and extending a stability setback line at 1.4 horz. to 1 vert. inclination through the shale portion of the slope (where applicable) and 1.8 horz. to 1 vert. through the native overburden.

The location of the Long-Term Stable Slope Crest was determined in accordance with the Long-Term Stable Slope Crest model (see enclosed) and is presented on Figure 2 (in plan) and Figures 3A to 3D (in section) extending the existing LTSSC from the 2016 report to cover the full site. For planning purposes, the long-term refers to a 100 year planning horizon.

The following general constraints on any future development on the property, are recommended:

a) site development and construction activities should be conducted in a manner which do 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, swimming pools and the like should not be permitted to flow over the slope, but a minor sheet flow may be acceptable,

b) the existing vegetation cover should be maintained on the slope.

c) the configuration of the slope should not be altered without prior consultation with a geotechnical engineer and approval from concerned authorities. In particular, the slope should not be steepened,

d) a silt fence should be erected and maintained downslope of the work area during construction, and

e) all necessary approvals and permits must be obtained from regulatory authorities/agencies prior to the commencement of site works.

## 7. LIMITATIONS AND USE OF REPORT

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. 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 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 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.

The discussion and recommendations are based on the factual data obtained from the investigation and are intended for use by the owner and its retained designers.

The investigation at this site was conceived and executed to provide information for the slope stability study. 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 have an effect on construction costs, techniques, equipment, and scheduling. Contractors bidding on or undertaking work on this project should therefore, in this light, be directed to decide on their own investigations, as well as their own interpretations of the factual investigation results. They should be cognizant of the risks implicit in subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was prepared for the express use of Bronte River LP c/o Argo Development Corporation and their retained design consultants. It 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 Bronte River LP c/o Argo Development Corporation 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
M.M. TALUKDAR
100078125
Dec. 21, 2021
PROVINCE OF ONTARIO

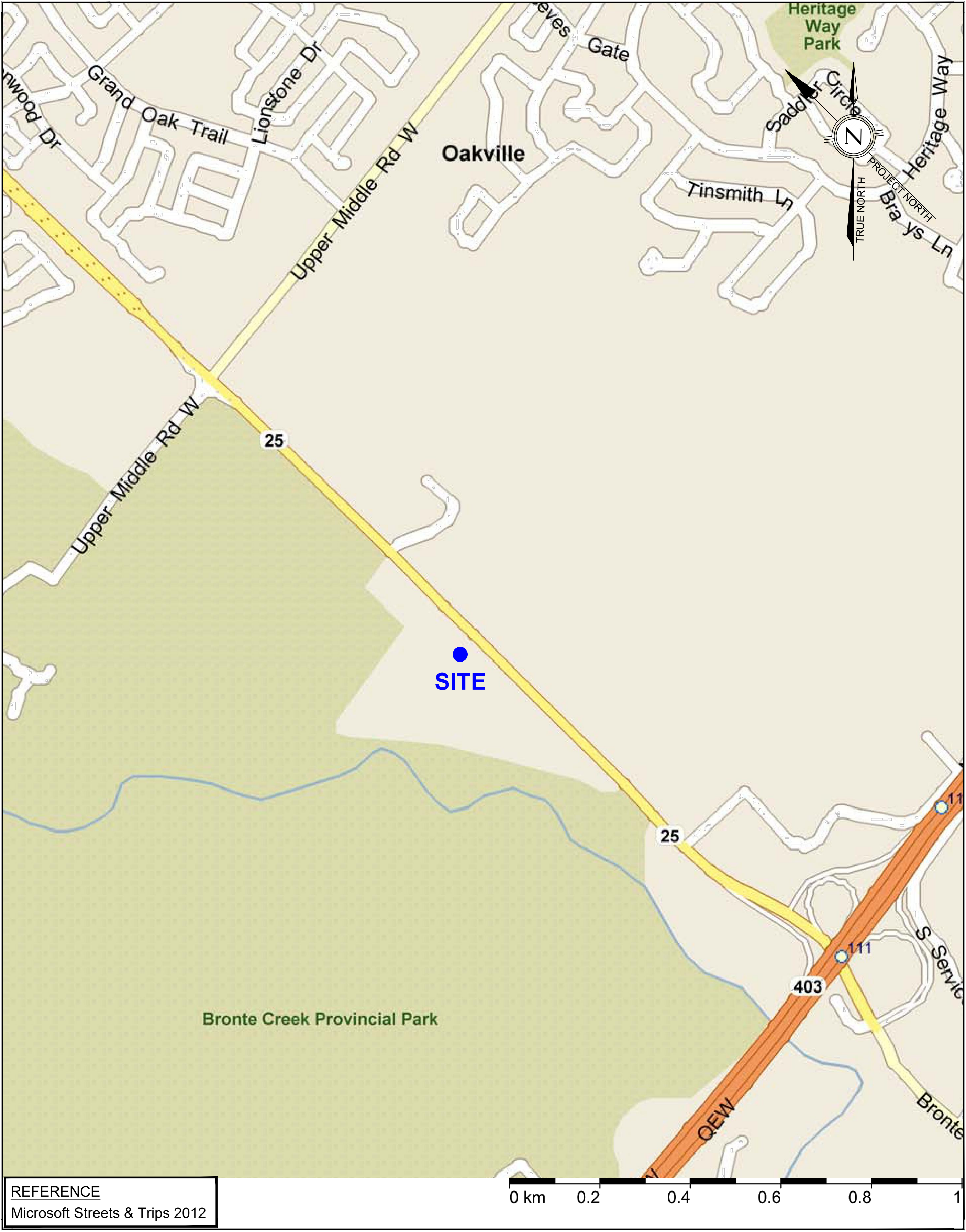
M. Talukdar

Connor McCormick, EIT.
Geotechnical Engineering Division

Madan Talukdar, P. Eng.
Associate

# FIGURES

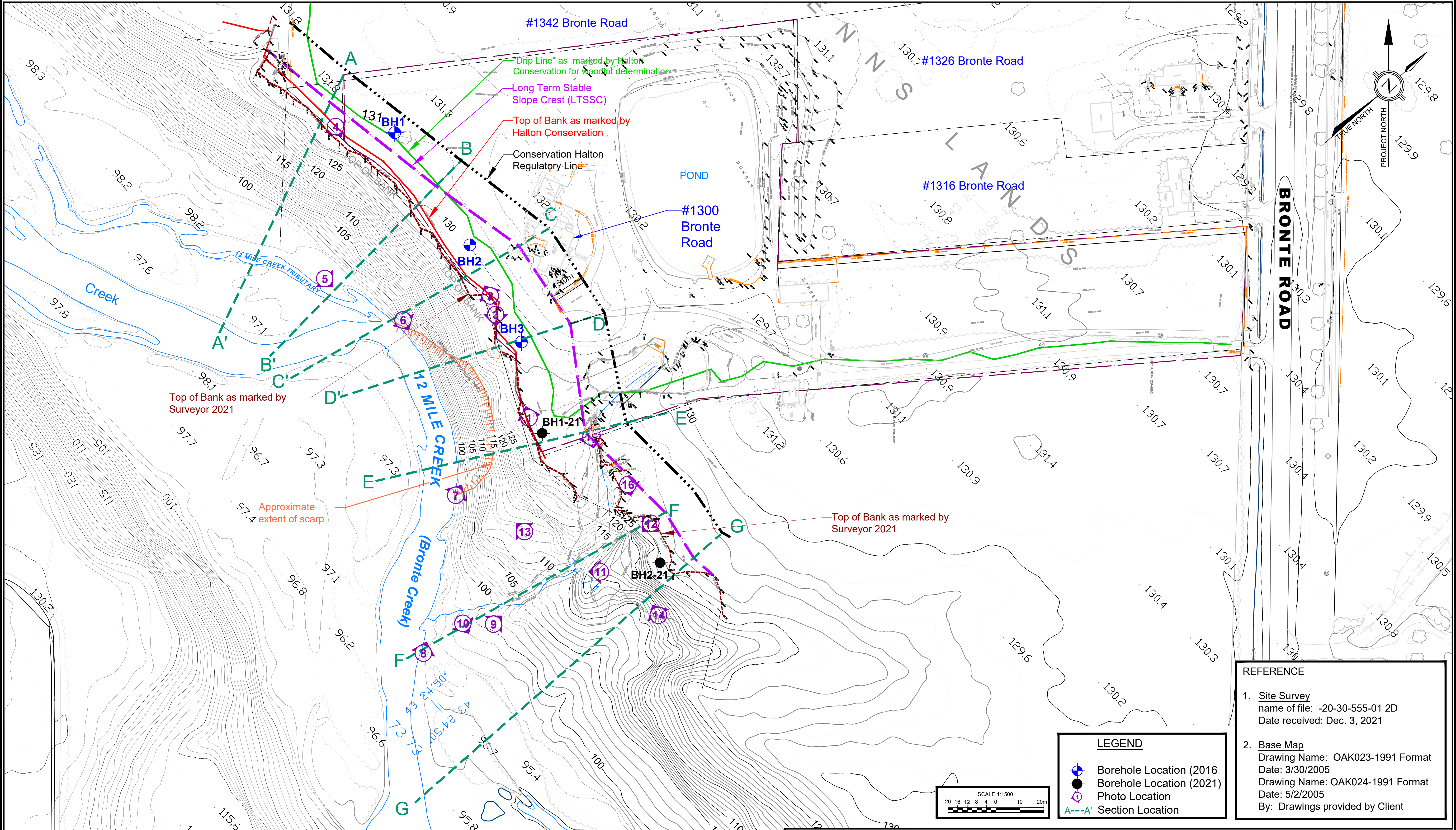
TERRAPROBE INC.



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. | 1-16-0035-02 |
| FIGURE : | 1 |



SCALE 1:1500
20 16 12 8 4 0 10 20m

LEGEND

- ⊕ Borehole Location (2016
- ● Borehole Location (2021)
- ① Photo Location
- A---A' Section Location

REFERENCE

1. Site Survey
   name of file: -20-30-555-01 2D
   Date received: Dec. 3, 2021

2. Base Map
   Drawing Name: OAK023-1991 Format
   Date: 3/30/2005
   Drawing Name: OAK024-1991 Format
   Date: 5/2/2005
   By: Drawings provided by Client

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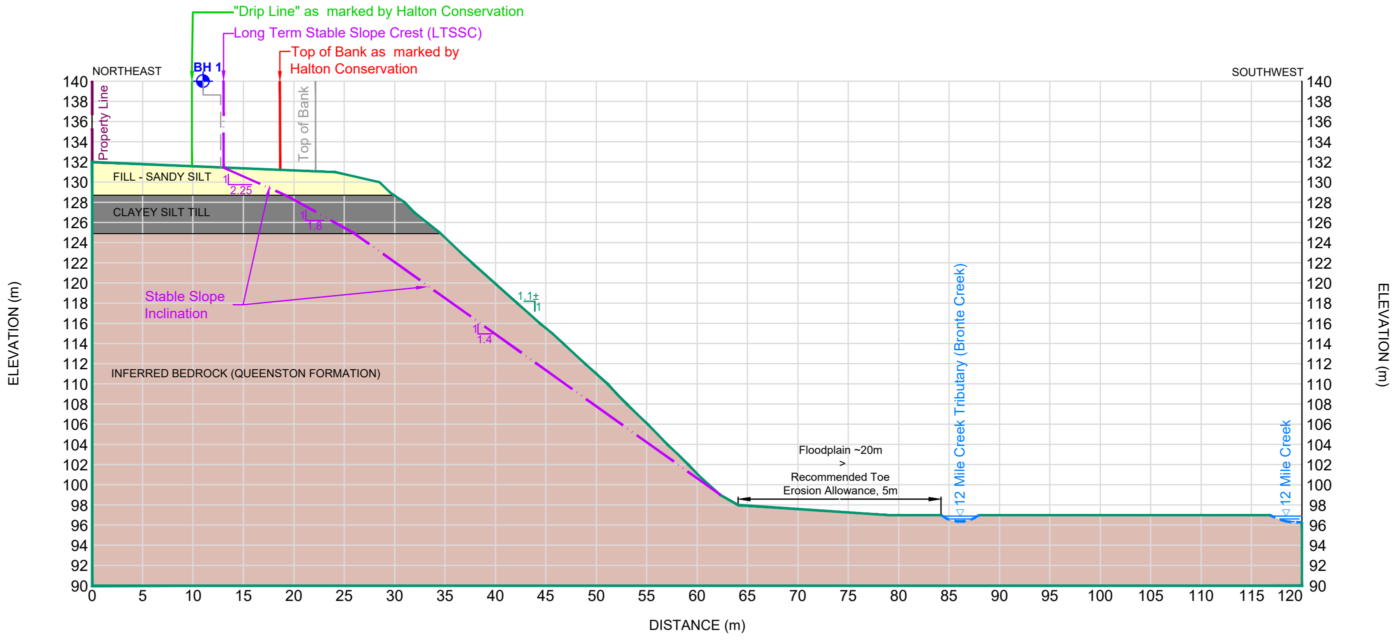
**Title:**
BOREHOLE LOCATION AND SITE FEATURES PLAN

**File No.** 1-16-0035-02

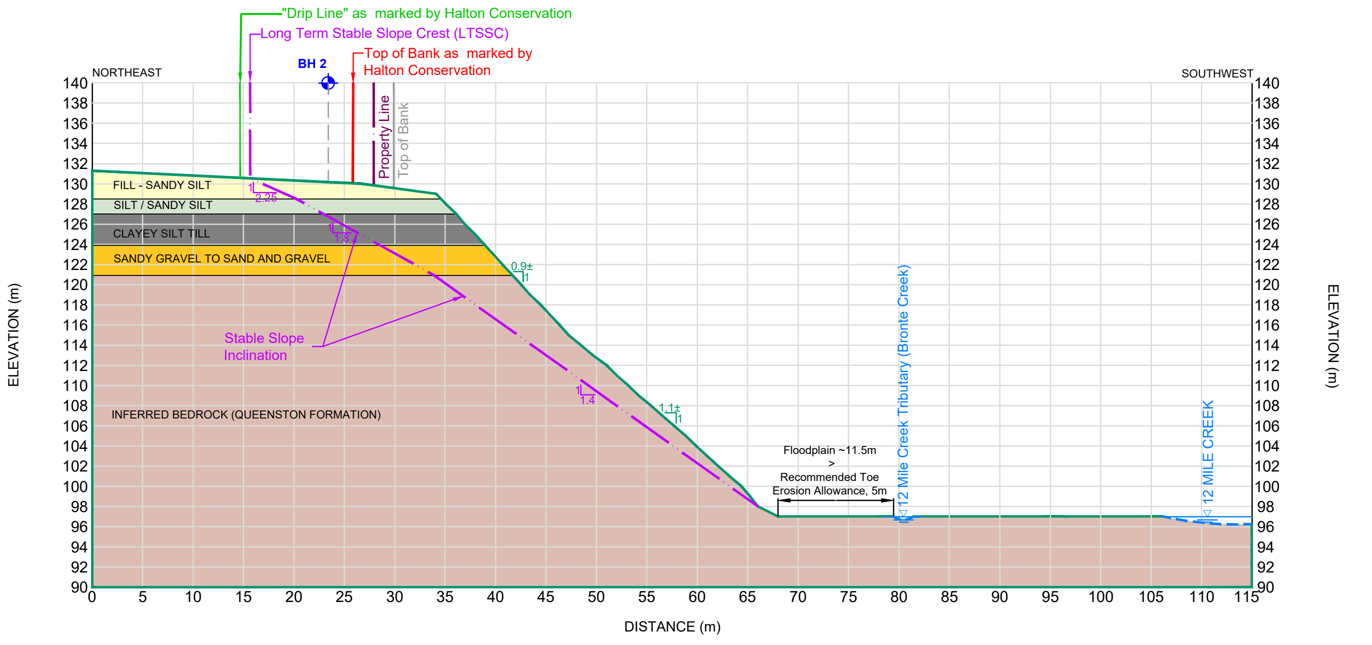
**FIGURE :** 2

\\10.70.216.35\tss\1-Project Files\2016\1-16-0035 - 1300 Bronte Road, Oakville\02-LTSSC Update - Geo Slope Erosion\A. Dwgs, Logs\AutoCAD\1-16-0035-02 (2021-12-06) FIG.dwg,
DWG To PDF.pc3, Kamal, Kamal

# SECTION A-A'



# SECTION B-B'



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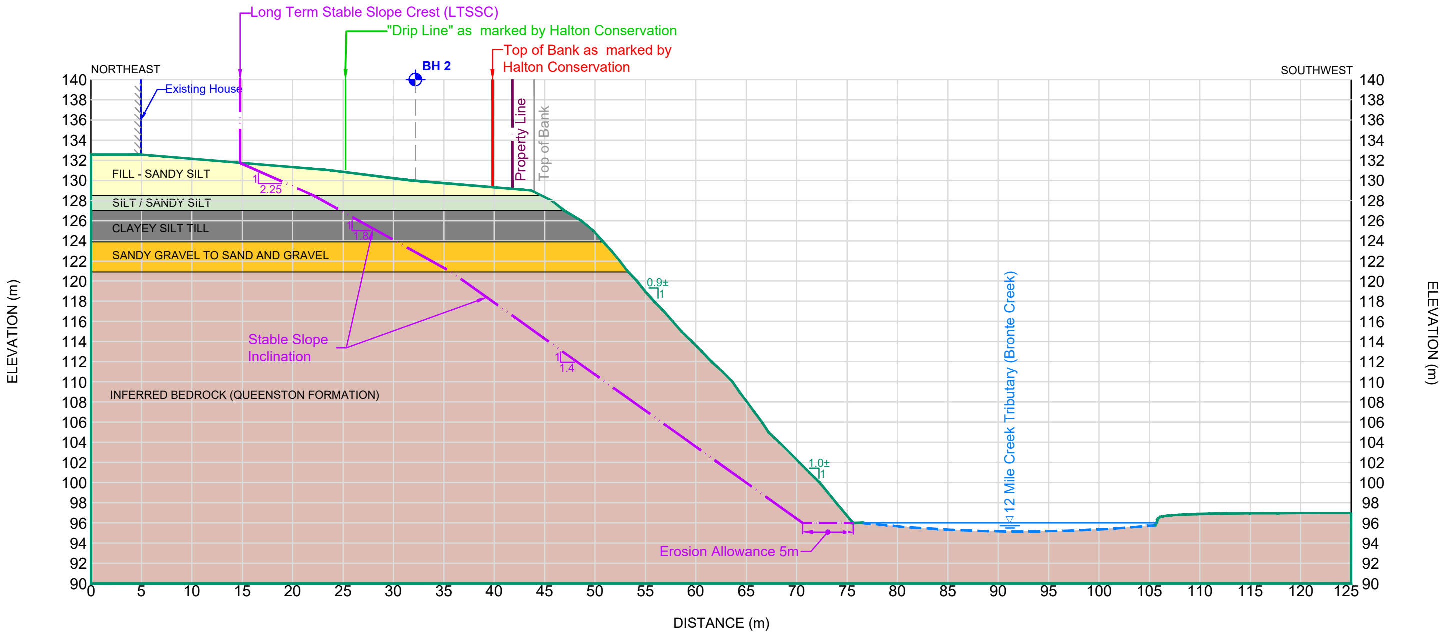

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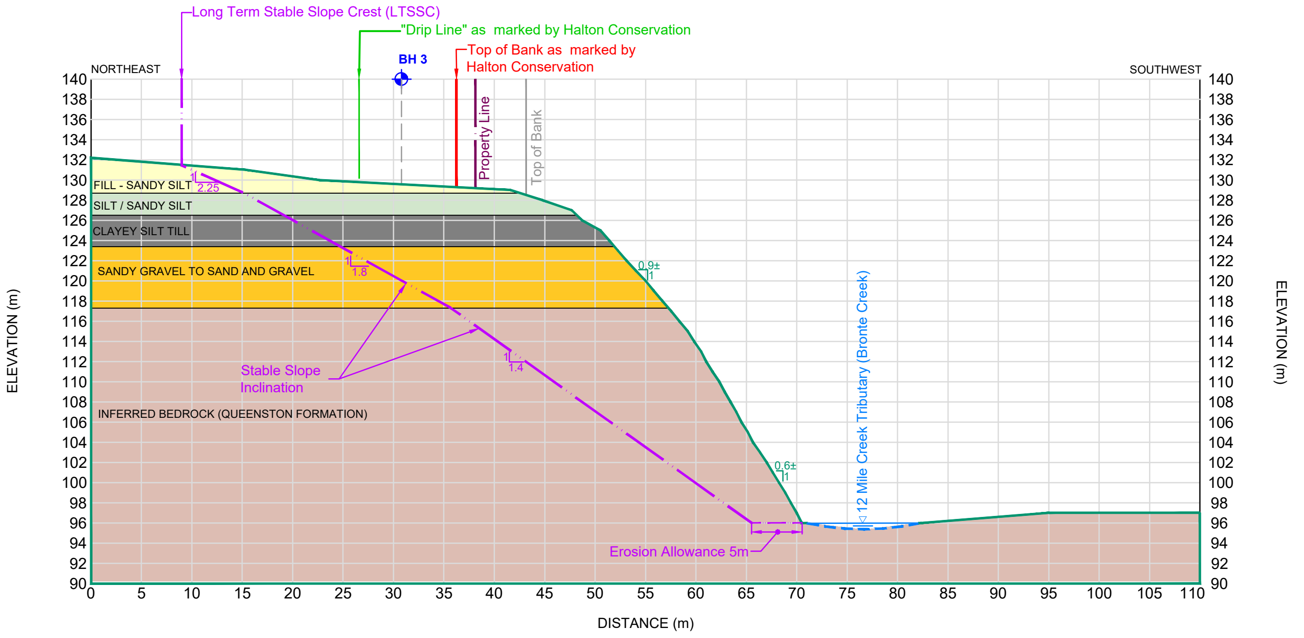

SCALE 1:750
2 10 5m

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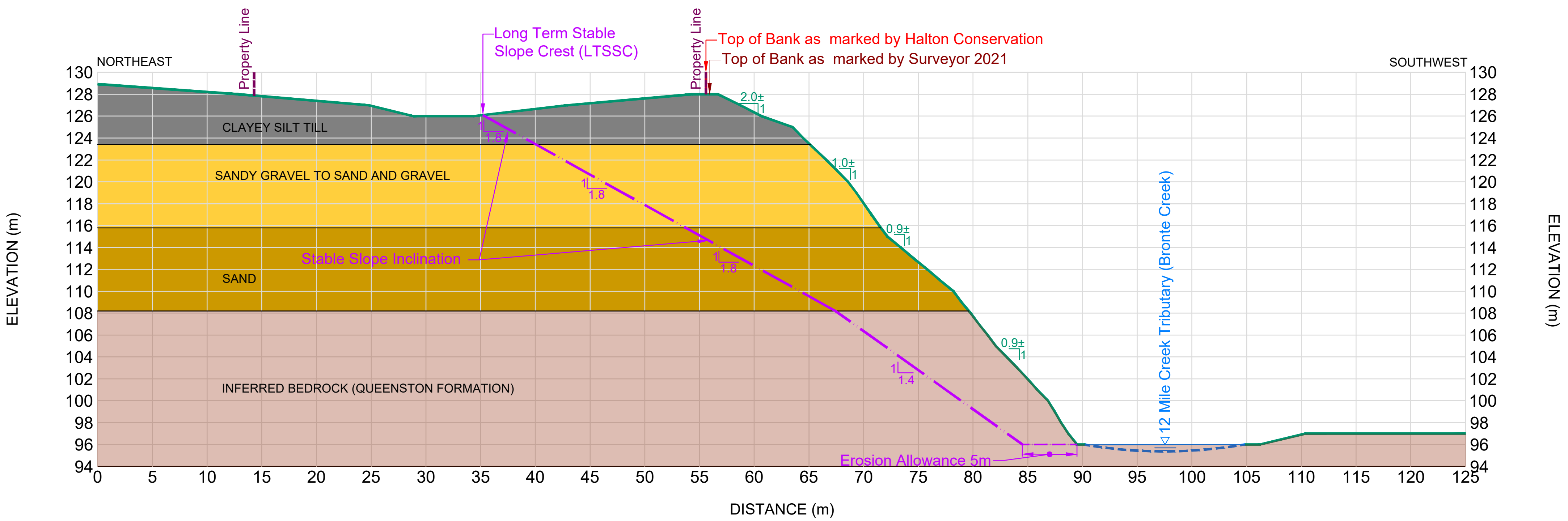
**Title:** SLOPE CROSS SECTIONS

**File No.** 1-16-0035-02

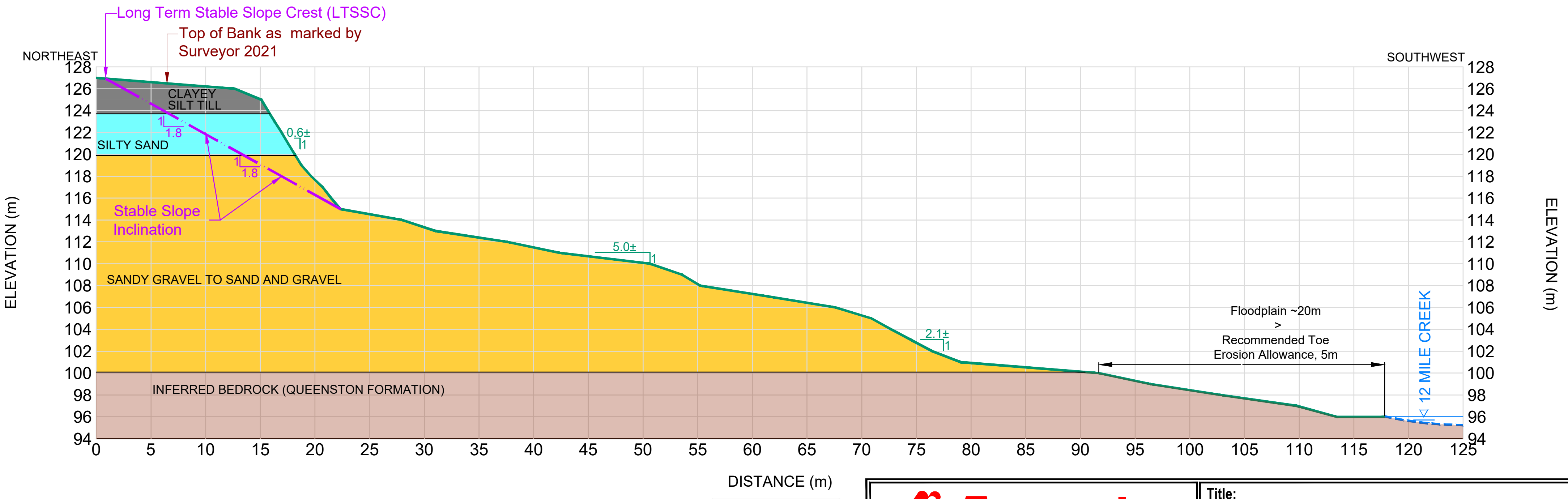
**FIGURE :** 3A

T:\1-Project Files\2016\1-16-0035 - 1300 Bronte Road, Oakville\02-LTSSC Update - Geo Slope Erosion\A. Dwgs, Logs\AutoCAD\1-16-0035-02 (2021 11 27) FIG.dwg, Sandy

## SECTION E-E'



## SECTION F-F'



SCALE 1:500
2 0 5m

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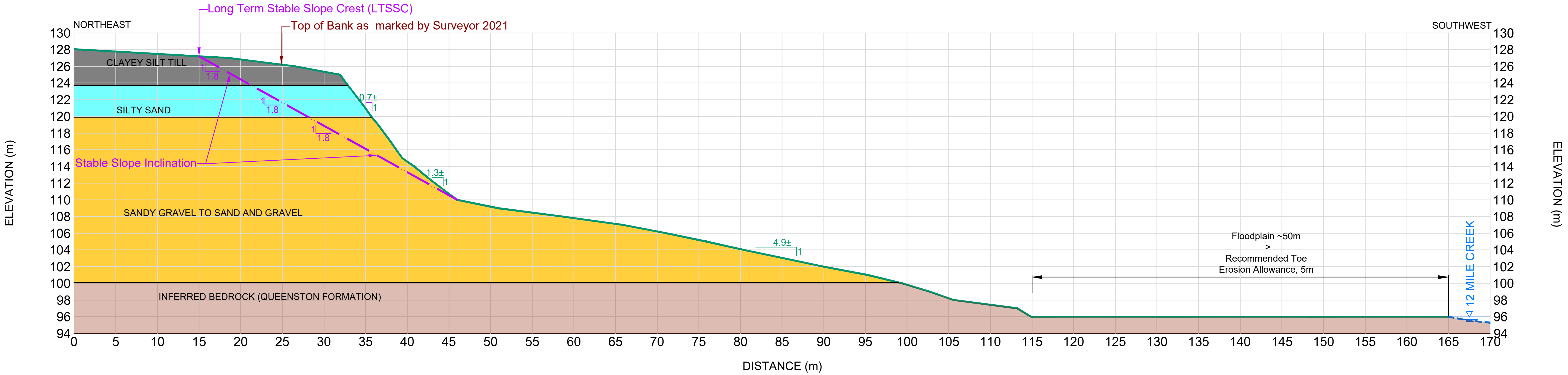
**Title:** SLOPE CROSS SECTIONS

**File No.** 1-16-0035-02

**FIGURE :** 3B

# SECTION G-G'



SCALE 1:500
2 0 5m

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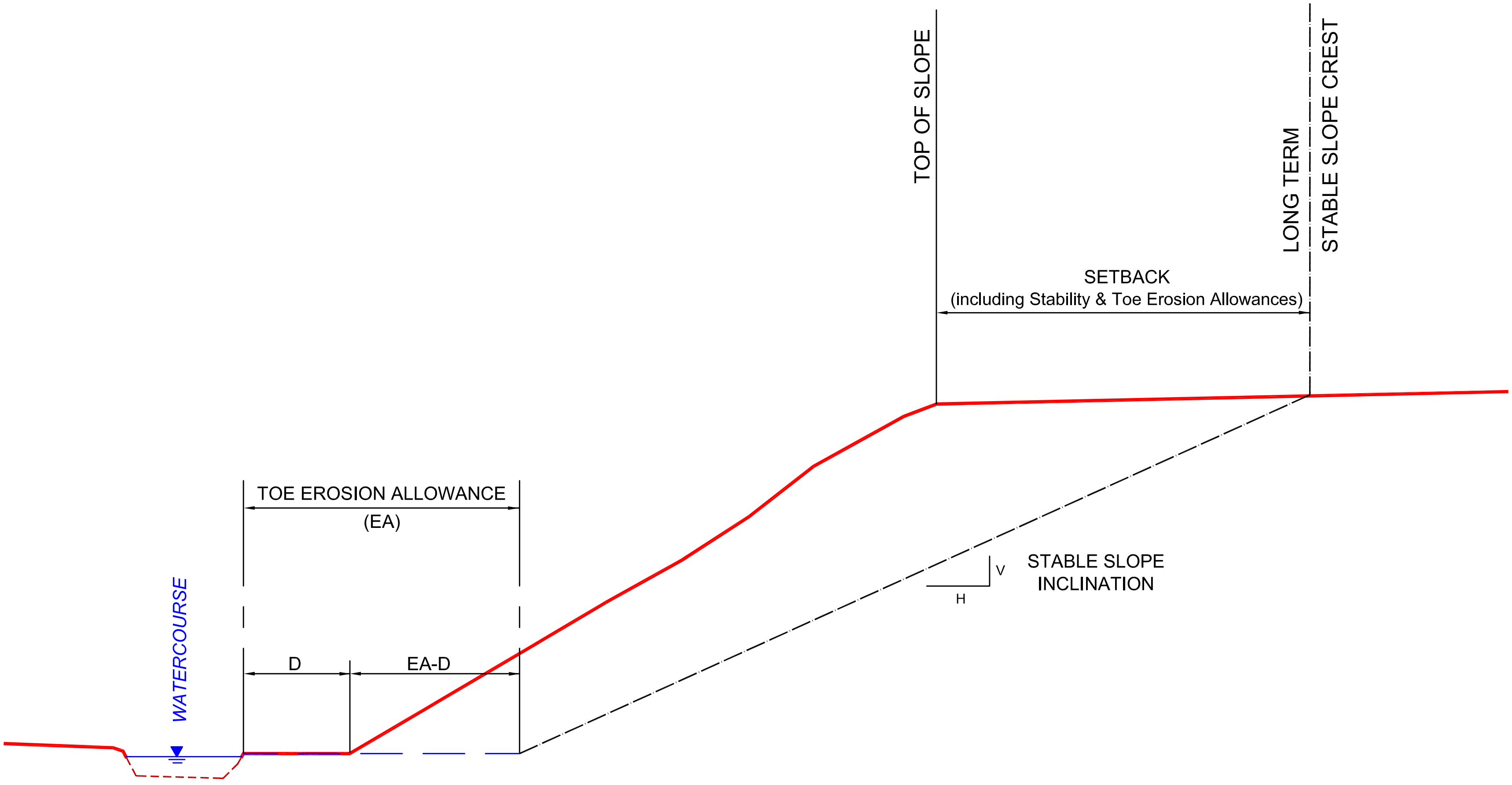
**Title:**
SLOPE CROSS SECTIONS

**File No.**
1-16-0035-02

**FIGURE :**
3C

\\10.70.216.35\tss\1-Project Files\2016\1-16-0035 - 1300 Bronte Road, Oakville\02-LTSSC Update - Geo Slope Erosion\A. Dwgs, Logs\AutoCAD\1-16-0035-02 (2021-12-06) FIG.dwg,
DWG To PDF.pc3, Kamal, Kamal



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

# APPENDICES

TERRAPROBE INC.

# APPENDIX A

TERRAPROBE INC.

# 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 |
| silt*y* | 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 |
| $\gamma$ | soil unit weight, bulk |
| $G_s$ | specific gravity |
| $\varphi'$ | 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 plastic limit) but does not have visible pore water |
| **Wet** | refers to a soil sample that has visible pore water |

**Terraprobe**

# LOG OF BOREHOLE 21-1

Project No. : 1-16-0035-02
Date started : November 4, 2021
Sheet No. : 1 of 2

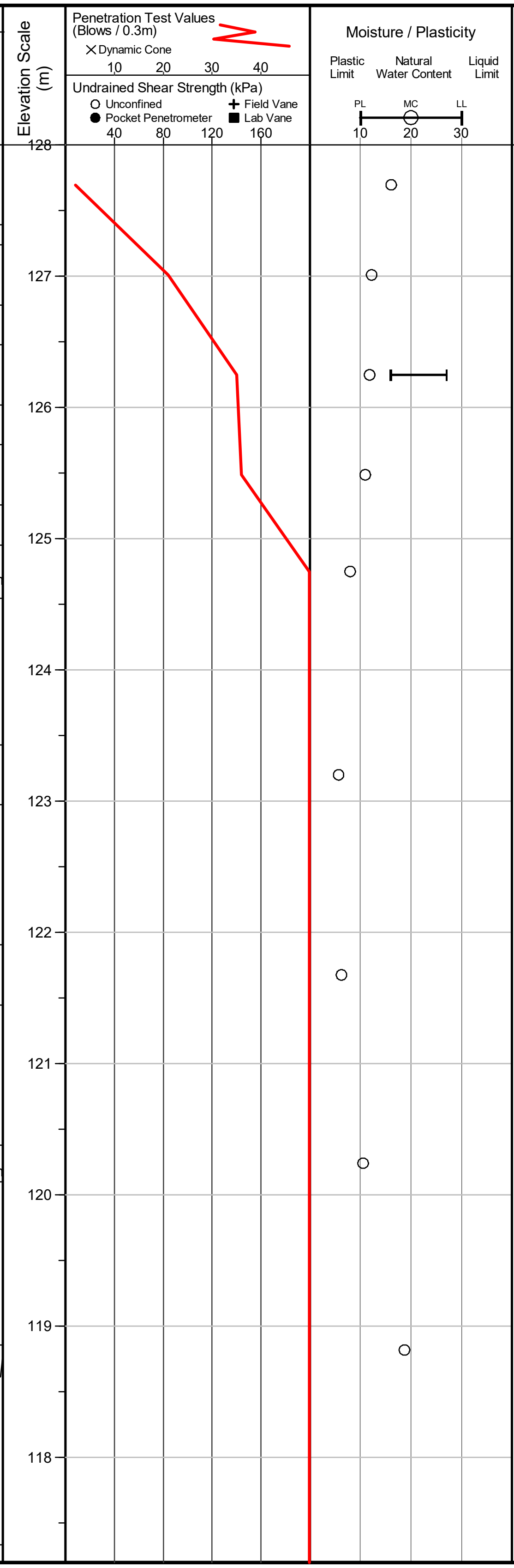
Client : Bronte River LP
Project : 1300 Bronte Road
Location : Oakville, Ontario

Originated by : RS
Compiled by : CM
Checked by : MMT

Position : E: 600943, N: 4807415 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Hollow stem augers / mud rotary (tricone)

| Elev Depth (m) | SOIL PROFILE Description | SAMPLES Number | SAMPLES Type | SPT 'N' Value | Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL |
|---|---|---|---|---|---|
| 128.0 | **GROUND SURFACE** | | | | |
| 127.8<br>0.2 | 150mm **TOPSOIL**<br>(WEATHERED/DISTURBED) | 1 | SS | 2 | |
| 127.2<br>0.8 | **CLAYEY SILT**, sandy, trace gravel, very stiff to hard, reddish brown, moist (GLACIAL TILL) | 2 | SS | 21 | |
| | | 3 | SS | 35 | 3 27 46 24 |
| | | 4 | SS | 36 | |
| | | 5 | SS | 88 / 250mm | |
| 123.4<br>4.6 | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, moist | 6 | SS | 78 | |
| | | 7 | SS | 95 | |
| | | 8 | SS | 50 / 125mm | |
| | ...at 9.1 m, wet below | 9 | SS | 50 / 75mm | |
| | | 10 | SS | 57 | |



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

(continued next page)

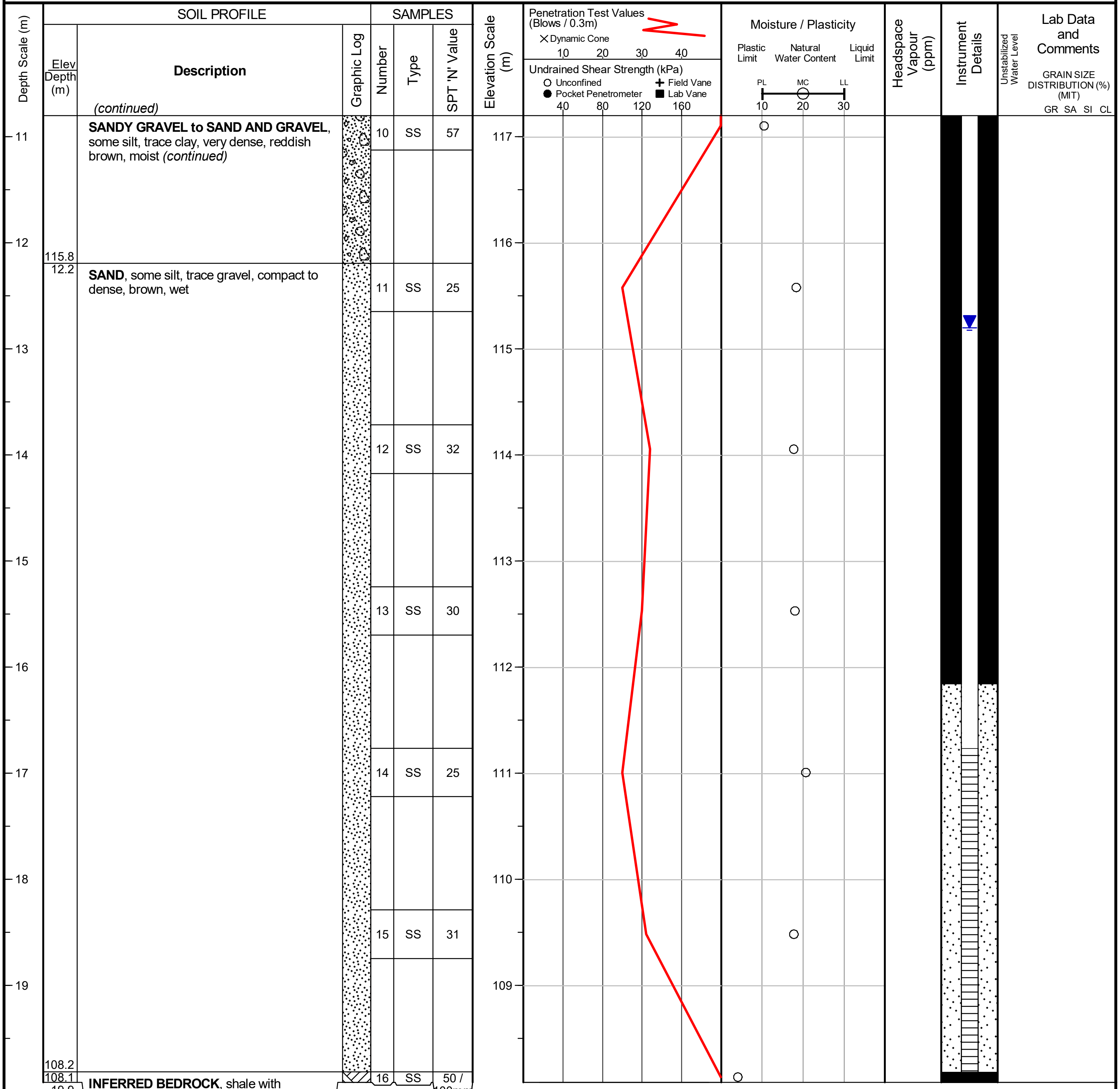
file: 1-16-0035-02 bh logs.gpj

# LOG OF BOREHOLE 21-1

Project No. : 1-16-0035-02
Client : Bronte River LP
Originated by : RS
Date started : November 4, 2021
Project : 1300 Bronte Road
Compiled by : CM
Sheet No. : 2 of 2
Location : Oakville, Ontario
Checked by : MMT

Position : E: 600943, N: 4807415 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Hollow stem augers / mud rotary (tricone)

| SOIL PROFILE | | | SAMPLES | | |
|---|---|---|---|---|---|
| Elev Depth (m) | Description | Graphic Log | Number | Type | SPT 'N' Value |
| | *(continued)* | | | | |
| | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, moist *(continued)* | | 10 | SS | 57 |
| 115.8<br>12.2 | **SAND**, some silt, trace gravel, compact to dense, brown, wet | | 11 | SS | 25 |
| | | | 12 | SS | 32 |
| | | | 13 | SS | 30 |
| | | | 14 | SS | 25 |
| | | | 15 | SS | 31 |
| 108.2<br>108.1<br>19.9 | **INFERRED BEDROCK**, shale with intermittent sandstone, limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) | | 16 | SS | 50 / 100mm |



WATER LEVEL READINGS

| Date | Water Depth (m) | Elevation (m) |
|---|---|---|
| Nov 30, 2021 | 12.8 | 115.2 |

**END OF BOREHOLE**

Unstabilized water level and depth at cave could not be determined due to use mud rotary drilling technique.

50 mm dia. monitoring well installed.

**Terraprobe**

# LOG OF BOREHOLE 21-2

Project No. : 1-16-0035-02
Date started : October 26, 2021
Sheet No. : 1 of 3

Client : Bronte River LP
Project : 1300 Bronte Road
Location : Oakville, Ontario

Originated by : OE/RS
Compiled by : CM
Checked by : MMT

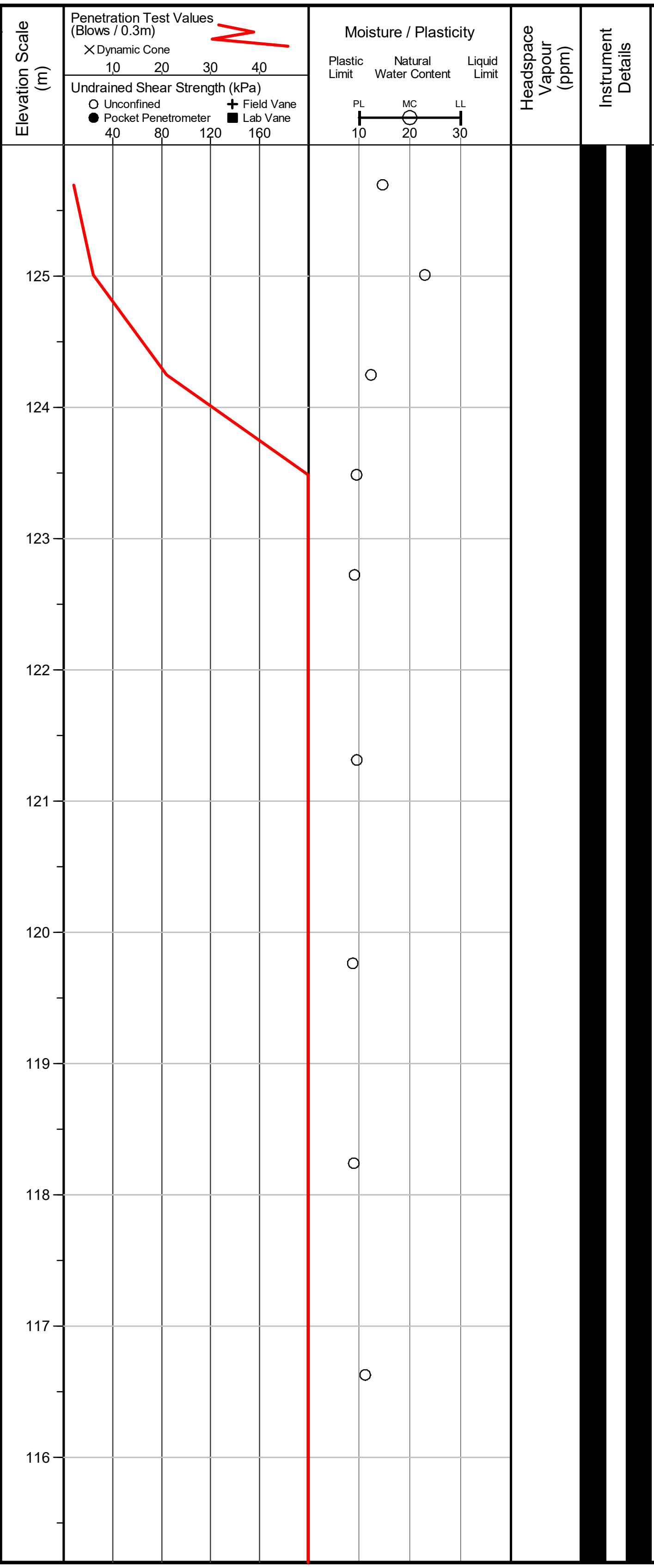
Position : E: 601025, N: 4807419 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers / mud rotary (tricone)

SOIL PROFILE

| Elev Depth (m) | Description |
|---|---|
| 126.0 | **GROUND SURFACE** |
| | 200mm **TOPSOIL** |
| 125.8<br>0.2 | (WEATHERED/DISTURBED) |
| 124.8<br>1.2 | **CLAYEY SILT**, some sand to sandy, trace gravel, very stiff, reddish brown, moist (GLACIAL TILL) |
| 123.7<br>2.3 | **SILTY SAND**, some gravel to gravelly, trace clay, very dense, reddish brown, moist |
| 119.9<br>6.1 | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, moist |

SAMPLES

| Number | Type | SPT 'N' Value | GR | SA | SI | CL |
|---|---|---|---|---|---|---|
| 1 | SS | 2 | | | | |
| 2 | SS | 6 | | | | |
| 3 | SS | 21 | | | | |
| 4 | SS | 57 | | | | |
| 5 | SS | 71 | | | | |
| 6 | SS | 50 / 75mm | 22 | 49 | 21 | 8 |
| 7 | SS | 50 / 125mm | | | | |
| 8 | SS | 50 / 125mm | | | | |
| 9 | SS | 59 | | | | |
| 10 | SS | 60 | | | | |



Depth Scale (m): 0 1 2 3 4 5 6 7 8 9 10

Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)

(continued next page)

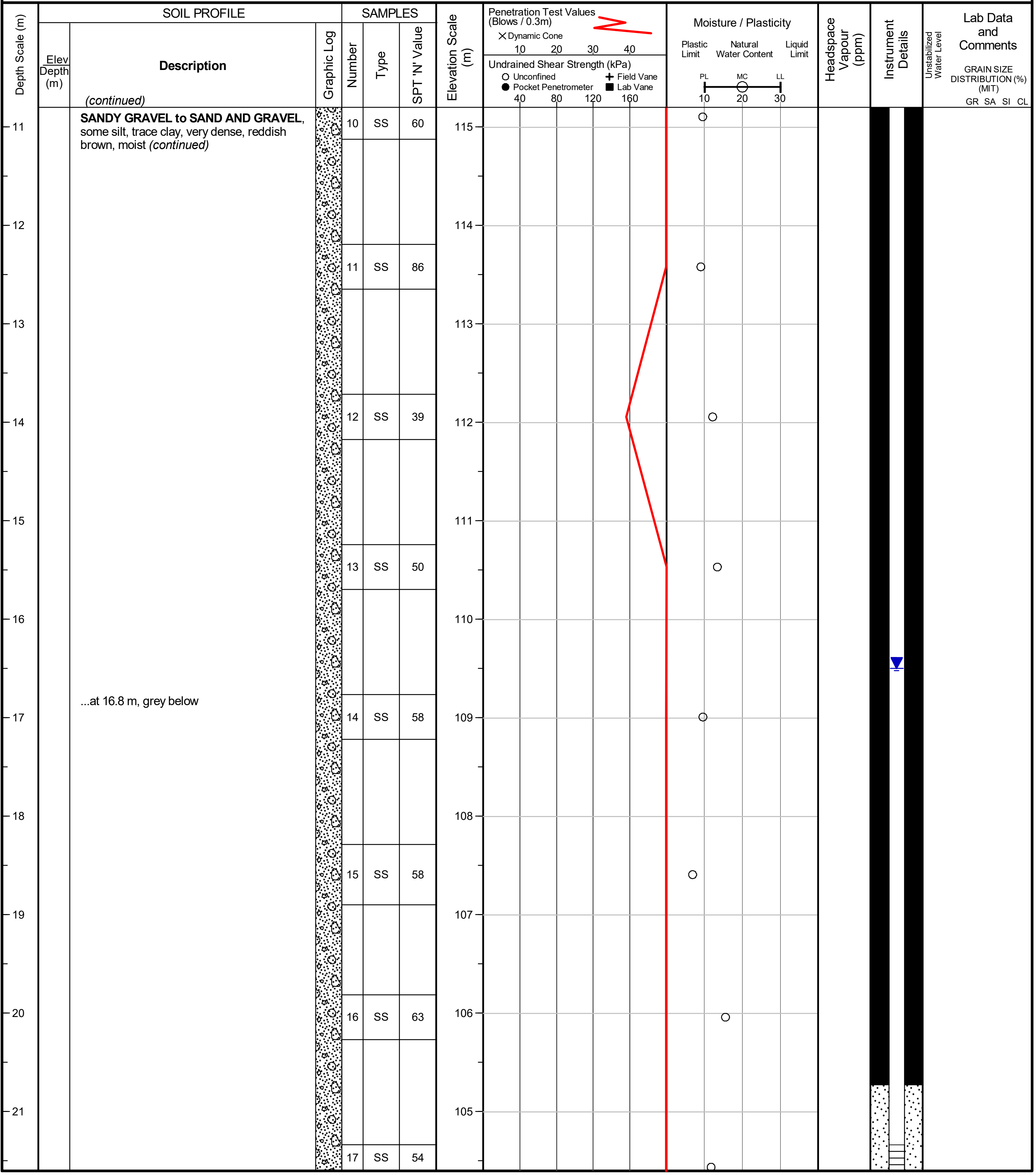
# LOG OF BOREHOLE 21-2

Project No. : 1-16-0035-02
Date started : October 26, 2021
Sheet No. : 2 of 3

Client : Bronte River LP
Project : 1300 Bronte Road
Location : Oakville, Ontario

Originated by : OE/RS
Compiled by : CM
Checked by : MMT

Position : E: 601025, N: 4807419 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Hollow stem augers / mud rotary (tricone)



*(continued)*

**SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, moist *(continued)*

...at 16.8 m, grey below

| Number | Type | SPT 'N' Value |
|---|---|---|
| 10 | SS | 60 |
| 11 | SS | 86 |
| 12 | SS | 39 |
| 13 | SS | 50 |
| 14 | SS | 58 |
| 15 | SS | 58 |
| 16 | SS | 63 |
| 17 | SS | 54 |

*(continued next page)*

file: 1-16-0035-02 bh logs.gpj

Terraprobe

# LOG OF BOREHOLE 21-2

Project No. : 1-16-0035-02
Date started : October 26, 2021
Sheet No. : 3 of 3

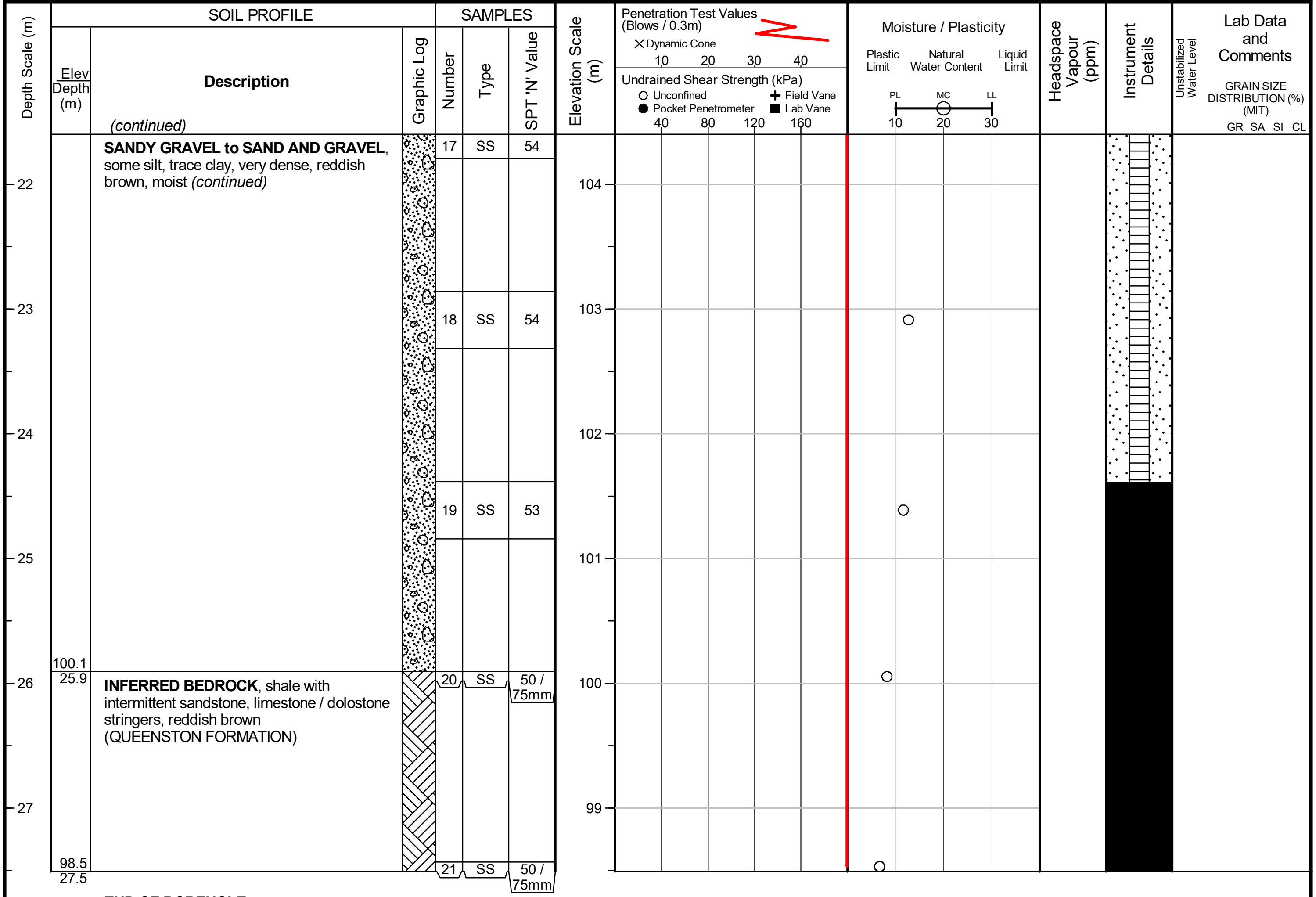
Client : Bronte River LP
Project : 1300 Bronte Road
Location : Oakville, Ontario

Originated by : OE/RS
Compiled by : CM
Checked by : MMT

Position : E: 601025, N: 4807419 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Hollow stem augers / mud rotary (tricone)

| SOIL PROFILE | | SAMPLES | | |
|---|---|---|---|---|
| Elev<br>Depth (m) | Description *(continued)* | Number | Type | SPT 'N' Value |
| | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, moist *(continued)* | 17 | SS | 54 |
| | | 18 | SS | 54 |
| | | 19 | SS | 53 |
| 100.1<br>25.9 | **INFERRED BEDROCK**, shale with intermittent sandstone, limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) | 20 | SS | 50 / 75mm |
| 98.5<br>27.5 | | 21 | SS | 50 / 75mm |



**END OF BOREHOLE**

Unstabilized water level and depth at cave could not be determined due to use mud rotary drilling technique.

50 mm dia. monitoring well installed.

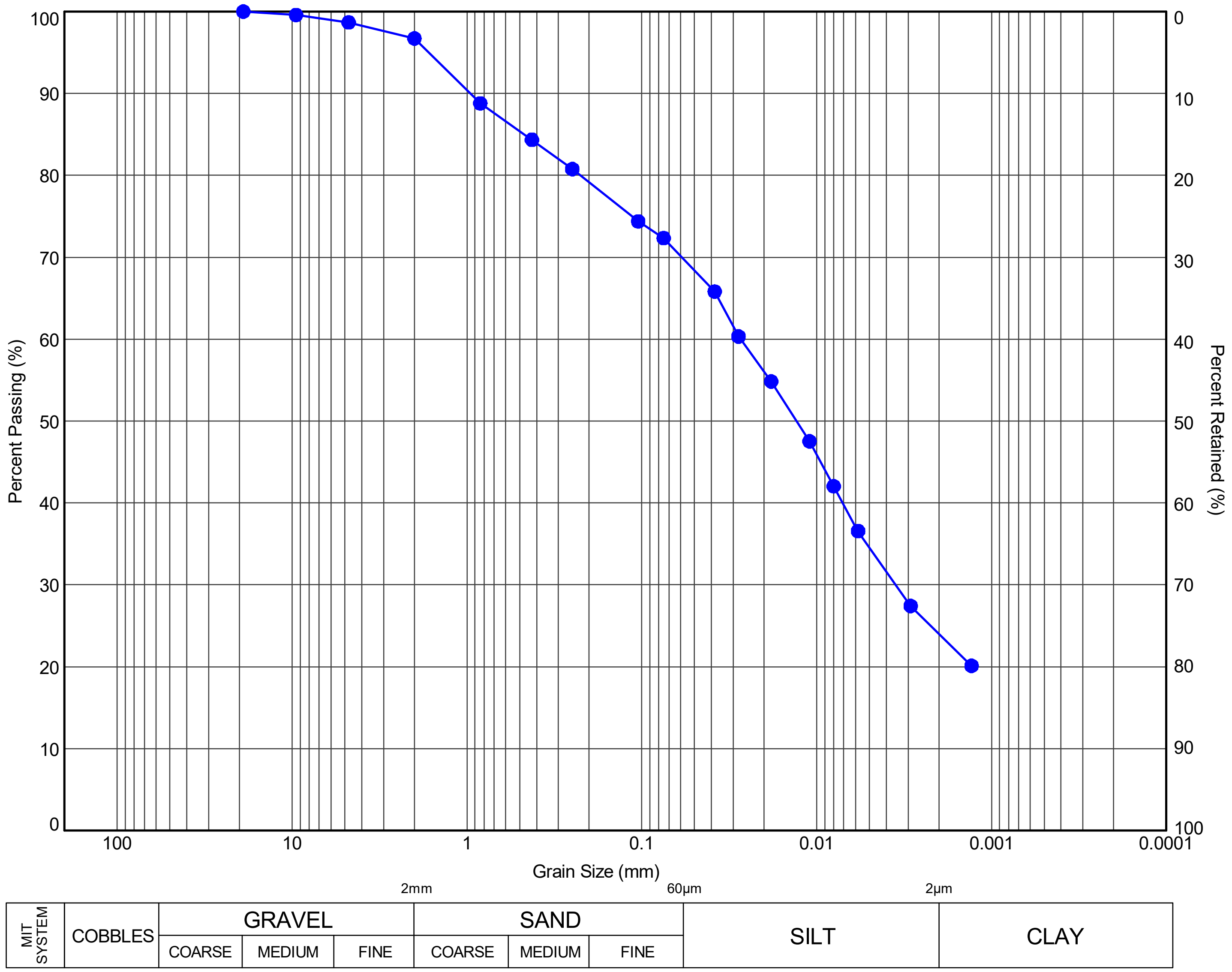
WATER LEVEL READINGS

| Date | Water Depth (m) | Elevation (m) |
|---|---|---|
| Nov 30, 2021 | 16.5 | 109.5 |

file: 1-16-0035-02 bh logs.gpj

# APPENDIX B

TERRAPROBE INC.



MIT SYSTEM

| | Hole ID | Sample | Depth (m) | Elev. (m) | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | *(Fines, %)* |
|---|---|---|---|---|---|---|---|---|---|
| ● | **21-1** | SS3 | 1.8 | 126.2 | 3 | 27 | 46 | 24 | |

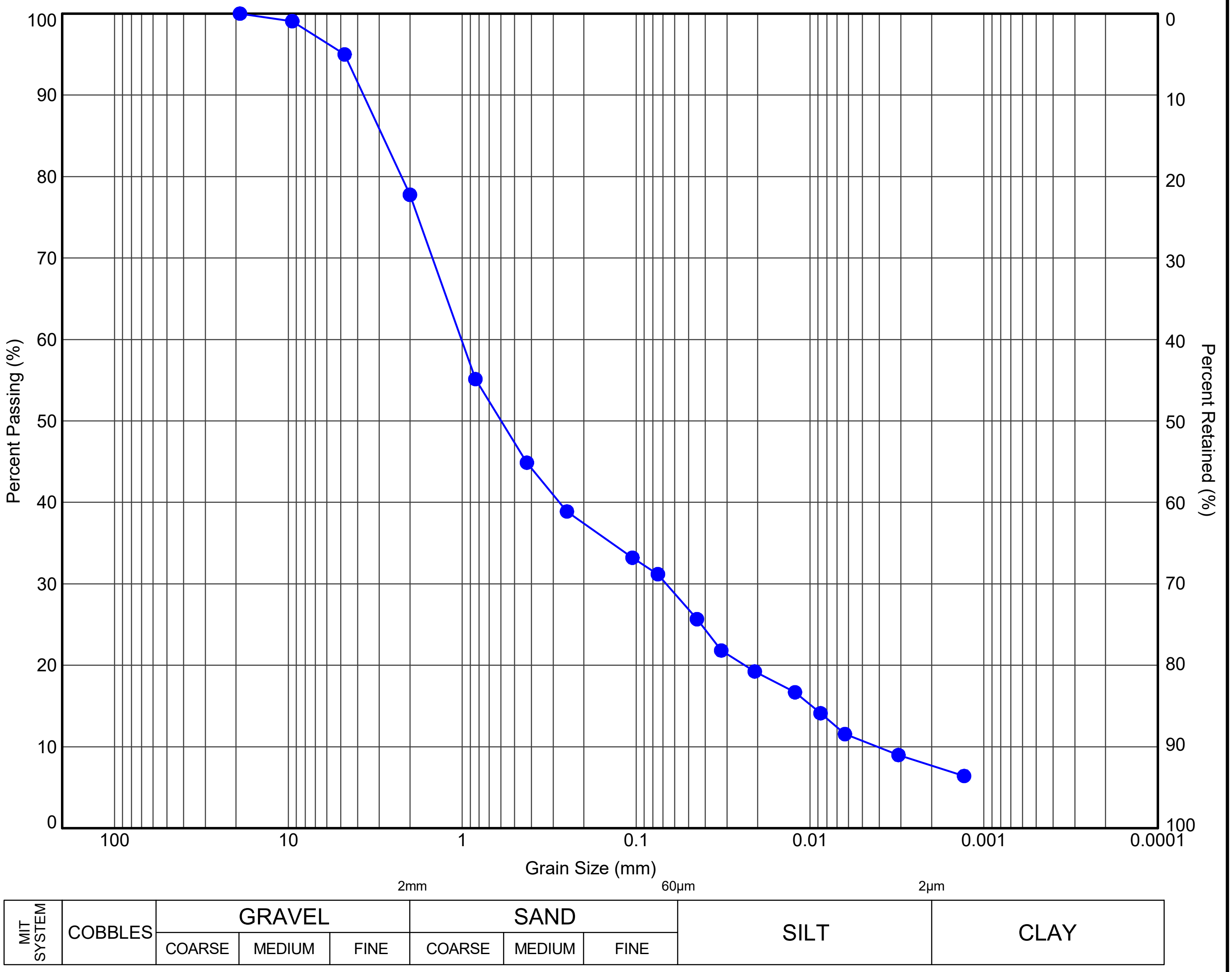
**Terraprobe**

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

Title:

**GRAIN SIZE DISTRIBUTION**
**CLAYEY SILT, SANDY, TRACE GRAVEL**

File No.: **1-16-0035-02**



| | | | | | MIT SYSTEM | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hole ID | Sample | Depth (m) | Elev. (m) | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | *(Fines, %)* |
| ● | **21-2** | SS6 | 4.7 | 116.3 | 22 | 49 | 21 | 8 | |

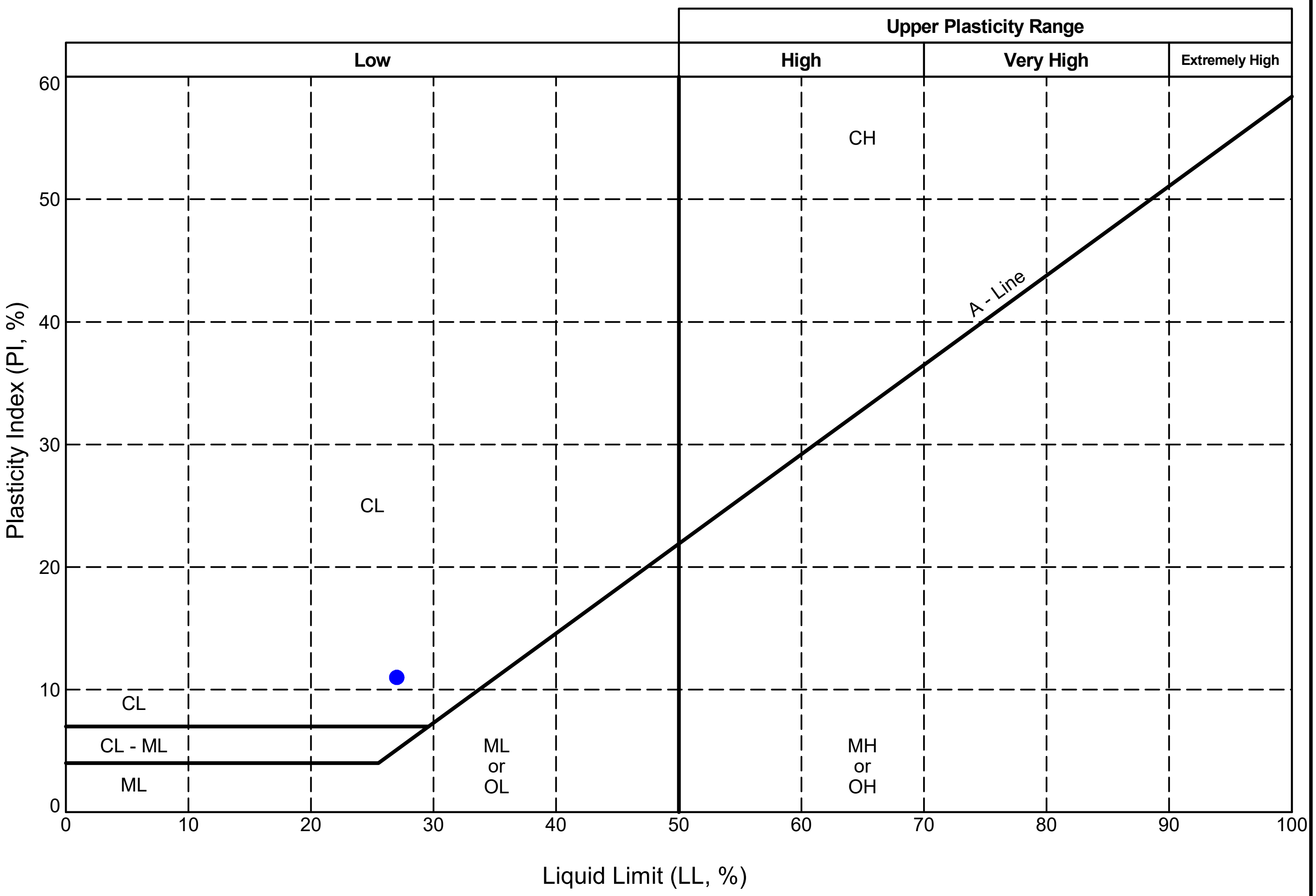
**Terraprobe**

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

Title:

**GRAIN SIZE DISTRIBUTION**
**SILTY GRAVELLY SAND, TRACE CLAY**

File No.: **1-16-0035-02**



| | Borehole | Sample | Depth (m) | Elev. (m) | LL (%) | PL (%) | PI (%) | Description |
|---|---|---|---|---|---|---|---|---|
| ● | 21-1 | SS3 | 1.8 | 121.2 | 27 | 16 | 11 | SLIGHTLY PLASTIC |

**Terraprobe**

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

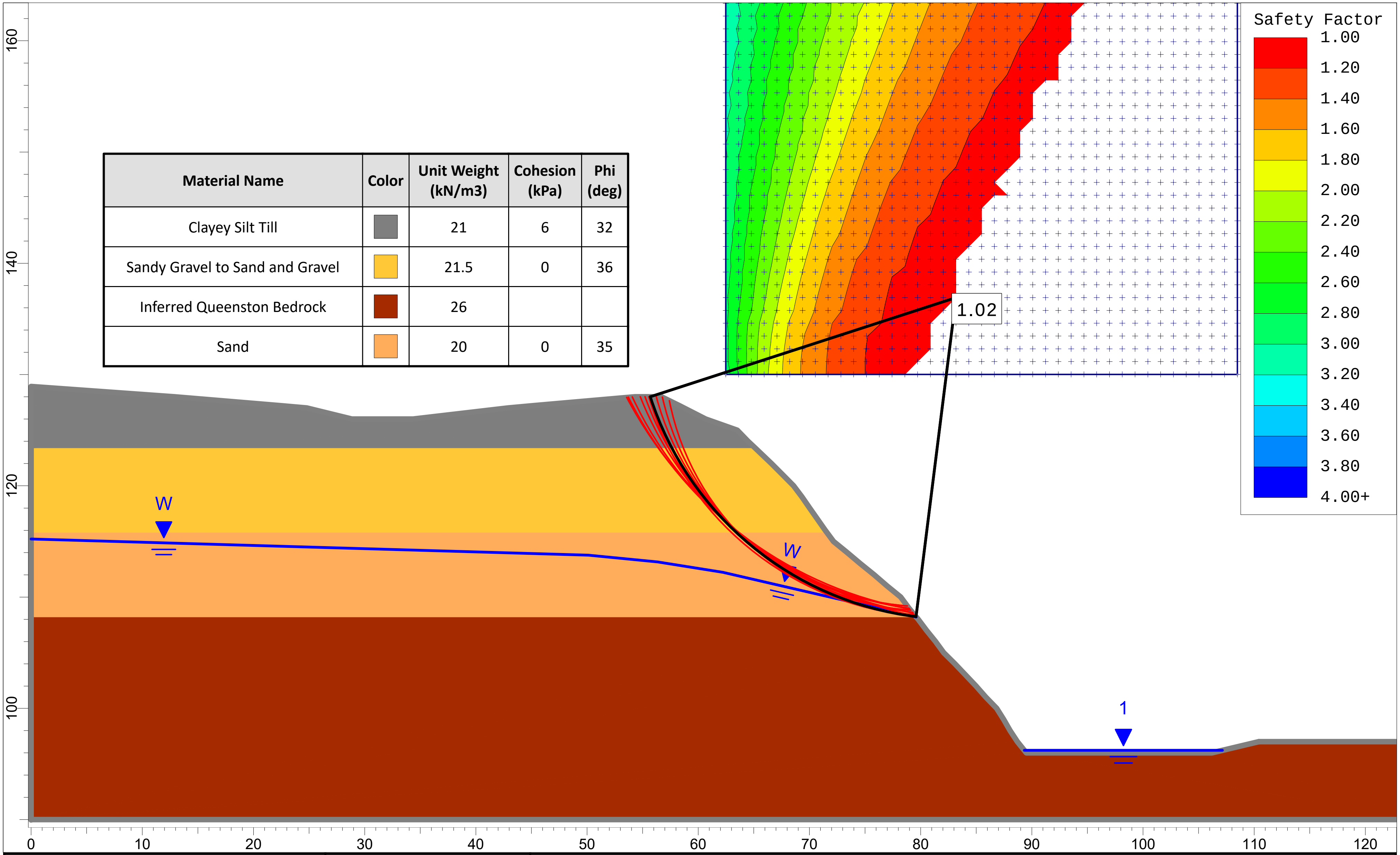
Title:

## ATTERBERG LIMITS CHART

File No.: **1-16-0035-02**

# APPENDIX C

TERRAPROBE INC.



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ■ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |
| Sand | 🟧 | 20 | 0 | 35 |

**Terraprobe**

Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 7.036

Notes

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

Project

**1300 Bronte Road | 1-16-0035-02**

Analysis

Slope Stability: Section E-E', Exisitng Conditions, Normal GWT

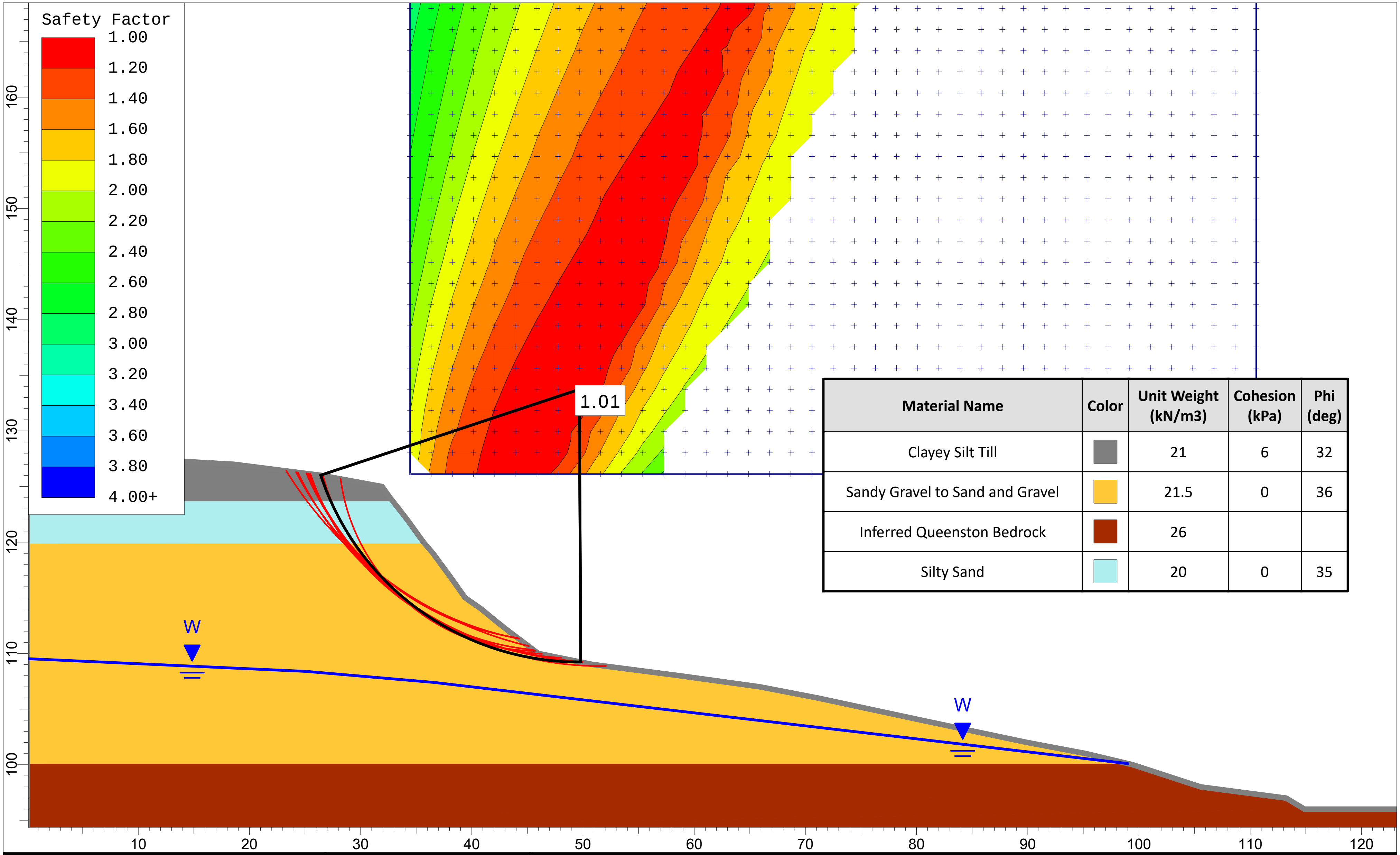
Date 12/7/2021

Scale 1:470

File 1-16-0035-02 Slope Stability.slmd

By Connor McCormick

Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |
| Silty Sand | 🟦 | 20 | 0 | 35 |

**Terraprobe**

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

SLIDEINTERPRET 7.036

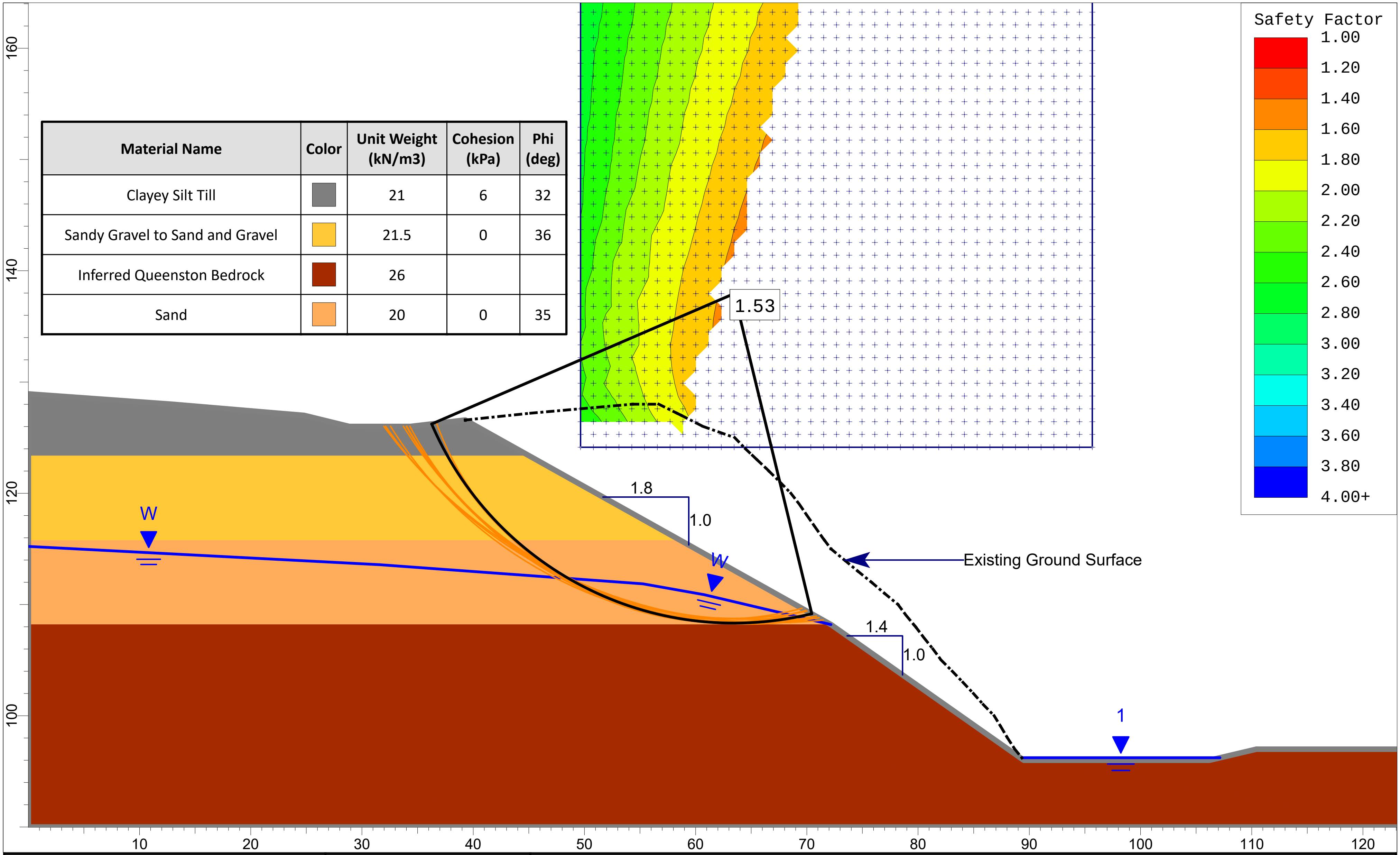
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project **1300 Bronte Road | 1-16-0035-02**

Analysis Slope Stability: Section G-G', Exisitng Conditions, Normal GWT

Date 12/7/2021
Scale 1:470
File 1-16-0035-02 Slope Stability.slmd

By Connor McCormick
Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |
| Sand | 🟧 | 20 | 0 | 35 |

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

SLIDEINTERPRET 7.036

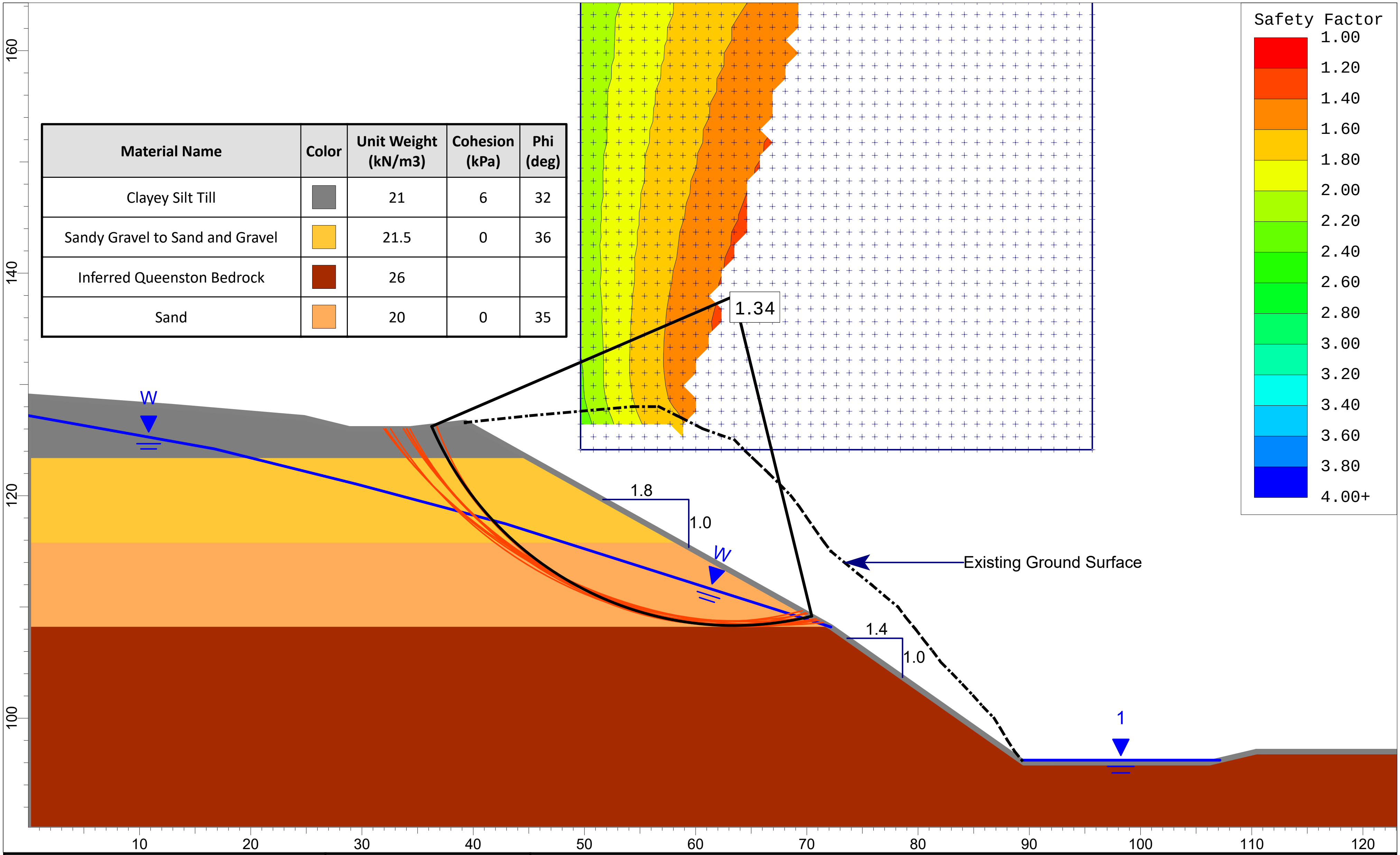
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project **1300 Bronte Road | 1-16-0035-02**

Analysis Slope Stability: Section E-E', Stable Slope, Normal GWT

Date 12/7/2021
Scale 1:470
File 1-16-0035-02 Slope Stability.slmd

By Connor McCormick
Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟥 | 26 | | |
| Sand | 🟧 | 20 | 0 | 35 |

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

SLIDEINTERPRET 7.036

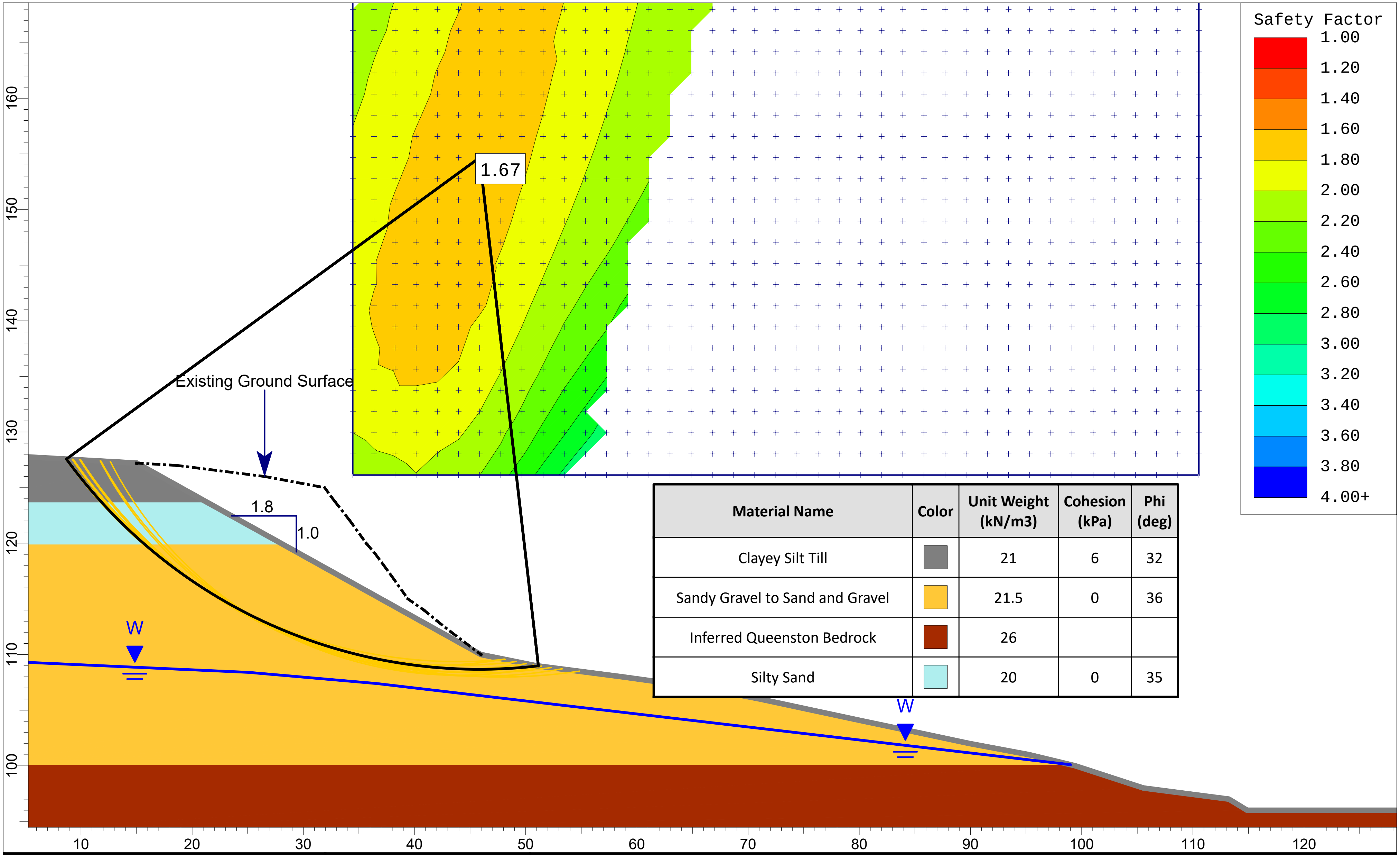
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project
**1300 Bronte Road | 1-16-0035-02**

Analysis
Slope Stability: Section E-E', Stable Slope, High GWT

Date 12/7/2021
Scale 1:470
File 1-16-0035-02 Slope Stability.slmd

By Connor McCormick
Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |
| Silty Sand | 🟦 | 20 | 0 | 35 |

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

SLIDEINTERPRET 7.036

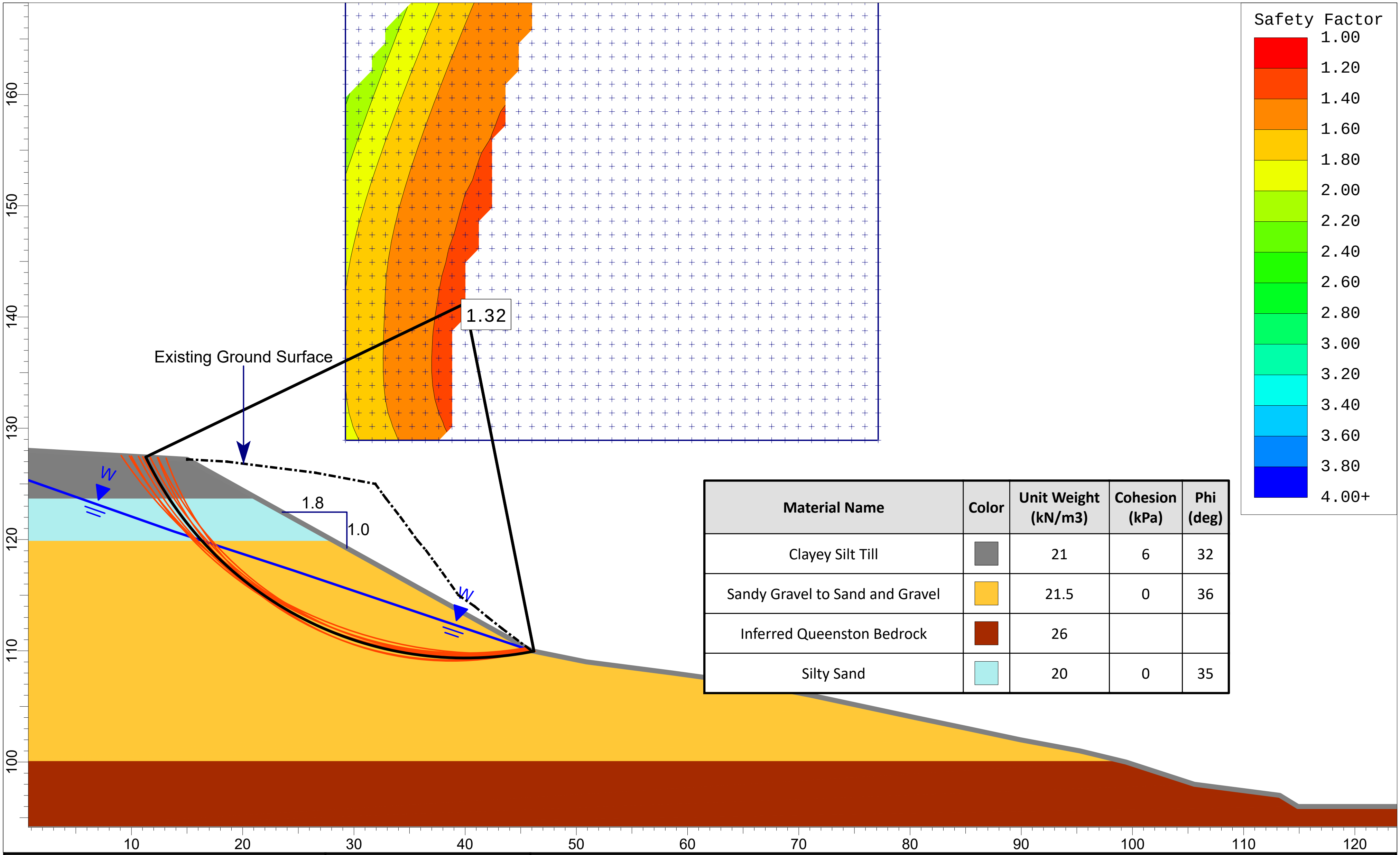
Notes
Refer to appended Slope Stability Analysis Explanation sheets for legend. Refer to cross-sections for inclinations and other pertinent slope information.

Project
**1300 Bronte Road | 1-16-0035-02**

Analysis
Slope Stability: Section G-G', Stable Slope, Normal GWT

Date 12/7/2021
Scale 1:470
File 1-16-0035-02 Slope Stability.slmd

By Connor McCormick
Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Clayey Silt Till | ◼ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟨 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |
| Silty Sand | 🟦 | 20 | 0 | 35 |

**Terraprobe**

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

SLIDEINTERPRET 7.036

Notes

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

Project

**1300 Bronte Road | 1-16-0035-02**

Analysis

Slope Stability: Section G-G', Stable Slope, High GWT

| Date | Scale | File |
|---|---|---|
| 12/7/2021 | 1:470 | 1-16-0035-02 Slope Stability.slmd |

By Connor McCormick

Ref. Lot 31 Concession 2 South of Dundas Street, Town of Oakville, by J.D. Barnes Limited, Ref No.: 20-30-555-01, dated November 22, 2021

# APPENDIX D

TERRAPROBE INC.

Photo 1. Looking north along the slope crest. The slope crest is well vegetated

Photo 2. Looking north along the slope crest. The slope crest is well vegetated and showns no sins of recent failure.

Photo 3. Looking south along the slope crest/upper slope. The slope is well vegetated and tree growth is generally upright and straight.

Photo 4. Looking south along the tableland/slope crest. The tablelland is relatively flat and the slope crest is well vegetated with mature trees.

Photo 5. Looking south toward the relatively steep scarp. The slope north of the scarp is speerated from the creek by a flood plain.

Photo 6. Looking south, a closer view of the relatively steep scarp located at the lower portion of the slpe. The creek is in direct contact with the slope resulting in active toe erosion.

Photo 7. Looking north toward the relatively steep scarp. The scarp is predominately comprised of bare shale.

Photo 8. Looking north along the creek south of the scarp. The slope is seperated from the creek by a floodplain and no active erosion was observed in this area.

Photo 9. Looking east up slope, the slope is generally well vegetated with mature trees. There are occasional fallen trees but typically tree growth is upright and straight.

Photo 10. Looking south across the large flood plain seperating the southern slope from the creek. The flood plain is well vegetated with young trees.

Photo 11. Looking west downslope along a small gully.

Photo 12. Looking west another veiw of the small gulley.

Photo 13. Looking north mid-slope toward the scarp. This section of the slope is well vegetated with young and mature trees.

Photo 14. Looking north mid-slope at the southern extent of the site. The slope is well vegetated with mature trees, whos growth is generally upright and sraight with some exceptions.

Photo 15. Looking south at the start of the small gulley containing intermitant drainage water flow.

Photo 16. Looking south along the tableland and slope crest at the south end of the site. The tableland is relatively flat and the slope crest is vegetated with young and mature trees.

# APPENDIX E

TERRAPROBE INC.

**Terraprobe**

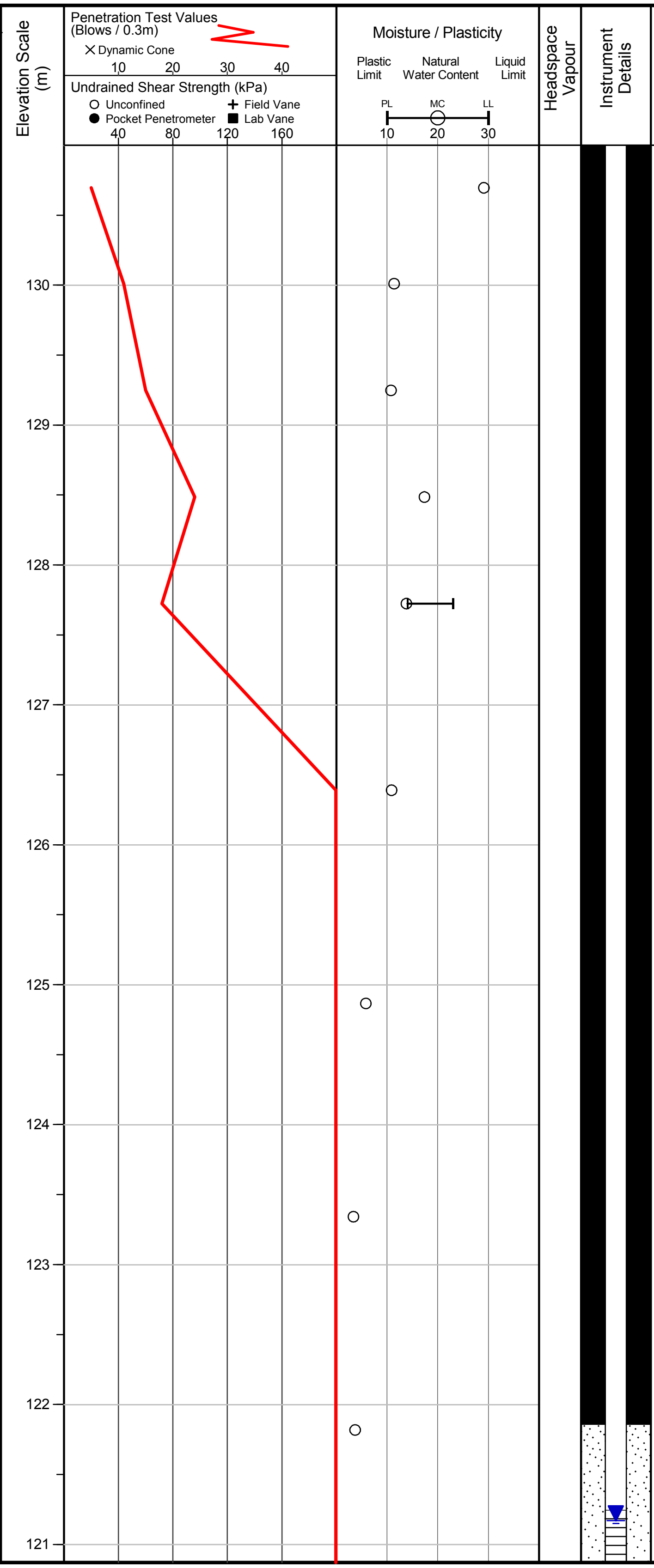
# LOG OF BOREHOLE 1

Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 11, 2016
Sheet No. : 1 of 2

Position : E: 600808, N: 4807676 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

| Depth Scale (m) | Elev Depth (m) | SOIL PROFILE Description | Graphic Log | SAMPLES Number | Type | SPT 'N' Value | Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL |
|---|---|---|---|---|---|---|---|
| 0 | **131.0** | **GROUND SURFACE** | | | | | |
| | 130.8<br>0.2 | 150mm **TOPSOIL** | | | | | |
| | | **FILL**, sandy silt, trace to some gravel, trace to some clay, with sporadic organic presence, loose to compact, reddish brown, moist | | 1 | SS | 5 | |
| 1 | | | | 2 | SS | 11 | |
| 2 | | | | 3 | SS | 15 | |
| | 128.7<br>2.3 | **CLAYEY SILT**, some sand to sandy, trace gravel,, very stiff to hard, brown, damp to moist (GLACIAL TILL) | | 4 | SS | 24 | |
| 3 | | | | 5 | SS | 18 | 6 27 42 25 |
| 4 | | ...till-shale complex, reddish brown | | 6 | SS | 50 / 75mm | heavy grinding |
| 6 | 124.9<br>6.1 | **INFERRED BEDROCK**, shale with intermittent sandstone / limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) | | 7 | SS | 100 / 75mm | |
| 7 | | | | 8 | SS | 100 / 75mm | |
| 9 | | | | 9 | SS | 100 / 75mm | |
| 10 | | | | | | | |



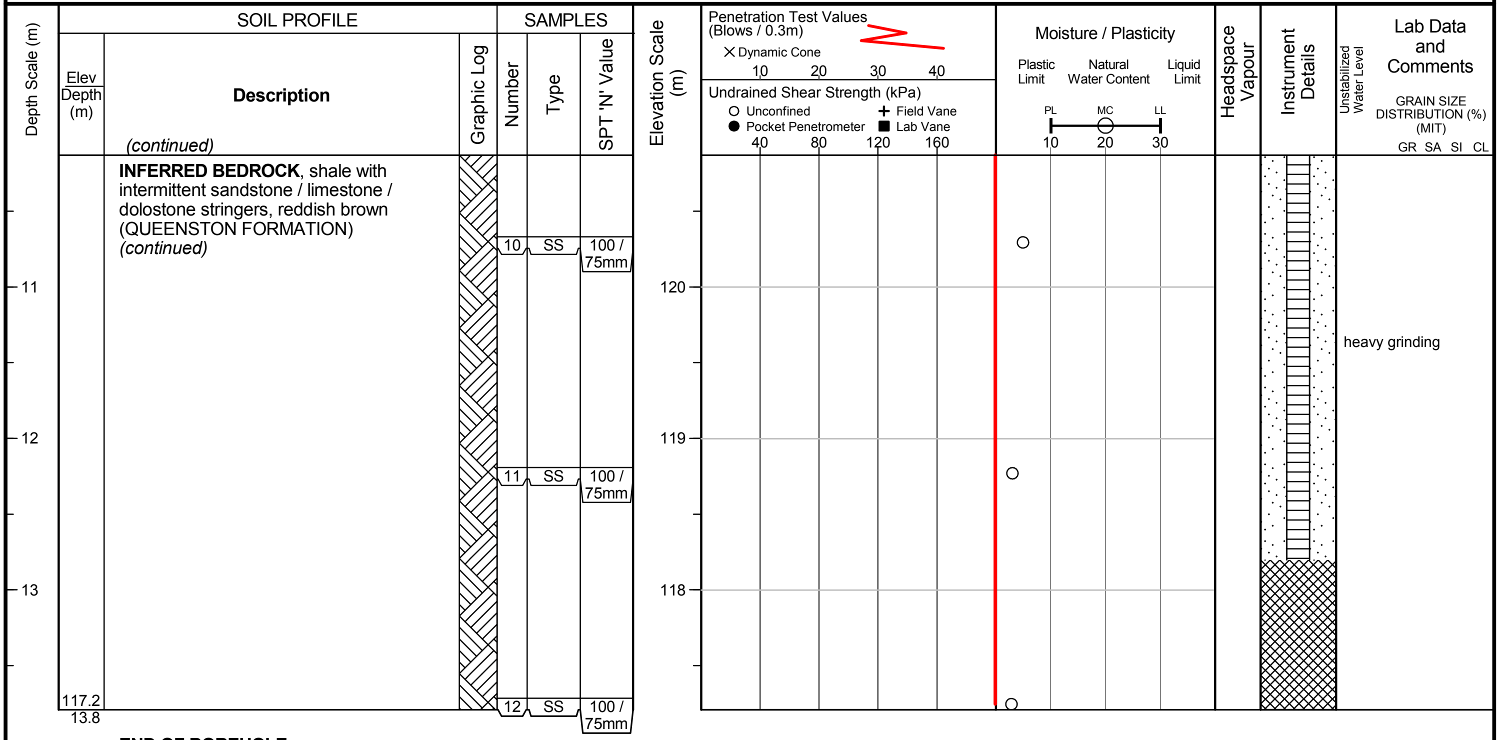
(continued next page)

# LOG OF BOREHOLE 1

Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 11, 2016
Sheet No. : 2 of 2

Position : E: 600808, N: 4807676 (UTM 17T)
Elevation Datum : Geodetic (NAD83)
Rig type : CME 55, track-mounted
Drilling Method : Solid stem augers



**INFERRED BEDROCK**, shale with intermittent sandstone / limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) *(continued)*

| Number | Type | SPT 'N' Value |
|---|---|---|
| 10 | SS | 100 / 75mm |
| 11 | SS | 100 / 75mm |
| 12 | SS | 100 / 75mm |

117.2
13.8

**END OF BOREHOLE**

Borehole was dry and caved to 12.8 m below ground surface upon completion of drilling.

25 mm dia. piezometer installed.

WATER LEVEL READINGS

| Date | Water Depth (m) | Elevation (m) |
|---|---|---|
| Feb 24, 2016 | 9.8 | 121.2 |

**Terraprobe**

# LOG OF BOREHOLE 2

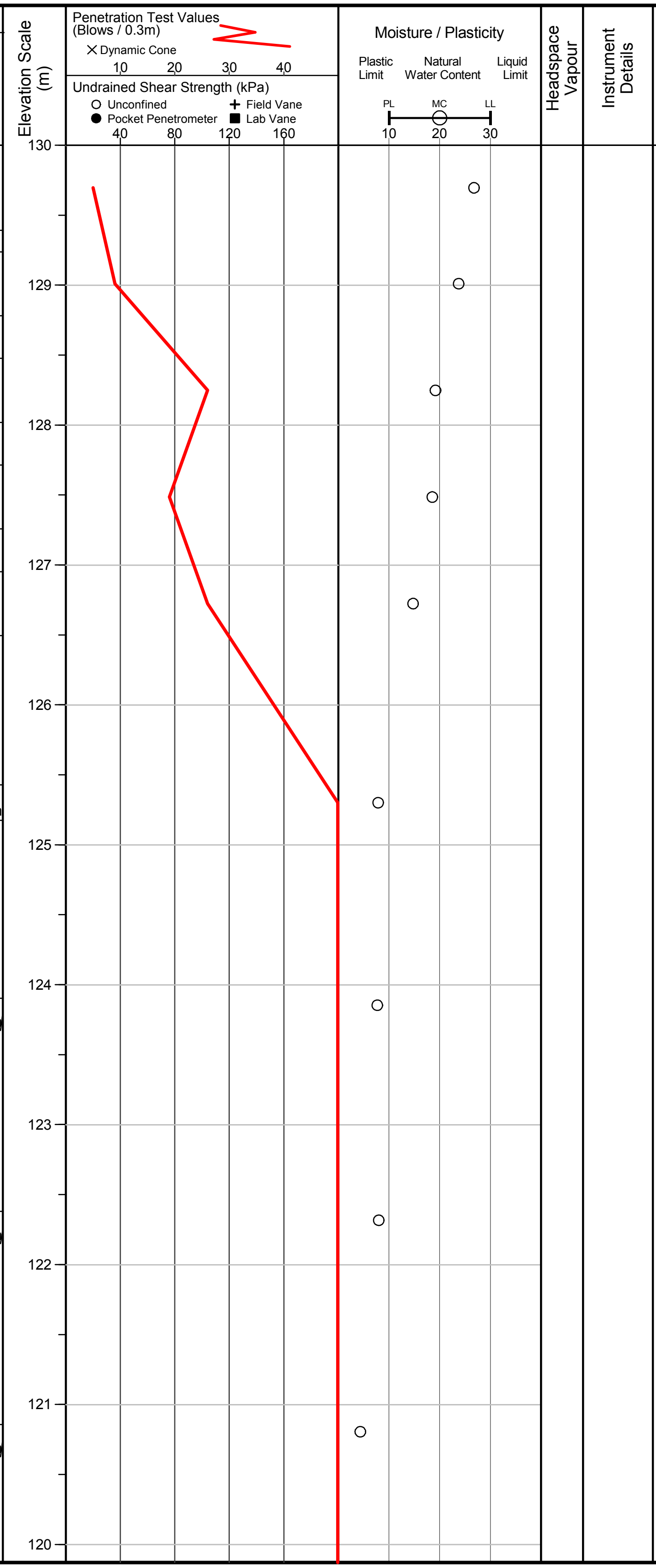
Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 12, 2016
Sheet No. : 1 of 2

Position : E: 600872, N: 4807678 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

| Elev Depth (m) | Description (SOIL PROFILE) | Number | Type | SPT 'N' Value | Lab Data and Comments / GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL |
|---|---|---|---|---|---|
| 130.0 | **GROUND SURFACE** | | | | |
| 129.8<br>0.2 | 180mm **TOPSOIL** | | | | |
| | **FILL**, sandy silt, some gravel to gravelly, trace to some clay, with sporadic organic presence, loose, reddish brown, moist | 1 | SS | 5 | |
| | | 2 | SS | 9 | |
| 128.5<br>1.5 | **SILT**, some sand to sandy, trace clay, trace gravel, compact, reddish brown, wet | 3 | SS | 26 | wet spoon<br>2 13 77 8 |
| | | 4 | SS | 19 | |
| 127.0<br>3.0 | **CLAYEY SILT**, some sand to sandy, trace gravel,, very stiff to hard, brown, damp to moist (GLACIAL TILL) | 5 | SS | 26 | |
| | | 6 | SS | 50 / 100mm | |
| 123.9<br>6.1 | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, very moist | 7 | SS | 50 / 100mm | |
| | | | | | grinding at 7.3m |
| | ...wet | 8 | SS | 100 / 125mm | |
| 120.9<br>9.1 | **INFERRED BEDROCK**, shale with intermittent sandstone / limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) | 9 | SS | 100 / 100mm | ∇<br>heavy grinding |



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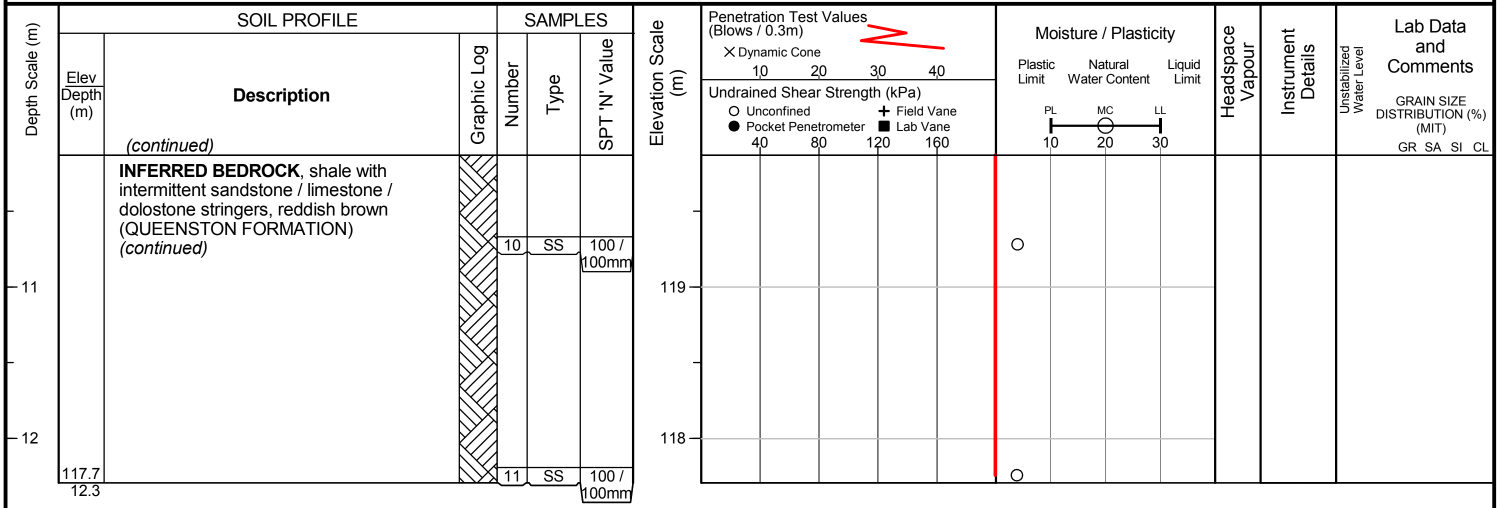
# LOG OF BOREHOLE 2

Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 12, 2016
Sheet No. : 2 of 2

Position : E: 600872, N: 4807678 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers



**INFERRED BEDROCK**, shale with intermittent sandstone / limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) *(continued)*

| Number | Type | SPT 'N' Value |
|---|---|---|
| 10 | SS | 100 / 100mm |
| 11 | SS | 100 / 100mm |

117.7
12.3

**END OF BOREHOLE**

Unstabilized water level measured at 9.1 m below ground surface; borehole caved to 11.0 m below ground surface upon completion of drilling.

# LOG OF BOREHOLE 3

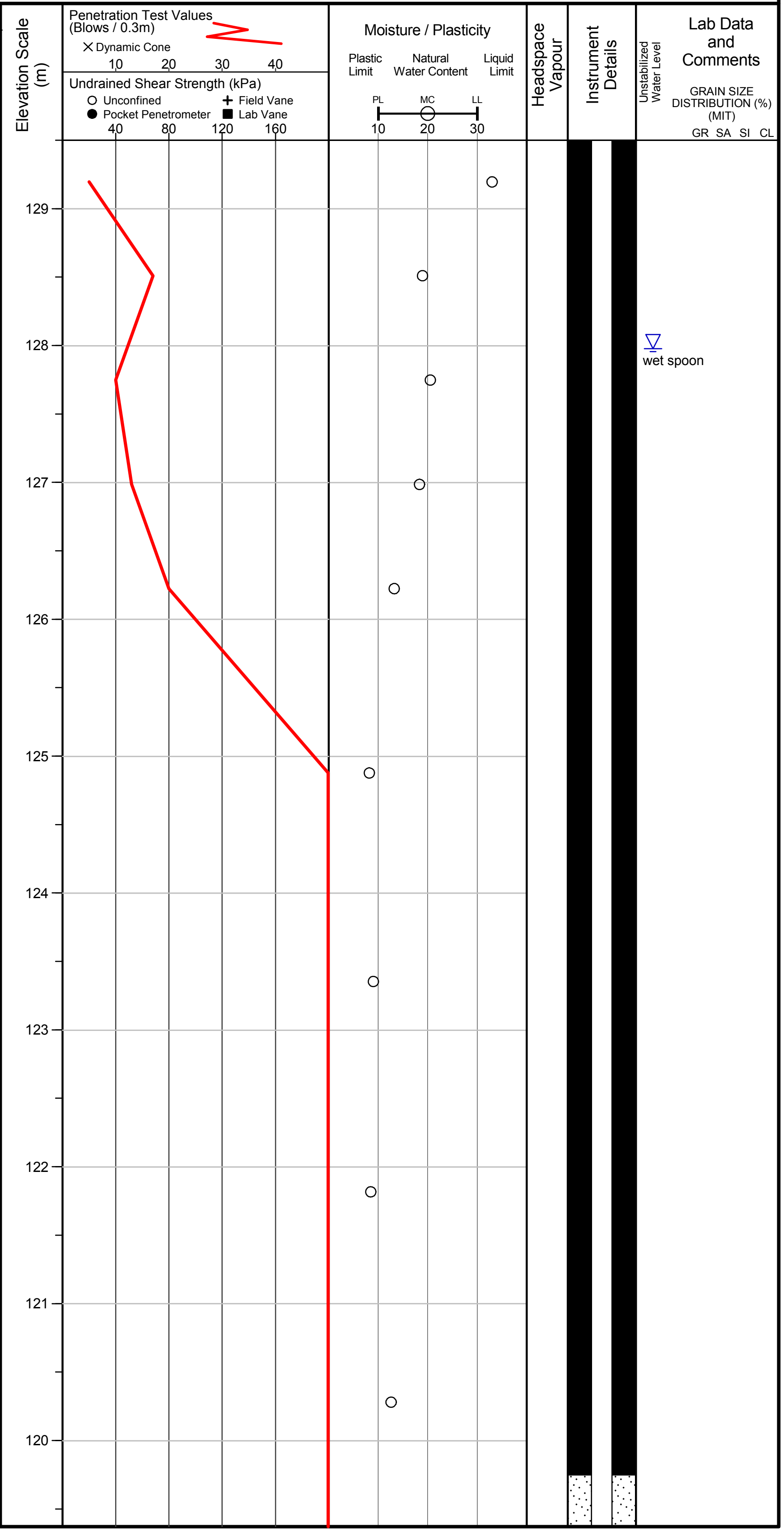
Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 12, 2016
Sheet No. : 1 of 2

Position : E: 600935, N: 4807669 (UTM 17T)
Rig type : CME 55, track-mounted

Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers

| Depth Scale (m) | Elev Depth (m) | SOIL PROFILE Description | SAMPLES Number | Type | SPT 'N' Value |
|---|---|---|---|---|---|
| 0 | 129.5 | **GROUND SURFACE** | | | |
| | 129.2<br>0.3 | 250mm **TOPSOIL** | | | |
| | | **FILL**, sandy silt, trace to some gravel, trace clay, trace organics, loose, reddish brown, moist | 1 | SS | 5 |
| 1 | 128.7<br>0.8 | **SANDY SILT**, trace clay, trace gravel, compact, reddish brown, wet | 2 | SS | 17 |
| 2 | | | 3 | SS | 10 |
| | | | 4 | SS | 13 |
| 3 | 126.5<br>3.0 | **CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, damp to moist (GLACIAL TILL) | 5 | SS | 20 |
| 4 | | | | | |
| 5 | | | 6 | SS | 50 / 100mm |
| 6 | 123.4<br>6.1 | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, very moist | 7 | SS | 100 / 100mm |
| 7 | | | 8 | SS | 100 / 125mm |
| 8 | | | | | |
| 9 | | ...<br>wet below | 9 | SS | 100 / 150mm |
| 10 | | | | | |



*(continued next page)*

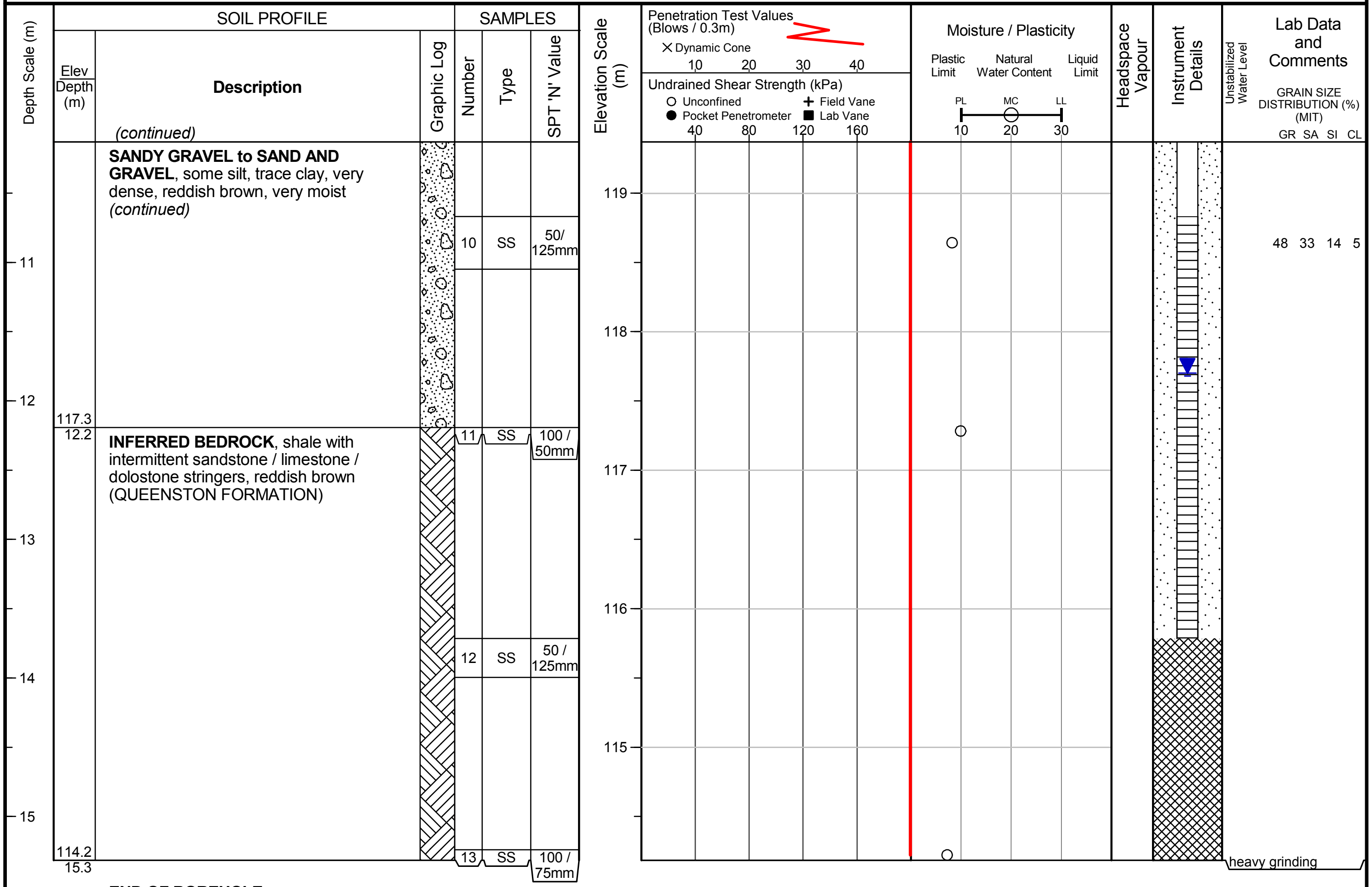
Terraprobe

# LOG OF BOREHOLE 3

Client : Victor and Joyce Enns
Project : 1300 Bronte Road
Location : Oakville

Project No.: 1-16-0035-01
Date started : February 12, 2016
Sheet No. : 2 of 2

Position : E: 600935, N: 4807669 (UTM 17T)
Rig type : CME 55, track-mounted
Elevation Datum : Geodetic (NAD83)
Drilling Method : Solid stem augers



| Elev Depth (m) | Description |
|---|---|
| | *(continued)* |
| | **SANDY GRAVEL to SAND AND GRAVEL**, some silt, trace clay, very dense, reddish brown, very moist *(continued)* |
| 117.3<br>12.2 | **INFERRED BEDROCK**, shale with intermittent sandstone / limestone / dolostone stringers, reddish brown (QUEENSTON FORMATION) |
| 114.2<br>15.3 | |

| Number | Type | SPT 'N' Value | Lab Data and Comments |
|---|---|---|---|
| 10 | SS | 50/ 125mm | 48 33 14 5 |
| 11 | SS | 100 / 50mm | |
| 12 | SS | 50 / 125mm | |
| 13 | SS | 100 / 75mm | heavy grinding |

**END OF BOREHOLE**

Unstabilized water level measured at 1.5 m below ground surface; borehole caved to 9.1 m below ground surface upon completion of drilling.

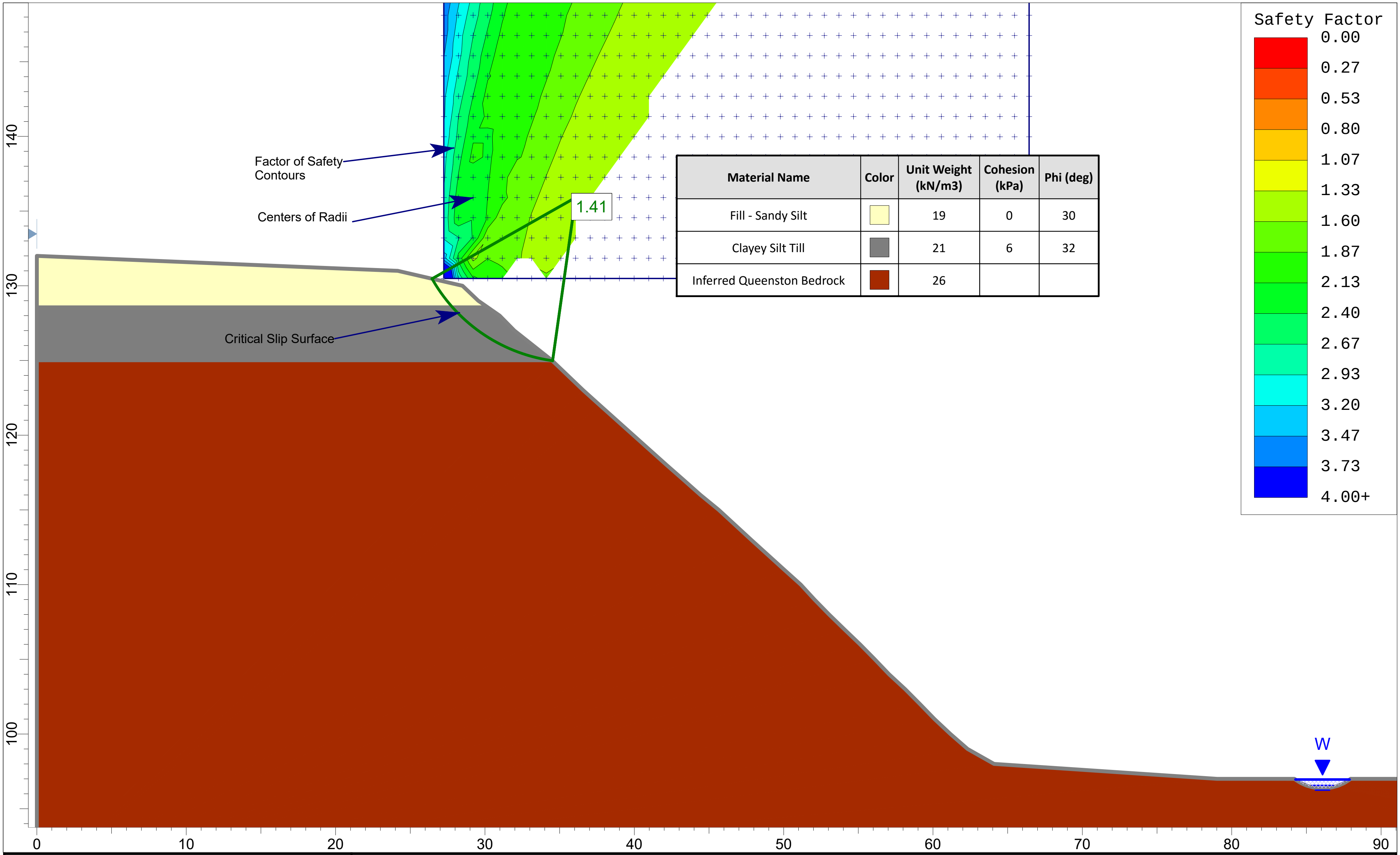
25 mm dia. piezometer installed.

WATER LEVEL READINGS

| Date | Water Depth (m) | Elevation (m) |
|---|---|---|
| Feb 24, 2016 | 11.8 | 117.7 |

# APPENDIX F

TERRAPROBE INC.



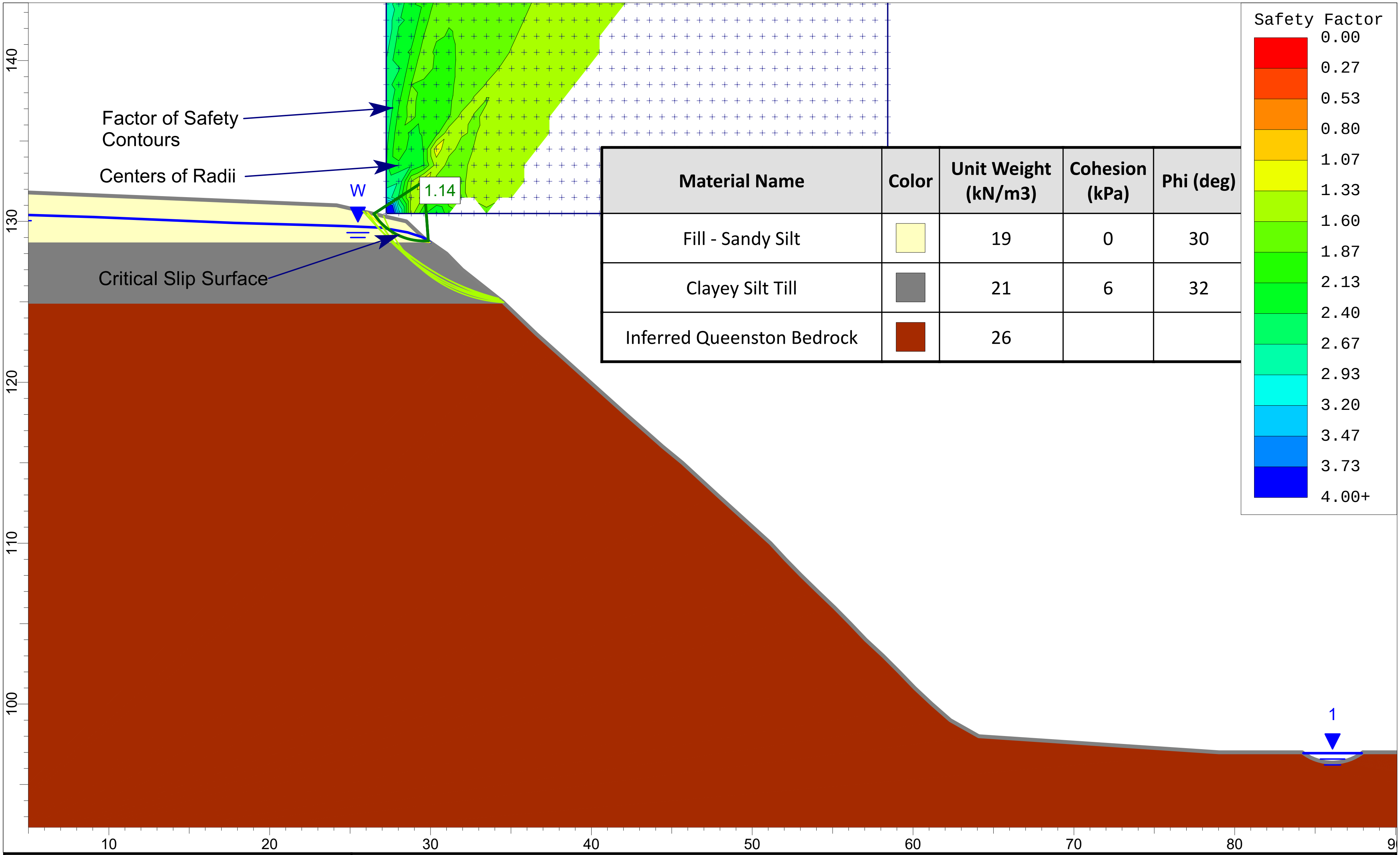
| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

**Terraprobe**

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

| | |
|---|---|
| Project | 1300 Bronte Road, Oakville |
| Analysis Description | Sec A-A' Normal Ground Water Level |
| Drawn By | George Thai |
| Scale | 1:350 |
| Method | Spencer |
| Date | 3/22/2016 |
| File No. | 1-16-0035-01 |
| File Name | Sec A-A NWL.slim |

SLIDEINTERPRET 6.036



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

**Terraprobe**

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

SLIDEINTERPRET 6.036

Project: 1300 Bronte Road, Oakville

Analysis Description: Sec A-A' Highl Ground Water Level

Drawn By: George Thai

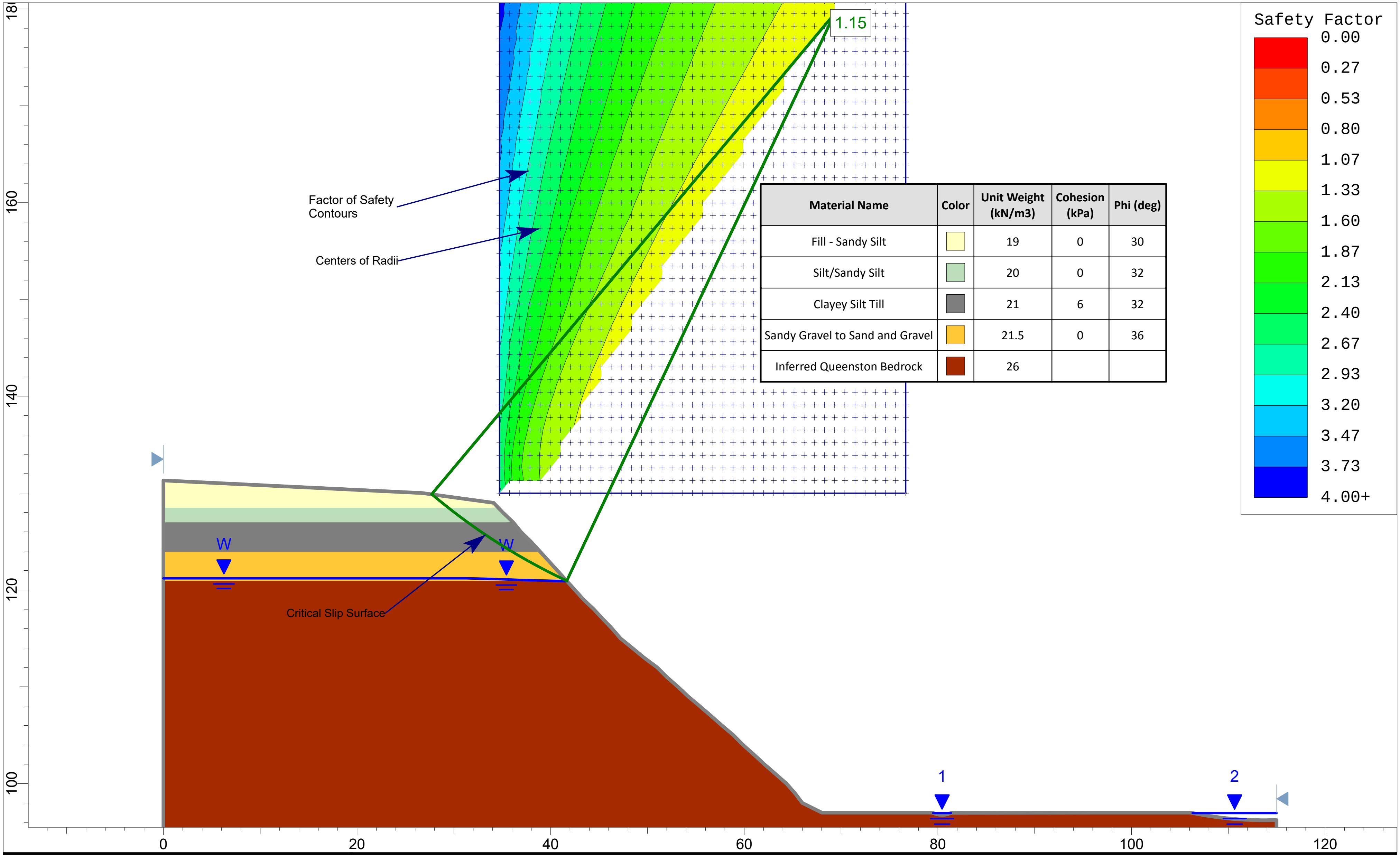
Scale: 1:325

Method: Spencer

Date: 3/22/2016

File No.: 1-16-0035-01

File Name: Sec A-A HWL.slim

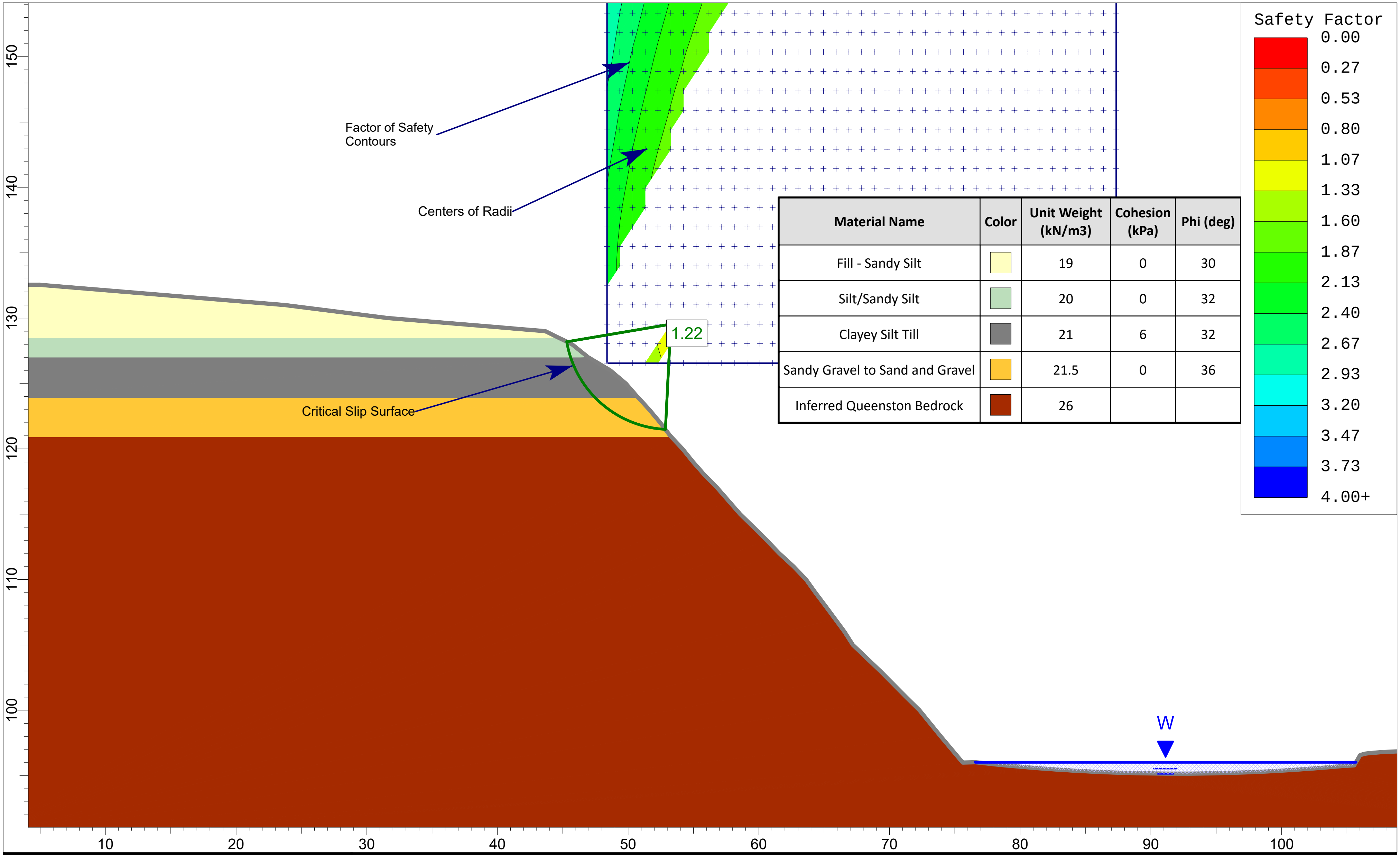


| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Silt/Sandy Silt | 🟩 | 20 | 0 | 32 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟧 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

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

| | |
|---|---|
| Project | 1300 Bronte Road, Oakville |
| Analysis Description | Sec B-B' Normal Ground Water Level |
| Drawn By | George Thai |
| Scale | 1:540 |
| Method | Spencer |
| Date | 3/22/2016 |
| File No. | 1-16-0035-01 |
| File Name | Sec B-B NWL.slim |

SLIDEINTERPRET 6.036



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Silt/Sandy Silt | 🟩 | 20 | 0 | 32 |
| Clayey Silt Till | ◼ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟧 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

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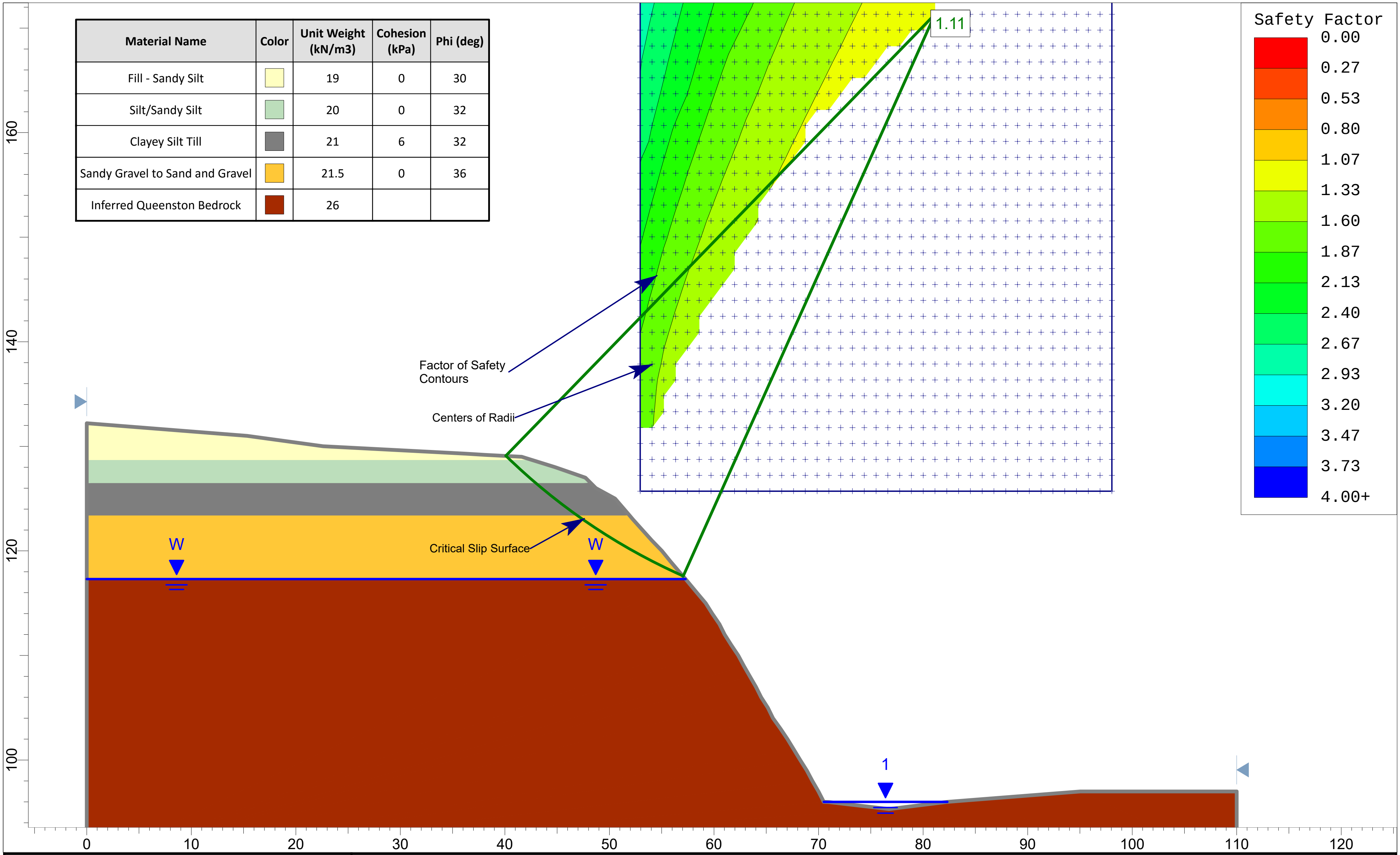
SLIDEINTERPRET 6.036

| | |
|---|---|
| Project | 1300 Bronte Road, Oakville |
| Analysis Description | Sec C-C' Normal Ground Water Level |
| Drawn By | George Thai |
| Scale | 1:400 |
| Method | Spencer |
| Date | 3/22/2016 |
| File No. | 1-16-0035-01 |
| File Name | Sec C-C NWL.slim |



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Silt/Sandy Silt | 🟩 | 20 | 0 | 32 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟧 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟥 | 26 | | |

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SLIDEINTERPRET 6.036

Project: 1300 Bronte Road, Oakville

Analysis Description: Sec D-D' Normal Ground Water Level

Drawn By: George Thai

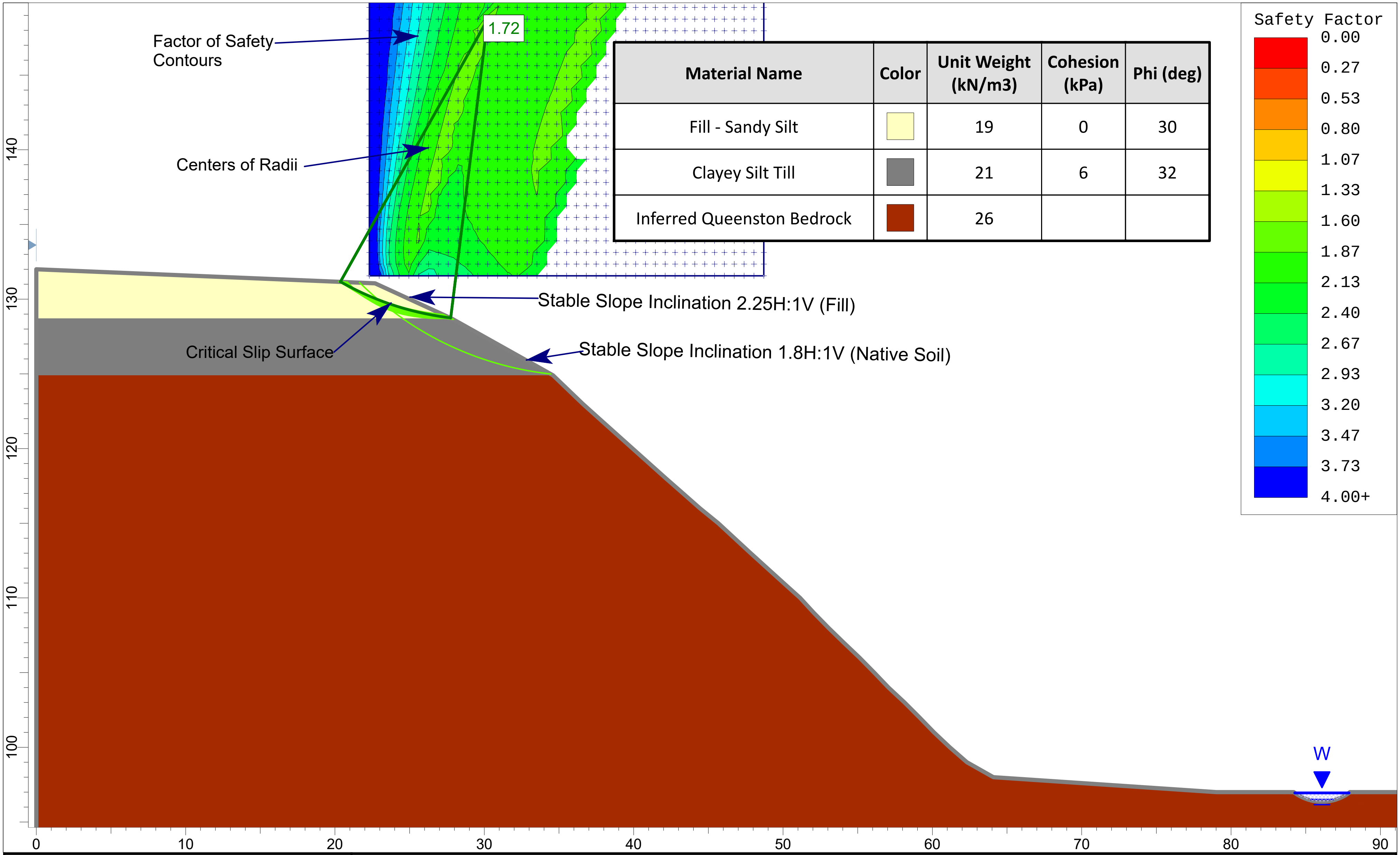
Scale: 1:500

Method: Spencer

Date: 3/22/2016

File No.: 1-16-0035-01

File Name: Sec D-D NWL.slim



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

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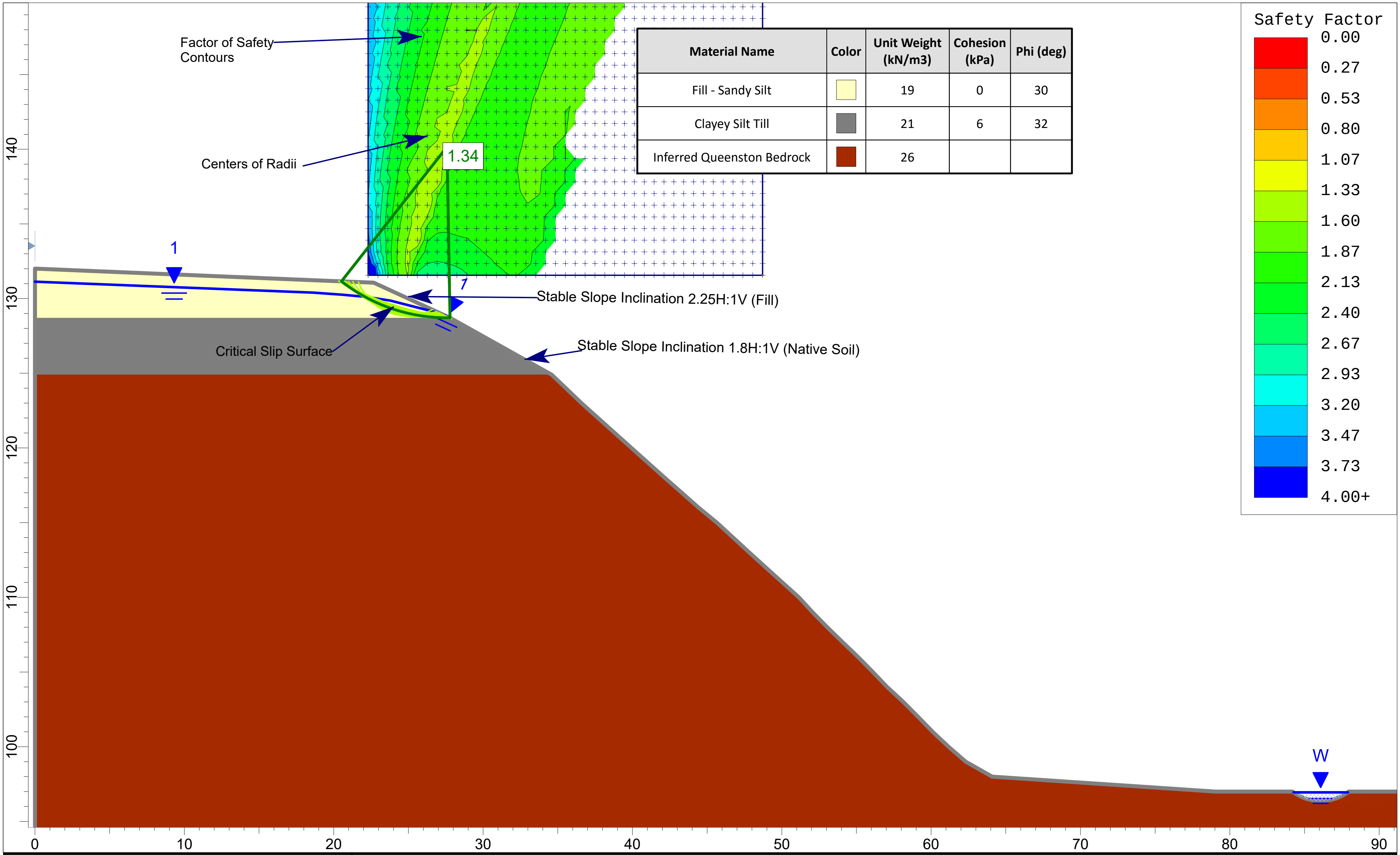
| | |
|---|---|
| Project | 1300 Bronte Road, Oakville |
| Analysis Description | Sec A-A' Normal Ground Water Level, Stable Slope |
| Drawn By | Madan T. |
| Scale | 1:350 |
| Method | Spencer |
| Date | 3/22/2016 |
| File No. | 1-16-0035-01 |
| File Name | Sec A-A NWL Stable Slope.slim |

SLIDEINTERPRET 6.036



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Clayey Silt Till | ◼ | 21 | 6 | 32 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

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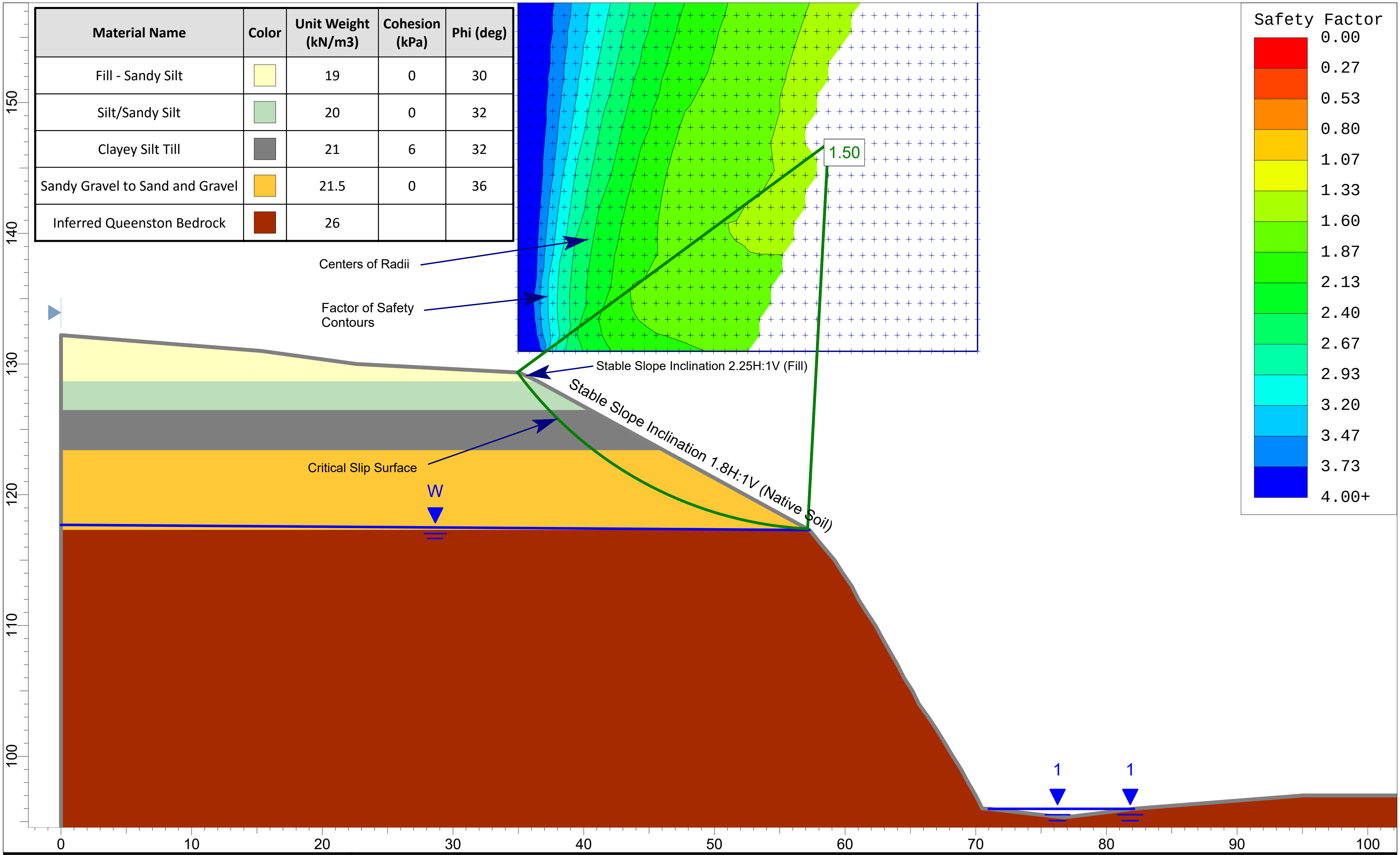
*Construction Materials Inspection & Testing*

SLIDEINTERPRET 6.036

| | |
|---|---|
| Project | 1300 Bronte Road, Oakville |
| Analysis Description | Sec A-A' High Ground Water Level, Stable Slope |
| Drawn By | Madan T. |
| Scale | 1:350 |
| Method | Spencer |
| Date | 3/23/2016 |
| File No. | 1-16-0035-01 |
| File Name | Sec A-A HWL Stable Slope.slim |



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Silt/Sandy Silt | 🟩 | 20 | 0 | 32 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟧 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟥 | 26 | | |

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SLIDEINTERPRET 6.036

Project: 1300 Bronte Road, Oakville

Analysis Description: Sec D-D' Normal Ground Water Level, Stable Slope

Drawn By: George Thai

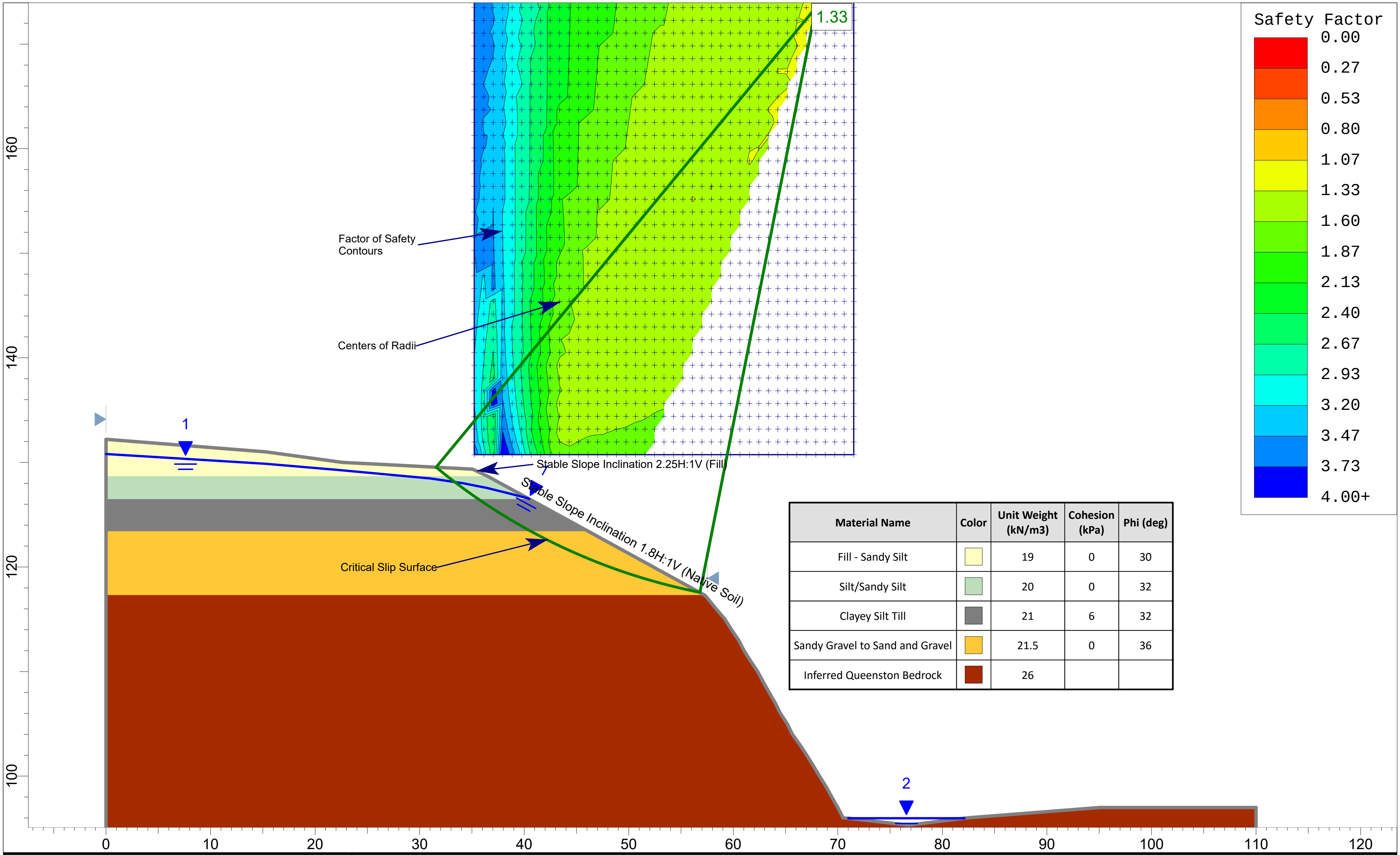
Scale: 1:400

Method: Spencer

Date: 3/22/2016

File No.: 1-16-0035-01

File Name: Sec D-D NWL Stable Slope.slim



| Material Name | Color | Unit Weight (kN/m3) | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|
| Fill - Sandy Silt | 🟨 | 19 | 0 | 30 |
| Silt/Sandy Silt | 🟩 | 20 | 0 | 32 |
| Clayey Silt Till | ⬛ | 21 | 6 | 32 |
| Sandy Gravel to Sand and Gravel | 🟧 | 21.5 | 0 | 36 |
| Inferred Queenston Bedrock | 🟫 | 26 | | |

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SLIDEINTERPRET 6.036

Project: 1300 Bronte Road, Oakville

Analysis Description: Sec D-D' High Ground Water Level, Stable Slope

Drawn By: George Thai
Scale: 1:500
Method: Spencer

Date: 3/23/2016
File No.: 1-16-0035-01
File Name: Sec D-D HWL Stable Slope.slim