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A REPORT TO
SHINING HILL ESTATES OPERATOR INC.

A GEOTECHNICAL INVESTIGATION AND SLOPE STABILITY ASSESSMENT FOR PROPOSED RESIDENTIAL DEVELOPMENT

SHINING HILL PHASE 3
162 ST. JOHN’S SIDEROAD

TOWN OF AURORA

REFERENCE NO. 2008-S135A

JANUARY 2021

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with the written authorization dated September 17, 2020 from Mr. Paul Bailey of Shining Hill Estates Operator Inc., a geotechnical investigation was carried out at 162 St. John's Sideroad, in the Town of Aurora.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the design and construction of a proposed residential development, and to carry out a slope stability assessment at the site. The geotechnical findings and resulting recommendations are presented in this report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Aurora is situated on Schomberg Lake (glacial) plain where drift has been partly eroded and filled with lacustrine clay, silt, sand and reworked till.

The subject site is located on the north side of St. John's Sideroad, slightly west of Yonge Street, in the Town of Aurora, and borders the Town of Newmarket to the north. At the time of the investigation, a barn building was located at the northwest corner of the site, a house was located at the southeast corner, and an old ice rink with stockpiled debris was located north of the house, with the surrounding area being mostly grass-covered. Driveways were located leading to various areas of the site, with a small parking lot directly west of the house. The ground surface on the tableland at the site was relatively flat with some undulations.

Along the east limit of the property, the ground surface descends towards a tributary of the East Branch Holland River. The slope surface is densely vegetated with trees and vegetation.

It is understood that the site will be redeveloped as a residential subdivision consisting of single-family homes, a medium density block, stormwater management facility and a park; the development will be provided with municipal services and roadways meeting urban standards.

3.0 FIELD WORK

The field work, consisting of 8 boreholes to depths of 6.6 to 30.9 m, was performed between September 9 and 16, 2020, at the locations shown on the Borehole and Cross-Section Location Plan, Drawing No. 1.

In addition, 19 boreholes were carried out at the site by our office in 2002. However, it is understood that the site has changed slightly in places since the previous study; therefore, the borehole logs and borehole location plan of the previous study have been provided in the attached Appendix as reference only.

The boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The test results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The relative density of the granular strata and the consistency of the cohesive strata are inferred from the ‘N’ values. Split-spoon samples were recovered for soil classification and laboratory testing. The field work was supervised and the findings were recorded by a Geotechnical Technician.

Upon completion of borehole drilling and sampling, groundwater monitoring wells were installed at all borehole locations, of which 7 of the wells were installed to facilitate a hydrogeological assessment by others, and 1 well was installed to facilitate the slope stability assessment.

The borehole location was surveyed using a handheld Global Navigation Satellite System (Trimble Geoexplorer 6000 series) equipment, and the ground surface elevation was then interpolated from the topographic survey prepared by Lloyd & Purcell, and provided by SCS Consulting Group Inc.

4.0 SUBSURFACE CONDITIONS

The investigation has disclosed that beneath a topsoil or topsoil fill layer or a pavement structure, and/or a layer of earth fill in places, the site is underlain by strata of silty clay, silt, sandy silt, silty fine sand and/or sand at various locations and depths.

Detailed descriptions of the encountered subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 8, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2, and the engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (Boreholes 102, 104 and 106) and **Topsoil Fill** (Boreholes 103 and 108)

The revealed topsoil layer is approximately 18 to 25 cm thick. In addition, a layer of topsoil fill to depths of 1.9 m and 0.8 m from the prevailing ground surface was encountered at

Boreholes 103 and 108, respectively. The topsoils are dark brown in colour, indicating appreciable amounts of roots and humus which are compressible under loads; they should be removed for site development. In order to prevent overstripping, diligent control of the stripping operation will be required.

The topsoils will generate an offensive odour and may produce volatile gases under anaerobic conditions. They can only be reused for general landscaping purposes, but they must not be buried below any structures or deeper than 1.2 m below the exterior finished grade so they will not have an adverse impact on the environmental well-being of the developed area.

4.2 **Pavement Structure** (Borehole 101)

The pavement structure within the existing parking lot consists of an asphalt concrete layer, approximately 80 mm thick, overlying a granular fill layer, approximately 300 mm thick. The granular fill consists of sand, with some silt, gravel and crushed stone.

In reusing the existing granular fill, frequent sampling and laboratory testing on bulk samples will be required during construction to determine its suitability for use as granular sub-base material. Nevertheless, the granular fill is suitable for use as structural backfill, bedding material or for subgrade stabilization.

4.3 **Earth Fill** (Boreholes 101, 105, 107 and 108)

The earth fill was encountered beneath the pavement structure, topsoil fill or at the ground surface, and extends to depths of 0.8± to 1.7± m below the prevailing ground surface; it consists of silty sand, with silty clay or sandy silt in places, and contains varying amounts of gravel; topsoil/organic inclusions were observed in the earth fill.

The obtained ‘N’ values range from 5 to 21, with a median of 12 blows per 30 cm of penetration, indicating the earth fill was loosely placed, and has since self-consolidated in places.

The natural water content of the samples were determined and the results are plotted on the Borehole Logs; the values range from 5% to 23%, with a median of 12%, indicating that the earth fill is in a damp to very moist condition.

Due to the unknown history of the earth fill, and the presence of topsoil and other organic inclusions in places, the fill is unsuitable for supporting any structures in its current condition. In using the fill for structural backfill, or in pavement or slab-on-grade construction, it must be subexcavated, inspected, sorted free of organic inclusions and any other deleterious materials, aerated and properly compacted in thin lifts. If it is impractical to sort the deleterious materials from the fill, the fill must be wasted and replaced with properly compacted inorganic earth fill.

The fill is amorphous in structure; it will ravel and is susceptible to collapse in steep cuts, particularly if the fill is in a wet condition.

One must be aware that the samples retrieved from boreholes 10 cm in diameter may not be truly representative of the geotechnical and environmental quality of the fill, and do not indicate whether the topsoil beneath the earth fill was completely stripped. This should be further assessed by laboratory testing and/or test pits.

4.4 **Silty Clay** (All Boreholes)

The silty clay was encountered at varying depths, and extends to the maximum investigated depth throughout the site. The silty clay contains a trace of sand with silt or sand seams or layers in places and occasional gravel. In addition, the clay is mostly varved, where the soils consist of layers of silty clay and silt, making it difficult to delineate. The laminated structure shows that the silty clay is a lacustrine deposit. Grain size analyses were performed on 5 representative samples of the silty clay; the results are plotted on Figures 9 and 10.

The obtained 'N' values range from 5 to 22, with a median of 9 blows per 30 cm of penetration, indicating that the consistency of the clay is firm to very stiff, being generally stiff.

The Atterberg Limits of 4 representative silty clay samples, and the water content of all of the clay samples, were determined. The results are plotted on the Borehole Logs and summarized below:

Liquid Limit	40%, 43%, 45% and 46%
Plastic Limit	20%, 21%, 22% and 23%
Natural Water Content	19% to 32% (median 24%)

The above results and sample examinations show that the clay has medium plasticity. The natural water content ranges from below the plastic limits to between its plastic and the liquid limits, but generally lies close to the plastic limit, confirming the generally stiff consistency of the clay as disclosed by the 'N' values, as well as the presence of silt layers.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility, high soil-adfreezing potential and low water erodibilty.
- Low permeability, with an estimated coefficient of permeability of 10^{-7} cm/sec, an estimated percolation time of more than 80 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.15
2% - 6%	0.20
6% +	0.28

- A cohesive-frictional soil, its shear strength is derived from consistency and augmented by internal friction of the silt. Its strength is moisture dependent and, to a lesser degree, dependent on the soil density.
- It will generally be stable in a relatively steep cut. However, prolonged exposure will allow infiltrating precipitation to saturate the sand and silt seams and layers; this may lead to localized sloughing.
- A very poor pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of 3% or less.
- Moderately high corrosivity to buried metal, with an estimated electrical resistivity of 2500 to 3000 ohm·cm.

4.5 **Silt** (Boreholes 102, 104, 105 and 106), **Sandy Silt** (Boreholes 103 and 108) and **Silty Fine Sand** (Boreholes 102, 104 and 106)

Layers of silt, sandy silt and/or silty fine sand were contacted primarily in the upper to mid zone of the revealed soil stratigraphy; they contain a trace to some clay with occasional gravel in places. The sorted structure indicates that the soils are glaciolacustrine deposits. A grain size analysis was performed on 1 representative sandy silt sample; the result is plotted on Figure 11.

The obtained 'N' values for the silt range from 5 to 15, with a median of 8 blows per 30 cm of penetration, and the obtained 'N' values for the sandy silt are 11, 14 and 17 per 30 cm, while the obtained 'N' values for the silty fine sand range from 10 to 17, with a median of 14 per 30 cm. This indicates that the relative density of the silts and silty fine sand is loose to compact, being generally compact.

The natural water content of the soil samples are plotted on the Borehole Logs; the values range from 13% to 21%, with a median of 17%, indicating moist to wet, generally wet conditions. The samples displayed dilatancy when wetted and shaken by hand.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- High frost susceptibility and high soil-adfreezing potential.
- High water erodibility; they are susceptible to migration through small openings under seepage pressure.
- Soils of high capillarity and water retention capacity.
- Pervious to relatively low permeability, depending on the clay content, with an estimated coefficient of permeability of 10^{-3} to 10^{-5} cm/sec, an estimated percolation time of 15 to 40 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.04 to 0.11
2% - 6%	0.09 to 0.16
6% +	0.13 to 0.23

- Frictional soils, their shear strength is derived from internal friction and is soil density dependent. Due to their dilatancy, the strength of the saturated silts and silty fine sand is susceptible to impact disturbance; i.e., the disturbance will induce a build-up of pore pressure within the soil mantle, resulting in soil dilation and a reduction of shear strength.
- In excavation, the silts and silty fine sand will slough in steep slopes, run slowly with water seepage, and boil under a piezometric head of 0.4 m.
- Poor pavement-supportive materials, with an estimated CBR value of 3% to 5%.
- Moderate to moderately low corrosivity to buried metal, with an estimated electrical resistivity of 4000 to 5000 ohm·cm.

4.6 **Sand** (Boreholes 103 and 105)

The sand deposit, ranging from fine to coarse grained, was encountered in the upper zone of the revealed soil stratigraphy beneath the topsoil fill or earth fill. The sand contains a trace to some silt. The sorted structure shows that the sand is a glaciolacustrine deposit.

The obtained 'N' value at one location is 28 blows per 30 cm of penetration, indicating the relative density of the sand is compact.

The natural water content of the sand was determined and the results are plotted on the Borehole Logs; the values are 5% and 10%, indicating damp to moist conditions.

Based on the above findings, the deduced engineering properties pertaining to the project are given below:

- Low to medium frost susceptibility.
- High water erodibility; susceptible to migration through small openings under seepage pressure.
- Pervious, with an estimated coefficient of permeability of 10^{-2} to 10^{-3} cm/sec, an estimated percolation time of less than 5 to 10 min/cm, and runoff coefficients of:

Slope	
0% - 2%	0.04
2% - 6%	0.09
6% +	0.13

- A frictional soil, its shear strength is derived from internal friction and is soil density dependent.
- In excavation, the sand will slough, run with seepage and boil under a piezometric head of 0.3 m.
- A fair to pavement-supportive material, with an estimated CBR value of 8% to 10%.
- Moderately low to low corrosivity to buried metal, with an estimated electrical resistivity of 6000 to 6500 ohm·cm.

4.7 Interpretation of Dynamic Cone Penetration Test Results (Borehole 105)

Dynamic cone penetration tests were performed at the bottom of Borehole 105 to obtain an indication of the soil strength changes with depth. The tests extended from a depth of 30.9 m to a depth of 38.1 m from the prevailing ground surface; the results indicate that the more competent soil occurs below a depth of 35.0 m from the existing grade.

4.8 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Earth Fill	5 to 23 (median 12)	12 to 15	8 to 20
Silty Clay	19 to 32 (median 24)	16 to 20	12 to 25
Silt/Sandy Silt/Silty Fine Sand	13 to 21 (median 17)	12 to 13	8 to 17
Sand	5 and 10	9 to 11	5 to 16

The above values show that most of the in situ soils are generally suitable for a 95% or + Standard Proctor compaction. However, portions of the earth fill, clay, silts and silty fine sand are too wet and may require aeration or mixing with drier soils prior to structural compaction. Aeration can be achieved by spreading the wet soil thinly on the ground in the dry and warm weather. The earth fill and any weathered soils must be sorted free of organic inclusions and any deleterious material prior to structural compaction.

The fill and clay should be compacted using a heavy-weight, kneading-type roller. The silts and sands can be compacted by a smooth roller with or without vibration, depending on the moisture content of the soils being compacted. The lifts for compaction should be limited to 20 cm, or to a suitable thickness as assessed by test strips performed by the equipment which will be used at the time of construction.

One should be aware that with considerable effort, a 90%± Standard Proctor compaction of the wet silts and sands is achievable. Further densification is prevented by the pore pressure induced by the compactive effort; however, large random voids will have been expelled and, with time, the pore pressure will dissipate and the percentage of compaction will increase. There are many cases on record where after a few months of rest, the density of the compacted mantle had increased to over 95% of its maximum Standard Proctor dry density (SPDD).

If the compaction of the soils is carried out with the water content within the range for 95% SPDD but on the wet side of the optimum, the surface of the compacted soil mantle will roll under the dynamic compactive load. This is unsuitable for road construction since each component of the pavement structure is to be placed under dynamic conditions which will induce the rolling action of the subgrade surface and cause structural failure of the new pavement. The slab-on-grade, foundations or bedding of the underground services will be placed on a subgrade which will not be subjected to impact loads. Therefore, the structurally compacted soil mantle with the water content on the wet side or dry side of the optimum will provide adequate subgrade strength for the project construction.

5.0 GROUNDWATER CONDITIONS

The boreholes were checked for the presence of groundwater and the occurrence of cave-in upon their completion. The groundwater data are plotted on the Borehole Logs and summarized in Table 2.

Upon completion of borehole drilling and sampling, groundwater monitoring wells were installed at all borehole locations, of which 7 of the wells were installed to facilitate a hydrogeological assessment by others, which will be presented under a separate cover. Groundwater levels were recorded in the wells on September 29, 2020 by our office, separate from the hydrogeological assessment and prior to any site visit for groundwater monitoring by the hydrogeological consultant; these water levels are also recorded on the Borehole Logs and summarized in Table 2, and were recorded prior to well development/purging.

Table 2 - Groundwater Levels

Borehole No.	Ground El. (m)	Borehole Depth (m)	Well Depth (m)	Measured Groundwater Level/ Cave-in* on Completion		Measured Groundwater Level in Wells on September 29, 2020	
				Depth (m)	El. (m)	Depth (m)	El. (m)
101 (MW)	265.0	17.2	7.6	6.4	258.6	4.5	260.5
102 (MW)	264.9	6.6	6.1	Dry	-	2.8	262.1
103 (MW)	268.0	6.6	4.6	2.7*	265.3*	2.5	265.5
104 (MW)	267.3	6.6	6.1	Dry	-	2.7	264.6
105 (MW)	266.8	30.9	16.8	N/A**	-	7.2	259.6
106 (MW)	265.3	17.2	7.6	11.6	253.7	Dry	-
107 (MW)	262.5	6.6	6.1	Dry	-	4.2	258.3
108 (MW)	269.3	6.6	4.6	3.5*	265.8*	3.2	266.1

* Cave-in level (In wet sand and silt layers, the level may represent the groundwater at the time of investigation.)

** No water level measurement taken since borehole was drilled using wash boring

As shown above, groundwater was recorded in 2 boreholes at depths of 6.4± m and 11.6± m on completion, and 2 of the boreholes caved at depths of 2.7± m and 3.5± m from the prevailing ground surface. At Borehole 105, water was added to aid in the drilling operation; therefore groundwater level was unable to be recorded. Wells were installed at all boreholes, as previously mentioned. Groundwater was recorded at depths of 2.5 to 7.2 m below the prevailing ground surface in 7 of the 8 wells on September 29, 2020, while the well at Borehole 106 remained dry; however, the groundwater condition of the site and its seasonal fluctuation should be confirmed through the hydrogeological assessment.

In excavation, groundwater yield from the silty clay is expected to be slow in rate and limited in quantity due to its low permeability, while the yield from the silts and sands may be moderate to appreciable, and likely persistent.

6.0 SLOPE STABILITY ASSESSMENT

A slope stability assessment has been carried out to determine the stability of the existing slope at the east limit of the property, and to establish the Long-Term Stable Top of Slope (LTSTOS). Visual inspection of the slope, carried out on September 29, 2020, revealed that the slope surface is densely vegetated with trees and tall vegetation. The tributary of the East Branch Holland River is located at or close to the bottom of slope. In addition, observation of the banks of the watercourse, where accessible, revealed active erosion of the bank, particular at the bends in the watercourse.

The existing slope has an overall height of approximately 10.5 to 17 m, measured from the bottom of slope to the top of slope. The slope has an average gradient ranging from 1.7 to 8.2+ horizontal (H):1 vertical (V), depending on the location; at one localized area at the top of slope, the gradient was found to be 0.8H:1V.

Seven (7) cross-sections, Cross-Sections A-A to G-G, inclusive, were selected as representative of the overall slope profile; the location of these cross-sections is shown on Drawing No. 1. The slope profiles were interpreted from the provided survey plan, prepared by Lloyd & Purcell. The subsurface profile at each cross-section was interpreted from the logs for Boreholes 101, 105 and 106, where appropriate.

Groundwater levels measured in the wells at Boreholes 101 and 105 on September 29, 2020 were recorded at El. 260.5 m and El. 259.6 m, respectively; these water levels have been modelled as a phreatic surface at all cross-sections, where appropriate. The water level is assumed to taper towards the bottom of slope and existing watercourse.

The slope stability at the cross-sections were analysed using the force-moment-equilibrium criteria of the Bishop Method with the soil strength parameters shown in Table 3.

Table 3 - Soil Strength Parameters

Soil Type	Unit Weight γ (kN/m^3)	Cohesion c (kPa)	Internal Friction Angle ϕ
Earth Fill	20.5	0	26°
Silty Clay (varved)	20.5	5	26°
Silt	21.0	0	30°
Silty Fine Sand	20.5	0	31°

The results of the analysis are presented on Drawing Nos. 3 to 13, inclusive, and the minimum Factors of Safety (FOS) are summarized in Table 4.

Table 4 - Minimum Factors of Safety (FOS)

Cross-Section	FOS	Drawing No.
A-A (Existing Condition)	1.228	3
A-A (Stable Condition with Toe Erosion Allowance)	1.503	4
B-B (Existing Condition)	1.807	5
B-B (Stable Condition with Toe Erosion Allowance)	1.771	6
C-C (Existing Condition)	1.847	7
C-C (Stable Condition with Toe Erosion Allowance)	1.566 (Local) 1.706 (Global)	8
D-D (Existing Condition)	1.207 (Local) 1.700 (Global)	9
D-D (Stable Condition with Toe Erosion Allowance)	1.707 (Local) 1.710 (Global)	10
E-E (Existing Condition)	1.998	11
F-F (Existing Condition)	1.827	12
G-G (Existing Condition)	1.563	13

The results of the analyses at Cross-Sections B-B, C-C, E-E, F-F and G-G shows that the minimum FOS is calculated to be between 1.563 and 1.998, meeting the Ontario Ministry of Natural Resources (OMNR) guideline requirements for active land use (minimum FOS of 1.5); however, at Cross-Sections A-A and D-D, the minimum FOS were calculated to be 1.228 and 1.207, respectively, which fail to meet the OMNR guideline requirements with an FOS less than 1.5. The results of the analyses are presented on Drawing Nos. 3, 5, 7, 9, 11, 12 and 13 for Cross-Sections A-A to G-G, respectively.

Cross-Sections A-A and D-D were subsequently reanalysed to determine the stable gradient at the site in order to meet the OMNR requirements for a minimum FOS of 1.5. Based on the reanalysis, the stable gradient was determined to be 2 or 3H:1V, depending on the height of the section of slope. In addition, due to the proximity of the watercourse to the bottom of slope, and considering that active erosion was observed along the slope bank, the reanalysis at Cross-Sections A-A to D-D, inclusive, were carried out to incorporate a 15.0 m toe erosion allowance; this is in accordance with the OMNR guidelines for firm clay material encountered along and at the bottom of slope. The results of the reanalyses at Cross-Sections A-A to D-D, inclusive, are presented on Drawing Nos. 4, 6, 8 and 10, respectively, and show that with the incorporation of the toe erosion allowance and stable gradients, where necessary, the resulting minimum FOS were determined to be 1.503 to 1.771; therefore, the incorporated stable gradient to the top of slope can be considered the stable top of slope.

The LTSTOS based on the slope stability analysis has been established on Drawing No. 1 and shows that the LTSTOS lies either at the physical top of slope alongside most of the slope, or upto approximately 26 m beyond the top of slope within the south portion of the site. Furthermore, a development setback for man-made and environmental degradation will be required from the LTSTOS. A 6 m development setback/erosion access allowance can be supported; however, this is subject to the requirements of the Lake Simcoe Region Conservation Authority (LSRCA).

In order to prevent disturbance of the existing slope, the following geotechnical constraints should be stipulated:

1. The prevailing vegetative cover on the slope must be maintained, since its extraction would deprive the slope of the rooting system that is reinforcement against soil erosion by weathering. If, for any reason, the vegetative cover is stripped, it must be reinstated to its original, or better than its original, protective condition. Restoration with selected native plantings including deep rooting systems which would penetrate the original buried topsoil must be carried out after the development to ensure bank stability.
2. Any leafy topsoil cover on the slope face should not be disturbed, since this provides an insulation and screen against frost wedging and rainwash erosion, or the bare slope surface must be adequately sodded.
3. The loose branches and landscape debris should be cleaned up and exposed surfaces after the cleanup should be vegetated.
4. Grading of the land adjacent to the slope must be such that concentrated runoff is not allowed to drain onto the slope face. Landscaping features which may cause runoff

to pond at the top of the slope, such as infiltration trenches, as well as saturating the crown of the bank, must not be permitted.

5. Where development is carried out adjacent to the slope, there are other factors to be considered related to possible human environmental abuse. These include soil saturation from frequent watering to maintain landscaping features, stripping of topsoil or vegetation, dumping of loose fill, and material storage close to the top of slope; none of these should be permitted.

The above recommendations are subject to the approval and requirements of the LSRCA.

7.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath a topsoil or topsoil fill layer or a pavement structure, and/or a layer of earth fill in places, the site is underlain by strata of firm to very stiff, generally stiff silty clay; loose to very dense, generally compact silt, sandy silt and/or silty fine sand; and/or compact sand at various locations and depths.

Upon completion of the field work, groundwater was recorded or cave-in occurred at 4 boreholes at depths of 2.7± to 11.6± m below the prevailing ground surface. In addition, groundwater monitoring wells were installed at all borehole locations. Groundwater in the wells on September 29, 2020 was recorded at depths of 2.5 to 7.2 m below the existing grade. However, these groundwater levels were recorded by our office prior to well development/purging, and should be confirmed through the hydrogeological assessment; the groundwater is subject to seasonal fluctuation.

The proposed development of this site will entail a residential subdivision consisting of single family homes, a medium density block, stormwater management ponds (1 or 2) and a park. The geotechnical findings which warrant special consideration are presented below:

1. The topsoil is unsuitable for engineering applications and must be removed for site development. It can be reused for general landscaping purposes, but it must not be buried below any structures or deeper than 1.2 m below the exterior finished grade so it will not have an adverse impact on the environmental well-being of the developed area.
2. In using the existing granular fill for pavement construction, its suitability must be confirmed by frequent laboratory testing of bulk samples collected during construction. Nevertheless, the granular fill is suitable for use as structural backfill, bedding material or for subgrade stabilization.
3. The earth fill is unsuitable for supporting any structures in its current condition. In using the fill for structural backfill, or in pavement of slab-on-grade construction, it

should be subexcavated, inspected, sorted free of organic inclusions and any deleterious materials, aerated and properly recompacted in thin lifts. If it is impractical to sort the deleterious material from the fill, the fill must be wasted and replaced with properly compacted inorganic earth fill.

4. The native soils are suitable for low density development with lightly loaded structures on conventional footings. The footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that its condition is compatible with the design of the foundation.
5. Where higher bearing is required, particularly for the medium density block, deep foundations are recommended, and it should extend into hard soils below the weaker overburden. Additional deeper boreholes will be required to confirm the depth of the competent soil stratum for design of building(s) within the medium density block.
6. If the site has to be regraded for development, it is more economical to place an engineered fill for conventional footings, underground services and pavement construction. The weathered soils should be subexcavated and upgraded to engineered fill status by aeration and proper compaction.
7. Excavation should be carried out in accordance with Ontario Regulation 213/91.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should subsurface variances become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

7.1 Site Preparation

After removal of topsoil, and/or any structures that are to be demolished/removed for site redevelopment, the site can be pregraded for development. Where earth fill is required to raise the site, it is generally more economical to place an engineered fill for construction. The engineering requirements for a certifiable fill for pavement construction, municipal services, slab-on-grade, and house footings are presented below:

1. The topsoil must be removed, and the subgrade must be inspected and proof-rolled prior to any fill placement.
2. The earth fill and any weathered soil must be subexcavated, sorted free of topsoil inclusions and other deleterious materials, if any, aerated and properly compacted.
3. Inorganic soils must be used for the engineered fill, and they must be uniformly compacted in lifts, 20 cm thick, to 98% or + of their maximum SPDD up to the proposed finished grade and/or slab-on-grade subgrade. The soil moisture must be properly controlled near the optimum. If the foundations are to be built soon after the

fill placement, the densification process for the engineered fill must be increased to 100% of the maximum SPDD.

4. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not being until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
5. If imported fill is to be used, it should be inorganic soils, free of any deleterious material with environmental issue (contamination). Any potential imported earth fill from off site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
6. The engineered fill must not be placed during the period from late November to early April, when freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
7. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action.
8. Where fill is to be placed on a bank steeper than 3H:1V, the face of the bank must flattened to 3+H:1V so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
9. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement, particularly if it is to be carried out on sloping ground.
10. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
11. The engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors.
12. Foundations partially on engineered fill must be reinforced by two 15-mm steel reinforcing bars in the footings and upper section of the foundation walls, or be designed by a structural engineer, to properly distribute the stress induced by the abrupt differential settlement (estimated to be 15± mm) between the natural soils and engineered fill.
13. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.
14. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who inspected the fill placement in order to document the locations of the excavation and/or to inspect reinstatement of the excavated areas to

engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.

15. Despite stringent control in the placement of the engineered fill, variations in soil type and density may occur in the engineered fill. Therefore, the strip footings and the upper section of the foundation walls constructed on the engineered fill may require continuous reinforcement with steel bars, depending on the uniformity of the soils in the engineered fill and the thickness of the engineered fill underlying the foundations. Should the footings and/or walls require reinforcement, the required number and size of reinforcing bars must be assessed by considering the uniformity as well as the thickness of the engineered fill beneath the foundations. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

7.2 **Foundations**

For low density development with light structures, it is recommended that conventional footings be placed below the earth fill and weathered soil onto the sound natural soils below depths of 1.0 to 2.0 m from the existing ground surface, depending on location and fill depth encountered in the area. The recommended bearing pressures for the design of conventional spread and strip footings are provided below:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 100 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 160 kPa

However, below depths of 3.0 m from the existing grade, the soils become slightly weaker with depth; therefore, below this depth, the recommended bearing pressures for the design of conventional spread and strip footings are reduced to the following:

- Maximum Soil Bearing Pressure at Serviceability Limit State (SLS) = 75 kPa
- Factored Ultimate Bearing Pressure at Ultimate Limit State (ULS) = 120 kPa

The existing earth fill and weathered soil can be subexcavated and replaced with engineered fill suitable for conventional footing construction. Furthermore, where fill is required to raise the grade, or where extended footings and/or cut and fill is required for the site grading, engineered fill suitable for normal construction can be considered. Soil pressures of 100 kPa (SLS) and 160 kPa (ULS) are recommended for footings founded on engineered fill. The fill must be certified by the geotechnical consultant that supervised and inspected the fill placement. Details of engineered fill are provided in Section 7.1 of this report.

Where higher bearing pressures are required, particularly for the medium density block, deep foundations such as helical piers should be considered, and should extend to a depth below the weaker clay soil. Based on results of the dynamic cone penetration tests at Borehole 105, the soils become harder below a depth of 35.0 m from the existing grade; however, the depth of the hard soil, and/or bearing confirmation for the medium density block, should be confirmed by deeper borehole once location and design of the block is available. Alternatively, raft foundation can also be considered.

The total and differential settlements of footings designed for the recommended bearing pressure at SLS are estimated to be 25 mm and 20 mm, respectively.

One must be aware that the recommended soil bearing pressures are given as a guide for foundation design. The bearing subsoil must be confirmed by subgrade inspection performed by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the revealed conditions are compatible with the foundation design requirements.

Footings exposed to weathering, or in unheated areas, should have at least 1.2 m of earth cover for protection against frost action.

If groundwater seepage is encountered during the footing excavations, or where the subgrade is found to be wet, the footings must be poured immediately after subgrade inspection or the subgrade should be protected by a concrete mud-slab immediately after exposure. This will prevent construction disturbance and costly rectification of the bearing subsoil.

The foundations should meet the requirements specified in the latest Ontario Building Code, and the structure should be designed to resist an earthquake force using Site Classification ‘D’ (stiff soil).

7.3 **Basement and Slab-On-Grade Construction**

Perimeter walls of basement should be designed to sustain a lateral earth pressure calculated using the soil parameters given in Table 6 in this report. Any applicable surcharge loads beside the basement must also be included in the design of the basement.

Perimeter subdrains and dampproofing of the foundation walls will be required in order to provide a dry basement. All the subdrains should be encased in a fabric filter to protect them against blockage by silting.

The on site subsoils consist of clay and silts with high soil-adfreezing potential. The foundation walls should be backfilled with non-frost susceptible granular material or protected by a slip membrane.

The subgrade for the basement slab and other slab-on-grade must consist of sound natural soils or properly compacted inorganic fill. In preparation of the subgrade, any topsoil should be removed. The earth fill and weathered soil should be subexcavated, sorted free of any deleterious material, aerated and uniformly compacted to 98% or + of its maximum SPDD. In addition, any new fill should consist of organic-free soil, compacted uniformly to 98% or + of its maximum SPDD. The final subgrade must be inspected and assessed by proof-rolling prior to placement of granular bedding.

The basement/floor slab should be constructed on a granular bedding of 20 cm in thickness, consisting of 20-mm Crusher-Run Limestone, or equivalent, compacted to 100% of its maximum SPDD.

A Modulus of Subgrade Reaction of 20 MPa/m is recommended for the slab-on-grade design.

The grading around the building structures must be such that it directs runoff away from the structures.

Where groundwater seepage is encountered during basement excavation, floor subdrain may be required. This can be further assessed during construction.

7.4 Underground Services

The subgrade for the underground services should consist of sound natural soils or properly compacted organic-free earth fill. Where topsoil, organic earth fill or badly weathered soil is encountered, it should be subexcavated and replaced with properly compacted inorganic soil and/or bedding material compacted to at least 98% or + SPDD.

A Class ‘B’ bedding is recommended for the underground services construction. The bedding material should consist of compacted 20-mm Crusher-Run Limestone, or equivalent. The pipe joints should be leak-proof, or the joints should be wrapped with a waterproof membrane, to prevent subgrade upfiltration through the joints. Where saturated soils are contacted at the pipe invert or extensive dewatering is required, a Class ‘A’ concrete bedding can be considered.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover of at least two times the diameter of the pipe should be in place at all times after completion of the pipe installation.

Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

The subgrade of underground services may have moderately high corrosivity to metal pipes and fittings; therefore, the underground services should be protected against soil corrosion. For estimation for the anode weight requirements, the estimated electrical resistivity given for the disclosed soil can be used. This, however, should be confirmed by testing the soil along the service alignment at the time of construction.

7.5 Backfilling in Trenches and Excavated Areas

The on site inorganic soils are generally suitable for use as trench backfill. However, the backfill soils should be sorted free of any topsoil inclusions and other deleterious materials prior to the backfilling.

The backfill in trenches and excavated areas should be compacted to at least 95% of its maximum SPDD and increased to 98% or + SPDD below the floor slab. In the zone within 1.0 m below the pavement subgrade, the materials should be compacted with the water content 2% to 3% drier than the optimum, and the compaction should be increased to at least 98% of the respective maximum SPDD. This is to provide the required stiffness for pavement construction. In the lower zone, the compaction should be carried out on the wet side of the optimum; this allows a wider latitude of lift thickness.

In normal underground services construction practice, the problem areas of settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, imported sand backfill should be used. Unless compaction of the backfill is carefully performed, the interface of the native soils and the sand backfill will have to be flooded for a period of several days.

Narrow trenches for services crossings should be cut at 2H:1V, or flatter, so that the backfill can be effectively compacted. Otherwise, soil arching will prevent the achievement of proper compaction. The lift of each backfill layer should either be limited to a thickness of 20 cm, or the thickness should be determined by test strips.

One must be aware of the possible consequences during trench backfilling and exercise caution as described below:

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within 1 to several years, depending on the depth of the trench which has been backfilled.
- In areas where the construction is carried out during the winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement and the slab-on-grade construction.
- In deep trench backfill, one must be aware that future settlement may occur, unless the side of the cut is flattened to at least 2H:1V, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% of the maximum SPDD, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand and the compaction must be carried out diligently prior to the placement of the backfill above this sector; i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.
- In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided, unless concrete bedding is used in the service trenches.

7.6 Garages, Driveways, Sidewalks, Interlocking Stone Pavement and Landscaping

Due to the high frost susceptibility of the underlying soils, excessive movement of the pavement structure and sidewalk can be expected during the freeze and thaw seasons.

In order to minimize the freeze and thaw movement, the garage floor and driveway leading to the garage should be backfilled with non-frost susceptible granular material, with a frost taper at a slope of 2H:1V. The garage floor slab and interior garage foundation walls should be insulated with 50-mm Styrofoam, or equivalent.

Interlocking stone pavement, sidewalks and landscaping structures in areas which are sensitive to frost-induced ground movement must be constructed on a free-draining, non-frost-susceptible granular material such as Granular 'B'. The material must extend to 0.3 to 1.2 m below the sidewalk, slab or pavement surface, depending on the degree of tolerance for movement, and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins. Alternatively, the landscaping structures, sidewalks and interlocking stone pavement should be properly insulated with 50-mm Styrofoam, or equivalent.

7.7 Pavement Design

The recommended pavement design for residential local and collector roads, meeting the Town of Aurora specifications, is presented in Table 5.

Table 5 - Pavement Design

Course	Thickness (mm)		OPS Specifications
	Residential Local	Residential Collector	
Asphalt Surface	40	50	HL-3
Asphalt Binder	50	75	HL-8
Granular Base	150	150	20-mm Crusher-Run Limestone, or equivalent
Granular Sub-base	300	450	50-mm Crusher-Run Limestone, or equivalent

In preparation of the subgrade, topsoil should be removed and the subgrade surface must be proof-rolled. The earth fill, weathered soil or soft/loose subgrade must be subexcavated, sorted free of any deleterious materials, aerated and properly compacted. New fill used to raise the grade for pavement construction should consist of uniformly compacted organic-free soil. In the zone within 1.0 m below the pavement subgrade, the fill should be compacted to at least 98% of its maximum SPDD, with the water content 2% to 3% drier than the optimum. In the lower zone, a 95% or + Standard Proctor compaction is considered adequate.

All the granular bases should be compacted to 100% of their maximum SPDD.

The road subgrade will suffer a strength regression if water is allowed to saturate the mantle. The following measures should, therefore, be incorporated into the construction procedures and pavement design:

- Areas adjacent to the road should be properly graded to prevent ponding of large amounts of water during the interim construction period.
- Curb subdrains will be required. The subdrains should consist of filter-sleeved weepers to prevent blockage by silting.
- If the road construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- If the road is to be constructed during wet seasons and extensively soft subgrade occurs, the granular sub-base should be thickened in order to compensate for the inadequate strength of the subgrade. This can be assessed during construction.

7.8 Stormwater Management Facility

It is understood that a stormwater management (SWM) facility is proposed at the site; however, details with regards to the SWM facility were not available at the time of report preparation, and it is understood that the location of the proposed facility has not yet been finalized.

Based on the borehole findings, the site consists primarily of silty clay, with sand and/or silt encountered within the surficial 1± to 4± m in places. In addition, groundwater was recorded in the wells installed at the site at varying levels ranging from 2.5 to 7.2 m from the existing grade prior to well development/purging; however, this should be confirmed through the hydrogeological study.

The encountered silty clay has an estimated coefficient of permeability of 10^{-7} cm/sec with an estimated percolation time above 80 min/cm, although the clay is varved with silt layers, particularly at lower depths. Where a SWM pond is constructed into the silty clay, the seepage of groundwater into the pond may be equal to or less than the amount of water lost through evaporation, and the impact on the storage volume of the pond will be minimal, but will be affected where prominent silt or sand layers occurs. The encountered silts and sands have an estimated coefficient of permeability of 10^{-2} to 10^{-5} cm/sec with an estimated percolation time ranging from 5 to 40 min/cm. Where a SWM pond is to be constructed into the silts and sands, or where silt layers are prevalent within the varved clay, a clay liner will be required for water retention purpose. The estimated percolation rates are bases on gradation analysis of soil samples. In-situ testing of subsoils can be conducted for the design of infiltration, if necessary.

Where sand or silt seams or layers are encountered, these soils will have an impact on the effective storage capacity of the SWM pond. Where necessary, a clay liner, at least 1.0 m thick, compacted to at least 98% of its maximum SPDD, should be installed on the sides or bottom of the SWM pond and should extend to 1.0 m (minimum) above the permanent pool level. The extent of the clay liner and its implementation can be assessed at the time of the pond construction.

The side slopes of the SWM pond should have gradients of at least 3H:1V above the wet perimeter, and flattened to at least 5H:1V below the wet perimeter. The side slopes should be surface compacted. All the proposed slopes must be vegetated and/or sodded to prevent erosion.

One should be aware that minor maintenance may be required after rapid drawdown as the water recedes from a high level to a lower level.

For construction of the SWM pond and surrounding earth berm, if any, the topsoil and ploughed soil must be removed and the subgrade must be proof-rolled. The weathered soils should be subexcavated, inspected, sorted free of any deleterious materials, aerated and properly compacted. Inorganic clay material compacted to at least 98% of its maximum SPDD in 20 cm lifts, must be used for berm construction.

The footings for all control structures for the SWM facility must be placed onto the sound natural soils or engineered fill. The recommended soil bearing pressures (SLS and ULS), along with the suitable founding levels for the design footings at the site, are presented in Section 7.2.

The footings must be placed below the frost depth of 1.2 m, or below the scouring depth, whichever is deeper. The footing subgrade must be inspected by a geotechnical engineer prior to concrete pouring to ensure its conformity to the design.

7.9 <u>Soil Parameters</u>

The recommended soil parameters for the project design are given in Table 6.

Table 6 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Earth Fill	20.5	11.5	1.20	0.98
Silty Clay	20.5	11.5	1.30	1.00
Silt/Sandy Silt/Silty Fine Sand	21.0	11.0	1.20	1.00
Sand	20.0	10.8	1.25	0.98

Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_0**	**Passive K_p**
Earth Fill and Silty Clay	0.40	0.50	2.50
Silts/Sands	0.33	0.48	3.00

Maximum Allowable Soil Pressure (SLS) for Thrust Block Design	
Sound Natural Soils and Engineered Fill	50 kPa

Coefficients of Friction	
Between Concrete and Granular Base	0.50
Between Concrete and Sound Natural Soils	0.35

7.10 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 7.

Table 7 - Classification of Soils for Excavation

Material	**Type**
Stiff to very stiff Clay	2
Earth Fill, weathered Soils, firm Clay and dewatered Silts and Sands	3
Saturated Silts and Sands	4

In excavation, groundwater yield from the silty clay is expected to be slow in rate and limited in quantity due to its low permeability, while the yield from the silts and sands may be moderate to appreciable, and likely persistent.

Where excavation is to be carried out in the wet or water-bearing silts or sands, the possibility of flowing sides and bottom boiling dictates that the ground be predrained by pumping from closely spaced sump-wells or, if necessary, the use of a well-point dewatering system. This should be assessed by test pumping prior to the project construction when the intended bottom of excavation is determined. In order to provide a stable subgrade for the services or foundation construction, the groundwater should be depressed at least 1.0 m below the subgrade level. The need for dewatering should be further assessed by a hydrogeologist.

Alternatively, sheeting structures can be installed around the excavation. The sheeting structure should be driven to a depth below the bottom of the excavation at least equal to the height of water above the bed of excavation. The sheeting structure must be properly designed by a qualified structural engineer to sustain the earth pressure, hydrostatic pressure and applicable surcharge loads.

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation. These test pits should be allowed to remain open for a period of at least 4 hours to assess the trenching conditions.

8.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the accounts of Shining Hill Estates Operator Inc., and for review by the designated consultants and government agencies. Use of the report is subject to the conditions and limitations of the contractual agreement.

The material in the report reflects the judgement of Mumta Mistry, B.A.Sc., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

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LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—•—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0	Field vane test in borehole; the number denotes the sensitivity to remoulding
△	Laboratory vane test
☐	Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 101

FIGURE NO.: 1

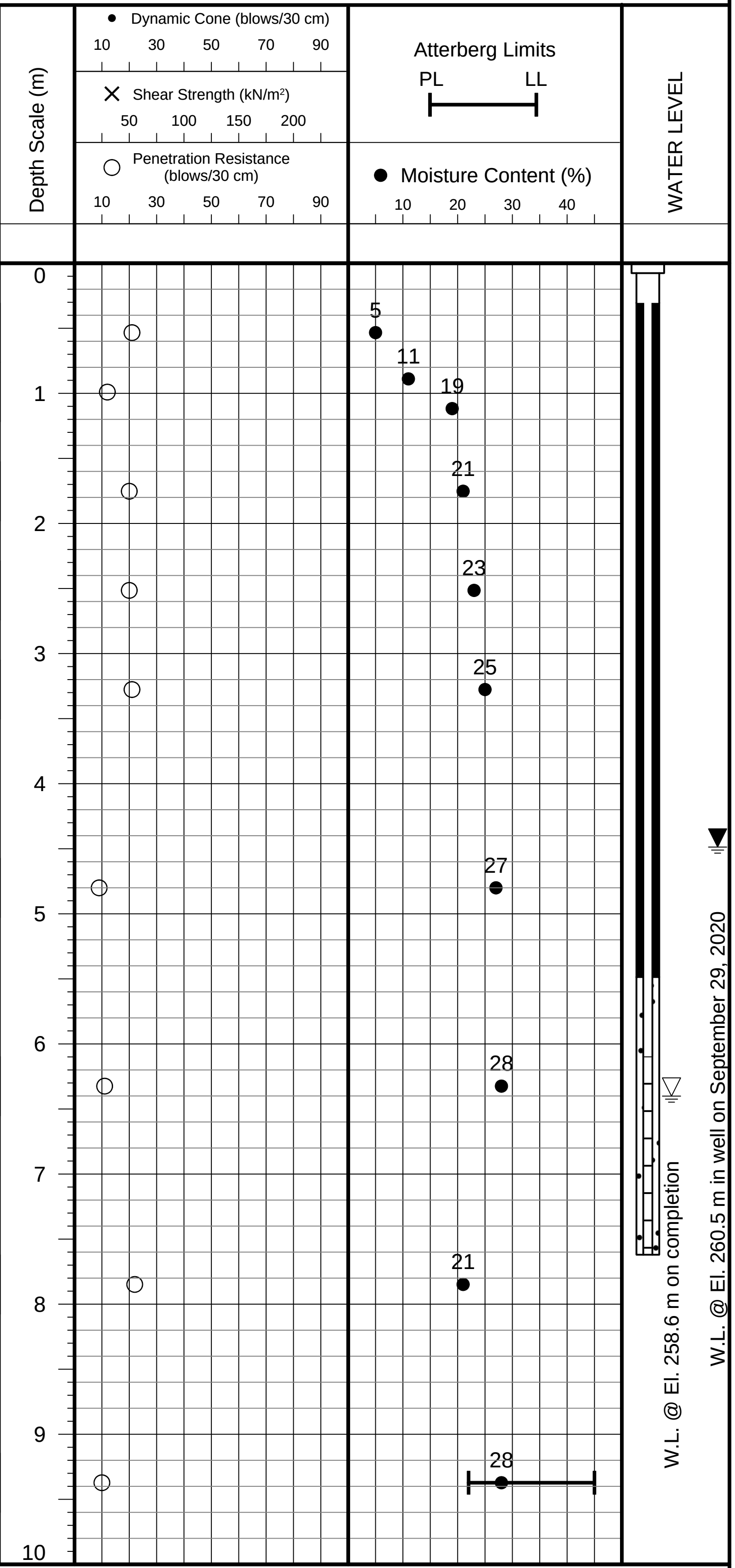
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 10 and 11, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
265.0	Pavement Surface			
0.0	**80 mm ASPHALT CONCRETE** **300 mm GRANULAR FILL**			
	Brown **EARTH FILL** **(Silty Sand)** a trace of gravel	1	DO	21
264.0 1.0		2A 2B	DO	12
	Stiff to very stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers	3	DO	20
		4	DO	20
		5	DO	21
	brown grey	6	DO	9
		7	DO	11
		8	DO	22
		9	DO	10
255.0	*(Continued on next page)*			



W.L. @ El. 258.6 m on completion

W.L. @ El. 260.5 m in well on September 29, 2020

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 101

FIGURE NO.: 1

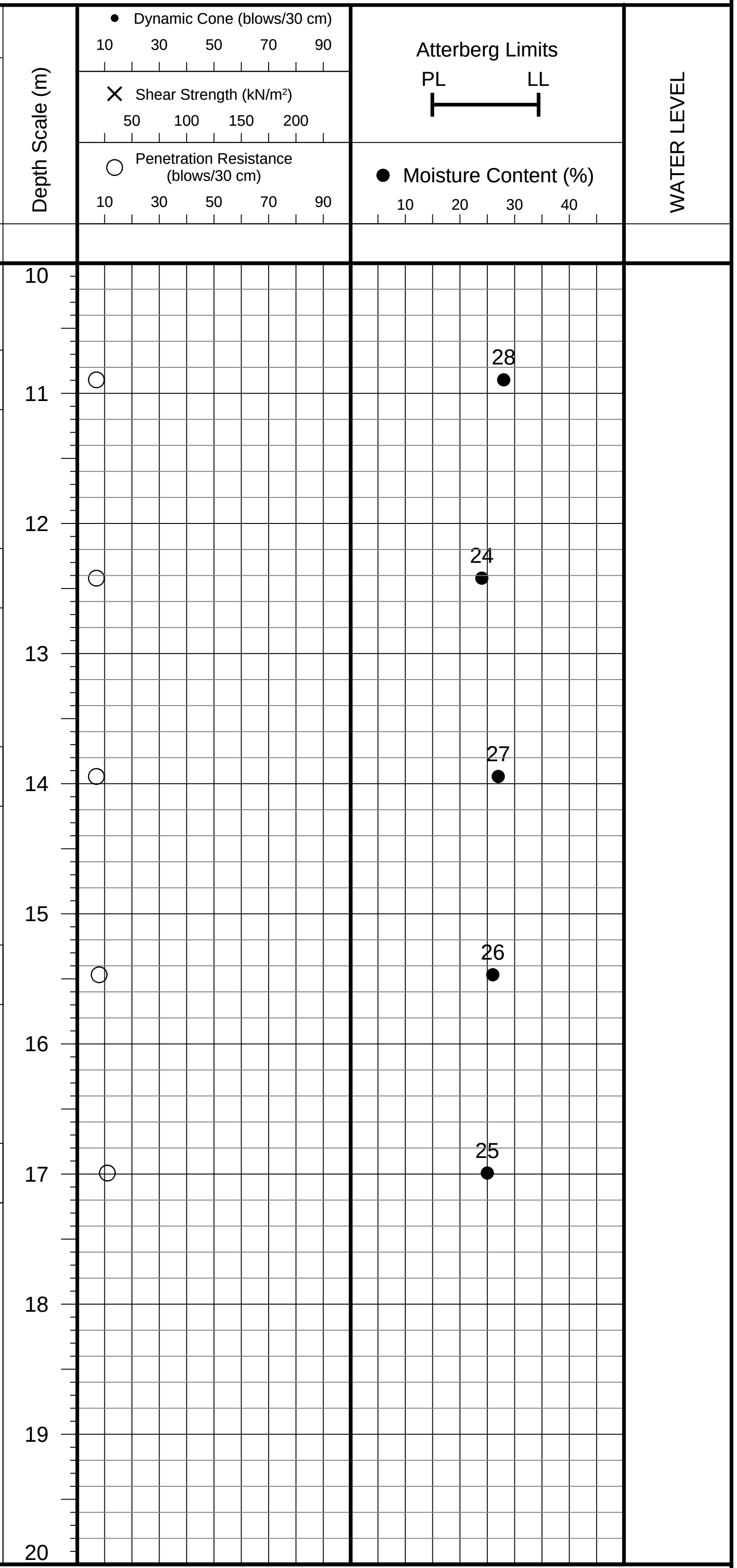
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 10 and 11, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
10.0	*(Continued)* Grey, firm to stiff **SILTY CLAY (varved)** a trace of sand with silt seams and layers			
		10	DO	7
		11	DO	7
		12	DO	7
		13	DO	8
		14	DO	11
247.8 17.2	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 7.6 m (1.5 m screen) Sand backfill from 5.5 m to 7.6 m Bentonite holeplug from 0.3 m to 5.5 m Provided with a flushmount casing Sealed with 0.3 m concrete to surface with top and bottom caps			



Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 102

FIGURE NO.: 2

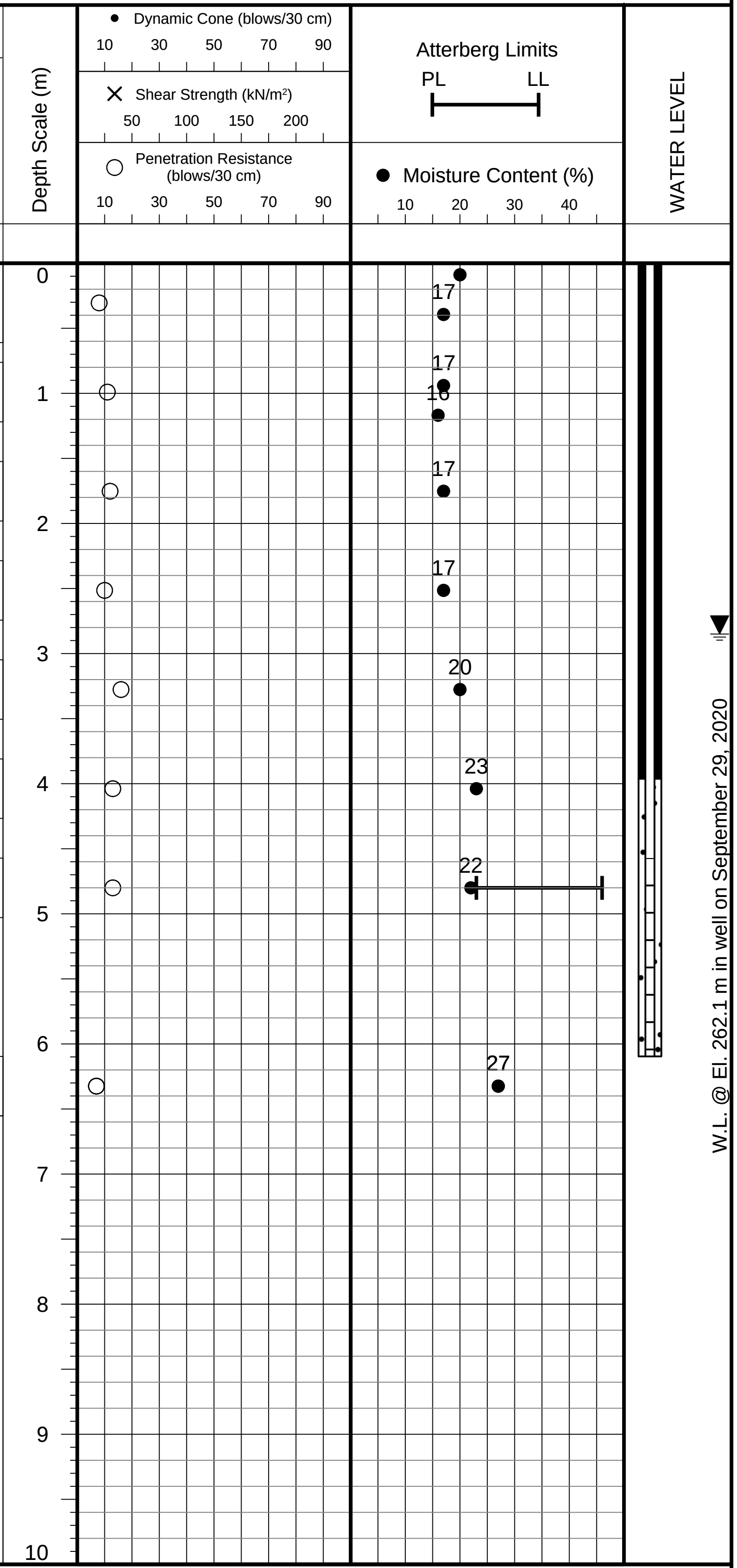
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
264.9	Ground Surface			
0.0	**18 cm TOPSOIL**	1A	DO	8
	Brown, loose to compact, weathered **SILT** a trace of clay a trace to some sand	1B		
		2A	DO	11
263.8 1.1	Brown, loose to compact **SILTY FINE SAND** — — weathered a trace of clay occ. gravel	2B		
		3	DO	12
		4	DO	10
261.6 3.3	Grey, firm to stiff **SILTY CLAY** a trace of sand	5	AS	16
		6	DO	13
		7	DO	13
		8	DO	7
258.3 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m (1.5 m screen) Sand backfill from 4.0 m to 6.1 m Bentonite holeplug from 0 m to 4.0 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 103

FIGURE NO.: 3

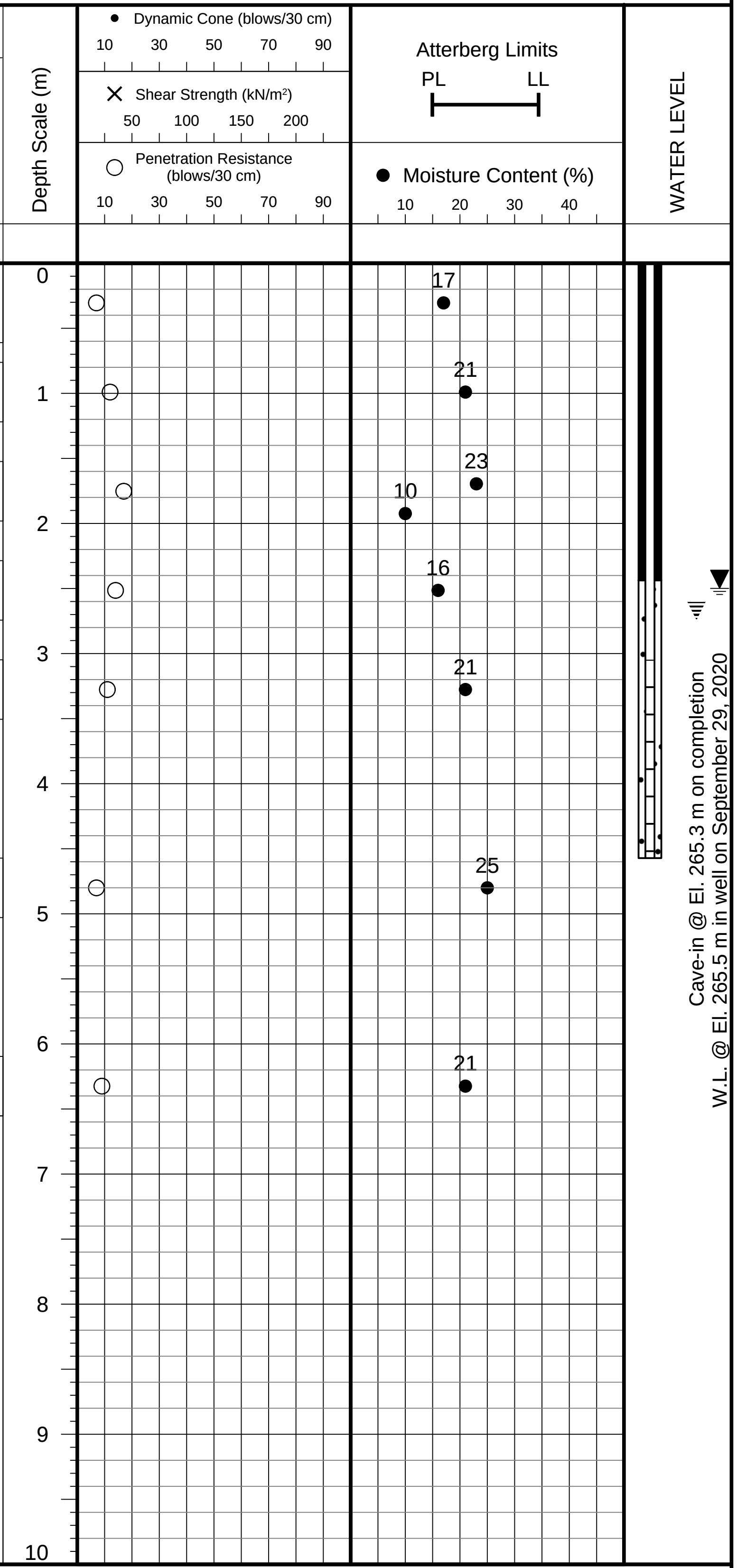
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 16, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
268.0	Ground Surface			
0.0	**TOPSOIL FILL** (mixed with clay and silt)	1	DO	7
		2	DO	12
		3A 3B	DO	17
266.1 1.9	Brown, compact **SAND** fine to coarse grained a trace of silt			
265.7 2.3	Brown, compact **SANDY SILT** a trace of clay occ. silt layers	4	DO	14
		5	DO	11
263.4 4.6	Grey, firm to stiff **SILTY CLAY** a trace of sand with sand and silt seams, and occ. gravel	6	DO	7
		7	DO	9
261.4 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 4.6 m (1.5 m screen) Sand backfill from 2.4 m to 4.6 m Bentonite holeplug from 0 m to 2.4 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



Cave-in @ El. 265.3 m on completion

W.L. @ El. 265.5 m in well on September 29, 2020

Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 104

FIGURE NO.: 4

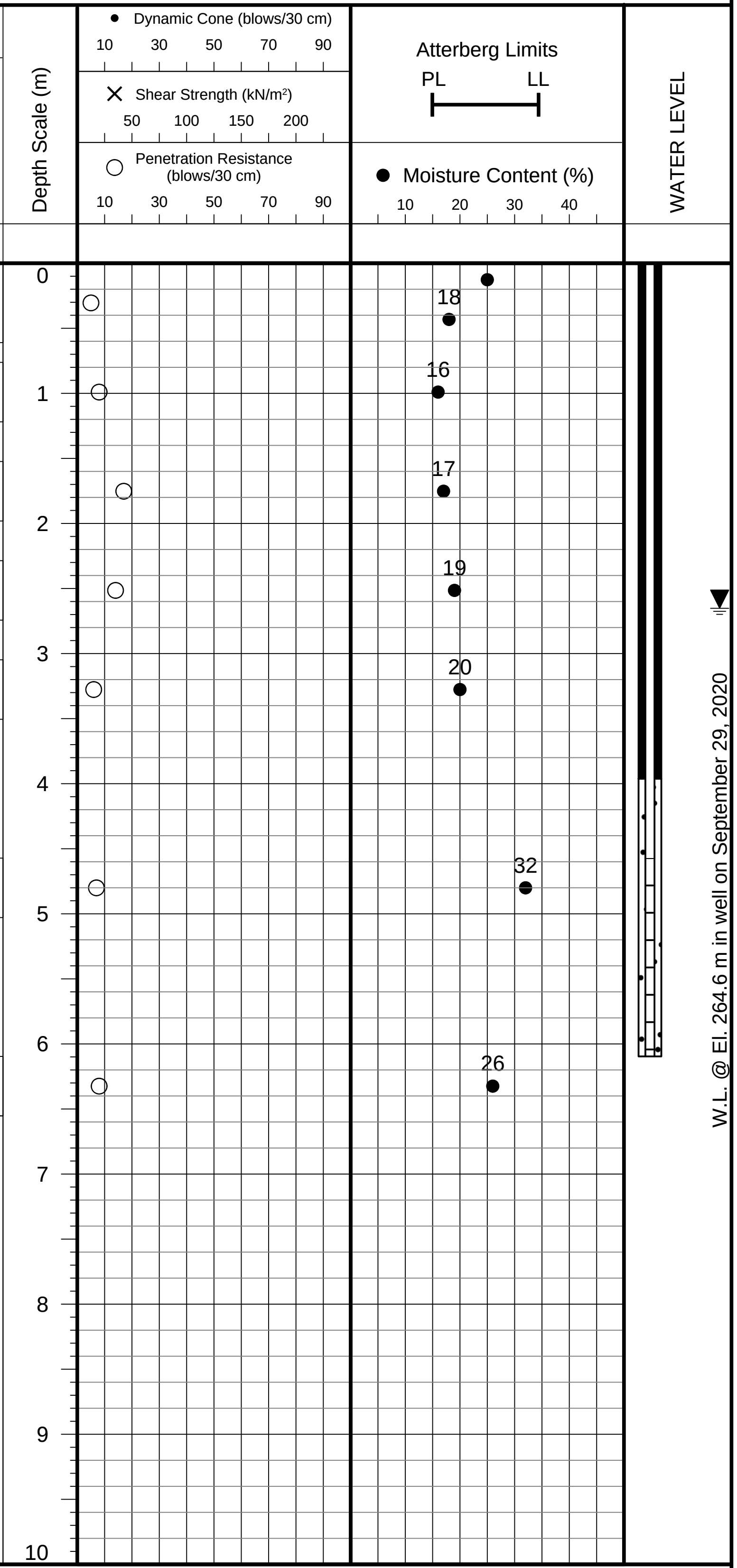
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 11, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
267.3	Ground Surface			
0.0	**25 cm TOPSOIL**	1A	DO	5
	Brown, loose, weathered **SILT** a trace of clay a trace to some sand occ. sand layers	1B		
		2	DO	8
265.8 1.5	Brown, compact **SILTY FINE SAND** a trace of clay	3	DO	17
		4	DO	14
264.3 3.0	Firm **SILTY CLAY** a trace of sand with sand and silt seams and layers silt/ brown — — — grey	5	DO	6
		6	DO	7
		7	DO	8
260.7 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m (1.5 m screen) Sand backfill from 4.0 m to 6.1 m Bentonite holeplug from 0 m to 4.0 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 105

FIGURE NO.: 5

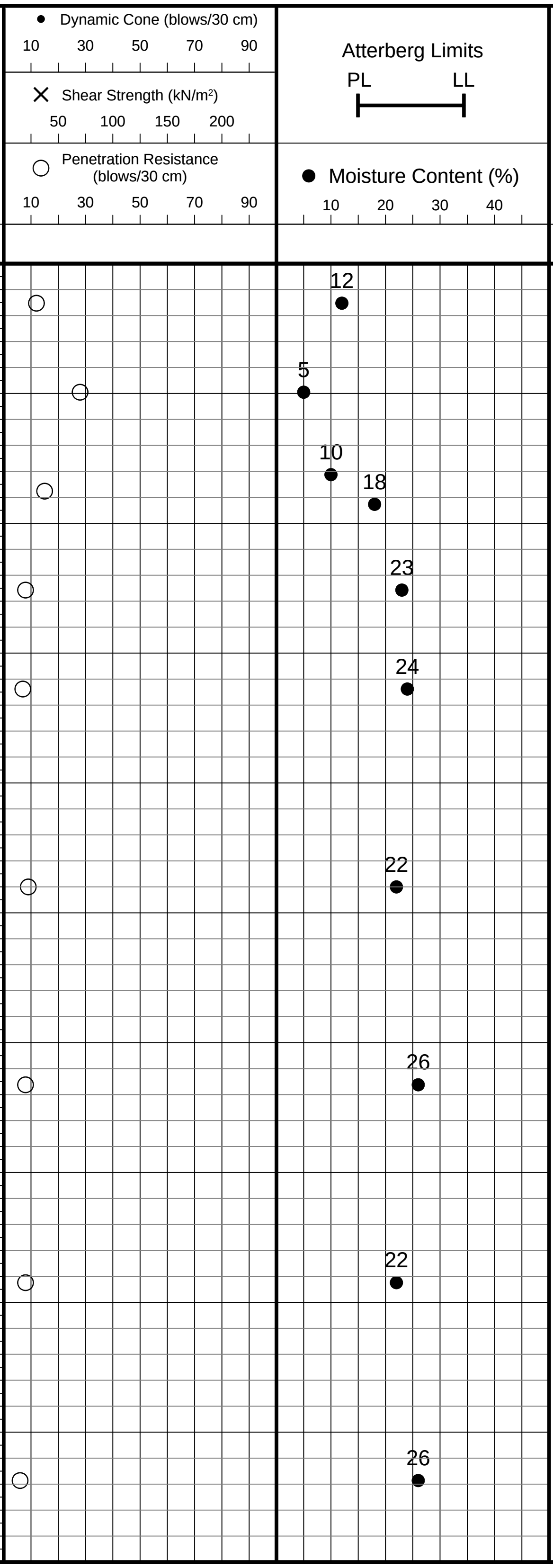
PROJECT DESCRIPTION: Proposed Residential Development

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

METHOD OF BORING: Hollow Stem Augers Washbore with Tri-Cone and Dynamic Cone

DRILLING DATE: September 9, 10, 14 and 15,

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
266.8	Ground Surface			
0.0	Brown **EARTH FILL** **(Silty Sand)** traces of clay and gravel with organic inclusions	1	DO	12
266.0 0.8	Brown, compact **SAND** fine grained a trace to some silt	2	DO	28
		3A	DO	15
265.1 1.7	Brown, compact **SILT** some clay, a trace of sand	3B		
264.5 2.3	Grey, firm to stiff **SILTY CLAY** **(varved)** a trace of sand with silt seams and layers	4	DO	8
		5	DO	7
		6	DO	9
		7	DO	8
		8	DO	8
		9	DO	6
256.8	*(Continued on next page)*			



WATER LEVEL

No W.L. recorded due to process of washboring to carry out deep borehole

W.L. @ El. 259.6 m in well on September 29, 2020

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 105

FIGURE NO.: 5

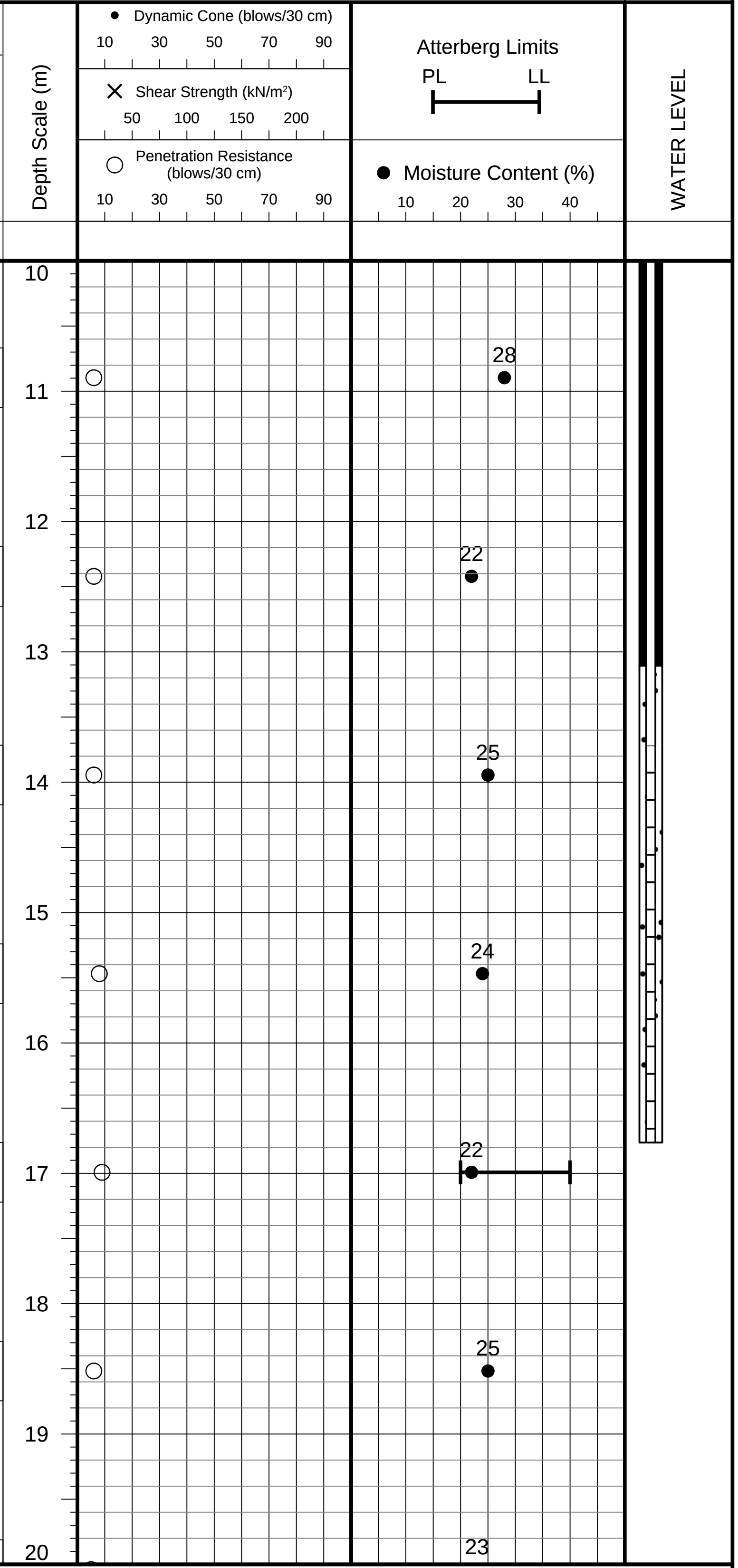
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers Washbore with Tri-Cone and Dynamic Cone

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 9, 10, 14 and 15,

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
10.0	*(Continued)* Grey, firm to stiff **SILTY CLAY (varved)** a trace of sand with silt layers			
		10	DO	6
		11	DO	6
		12	DO	6
		13	DO	8
		14	DO	9
		15	DO	6
246.8	*(Continued on next page)*			



JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 105

FIGURE NO.: 5

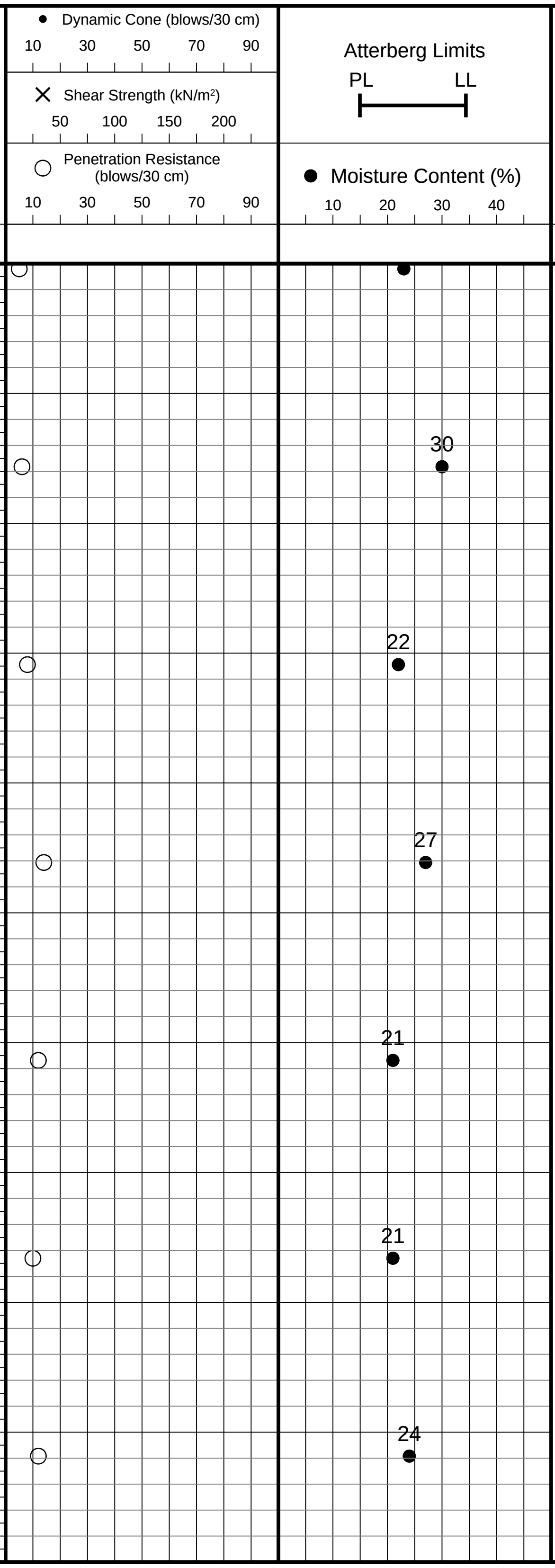
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers Washbore with Tri-Cone and Dynamic Cone

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 9, 10, 14 and 15,

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	WATER LEVEL
20.0	*(Continued)* Grey, firm to stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers	16	DO	5	20	
					21	
		17	DO	6		
					22	
		18	DO	8	23	
					24	
		19	DO	14		
					25	
		20	DO	12	26	
					27	
		21	DO	10		
					28	
		22	DO	12	29	
236.8	*(Continued on next page)*				30	



Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 105

FIGURE NO.: 5

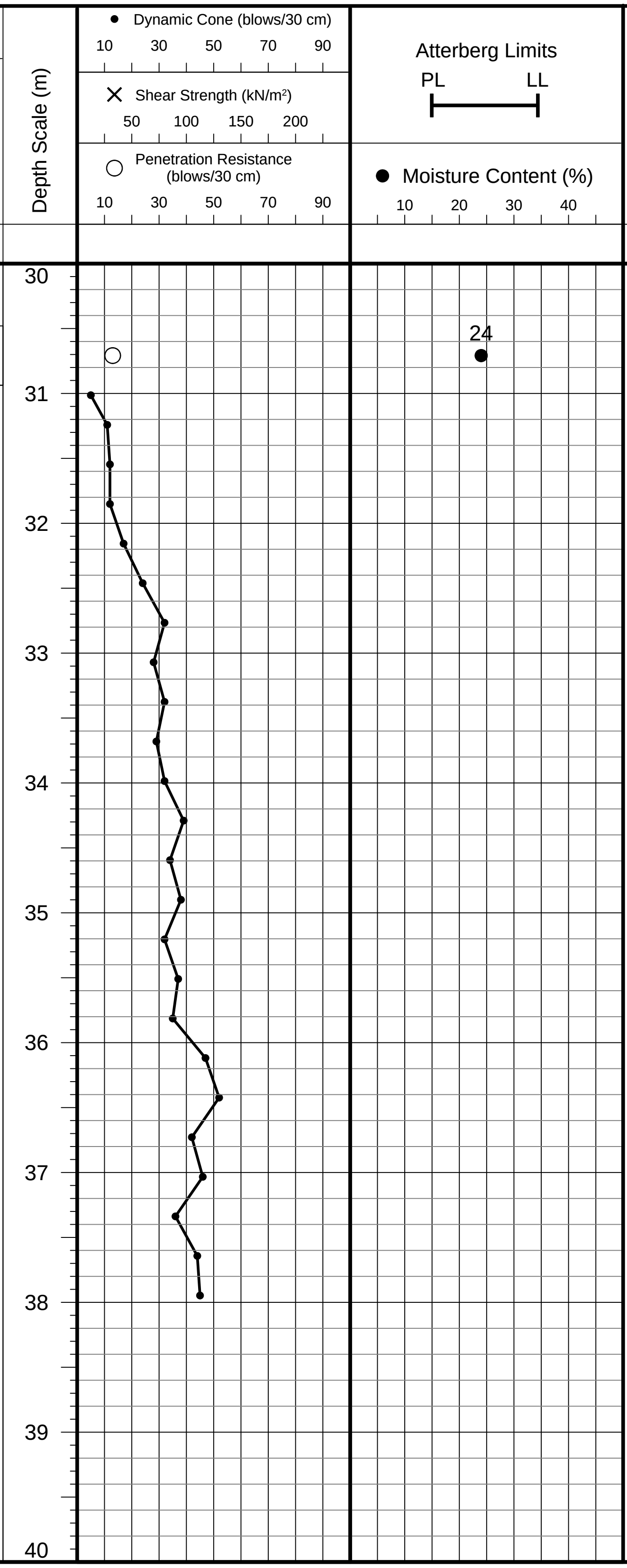
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Hollow Stem Augers Washbore with Tri-Cone and Dynamic Cone

PROJECT LOCATION:
Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 9, 10, 14 and 15,

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES			WATER LEVEL
		Number	Type	N-Value	
30.0	*(Continued)* Grey, stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers	23	DO	13	
235.9 30.9	**END OF BOREHOLE** **DYNAMIC CONE PENETRATION TEST**				
228.7 38.1	**END OF DYNAMIC CONE TEST** Installed 50 mm Ø PVC monitoring well to 16.8 m (3.0 m screen) Sand backfill from 13.1 m to 16.8 m Bentonite holeplug from 0 m to 13.1 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock				



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JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 106

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

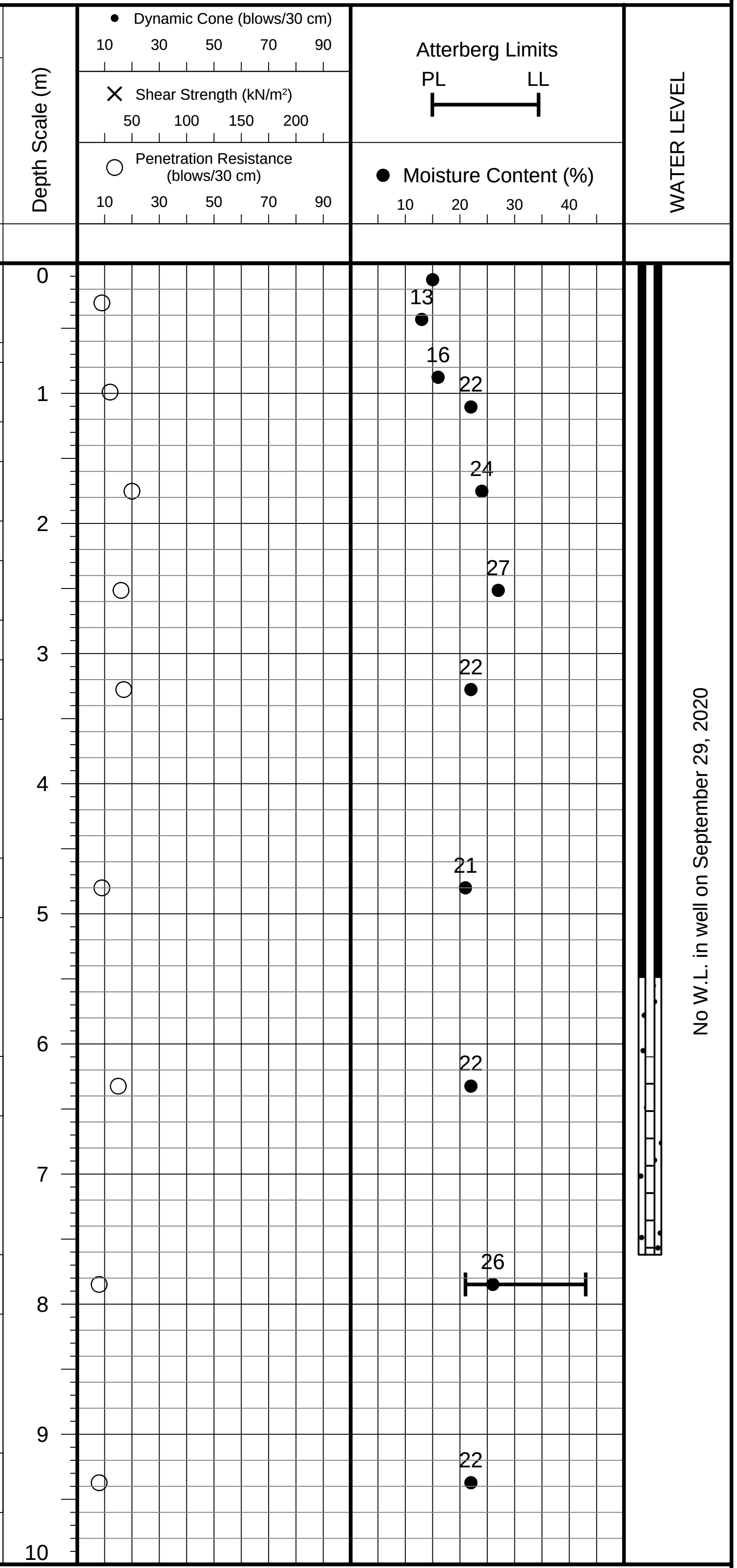
METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 11 and 14, 2020

El. (m) Depth (m)	SOIL DESCRIPTION
265.3	Ground Surface
0.0	**25 cm TOPSOIL**
	Brown, loose, weathered **SILT** a trace of clay a trace to some sand
264.5 0.8	Brown, compact, weathered **SILTY FINE SAND** a trace of clay
264.3 1.0	Firm to very stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers
	weathered
	brown grey
255.3	*(Continued on next page)*

SAMPLES Number	Type	N-Value
1A	DO	9
1B		
2A	DO	12
2B		
3	DO	20
4	DO	16
5	DO	17
6	DO	9
7	DO	15
8	DO	8
9	DO	8



No W.L. in well on September 29, 2020

Soil Engineers Ltd.

JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 106

FIGURE NO.: 6

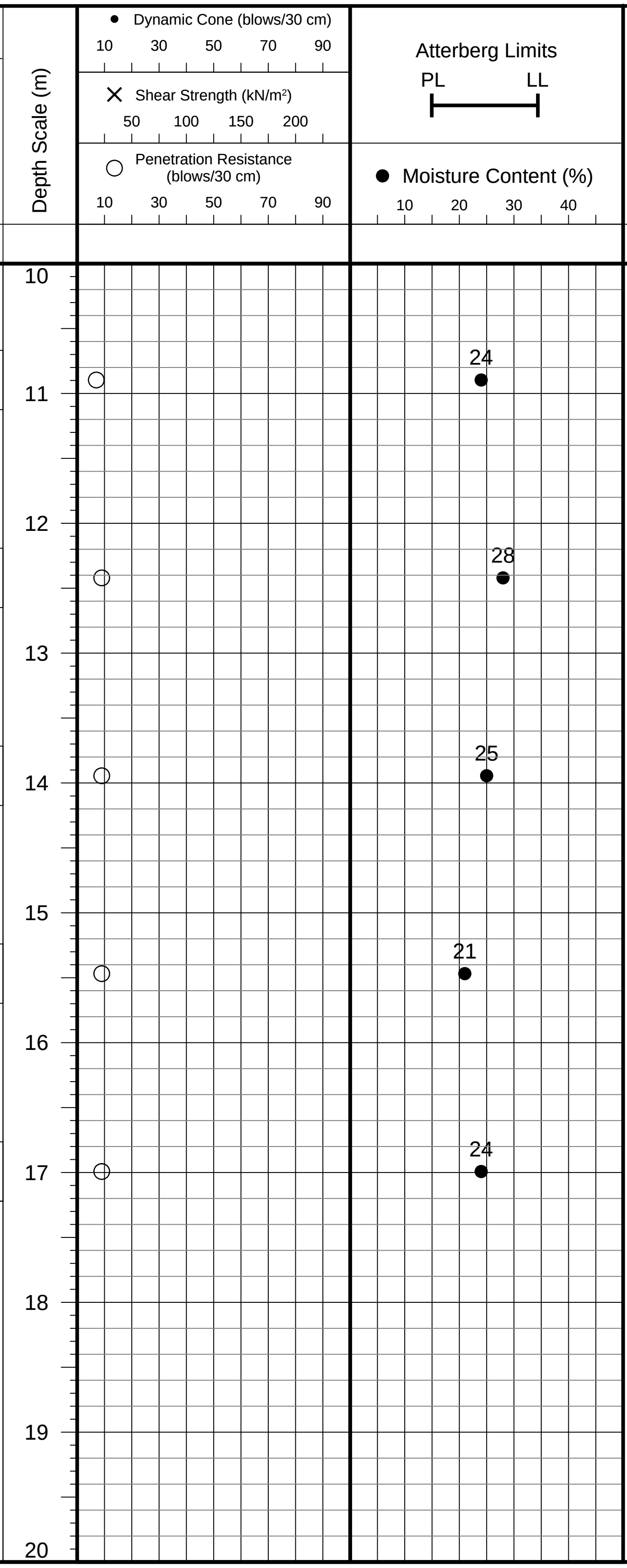
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 11 and 14, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
10.0	*(Continued)* Grey, firm to stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers			
		10	DO	7
		11	DO	9
		12	DO	9
		13	DO	9
		14	DO	9
248.1 17.2	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 7.6 m (1.5 m screen) Sand backfill from 5.5 m to 7.6 m Bentonite holeplug from 0 m to 5.5 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



WATER LEVEL

W.L. @ El. 253.7 m on completion

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JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 107

FIGURE NO.: 7

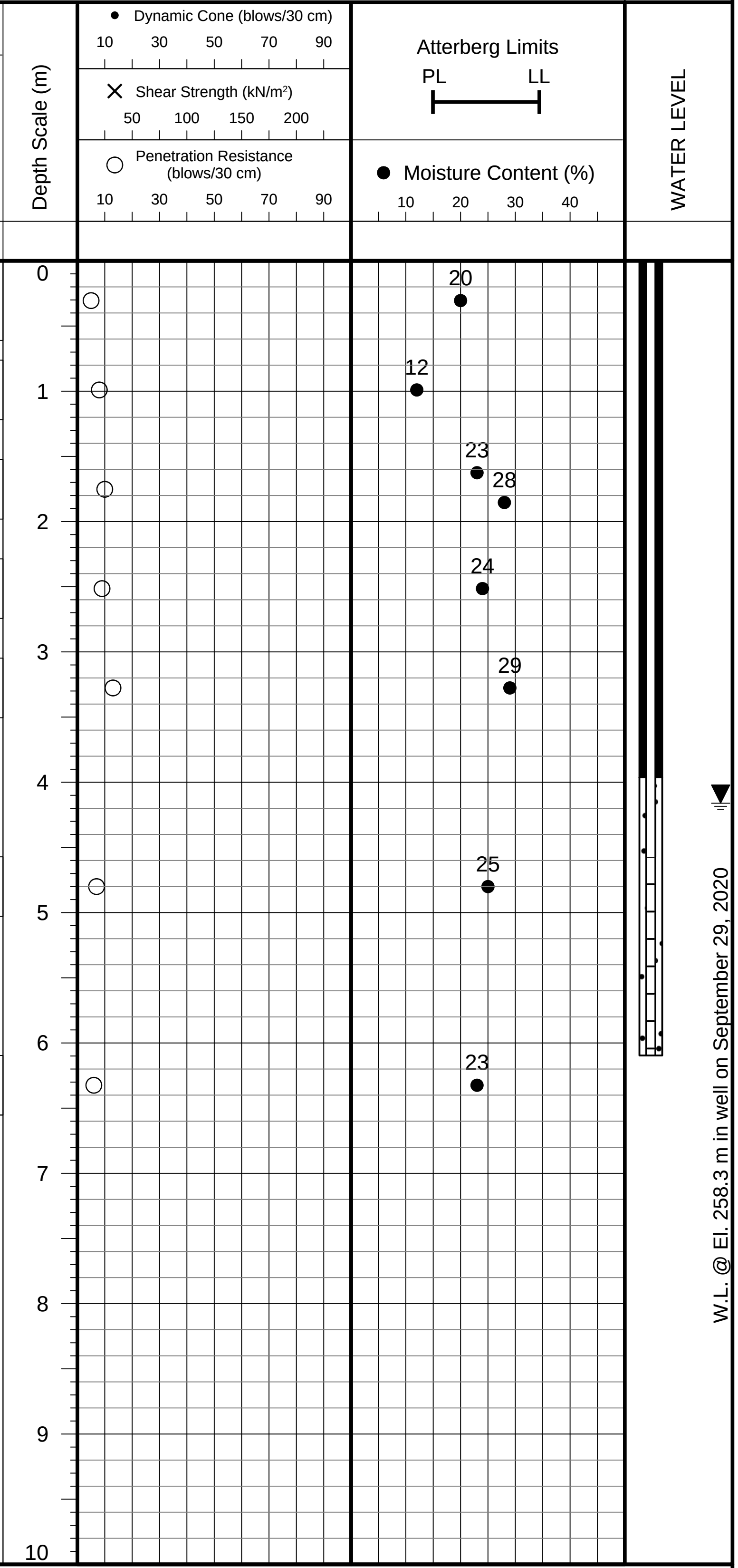
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 14, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
262.5	Ground Surface			
0.0	Brown/grey/dark brown **EARTH FILL** **(Silty Clay and Sandy Silt)** a trace of gravel with topsoil/organic inclusions	1	DO	5
		2	DO	8
260.8 1.7	Firm to stiff **SILTY CLAY** **(varved)** a trace of sand with silt layers	3A 3B	DO	10
		4	DO	9
		5	DO	13
	— — — brown grey	6	DO	7
		7	DO	6
255.9 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 6.1 m (1.5 m screen) Sand backfill from 4.0 m to 6.1 m Bentonite holeplug from 0 m to 4.0 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



W.L. @ El. 258.3 m in well on September 29, 2020

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JOB NO.: 2008-S135A

LOG OF BOREHOLE NO.: 108

FIGURE NO.: 8

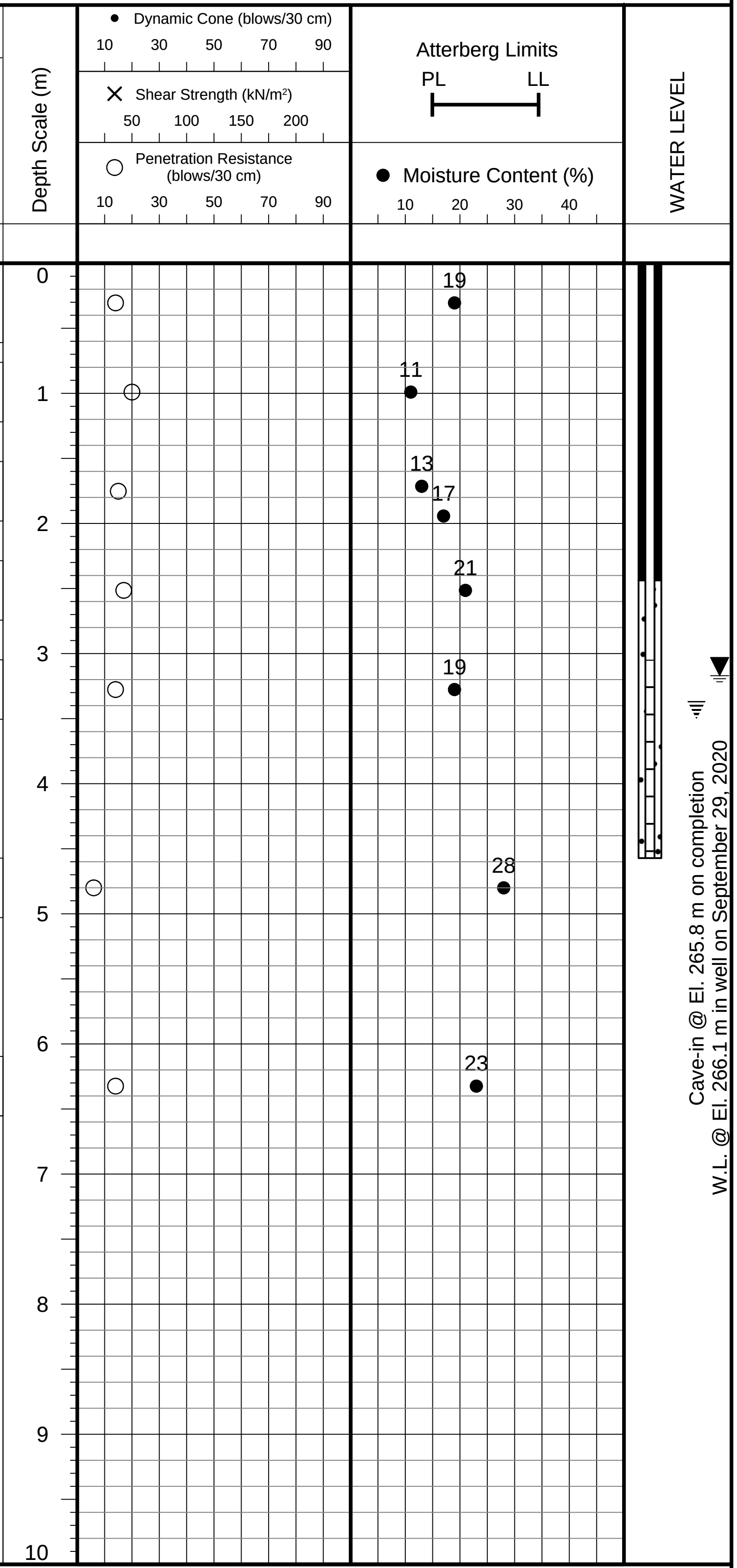
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Solid Stem Augers

PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

DRILLING DATE: September 15, 2020

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
269.3	Ground Surface			
0.0	**TOPSOIL FILL** (mixed with silty sand)	1	DO	14
268.5 0.8	Brown **EARTH FILL** **(Silty Sand)** a trace of gravel	2	DO	20
267.8 1.5	Brown, compact **SANDY SILT** silty fine sand layer a trace of clay occ. sand and silt layers	3A 3B 4 5	DO DO DO	15 17 14
264.7 4.6	Grey, firm to stiff **SILTY CLAY** a trace of sand with silt seams	6 7	DO DO	6 14
262.7 6.6	**END OF BOREHOLE** Installed 50 mm Ø PVC monitoring well to 4.6 m (1.5 m screen) Sand backfill from 2.4 m to 4.6 m Bentonite holeplug from 0 m to 2.4 m Provided with a 4x4 steel monument casing with top and bottom caps, and lock			



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Page: 1 of 1

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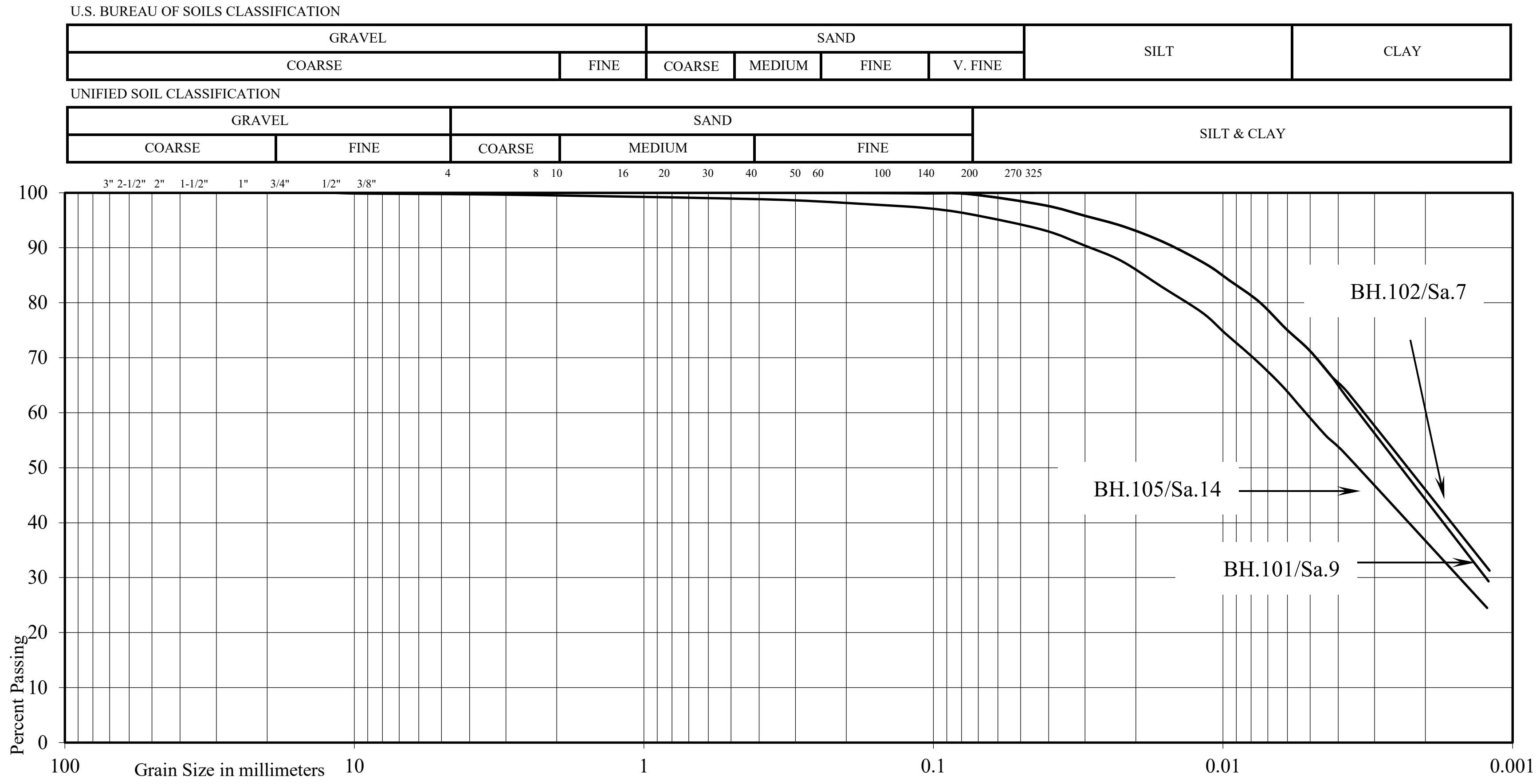
GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (A)



Project: Proposed Residential Development

Location: Shining Hill Phase 3

162 St. John's Sideroad, Town of Aurora

Borehole No:	101	102	105
Sample No:	9	7	14
Depth (m):	9.4	4.8	17.0
Elevation (m):	255.6	260.1	249.8

BH./Sa.	101/9	102/7	105/14
Liquid Limit (%) =	45	46	40
Plastic Limit (%) =	22	23	20
Plasticity Index (%) =	23	23	20
Moisture Content (%) =	28	22	22
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY, a trace of sand

Figure: 9

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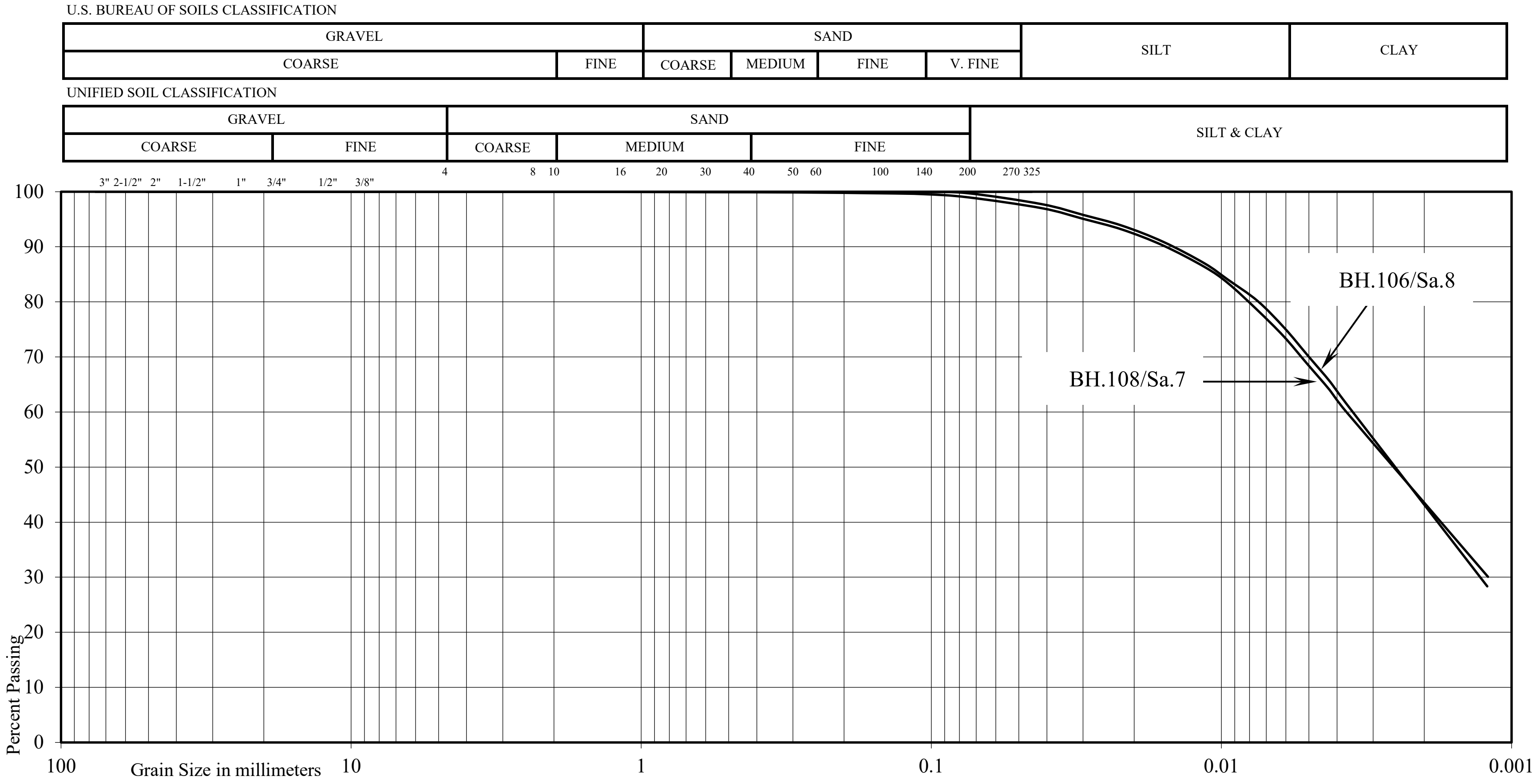
GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (A)



Project: Proposed Residential Development

Location: Shining Hill Phase 3

162 St. John's Sideroad, Town of Aurora

Borehole No:	106	108
Sample No:	8	7
Depth (m):	7.8	6.3
Elevation (m):	257.5	263.0

BH./Sa.	106/8	108/7
Liquid Limit (%) =	43	-
Plastic Limit (%) =	21	-
Plasticity Index (%) =	22	-
Moisture Content (%) =	26	23
Estimated Permeability (cm./sec.) =	10^{-7}	10^{-7}

Classification of Sample [& Group Symbol]: SILTY CLAY, a trace of sand

Figure: 10

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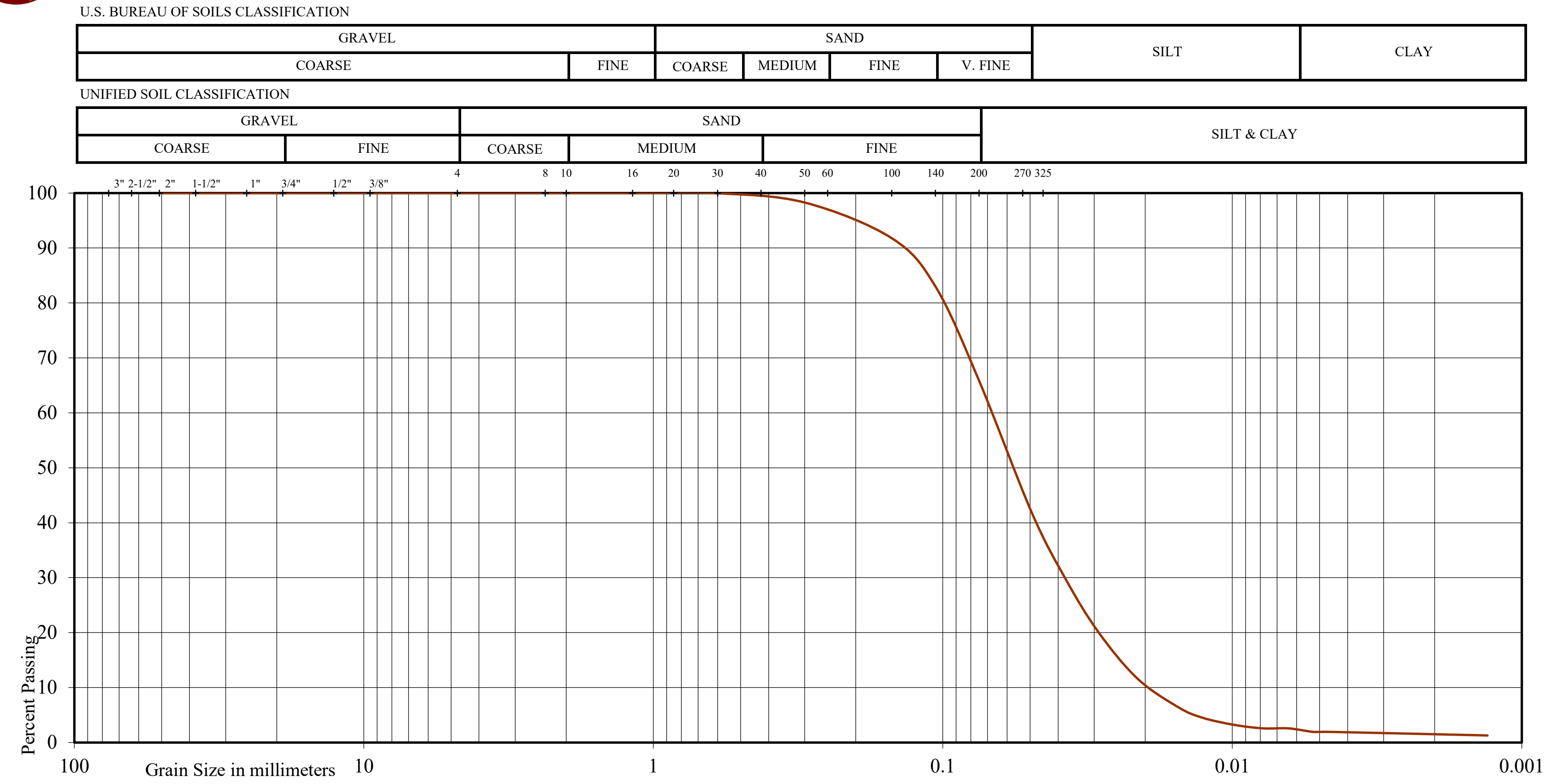
GRAIN SIZE DISTRIBUTION

Reference No: 2008-S135 (A)



Project: Proposed Residential Development

Location: Shining Hill Phase 3

162 St. John's Sideroad, Town of Aurora

Borehole No: 103

Sample No: 5

Depth (m): 3.3

Elevation (m): 264.7

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

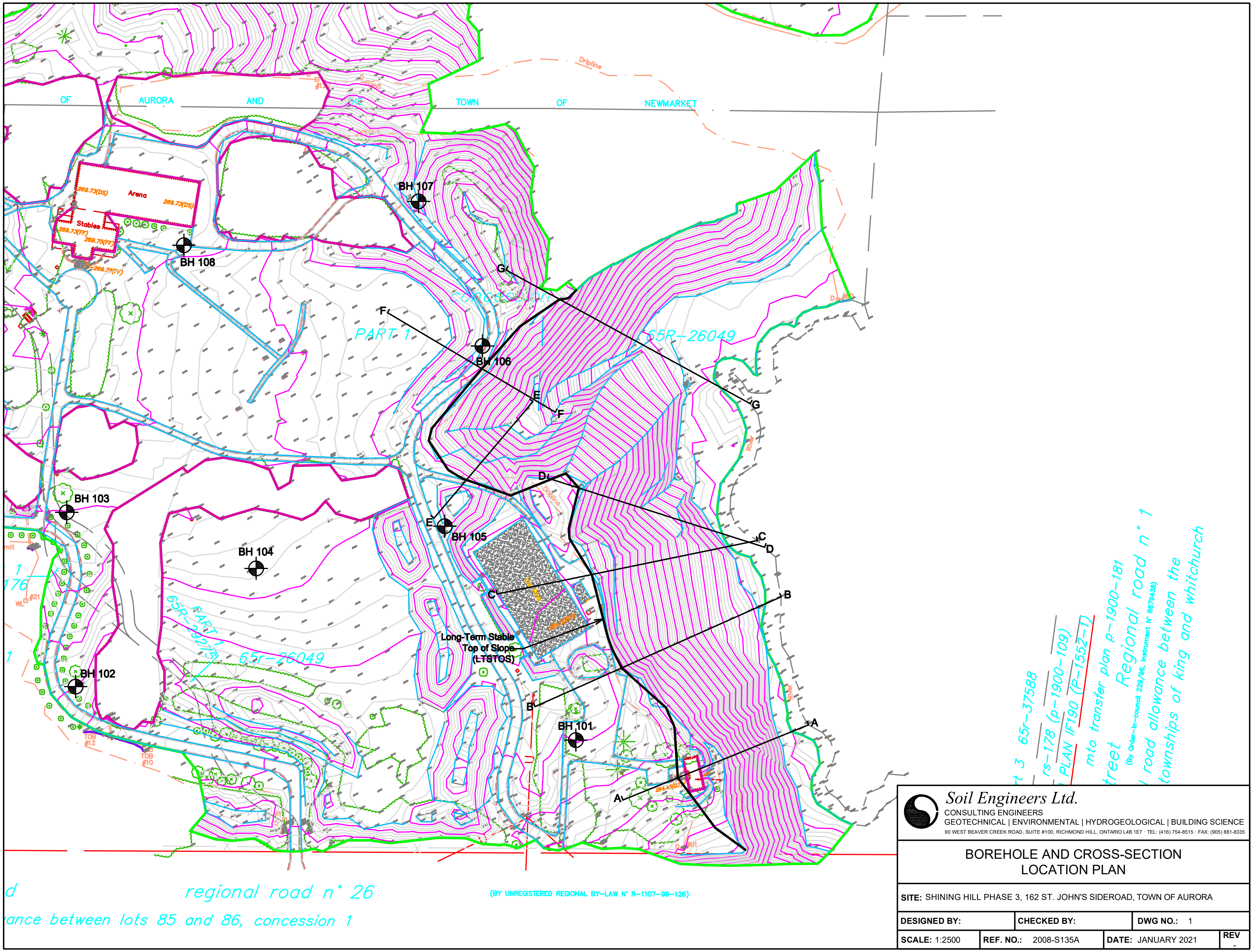
Moisture Content (%) = 21

Estimated Permeability

(cm./sec.) = 10^{-3}

Classification of Sample [& Group Symbol]: SANDY SILT, a trace of clay

Figure: 11



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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

BOREHOLE AND CROSS-SECTION LOCATION PLAN

SITE: SHINING HILL PHASE 3, 162 ST. JOHN'S SIDEROAD, TOWN OF AURORA

DESIGNED BY:
CHECKED BY:
DWG NO.: 1
SCALE: 1:2500
REF. NO.: 2008-S135A
DATE: JANUARY 2021
REV -

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.: 2008-S135A

REPORT DATE: January 2021

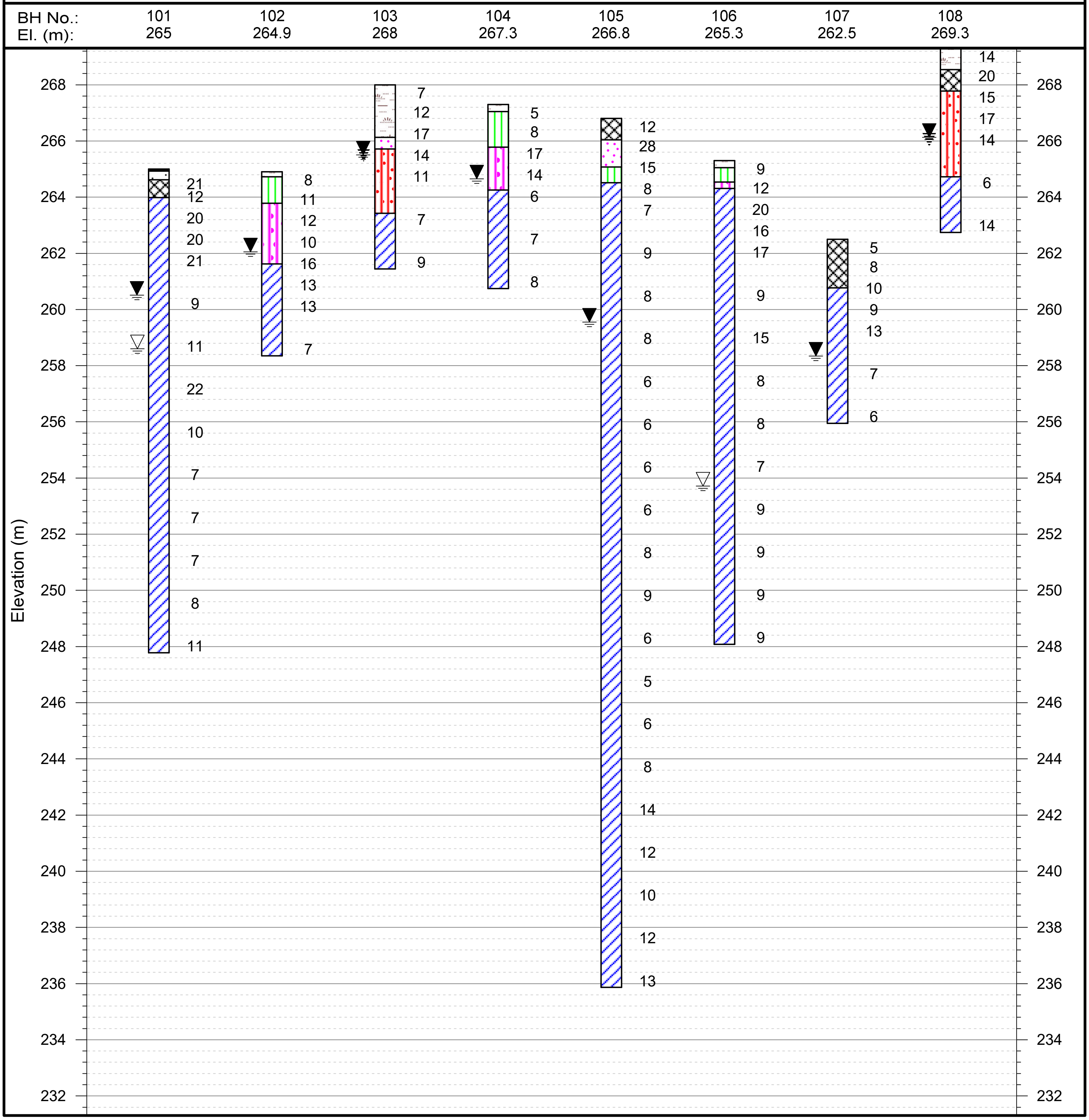
PROJECT DESCRIPTION: Proposed Residential Development

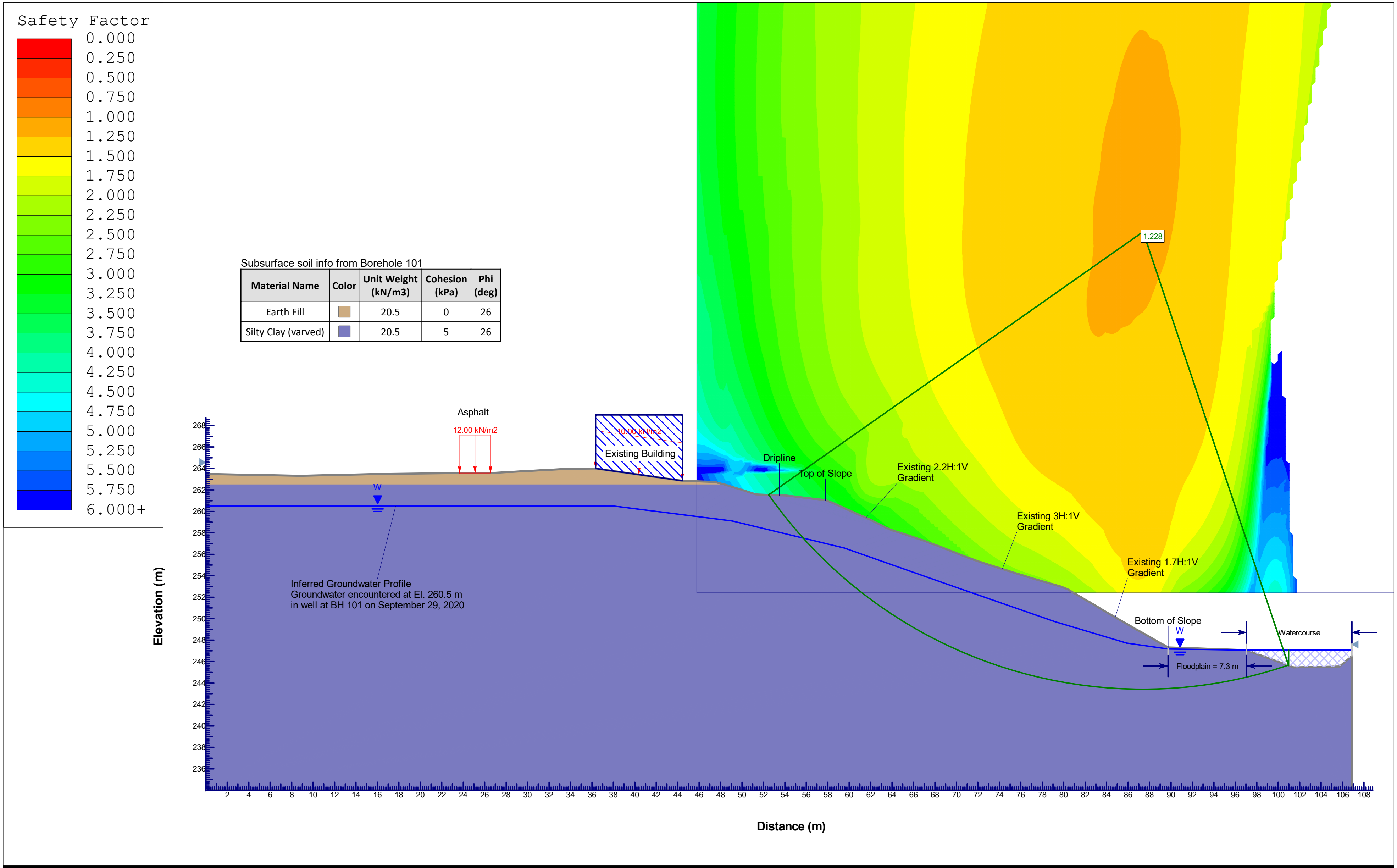
PROJECT LOCATION: Shining Hill Phase 3
162 St. John's Sideroad
Town of Aurora

LEGEND

⬚	TOPSOIL	▩	FILL	▥	SANDY SILT
■	ASPHALT	⁘	SAND	▥	SILT
⁘	GRANULAR	▥	SILTY FINE SAND	▨	SILTY CLAY

▽ WATER LEVEL (END OF DRILLING) ≡ CAVE-IN ▼ WATER LEVEL (STABILIZED)





Subsurface soil info from Borehole 101

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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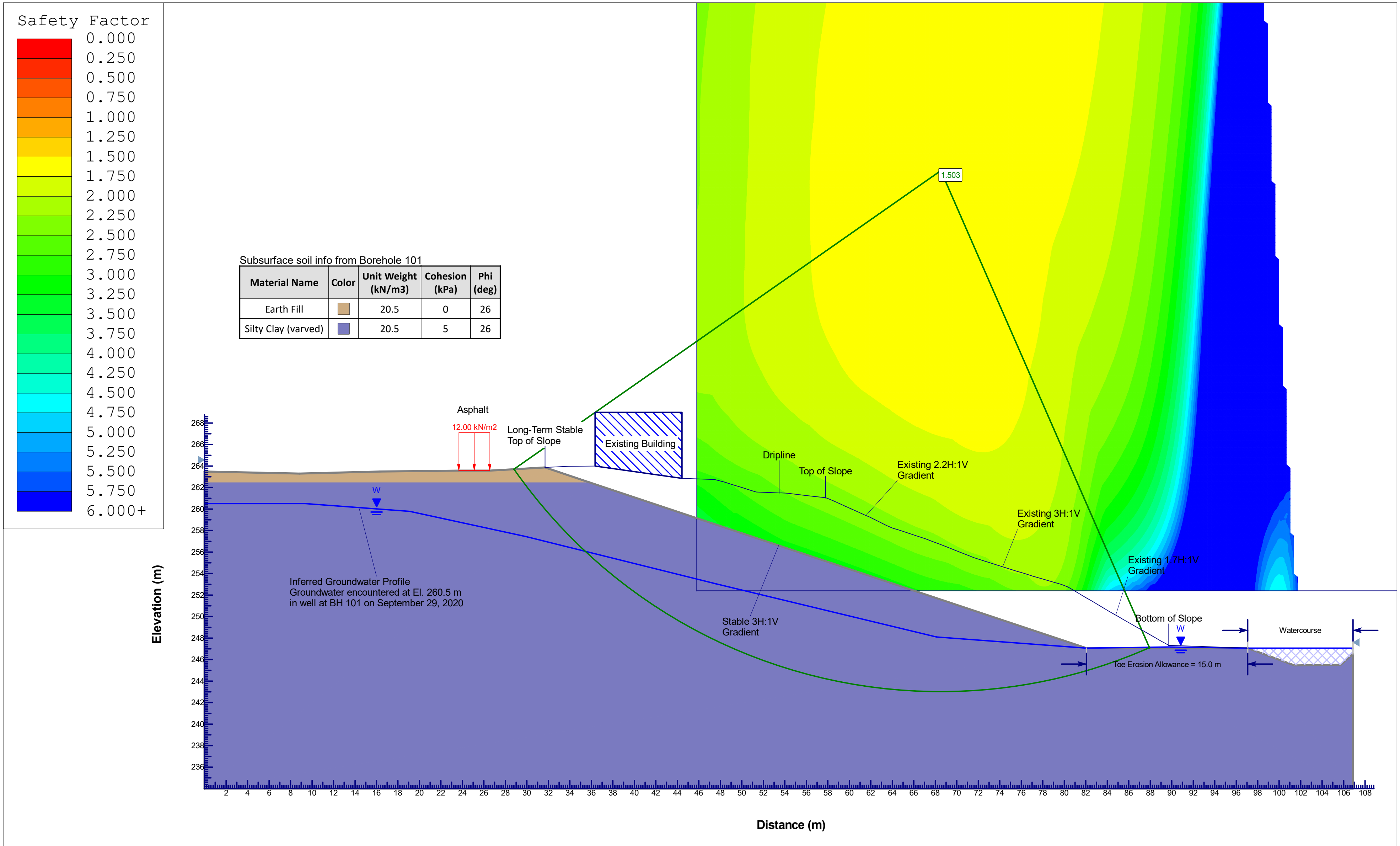
Project Title: Cross-Section A-A
Load Case: Existing Condition
Location: Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora
Drawn By: MM
Checked By: BL
Scale: 1:500
Revision:
Date: January 2021
Reference No.: 2008-S135A
Drawing No.: 3



Subsurface soil info from Borehole 101

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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Project Title: Cross-Section A-A

Load Case: Stable Condition

Location: Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora

Drawn By: MM

Checked By: BL

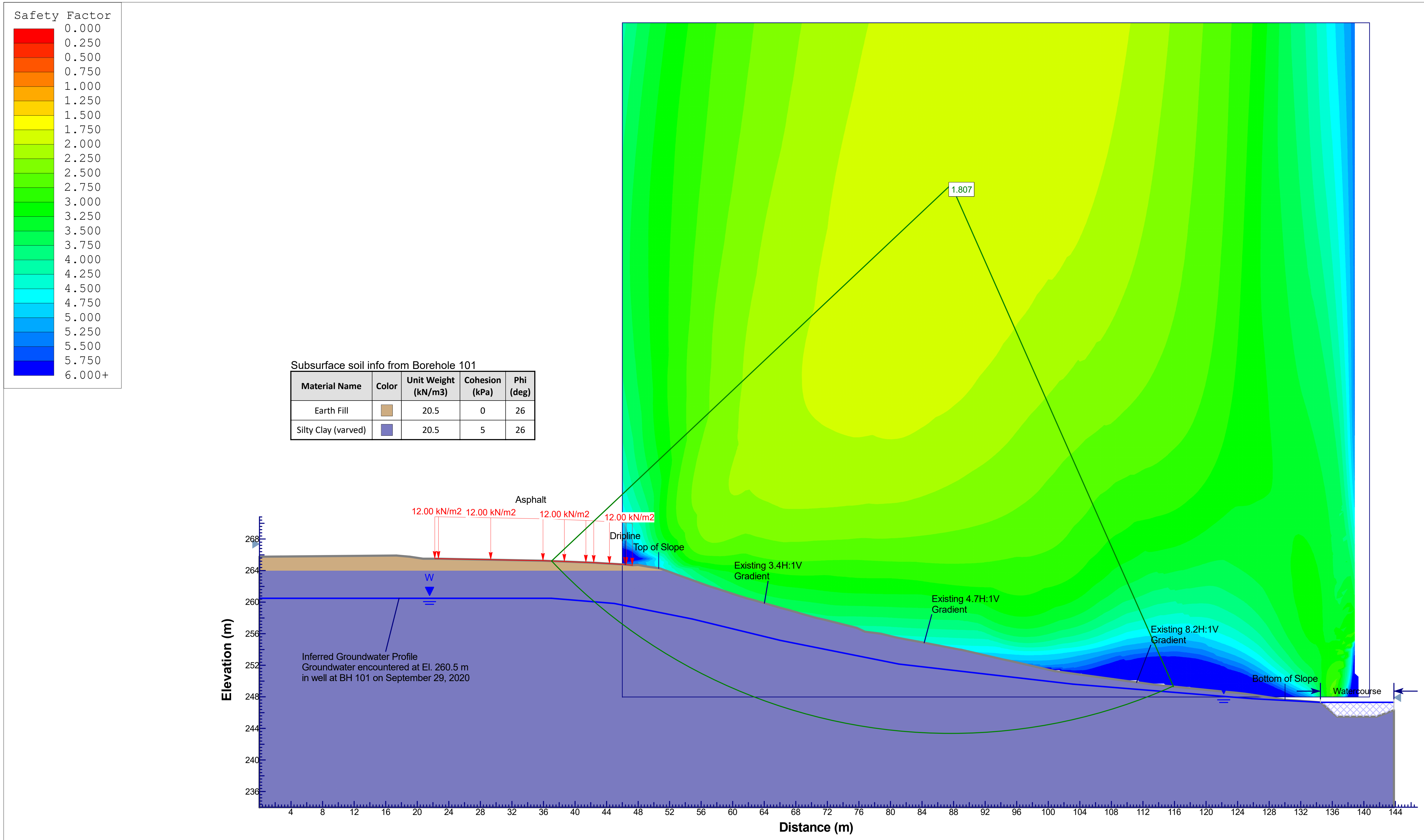
Scale: 1:500

Revision:

Date: January 2021

Reference No.: 2008-S135A

Drawing No.: 4



Subsurface soil info from Borehole 101

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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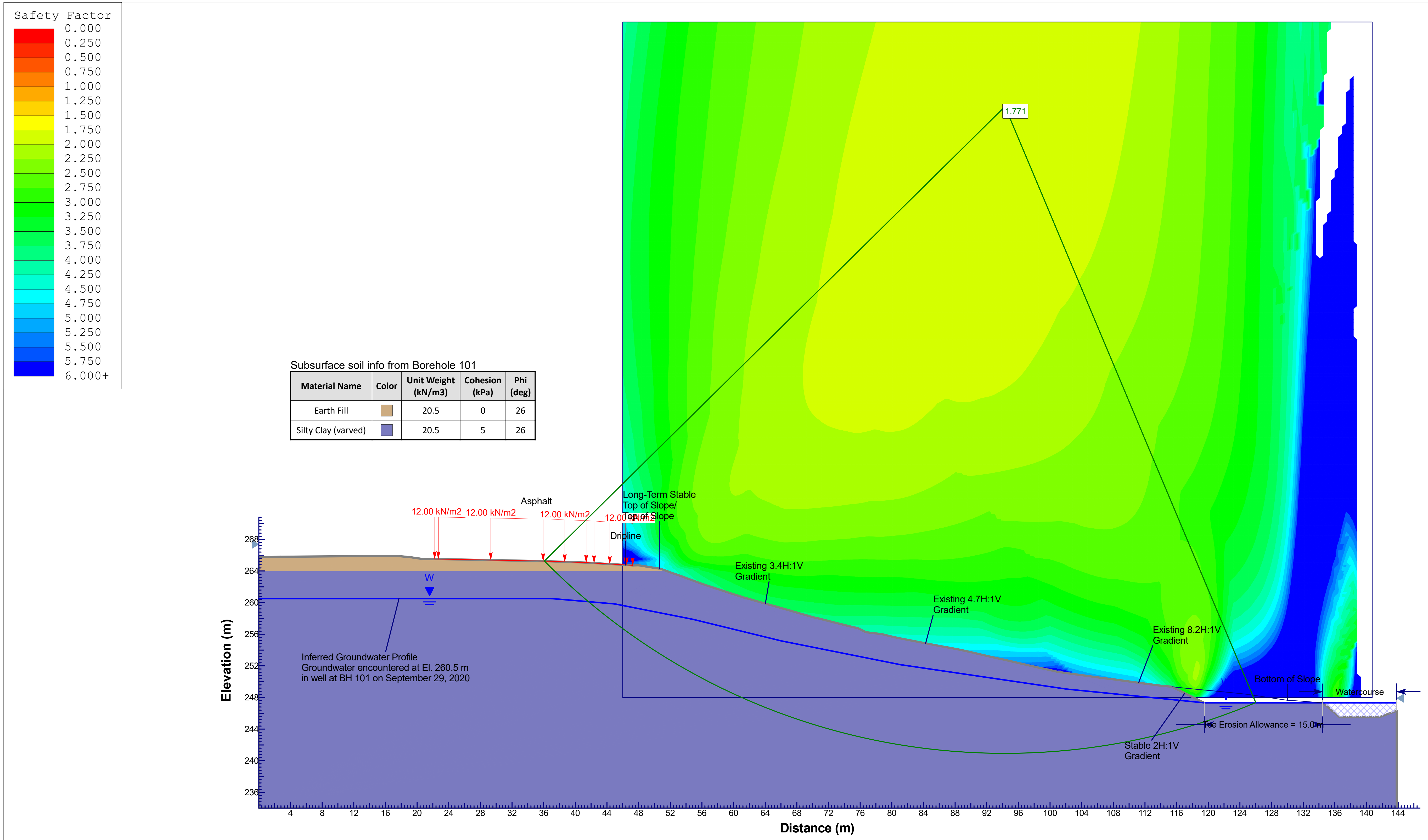
Project Title	Cross-Section B-B			Load Case	Existing Condition
Location	Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora				
Drawn By	MM	Checked By	BL	Scale	1:500
Revision					
Date	January 2021	Reference No.	2008-S135A	Drawing No.	5



Subsurface soil info from Borehole 101

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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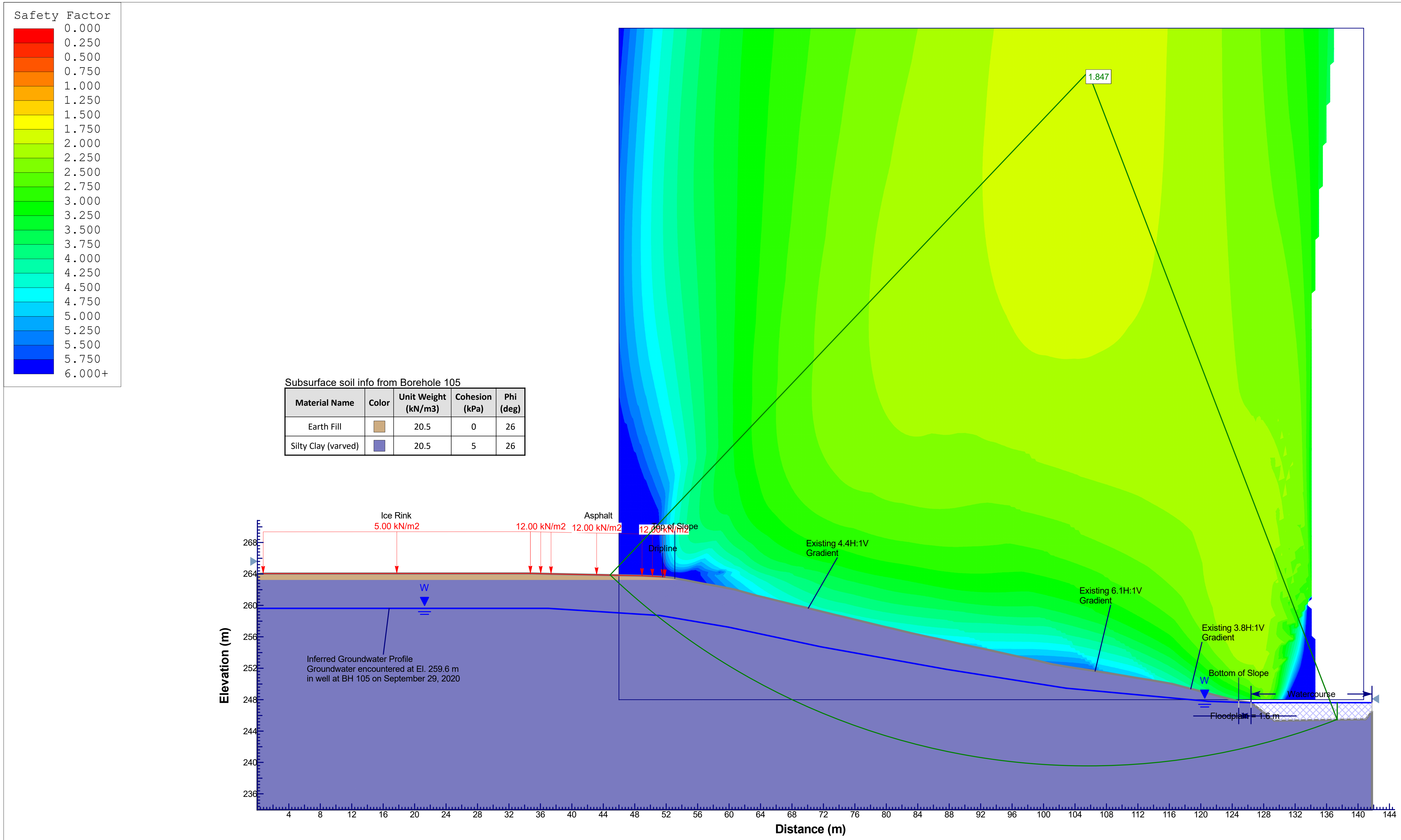
Project Title	Cross-Section B-B	Load Case	Stable Condition
Location	Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora		
Drawn By	MM	Checked By	BL
Scale	1:500	Revision	
Date	January 2021	Reference No.	2008-S135A
Drawing No.	6		



Subsurface soil info from Borehole 105

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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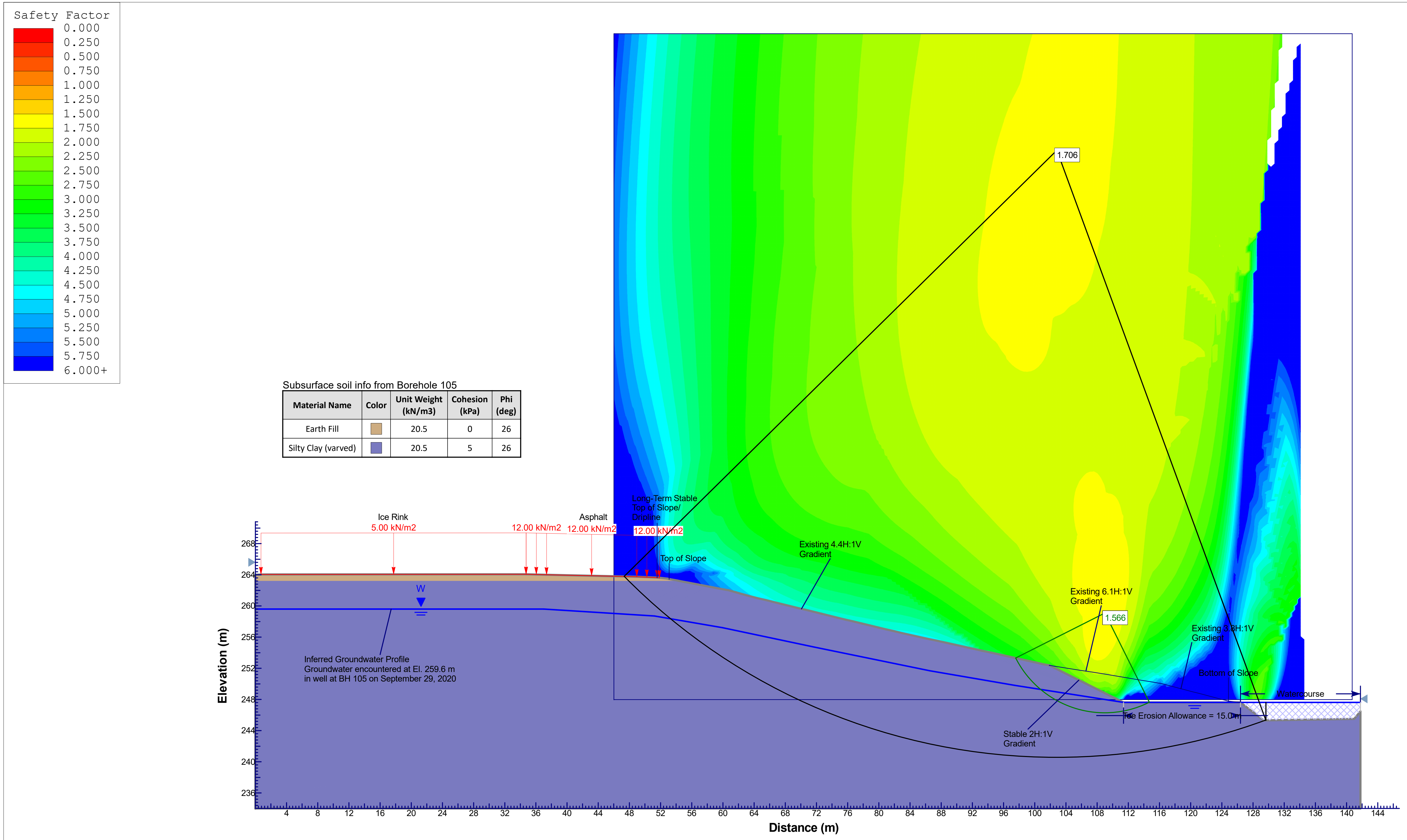
Project Title	Cross-Section C-C	Load Case	Existing Condition
Location	Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora		
Drawn By MM	Checked By BL	Scale 1:500	Revision
Date January 2021		Reference No. 2008-S135A	Drawing No. 7



Subsurface soil info from Borehole 105

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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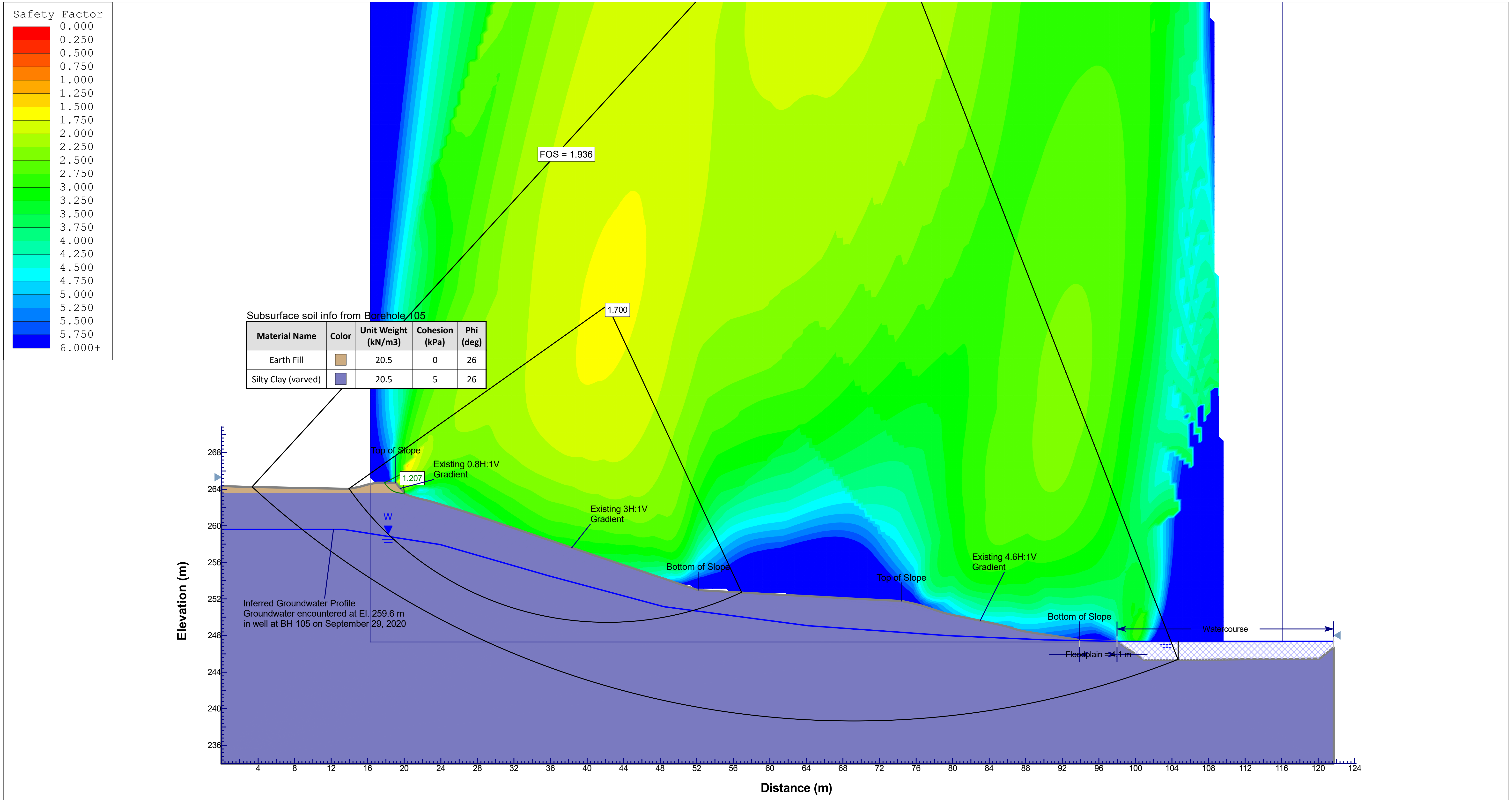
Project Title	Cross-Section C-C	Load Case	Stable Condition
Location	Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora		
Drawn By	MM	Checked By	BL
Scale	1:500	Revision	
Date	January 2021	Reference No.	2008-S135A
Drawing No.	8		



Subsurface soil info from Borehole 105

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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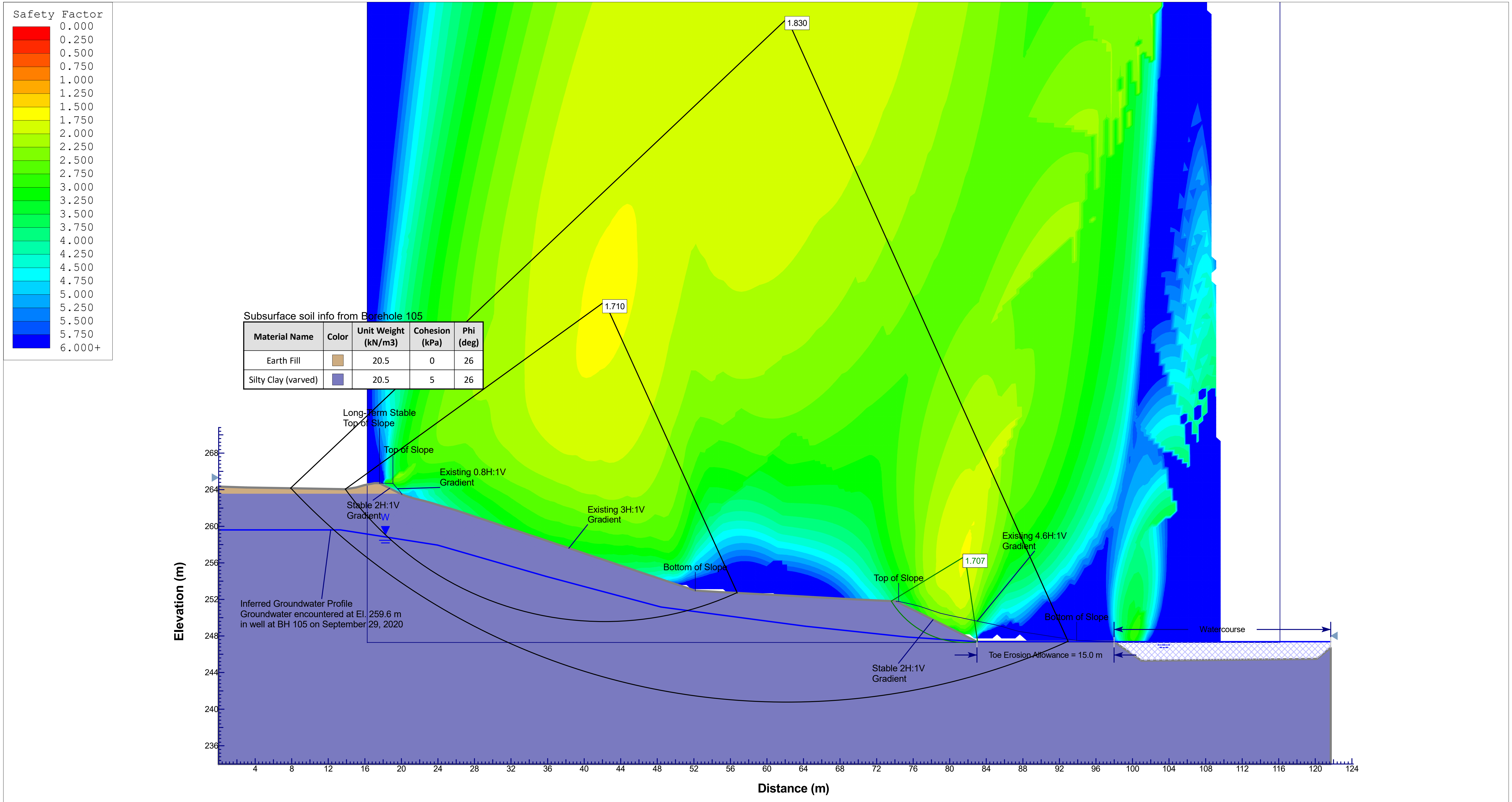
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Project Title: Cross-Section D-D
Load Case: Existing Condition
Location: Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora
Drawn By: MM
Checked By: BL
Scale: 1:400
Revision:
Date: January 2021
Reference No.: 2008-S135A
Drawing No.: 9



Subsurface soil info from Borehole 105

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26

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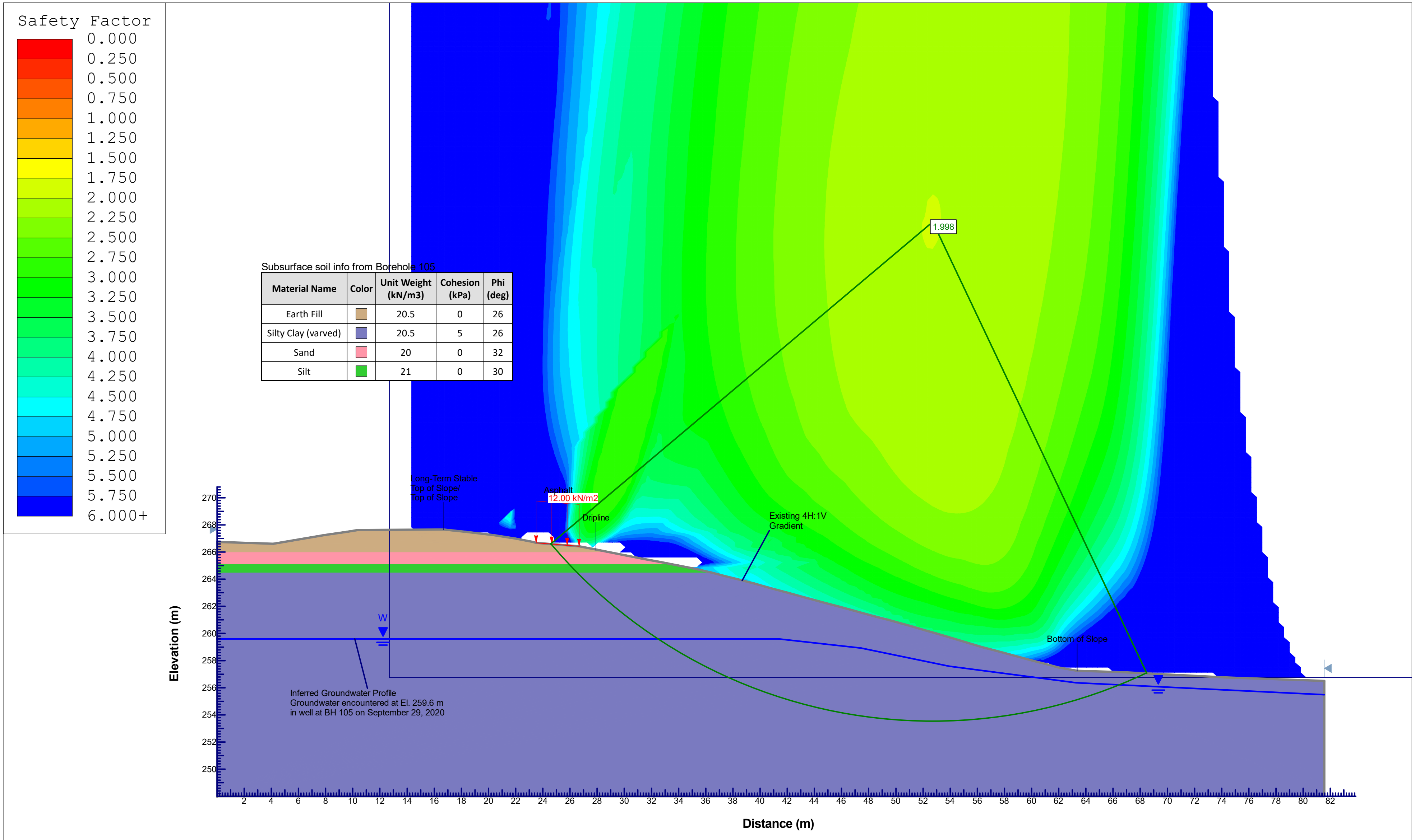
Project Title	Cross-Section D-D			Load Case	Stable Condition
Location	Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora				
Drawn By	MM	Checked By	BL	Scale	1:400
Revision					
Date	January 2021	Reference No.	2008-S135A	Drawing No.	10



Subsurface soil info from Borehole 105

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Earth Fill	🟫	20.5	0	26
Silty Clay (varved)	🟪	20.5	5	26
Sand	🟥	20	0	32
Silt	🟩	21	0	30

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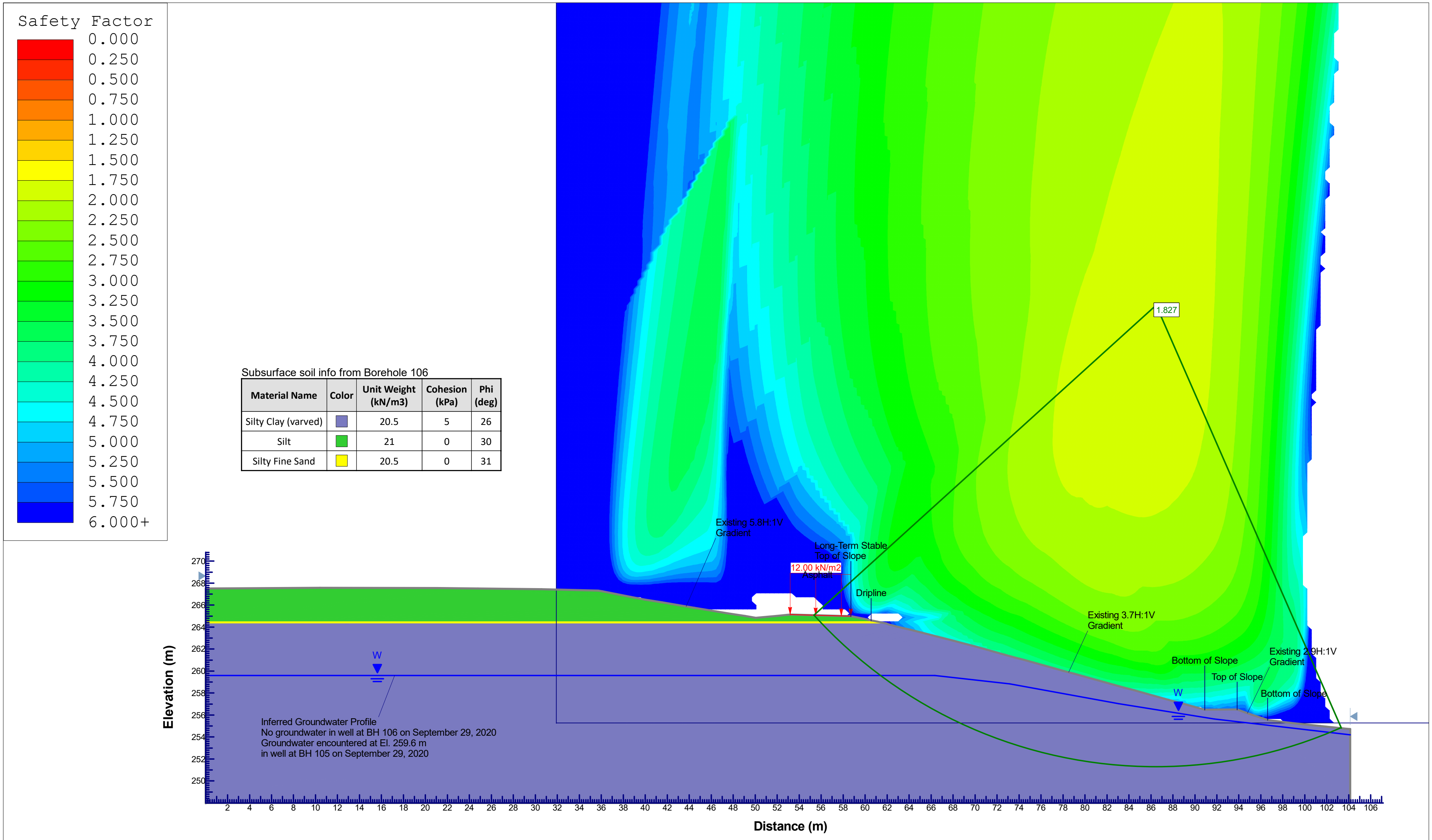
Project Title: Cross-Section E-E
Load Case: Existing Condition
Location: Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora
Drawn By: MM
Checked By: BL
Scale: 1:400
Revision:
Date: January 2021
Reference No.: 2008-S135A
Drawing No.: 11



Subsurface soil info from Borehole 106

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Silty Clay (varved)	🟪	20.5	5	26
Silt	🟩	21	0	30
Silty Fine Sand	🟨	20.5	0	31

Inferred Groundwater Profile
No groundwater in well at BH 106 on September 29, 2020
Groundwater encountered at El. 259.6 m
in well at BH 105 on September 29, 2020

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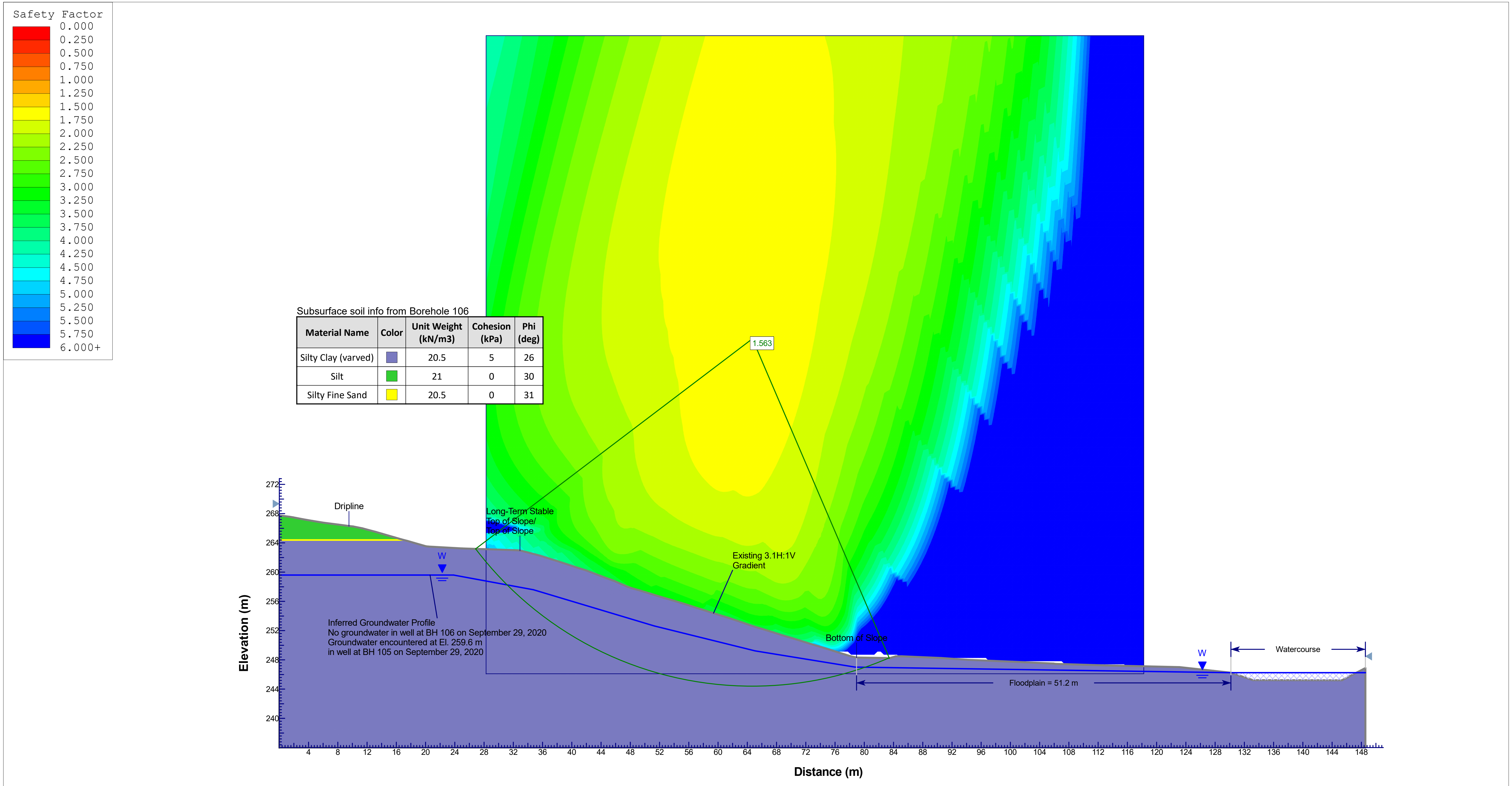
Project Title
Cross-Section F-F

Load Case
Existing Condition

Location
Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora

Drawn By MM
Checked By BL
Scale 1:500
Revision

Date January 2021
Reference No. 2008-S135A
Drawing No. 12



Subsurface soil info from Borehole 106

Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Silty Clay (varved)	🟪	20.5	5	26
Silt	🟩	21	0	30
Silty Fine Sand	🟨	20.5	0	31

Long-Term Stable Top of Slope/ Top of Slope

Existing 3.1H:1V Gradient

Bottom of Slope

Inferred Groundwater Profile
No groundwater in well at BH 106 on September 29, 2020
Groundwater encountered at El. 259.6 m
in well at BH 105 on September 29, 2020

Floodplain = 51.2 m

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Project Title: Cross-Section G-G
Load Case: Existing Condition
Location: Shining Hill Phase 3, 162 St. John's Sideroad, Town of Aurora
Drawn By: MM
Checked By: BL
Scale: 1:500
Revision:
Date: January 2021
Reference No.: 2008-S135A
Drawing No.: 13

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BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

APPENDIX

BOREHOLE LOGS AND BOREHOLE LOCATION PLAN
FROM SOIL REPORT, REFERENCE NO. 0207-S2
DATED SEPTEMBER 2002

REFERENCE NO. 2008-S135A

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

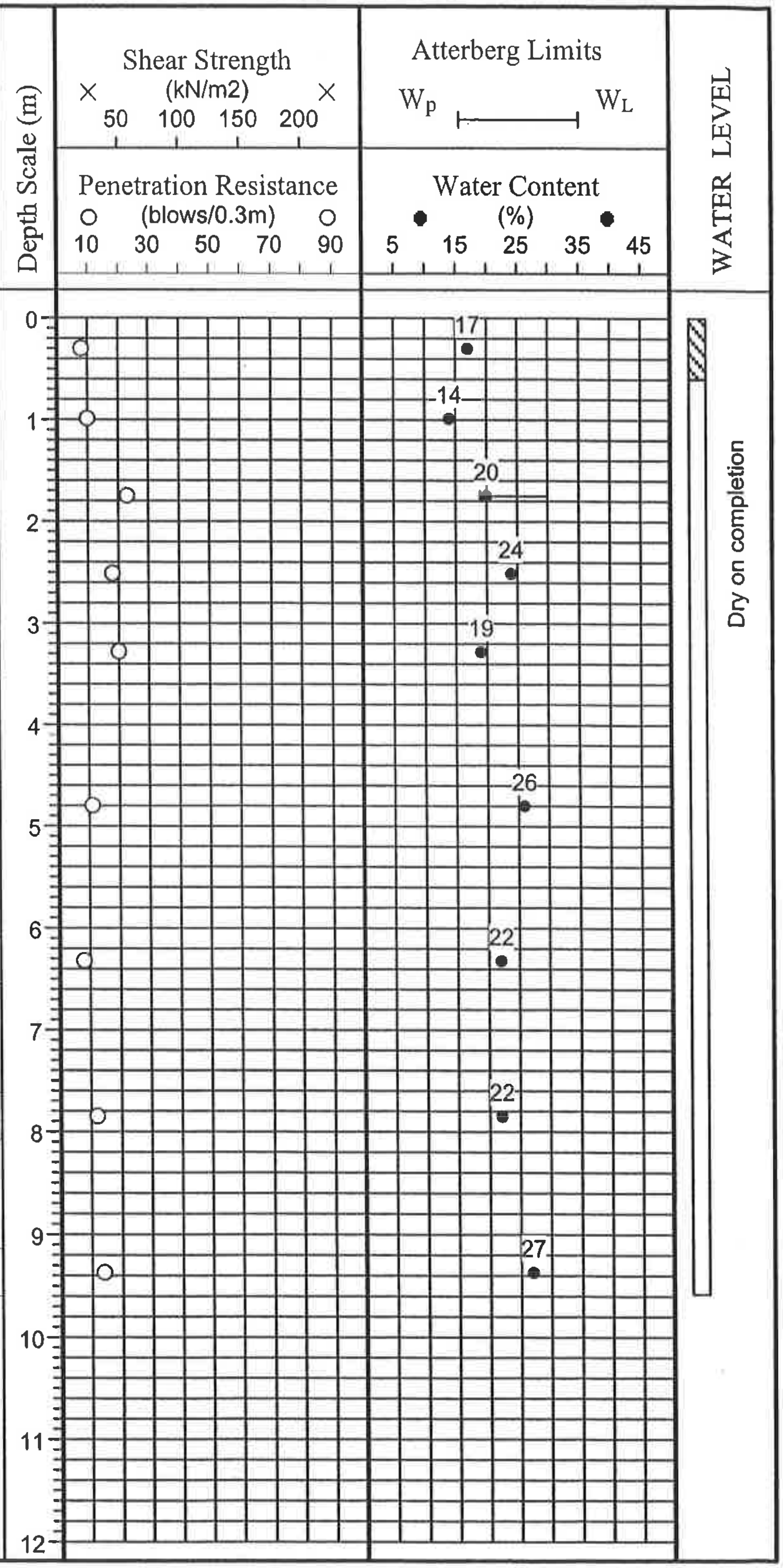
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION:
North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
265.0	Ground Surface			
0.0	**20cm TOPSOIL**			
	Brown	1	DO	8
	SAND, Fill occ. topsoil inclusions	2	DO	10
263.8 1.2	Stiff to very stiff			
		3	DO	23
		4	DO	18
	SILTY CLAY	5	DO	20
		6	DO	11
	brown ---- grey			
		7	DO	8
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)			
		8	DO	12
255.4		9	DO	14
9.6	**END OF BOREHOLE** Installed 50mm ø standpipe to 9.6 m. Sand backfill from 0.6 to 9.6 m. Sealed with bentonite from 0 to 0.6 m.			



JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

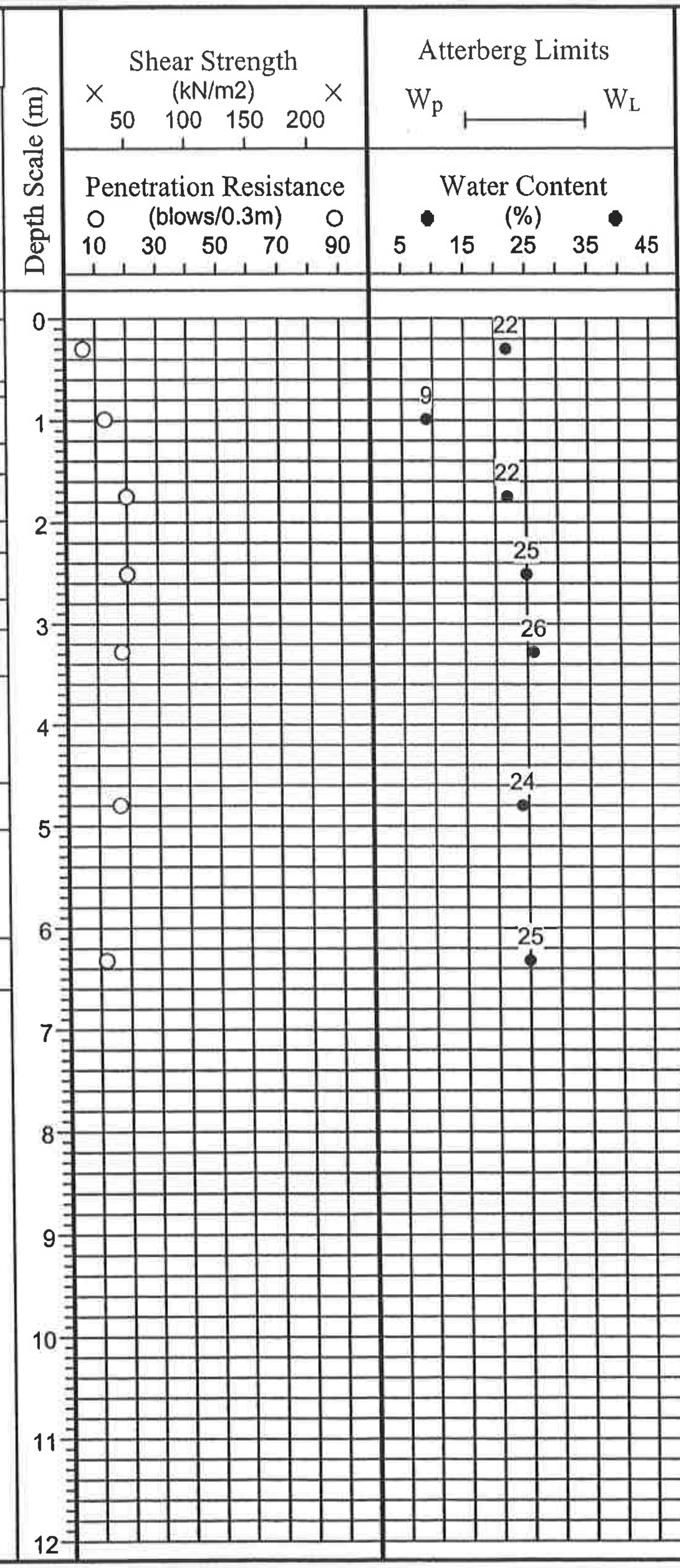
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
266.1	Ground Surface				
0.0	**40cm TOPSOIL**	1	DO	6	Dry on completion
	Brown **SAND, Fill** occ. topsoil inclusions	2	DO	13	
264.7 1.4	Stiff to very stiff	3	DO	20	
		4	DO	20	
		5	DO	18	
	SILTY CLAY brown ---- grey				
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	17	
		7	DO	12	
259.5 6.6	**END OF BOREHOLE**				



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

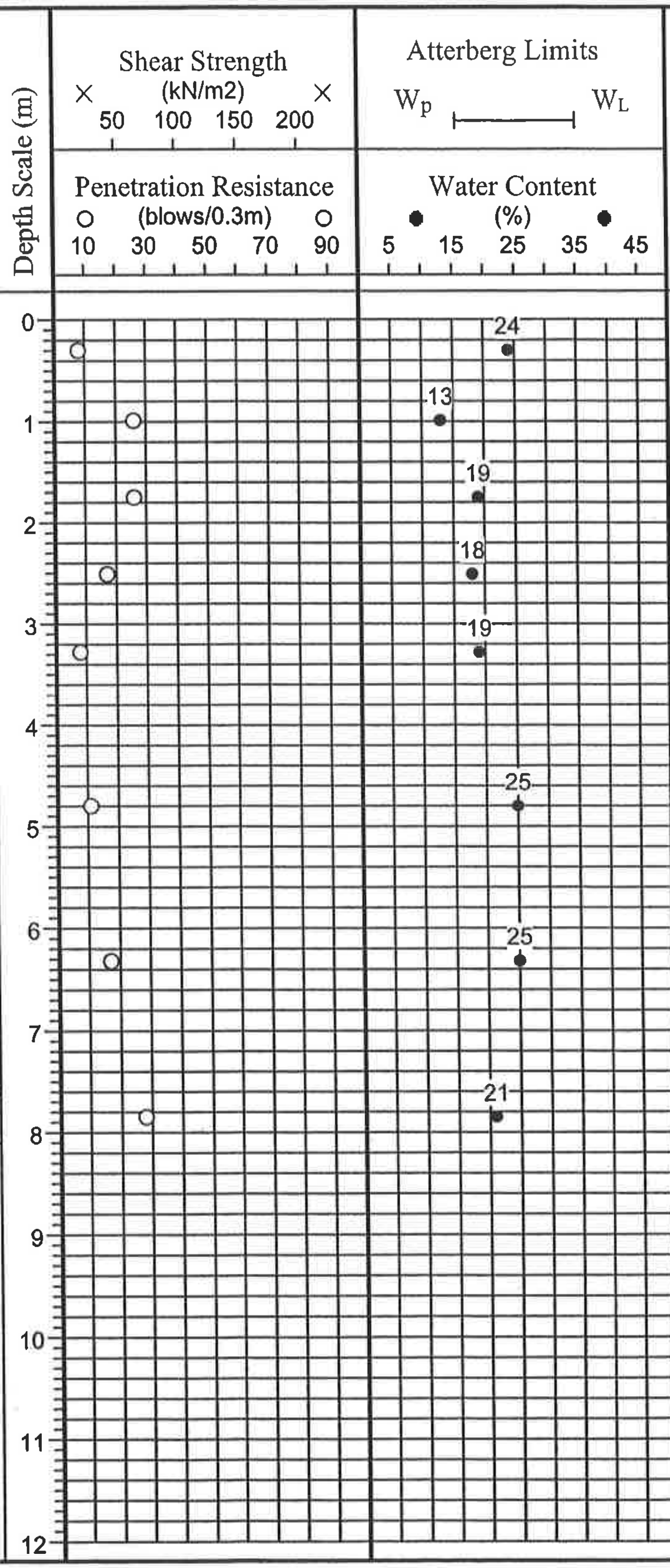
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
266.7	Ground Surface			
0.0	**25cm TOPSOIL** Brown **SAND, Fill** occ. gravel inclusions	1	DO	8
		2	DO	26
265.5 1.2	Brown, loose to compact **FINE TO COARSE SAND** silty	3	DO	26
		4	DO	17
		5	DO	8
262.6 4.1	Grey, stiff to very stiff **SILTY CLAY** a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	11
		7	DO	17
		8	DO	28
258.6 8.1	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

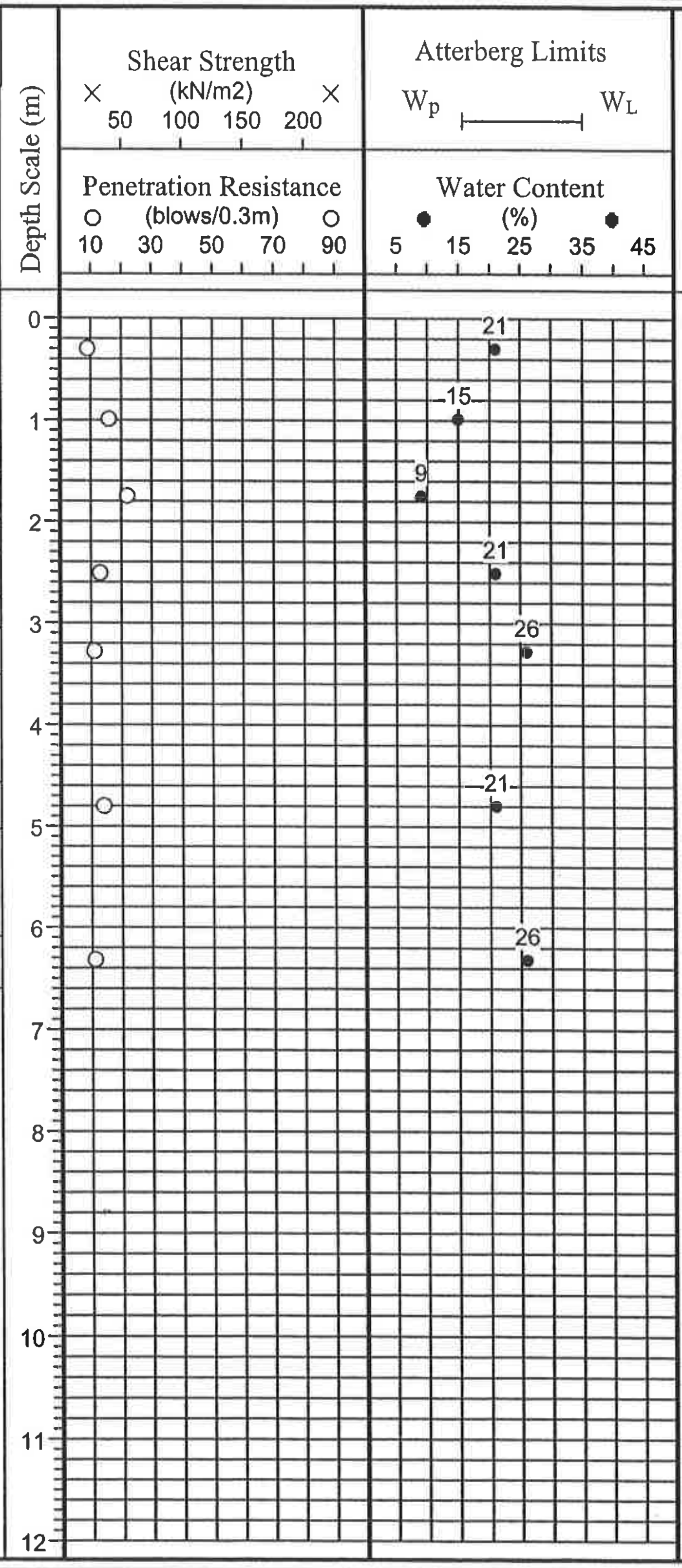
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
266.5	Ground Surface			
0.0	**45cm TOPSOIL**	1	DO	9
	Brown **SAND, FIll** occ. topsoil inclusions	2	DO	16
		3	DO	22
264.7 1.8	Stiff to very stiff brown grey	4	DO	13
	SILTY CLAY	5	DO	11
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	14
		7	DO	11
259.9 6.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 262.1 m on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

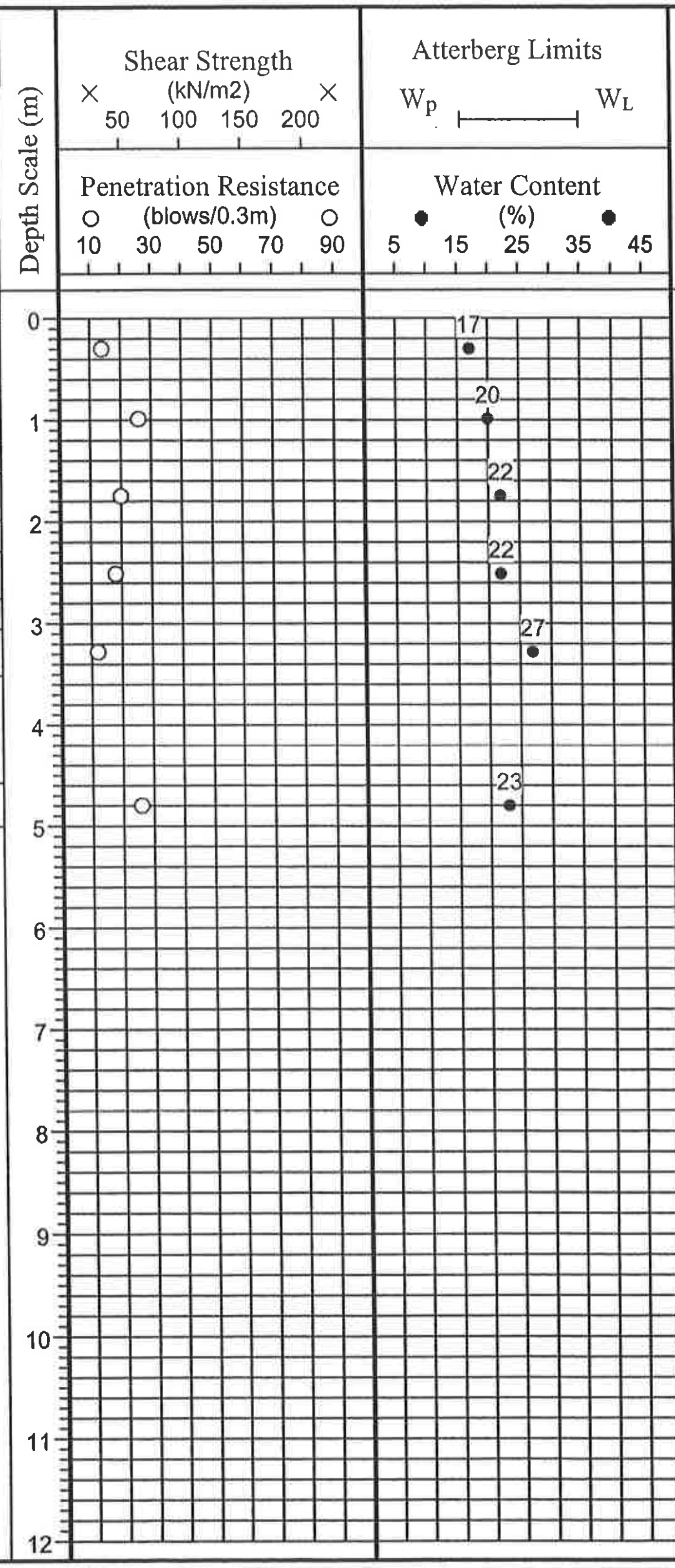
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value	WATER LEVEL
264.3	Ground Surface				
0.0	**38cm TOPSOIL**	1	DO	14	Dry on completion
	Stiff to very stiff weathered	2	DO	26	
		3	DO	20	
	SILTY CLAY	4	DO	18	
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	5	DO	12	
	brown grey				
		6	DO	26	
259.3 5.0	**END OF BOREHOLE**				



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

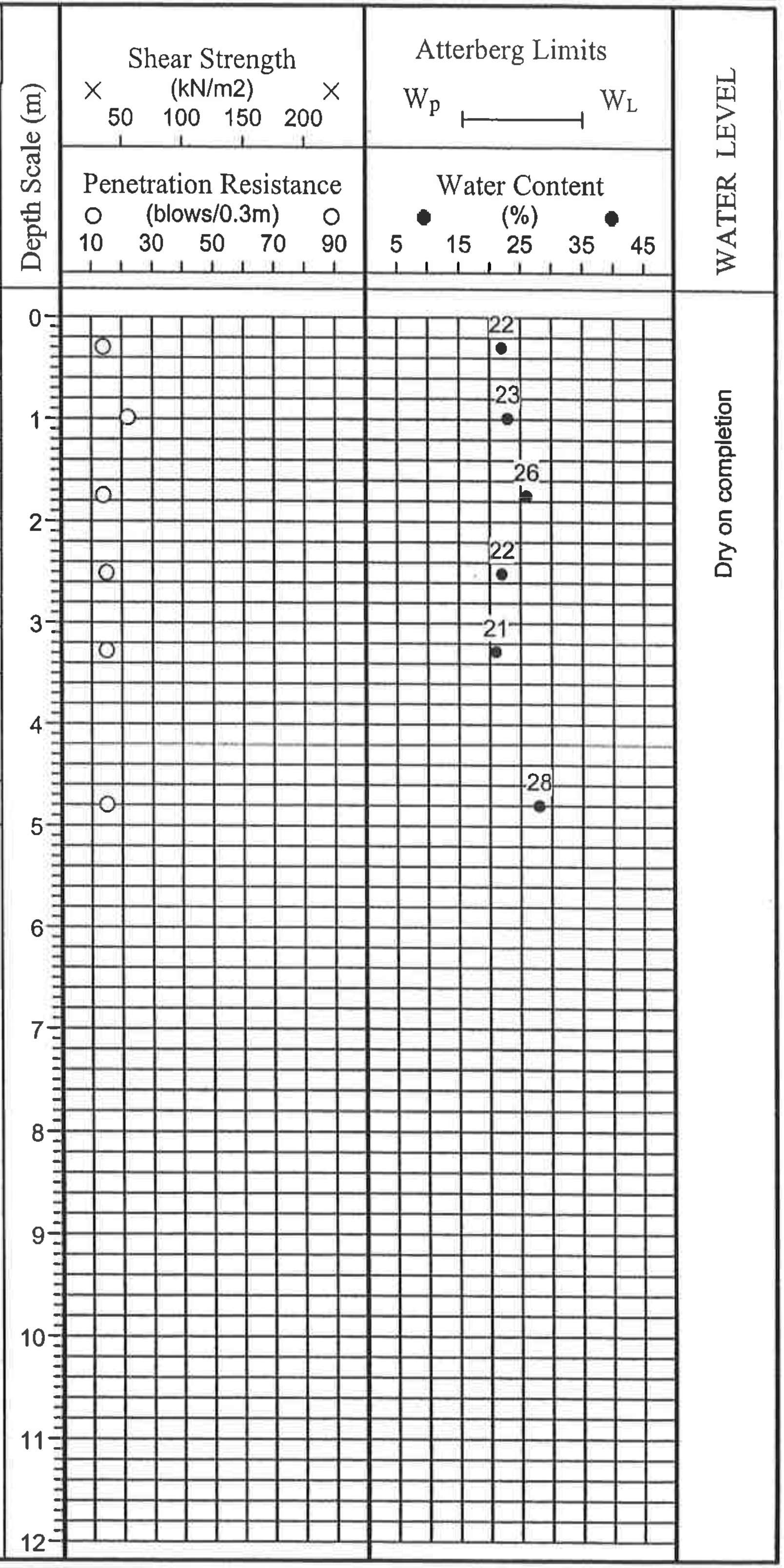
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
258.0	Ground Surface			
0.0	**45cm TOPSOIL**	1	DO	14
	Stiff to very stiff weathered	2	DO	22
		3	DO	14
	SILTY CLAY	4	DO	15
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE) brown	5	DO	15
	grey	6	DO	15
253.0 5.0	**END OF BOREHOLE**			



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 7

FIGURE NO.: 7

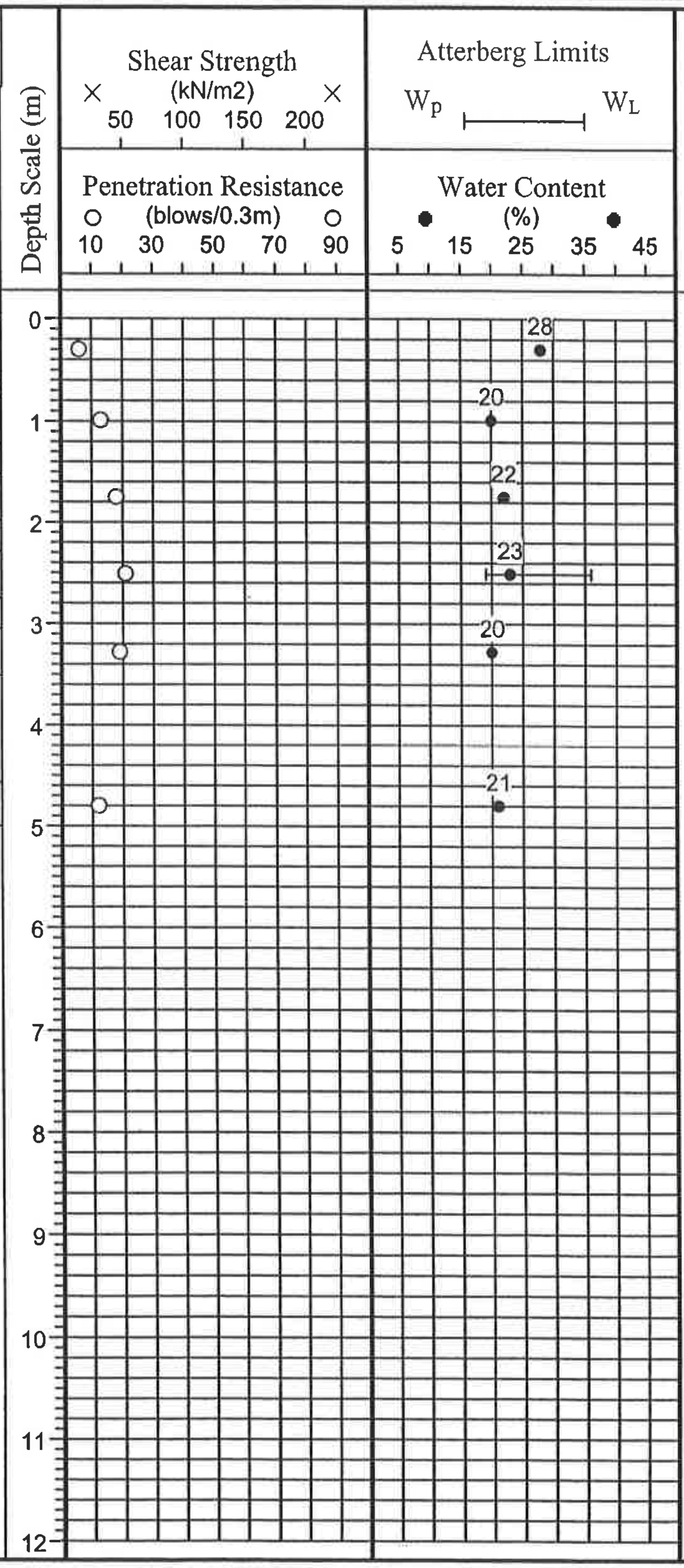
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
249.8	Ground Surface				
0.0	**20cm TOPSOIL**	1	DO	6	Dry on completion
	Firm to very stiff, weathered	2	DO	13	
		3	DO	18	
	SILTY CLAY	4	DO	21	
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	5	DO	19	
	brown grey				
244.8		6	DO	12	
5.0	**END OF BOREHOLE**				



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 8

FIGURE NO.: 8

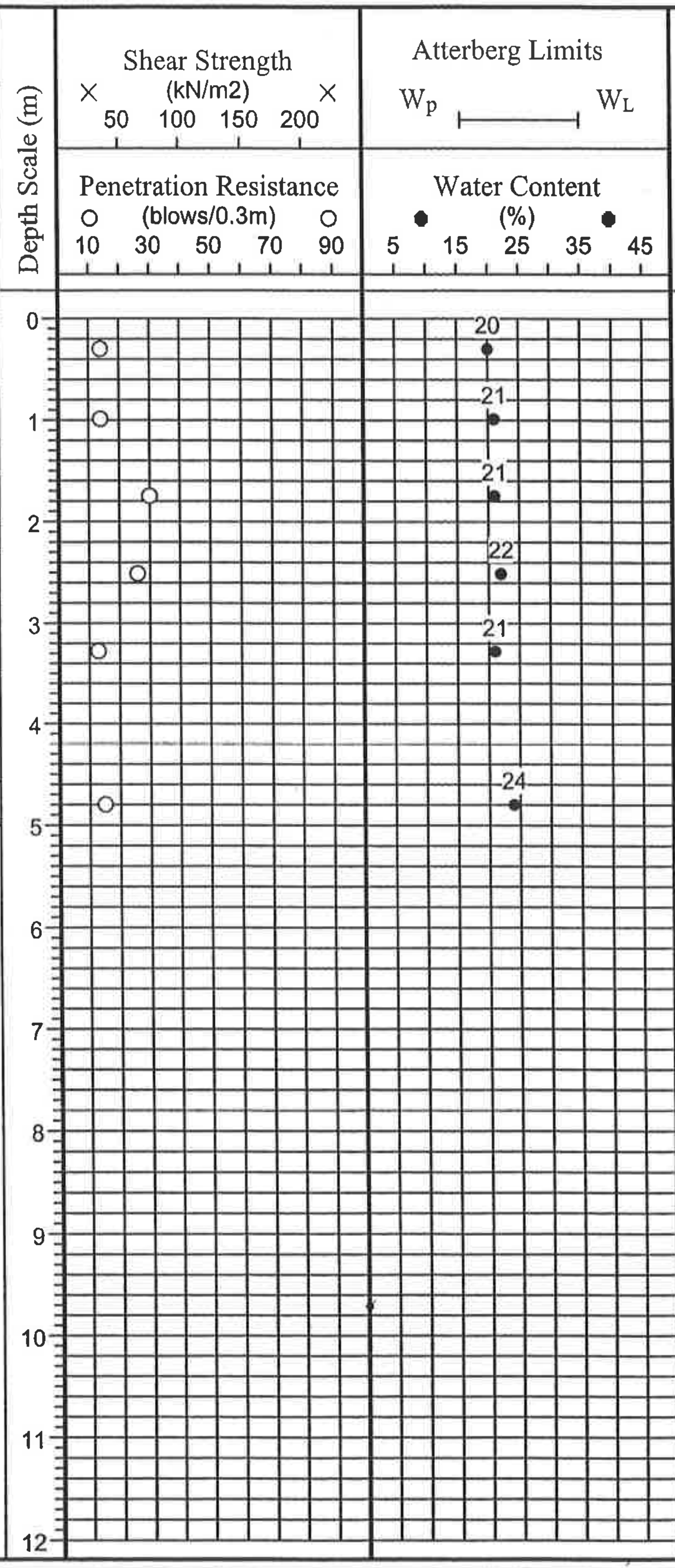
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
255.0	Ground Surface				
0.0	**30cm TOPSOIL**	1	DO	14	Dry on completion
	Stiff to very stiff weathered	2	DO	14	
	SILTY CLAY	3	DO	30	
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	4	DO	26	
		5	DO	13	
250.0	brown grey	6	DO	15	
5.0	**END OF BOREHOLE**				



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 9

FIGURE NO.: 9

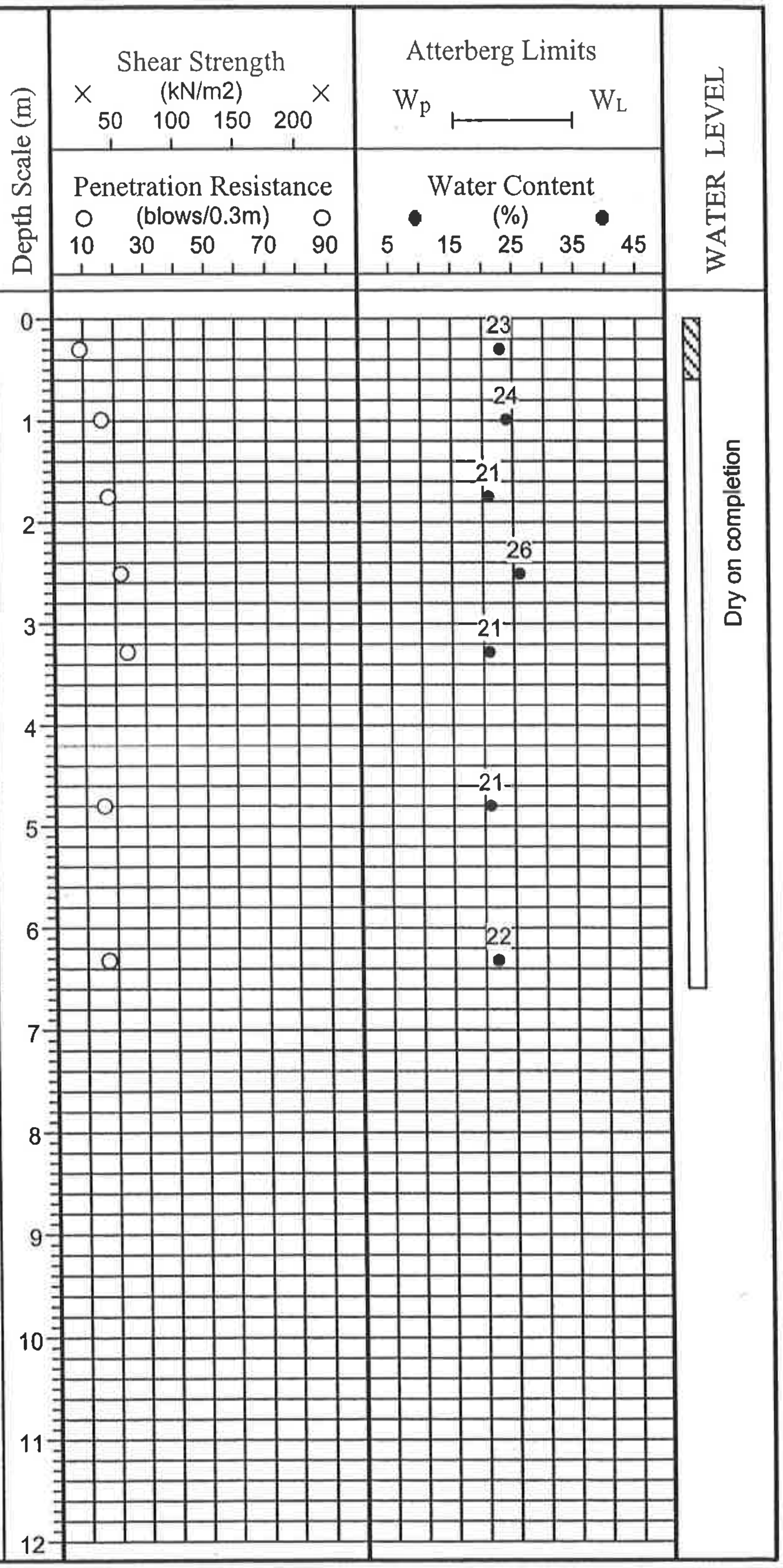
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
259.0	Ground Surface			
0.0	**30cm TOPSOIL**	1	DO	9
	Stiff to very stiff weathered	2	DO	16
		3	DO	18
		4	DO	22
	SILTY CLAY	5	DO	24
	brown grey			
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	16
252.4		7	DO	17
6.6	**END OF BOREHOLE** Installed 50 mm ø standpipe to 6.6 m. Sand backfill from 0.6 to 6.6 m. Sealed with bentonite from 0.0 to 0.6 m.			



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 10

FIGURE NO.: 10

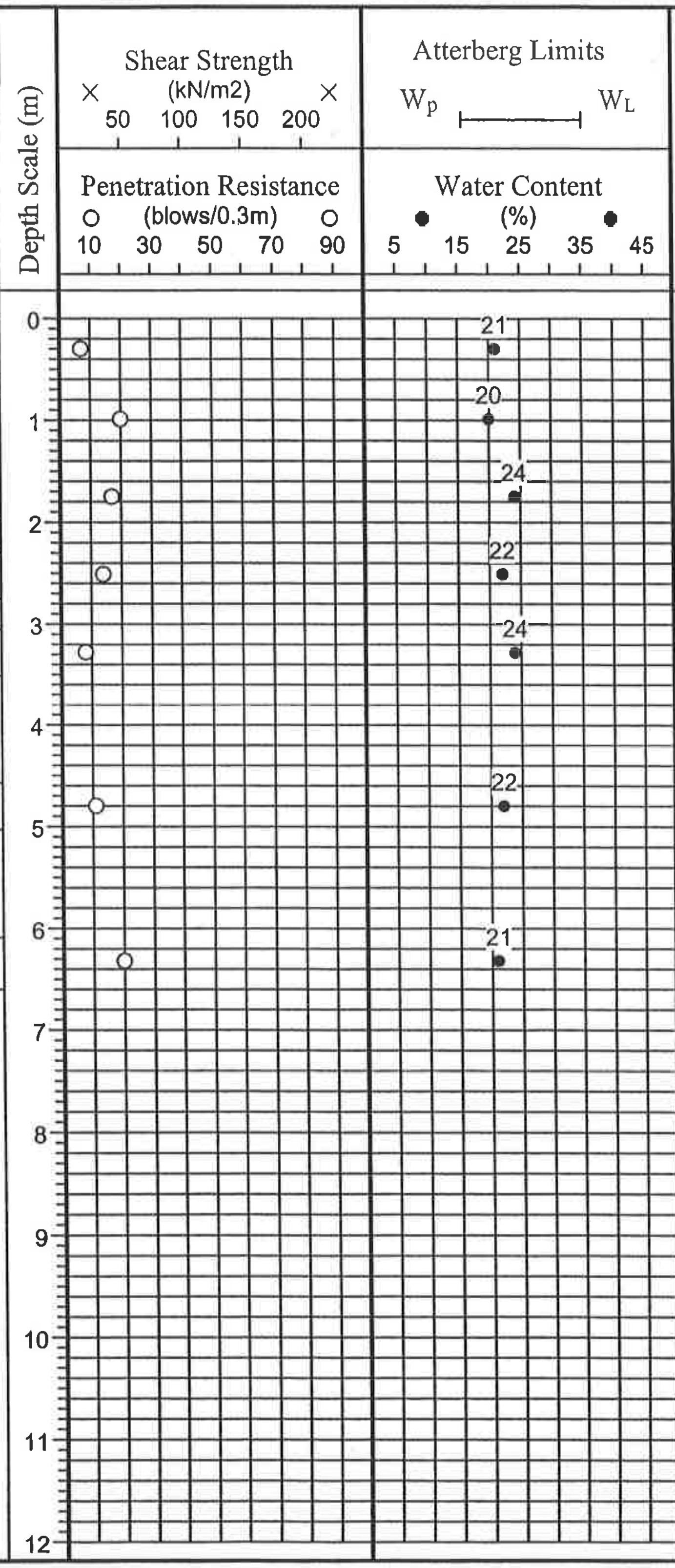
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
267.1	Ground Surface			
0.0	**20cm TOPSOIL**	1	DO	7
	Firm to very stiff weathered	2	DO	20
		3	DO	17
	brown grey	4	DO	14
	SILTY CLAY	5	DO	8
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	11
260.5 6.6		7	DO	20
	END OF BOREHOLE			



WATER LEVEL

Dry on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 11

FIGURE NO.: 11

JOB DESCRIPTION: Proposed Residential Development

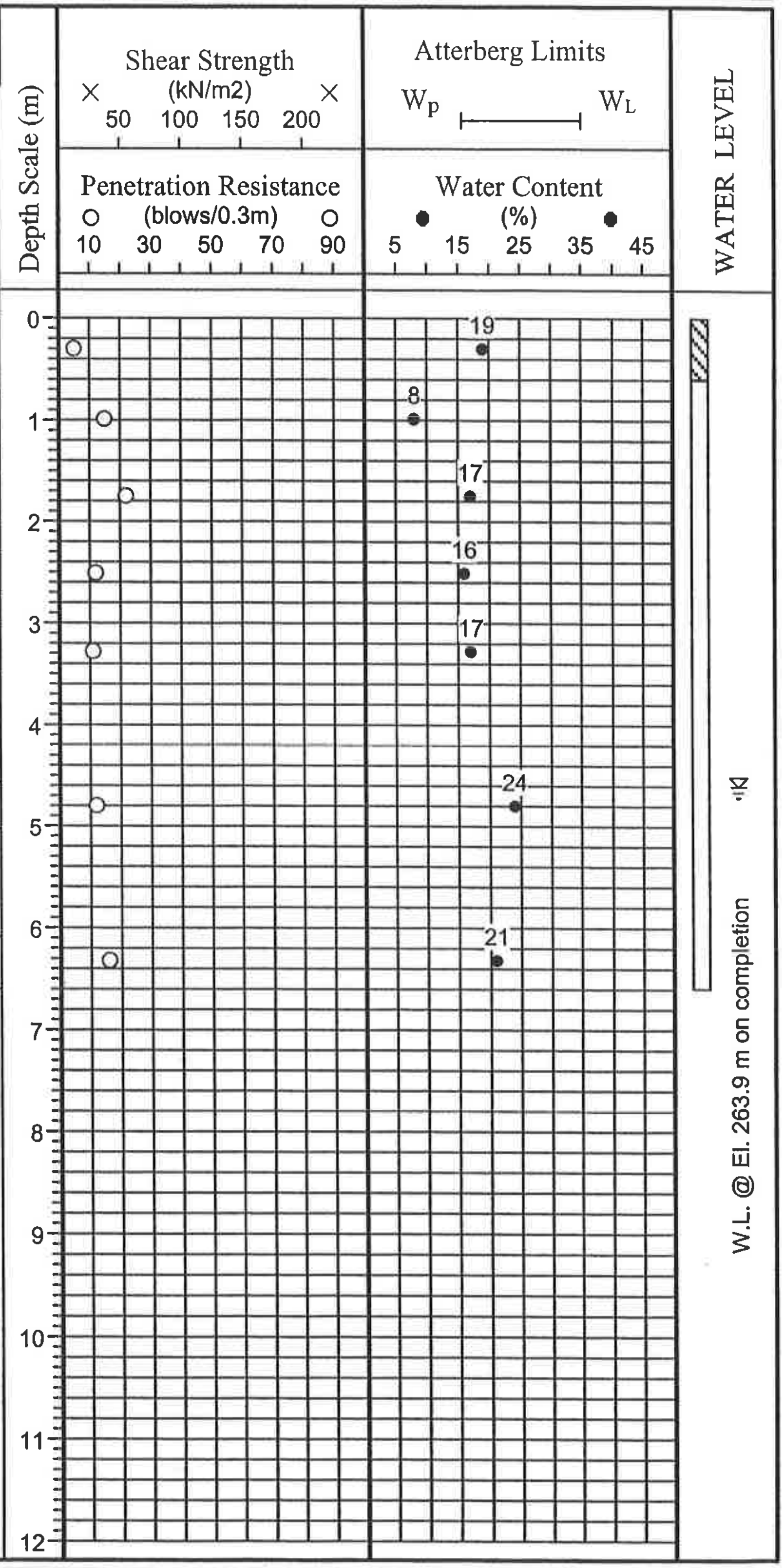
JOB LOCATION:
North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION
268.5	Ground Surface
0.0	**25cm TOPSOIL** Brown, loose to compact **SILTY FINE SAND**
267.1 1.4	Brown, compact **SILT** occ. silty clay, sandy silt and clayey silt layers, and wet fine sand seams and layers
264.5 4.0	Grey, stiff to very stiff **SILTY CLAY** a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)
261.9 6.6	**END OF BOREHOLE** Installed 50 mm ø standpipe to 6.6 m. Sand backfill from 0.6 to 6.6 m. Sealed with bentonite from 0 to 0.6 m.

SAMPLES		
Number	Type	N-Value
1	DO	5
2	DO	15
3	DO	22
4	DO	12
5	DO	11
6	DO	12
7	DO	16



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JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 12

FIGURE NO.: 12

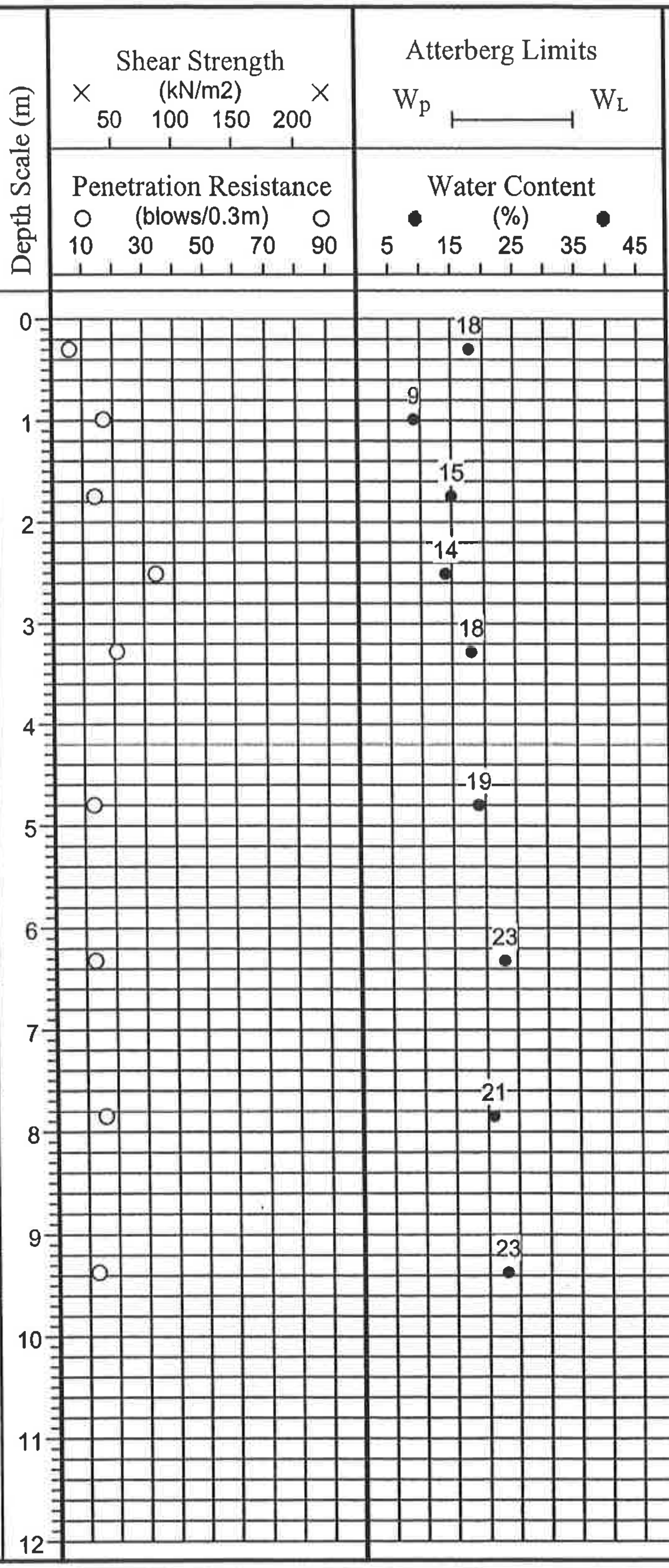
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
269.8	Ground Surface			
0.0	**33cm TOPSOIL**	1	DO	6
	Brown, loose to compact **SAND, Fill**	2	DO	17
268.4 1.4	Brown, compact to dense **SILTY FINE SAND** occ. sandy silt and sandy silt till layers	3	DO	14
		4	DO	34
		5	DO	21
265.7 4.1	Grey, stiff to very stiff **SILTY CLAY** a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	13
		7	DO	13
		8	DO	16
		9	DO	13
260.2 9.6	**END OF BOREHOLE**			



WATER LEVEL

W.L. @ El. 267.1 m on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 13

FIGURE NO.: 13

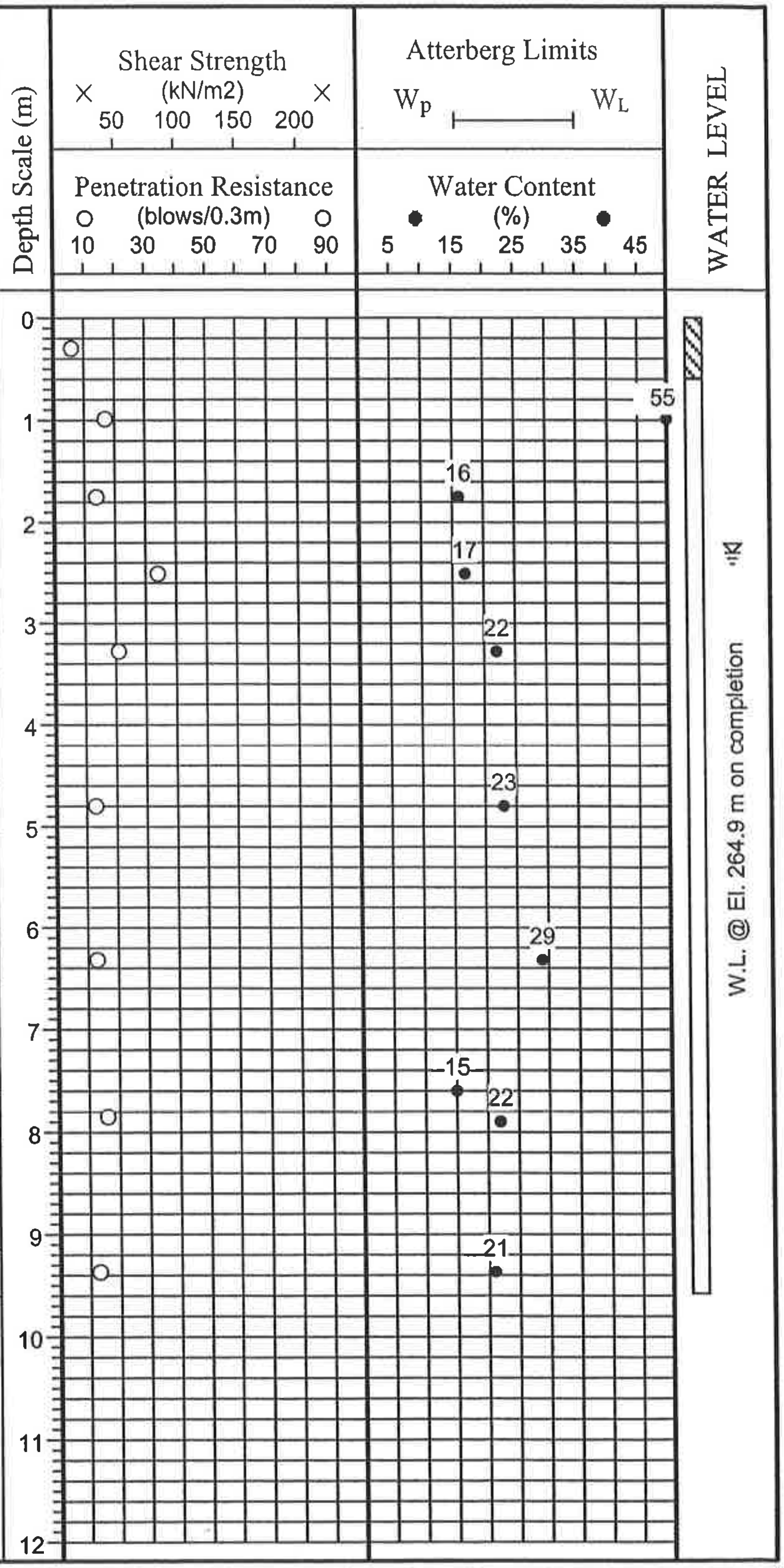
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 10, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
267.2	Ground Surface			
0.0	**30cm TOPSOIL, Fill**			
	Brown	1	DO	2
	SAND, Fill occ. topsoil inclusions	2	DO	20
266.0 1.2	Brown, loose to dense	3	DO	8
	SILTY FINE SAND	4	DO	33
	occ. sandy silt and sandy silt till layers	5	DO	18
263.3 3.9	Firm to very stiff			
	brown grey	6	DO	13
	SILTY CLAY	7	DO	7
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	8	DO	19
257.6		9	DO	13
9.6	**END OF BOREHOLE** Installed 50 mm ø standpipe to 9.6 m. Sand backfill from 0.6 to 9.6 m. Sealed with bentonite from 0.0 to 0.6 m.			



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 14

FIGURE NO.: 14

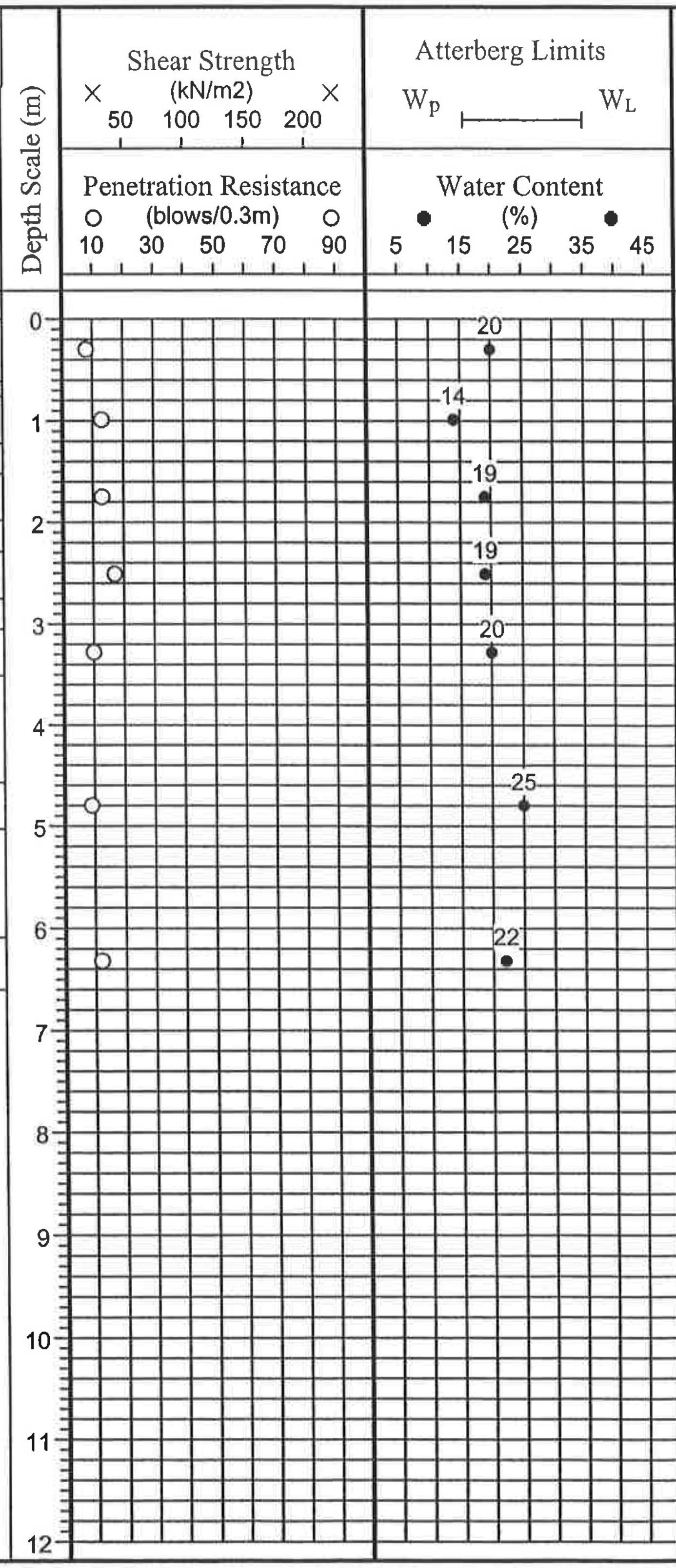
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	WATER LEVEL
268.1	Ground Surface				
0.0	**40cm TOPSOIL, Fill**	1	DO	8	Dry on completion
	Brown **SILTY SAND, Fill** occ. topsoil inclusions	2	DO	13	
266.7 1.4	Compact **SILT**	3	DO	13	
	sandy silt layer	4	DO	17	
	brown grey	5	DO	10	
	occ. silty clay, sandy silt, clayey silt layers, and wet fine sand seams and layers				
264.0 4.1	Grey, stiff to very stiff **SILTY CLAY**	6	DO	9	
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	7	DO	12	
261.5 6.6	**END OF BOREHOLE**				



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 15

FIGURE NO.: 15

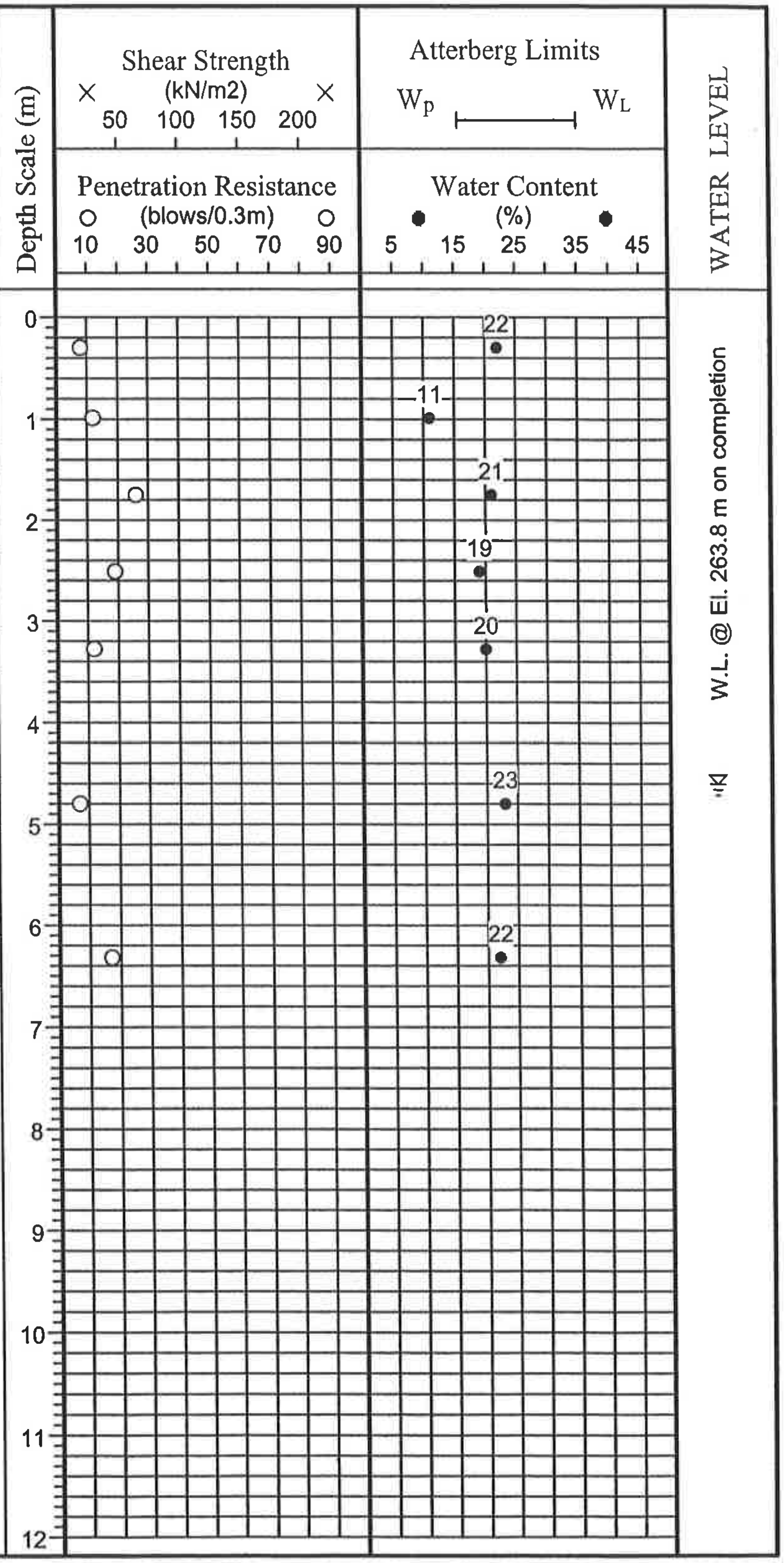
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
268.4	Ground Surface			
0.0	**33cm TOPSOIL, Fill** Brown **SAND, Fill** occ. topsoil inclusions	1	DO	8
		2	DO	12
267.2 1.2	Brown, compact **SILTY FINE SAND** occ. sandy silt and sandy silt till layers	3	DO	26
		4	DO	19
265.3 3.1	Firm to very stiff brown grey **SILTY CLAY** a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	5	DO	12
		6	DO	7
		7	DO	17
261.8 6.6	**END OF BOREHOLE**			



SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 16

FIGURE NO.: 16

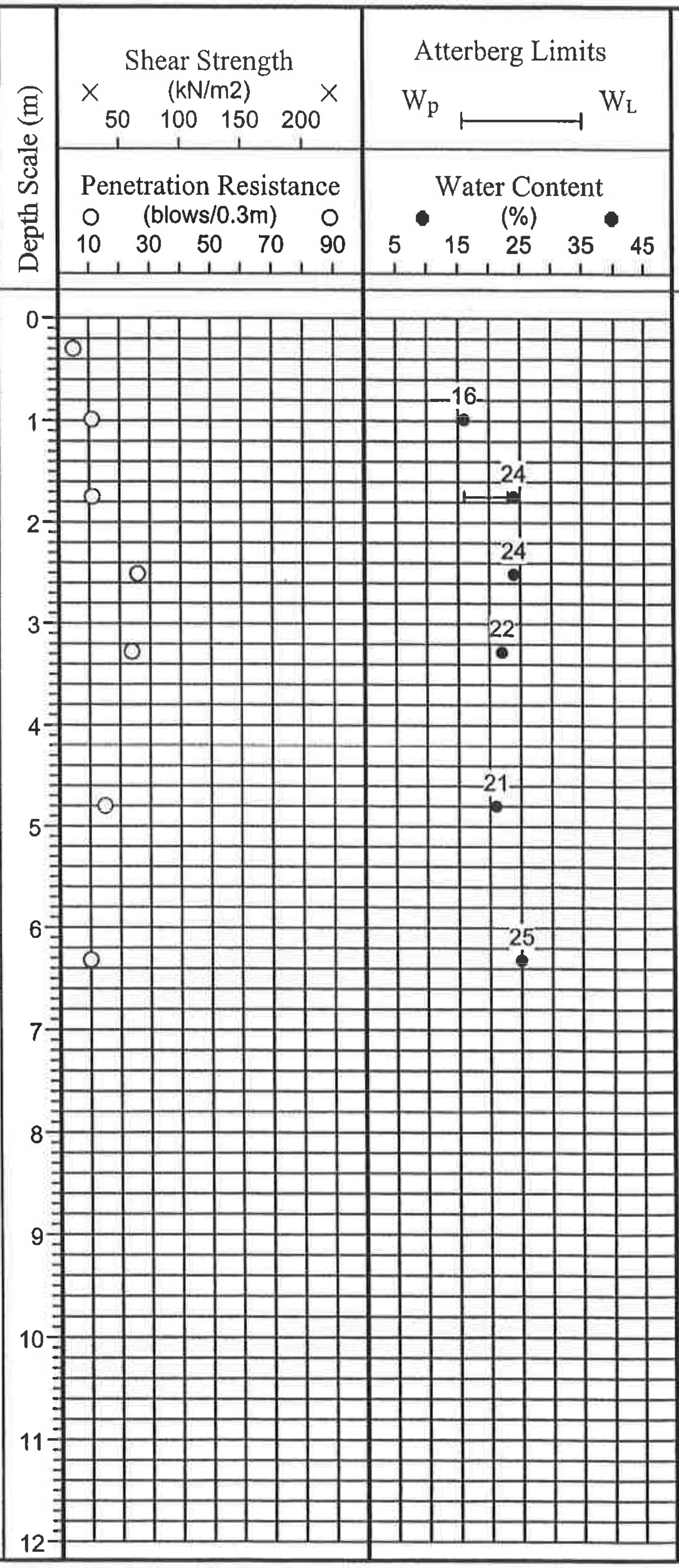
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
265.8	Ground Surface			
0.0	**25cm TOPSOIL** Brown, loose to compact **SILT**	1	DO	5
		2	DO	11
264.6 1.2	Stiff to very stiff	3	DO	11
		4	DO	26
	SILTY CLAY brown ---- grey	5	DO	24
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	15
259.2		7	DO	10
6.6	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 17

FIGURE NO.: 17

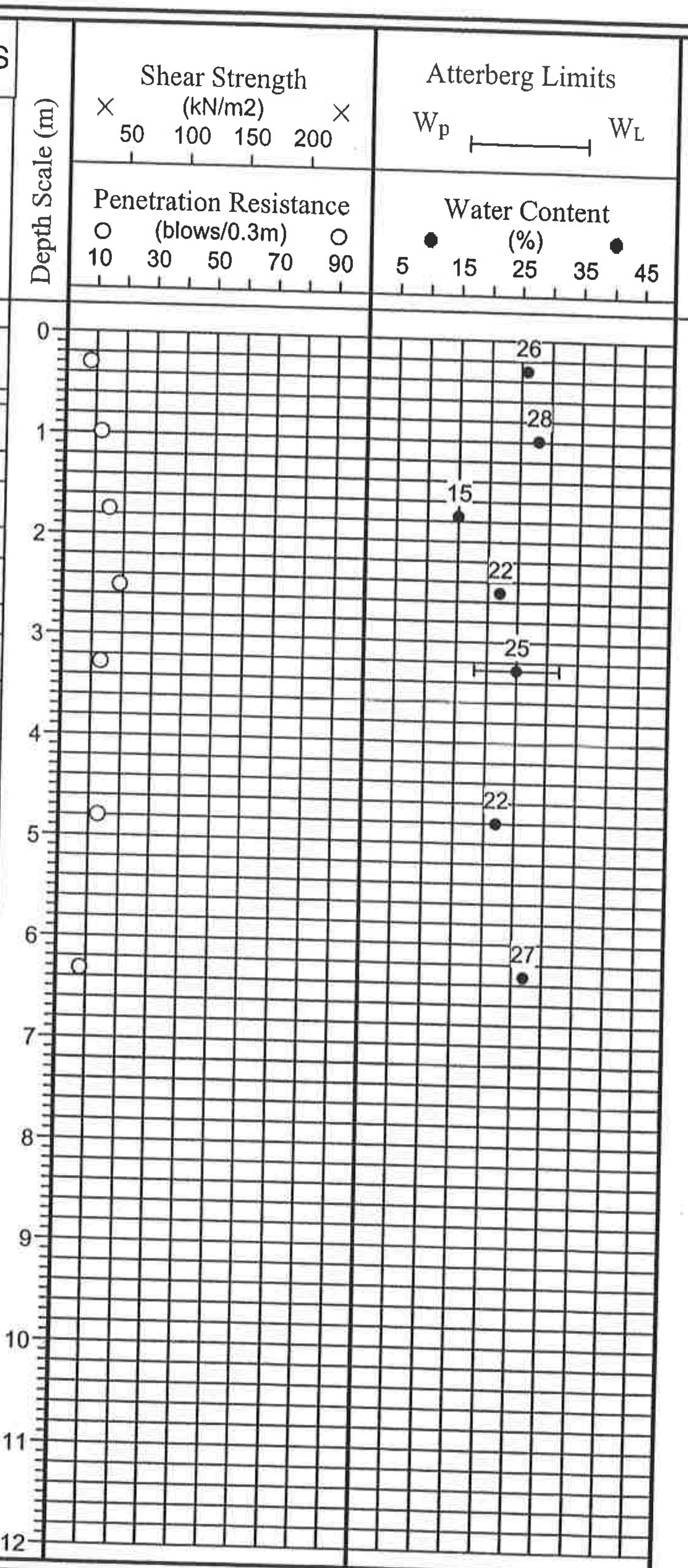
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION:
North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: July 9, 2002

Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
265.0 0.0	Ground Surface			
	25cm TOPSOIL Brown, loose to compact	1	DO	8
	SILTY FINE SAND weathered ----	2	DO	12
	occ. sandy silt layers	3	DO	15
262.9 2.1	Stiff to very stiff	4	DO	19
	brown ---- grey	5	DO	13
	SILTY CLAY			
	a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	6	DO	13
		7	DO	8
258.4 6.6	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 18

FIGURE NO.: 18

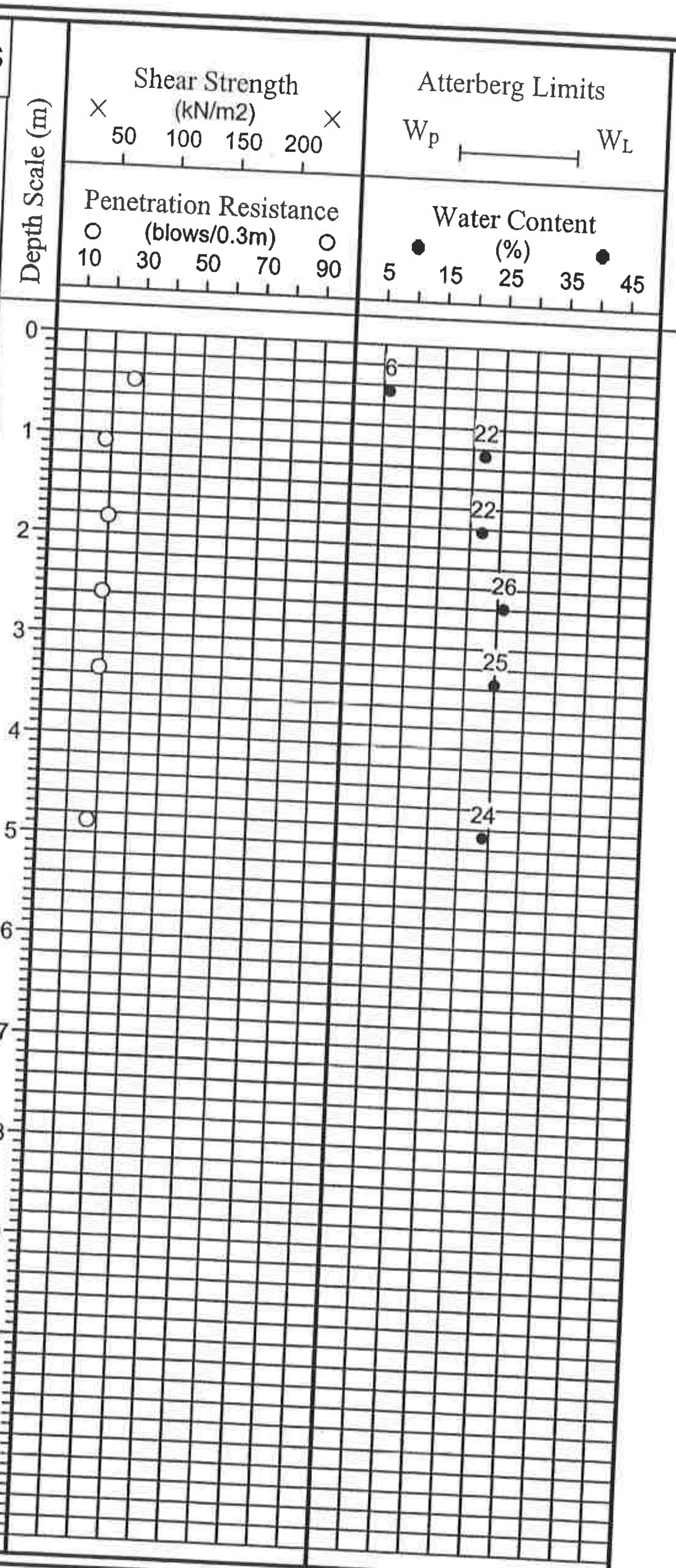
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION: North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: August 22, 2002

Elev. Depth m	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
264.0 0.0	Pavement Surface			
	64mm ASPHALTIC CONCRETE			
	254mm GRANULAR, Fill	1	DO	27
	Very stiff **SILTY CLAY** a tr. of sand occ. wet sand seams, silt and clayey silt layers (VARVED STRUCTURE)	2	DO	18
		3	DO	20
		4	DO	19
		5	DO	19
	brown grey			
		6	DO	17
259.0 5.0	**END OF BOREHOLE**			



WATER LEVEL

Dry on completion

SOIL-ENG LIMITED

JOB NO.: 0207-S2

LOG OF BOREHOLE NO.: 19

FIGURE NO.: 19

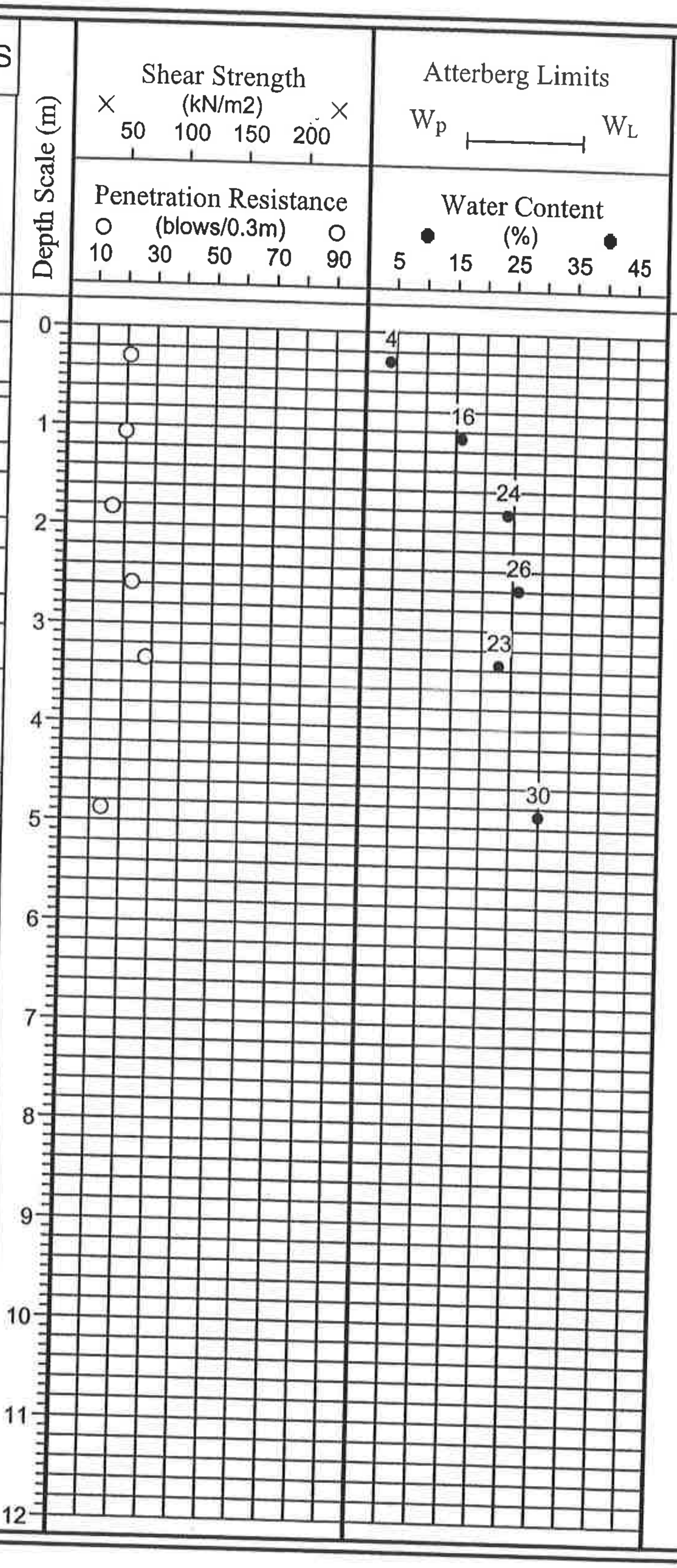
JOB DESCRIPTION: Proposed Residential Development

JOB LOCATION:
North Side of St. John's Sideroad and
West of Yonge Street
Town of Aurora

METHOD OF BORING: Flight-Auger

DATE: August 22, 2002

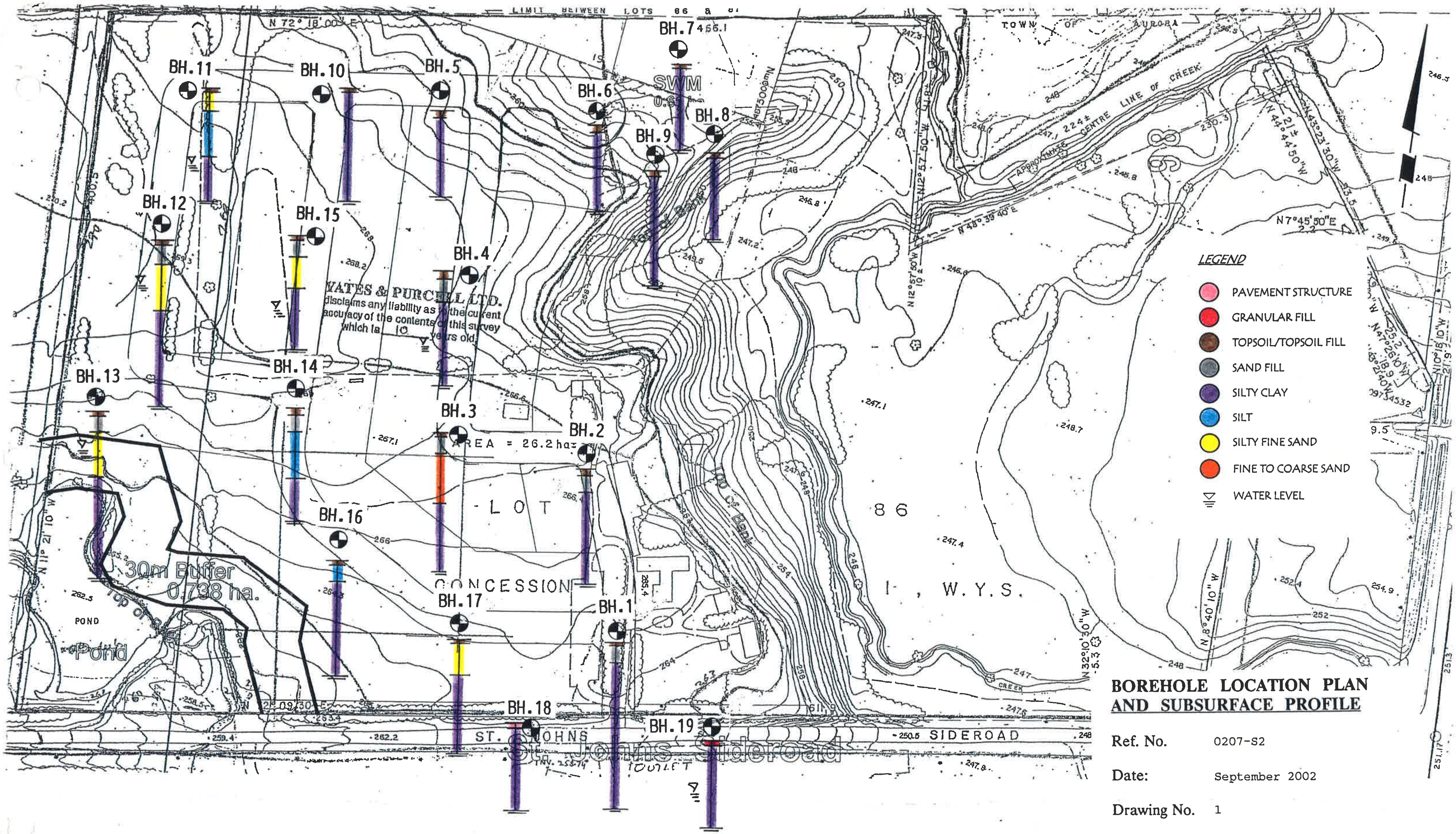
Elev. Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
260.5 0.0	Ground Surface			
	254mm GRANULAR, Fill	1	DO	21
	Stiff to very stiff	2	DO	20
	SILTY CLAY	3	DO	16
	a tr. of sand occ. wet sand seams, silt and clayey silt layers brown grey	4	DO	23
	(VARVED STRUCTURE)	5	DO	28
255.5 5.0		6	DO	14
	END OF BOREHOLE			



WATER LEVEL

W.L. @ El. 257.4 m on completion

SOIL-ENG LIMITED



BOREHOLE LOCATION PLAN AND SUBSURFACE PROFILE

Ref. No. 0207-S2

Date: September 2002

Drawing No. 1

Scale: Horiz. - 1:2000 **Vert. -** 1:200

SOIL-ENG LIMITED