Geotechnical Assessment and Engineering Review of Slope Stability

105 Avondale Court & 143 Bluewater Place
Burlington, Ontario

Prepared For:
Veyron Inc.

Final Report

October 31, 2024
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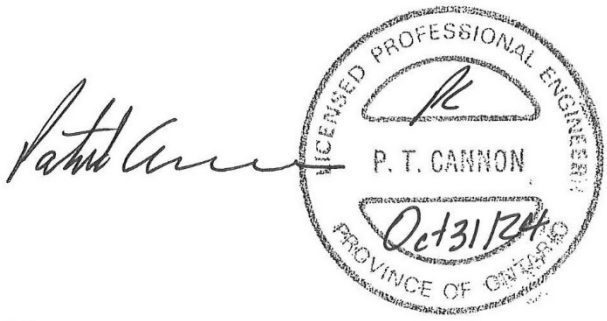
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1 Introduction

Englobe Corp. (Englobe) was retained by Veyron Inc. (hereinafter referred to as the "Client") to carry out a geotechnical assessment and engineering review of slope stability at a property located at 105 Avondale Court & 143 Bluewater Place in Burlington, Ontario (hereinafter referred to as the "Site"). A site location plan is provided on Drawing 1 in Appendix A. A proposal and cost estimate to carry out the work were outlined in our letter of October 15, 2024. Authorization to proceed with the investigation was provided by Robert Jovanovski of Aventus Development Corp, on behalf of Veyron Inc. on October 17, 2024. It is understood that the geotechnical assessment will be required as part of the permitting process for proposed site redevelopment.

A previous subsurface investigation of the site was carried out by Englobe Corp (formerly Terraprobe Inc.) in 2015[1] for various other development initiatives. The boreholes from this previous investigation have been reviewed and appended as part of the current geotechnical assessment. This report presents the results of all of the known subsurface information from the investigation works in the area of the proposed development.

The purpose of the work was to report on the subsurface soil, rock and ground water conditions in a series of boreholes drilled at the site. Based on this information a slope stability assessment was completed to determine the erosion hazard limits for the shoreline and valley slopes. Advice is provided with respect to the geotechnical aspects of the proposed development, including the design of foundations, floor slabs-on-grade and pavements. The anticipated construction conditions pertaining to excavation, backfill and temporary ground water control are discussed also, but only with regard to how these might influence the design.

The geotechnical assessment was completed to satisfy the intent of the policy guidelines outlined in the document entitled *Understanding Natural Hazards Guide* (Ministry of Natural Resources, 2001) and the Halton Region Conservation Authority (Conservation Halton) document entitled '*Polices and Guidelines for the Administration of Part VI of the Conservation Authorities Act and O.Reg. 41/24 and Land Use Planning Policy Document*', dated April 27, 2006 (Last amended June 21, 2024).

Ongoing liaison with Englobe during the final design and construction phase of the project is recommended to ensure that the recommendations in this report are applicable and/or correctly interpreted and implemented.

The recommendations and opinions in this report are applicable only to the proposed development as described above and the Limitations of the Investigation found in Section 9 is an integral part of this report.

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1 *Geotechnical Investigation and Engineering Review of Slope Stability, Bluewater Place, Burlington, Ontario*; prepared by Terraprobe Inc. for Bloomfield Developments; File No. 71-15-5064; December 10, 2015

2 Site Description

2.1 Existing Site Conditions

The site was examined by a senior geotechnical engineer from our staff on October 18, 2024 to obtain information regarding the existing site and slope features. The existing site features are shown on Drawing 2, as derived from a topographical survey of the property, prepared by Guido V. Consoli, O.L.S. This survey includes supplementary survey measurements along the shoreline by Mackay, Mackay, Peters Limited, O.L.S. Photographs illustrating the general features of the property are provided in Appendix B.

At the time of this investigation, existing development consisted of single detached dwellings on 105 Avondale Court (Photographs 1 to 5) and 143 Bluewater Place (Photographs 21 to 24). The site topography is irregular with ground surface elevations varying from about 76.8 to 84.4 m.

2.1.1 Shoreline Slope

The shoreline slope has an overall height of about 7 to 9 metres, has an approximate inclination of about 1.4 horizontal to 1 vertical, and was relatively well vegetated with a variety of grasses, bush and weed growth. There was no evidence of deep-seated instability of the slope such as large slumps, tension cracks and scarp zones. The overall slope appeared to be in a stable condition. (Photograph 6)

A seawall had been constructed at the toe of the slope and along the shoreline as an erosion protection measure. The seawall is irregular in shape, configuration and construction; the west side shoreline consists of stacked armourstone; and the east central shoreline consists of a composite of concrete and armourstone (Photographs 7 and 8). Along the eastern limit of the site, there was a cobble beach area about 12 metres wide and a timber retaining wall (Photographs 9 and 11). The water level of Lake Ontario at the time of this assessment was at about elevation 74.8 metres. Drawings 3 and 4 presents cross-sections of the site and shoreline slopes, Sections A-A', B-B', C-C' and D-D'.

2.1.2 Valley Slope and Stormwater Outfall

A water course, associated with a storm water outfall, is located along the eastern limit of 105 Avondale Court. It is understood that the water course collects storm water runoff from a residential area upstream (north) of the property. The water course enters a 1.3m diameter corrugated steel pipe underneath the driveway. The water course from the driveway to Lake Ontario was noted to be about 1 to 1.2 m wide and formed in clayey silt till and/or weathered shale bedrock (Photographs 12 to 16). The flow of the water course was observed to be relatively shallow at the time of our site inspection. The west bank of the water course has an approximate height ranging from about 1 to 2 m. Based on the topographic survey by Guido V. Consoli, O.L.S., the embankment slopes in the study area are about 1 horizontal to 1 vertical. Active erosion along the west bank was apparent. Further upstream, a gabion wall had been constructed along the west bank and has experienced some deformation (Photograph 17). Drawing 4 presents cross-sections of the site and valley slope, Section E-E' and F-F'.

The above information was used to complete the Slope Stability Rating Chart as shown in Table 4.2 of the Technical Guide of the River and Stream Systems: Erosion and Hazard Limit, by the Ontario Ministry of Natural Resources (MNR Guide). The results of the rating are shown in the attached Table 1. A slope stability rating of 48 has been indicated for the valley slope. The MNR guidelines indicate a

"moderate potential" for unstable slopes for sites with a rating greater than 35. The present assessment meets the level of effort outlined in the MNR Guidelines for slopes with this rating.

Table 1: Slope Stability Rating Chart - Valley Slope

Site Location:	**105 Avondale Court, Burlington, Ontario**		**File No. 02410577.000**	
Property Owner:	**Veyron Inc.**			
Inspection Date:	**October 18, 2024**			
Inspected By:	**Patrick Cannon, P. Eng.**			
1. SLOPE INCLINATION			**Slope Section**	
Degrees		Horizontal / Vertical	**E-E'**	**F-F'**
a)	18 or less	3 : 1 or flatter	0	0
b)	18 - 26	2: 1 to more than 3:1	6	6
c)	> 26	Steeper than 2:1	16*	16*
2. SOIL STRATIGRAPHY				
a)	Shale Limestone, Granite (Bedrock)		0	0
b)	Sand, Gravel		6	6
c)	Glacial Till		9	9
d)	Clay, Silt		12	12
e)	Fill		16*	16*
f)	Leda clay		24	24
3. SEEPAGE FROM SLOPE FACE				
a)	None or Near bottom only		0*	0*
b)	Near mid-slope only		6	6
c)	Near crest only or, From several levels		12	12
4. SLOPE HEIGHT				
a)	2 m or less		0*	0*
b)	2.1 to 5 m		2	2
c)	5.1 to 10m		8	8
5. VEGETATION COVER ON SLOPE FACE				
a)	Well vegetated; heavy shrubs or forested with mature trees		0	0
b)	Light vegetation; mostly grass, weeds, occasional trees, shrubs		4	4
c)	No vegetation, bare		8*	8*
6. TABLE LAND DRAINAGE				
a)	Table land flat, no apparent drainage over slope		0	0
b)	Minor drainage over slope, no active erosion		2*	2*
c)	Drainage over slope, active erosion, gullies		4	4
7. PROXIMITY OF WATERCOURSE AT SLOPE TOE				
a)	15 metres or more from slope toe		0	0
b)	Less than 15 metres from slope toe		6*	6*
8. PREVIOUS LANDSLIDE ACTIVITY				
a)	No		0*	0*
b)	Yes		6	6
SLOPE STABILITY RATING VALUE				
INVESTIGATION RATING SUMMARY		**TOTAL**	**48**	**48**

SLOPE INSTABILITY RATING		**RATING**	**INVESTIGATION REQUIREMENTS**
1.	Low potential	< 24	Site inspection only, confirmation, report letter.
2.	Slight potential	25-35	Site inspection and surveying, preliminary study, detailed report.
3.	Moderate potential	> 35	Site inspection, boreholes, surveying, detailed report.

2.1.3 Property Boundary Adjoining 4342 Blue Water Place

Along the east property boundary of 143 Bluewater Place, adjoining 4342 Blue Water Place, there is a slope which has an overall height of about 2.2 to 2.6 metres and an approximate inclination of about 2.0 horizontal to 1 vertical. The slope was relatively well vegetated with a variety of grasses, bush and weed growth. There was no evidence of deep-seated instability of the slope such as large slumps, tension cracks and scarp zones. The overall slope appeared to be in a stable condition.

At a localized section of the slope, within the property limits of 4342 Blue Water Place, there is a timber retaining wall which was constructed presumable to improve driveway access to a neighbouring garage. The timber wall exhibits evidence of deterioration but was generally intact.

2.2 Site Geology

Based on published geological information for the general area, near surface soil at and in the vicinity of the subject property generally consists of Glaciolacustrine beach and nearshore sand and gravel of Lake Iroquois overlying Halton Till: clay or silt till.[2] The overburden is underlain by the bedrock of the Queenston Formation of Ordovician Age. The Queenston Formation consists of reddish-brown shale, interbedded with limestone and calcareous sandstone.[3] The geological mapping indicates that the bedrock beneath the site is about 5 to 9 metres below existing ground surface (m BGS).[4]

2.3 Proposed Development Features

The proposed development features are shown on Drawing 5, as derived from a site plan drawing prepared by Shoreplan. In this design it is proposed to construct a new 3-storey single family dwelling.

The field work for this investigation was carried out on August 25, 2015, during which time nine (9) boreholes were drilled to depths of about 2.0 to 10.1 metres below the existing ground surface (m BGS). The locations of the boreholes are shown on the Site Plan, Drawing 2. The results of the boreholes are shown on the Log of Borehole sheets presented in Appendix C.

The borehole drilling and sampling was carried out using a track mounted drill rig supplied and operated by a specialist drill contractor. The boreholes were advanced using conventional interval augering and sampling techniques and soil samples were recovered at regular intervals of depth by split barrel sampling in accordance with ASTM Standard D1586. After the drilling, sampling, and logging was completed, the boreholes were backfilled with auger cuttings and bentonite sealant.

The field work was observed throughout by members of our engineering staff who located the boreholes, arranged for the underground utility clearances at the borehole locations and cared for the samples obtained. The boreholes were located in the field with respect to the existing development features shown on a site survey drawing. The ground surface elevations at the boreholes were inferred from spot elevations shown on a topographic survey of the property prepared by Guido V. Consoli, OLS, which was understood to have been referred to the geodetic datum.

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2 *Quaternary Geology of the Hamilton Area, Southern Ontario*; Ontario Division of Mines; Map No. 2605; 1983.

3 *Paleozoic Geology, Hamilton Area, Southern Ontario*; Ontario Division of Mines; Map No. 2336; 1976.

4 *Bedrock Topography of the Hamilton Area, Southern Ontario*; Ontario Department of Mines; Map No. 2034; 1964.

Ground water observations were made in each borehole during and upon completion of drilling and sampling. There was no provision for long term ground water monitoring at the site. The boreholes were decommissioned and sealed with bentonite pellets in accordance with Ontario Regulation 903.

All of the samples recovered in the course of the investigation were brought to our Stoney Creek laboratory for further examination and water content determinations. The results of moisture content tests are plotted on the Log of Borehole sheets in Appendix C. Soil quality analyses were not carried out as part of this assignment.

4 Subsurface Conditions

The subsurface soil, rock and ground water conditions encountered in the boreholes, and the results of the field and laboratory testing, are shown on the Log of Borehole sheets in Appendix C. A list of abbreviations and symbols are provided to assist in the interpretation of the borehole logs. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent exact planes of geological change. Further, conditions will vary between and beyond the locations investigated.

4.1 Soil Conditions

The following discussion has been simplified in terms of the major soil strata. In general, the boreholes drilled at the site penetrated topsoil and fill, overlying strata of silty sand, clayey silt till and weathered shale bedrock.

4.1.1 Topsoil / Fill

A 50 to 150 mm thick layer of topsoil was encountered at the ground surface in most of the boreholes. Fill was encountered at all borehole locations and was found to vary in depth from 0.6 to 2.3 metres below existing ground surface. The fill was variable in nature but generally consisted of silty sand or silty clay. The N values, as determined in the Standard Penetration testing carried out within the fill, ranged from 2 to 16 blows per 0.3 m, inferring a loose to compact state of packing. The range in penetration resistance observed suggests that the fill was not constructed as an engineered fill. The in-situ water content of the samples of fill recovered from the standard penetration testing ranged from about 4 to 15 percent.

4.1.2 Silty Sand

All of the boreholes, except for boreholes 3 and 4, encountered a stratum of silty sand beneath the fill. The N values determined within the silty sand ranged from 10 to 70 blows per 0.3 m. The natural water content of the silty sand samples ranged from about 9 to 30 percent.

4.1.3 Clayey Silt Till

The boreholes encountered clayey silt till beneath the silty sand and/or fill at elevations in the range of about 76.4 to 77.9 metres. The N values within the clayey silt till ranged from 15 to 47 blows per 0.3 m, inferring a relatively stiff to hard consistency. The natural water content of the clayey silt till was about 6 to 21 percent.

4.1.4 Weathered Shale Bedrock

Most of the boreholes were terminated in weathered shale bedrock which was encountered at elevations in the range of about 74.9 to 76.7 metres. The N values determined in the shale bedrock were typically greater than 100 blows per 0.3 m. The natural water content of the samples of the shale recovered from the standard penetration testing ranged from about 6 to 13 percent. Detailed exploration of the bedrock was not carried out as part of this assignment; however, the bedrock beneath the site is known to consist of the Queenston Formation which is comprised of predominantly thinly bedded reddish brown shale of Ordovician age. The shale typically contains interbeds of green calcareous shale, limestone, sandstone and siltstone.

4.2 Ground Water Conditions

Boreholes 3, 4 and 5 were dry during and upon completion of drilling. All of the other boreholes encountered ground water at depths of about 3.0 and 6.1 m below existing grade, or at elevations in the range of about 77.9 to 80.6 m. This is a perched ground water condition in the silty sand stratum, above low permeability deposits of clayey silt till. At this site, the ground water levels will likely coincide with the level of Lake Ontario, which was at about elevation 74.8 metres at the time of the investigation.

5 Engineering Development Limit - Shoreline

Ontario Regulation 162/06 stipulates that permission is required from the Halton Region Conservation Authority to undertake development or redevelopment within the shoreline hazard limit. O. Reg 162/06 s.2(1) defines the hazardous lands adjacent to the shorelines of the Great Lakes - St. Lawrence River System as those lands, which are impacted by flooding, erosion, or dynamic beach hazards. The furthest landward limit of the three hazards defines the shoreline hazard limit. O. Reg 162/06 s.3(1) further provides that the Authority may grant permission for development within the shoreline hazard limit 'if, in its opinion, the control of flooding, erosion, dynamic beaches, pollution or the conservation of land will not be affected by development'.

At this site, the erosion hazard limit is defined as the average annual recession rate for a 100-year planning horizon (erosion allowance), plus the stable slope allowance. In the absence of a site-specific study, an average annual recession rate of 0.3 metres per year for Lake Ontario (30 metres) and a stable slope allowance (based on a 3 horizontal to 1 vertical stable profile) are typically applied by Conservation Halton to determine the baseline erosion hazard limit. Any reduction in the baseline erosion hazard limit is termed by Conservation Halton as the Engineered Development Setback (EDS). The EDS limit is applied as an offset from an inferred toe of slope. Where there is existing shoreline protection, Conservation Halton requires that the back of the protection structure, from an elevation of about 75.0 metres, be used as the inferred toe of the slope.

The specific location of the EDS limit has not been determined, since this is subject to the review of the existing seawall by Conservation Halton and/or an experienced coastal engineer. The following presents a discussion of each setback component to assist in the determination of the EDS Limit.

5.1 Erosion Allowance

Conservation Halton will provide guidance with respect to the applicable erosion allowance to be applied at this site. Based on our experience on other properties in this area, Conservation Halton may permit the reduction of the 100-year recession from 30 to 20 metres. This is subject to the existing shoreline protection works being in good order (as determined by a professional engineer with experience in coastal processes and approved by Conservation Halton), and assuming a 5-metre unobstructed access to and along those works (for maintenance and repair/replacement) will be maintained.

5.2 Stable Slope Allowance

A detailed engineering analysis of slope stability was carried out for a selected slope cross-section utilizing a commercially available slope stability program Rocscience - Slide 6.0. The slope stability assessment was based on an effective stress limiting equilibrium analysis for long term slope stability using Spencer, Bishop and Morgenstern-Price methods. The methods of analysis allow for the calculation of Factors of Safety for hypothetical or assumed failure surfaces through the slope. The analysis method is used to assess potential for movements of large masses of soil over a specific failure surface which is often curved or circular.

For a specific failure surface, the Factor of Safety is defined as the ratio of available strength resisting movement, divided by the gravitational forces tending to cause movement. The Factor of Safety of 1.0 represents a 'limiting equilibrium' condition where the slope is at the point of pending failure since the soil resistance is equal to the forces tending to cause movement. The analysis involves dividing the sliding mass into many thin slices and calculating the forces on each slice. The normal and shear forces acting on the slides and base of each slice are calculated. It is an iterative process that converges on a solution. The typical Factor of Safety used for engineering design of slopes for stability in building applications, ranges from about 1.3 to 1.5. Conservation Halton policies are based on a minimum Factor of Safety of 1.5 for development applications. The following average soil properties were assumed for the soil strata in the slope stability analysis.

Table 2: Soil Strength parameters for drained (long-term) conditions

Stratigraphic Unit	Unit Weight (kN/cu.m)	Effective Shear Resistance, c' (kPa)	Effective Angle of Internal Friction φ' (degrees)
FILL: silty sand, loose to compact	18	0	28
Clayey Silt / Similar Fill	19.5	0	36
Clayey Silt Till, very stiff to hard	18	4	36
Queenston Formation Weathered Shale Bedrock	Infinite Strength		

Cross-sections of the shoreline slope were derived from the topographic survey information provided by Guido V. Consoli, O.L.S., which includes supplementary survey measurements along the shoreline by MacKay, MacKay, Peters Limited, O.L.S. Lake levels starting at about elevation 75.0 metres and rising to the 100-year return period level of 76.0 m were considered in this assessment. The 100-year return period level means that on average there is a 1 percent chance in any given year that the lake water will reach that level. The results of the slope stability analyses are presented in Appendix D.

Based on the results of the analyses, the soil stratigraphy and the anticipated ground water and lake levels, an overall inclination of 1.8 horizontal to 1 vertical would be required to achieve a minimum

Factor of Safety of 1.5. The stable slope allowance will therefore be a total of 1.8 times the height of the slope.

6 Long Term Stable Top of Bank

The long-term stable top of bank for river and stream systems is determined based on the potential for bank erosion to impact on the stability of the slope (toe erosion allowance), the stability of the slopes (stable slope allowance), and a need for access during emergencies (erosion access allowance). The following presents an assessment of each component to determine the erosion hazard limit.

6.1 Toe Erosion Allowance

A toe erosion allowance is recommended in areas where the water course position is within 15 m of the slope toe. A guideline table recommended for estimating the erosion allowance is presented as follows:

Table 3: Minimum Toe Erosion Allowance – River within 15 m of Slope Toe*

Type of Material	Evidence of active erosion** or bankfull flow velocity>competent flow velocity***	No evidence of active erosion**or flow velocity<<competent flow velocity***		
		Bankfull Width		
		< 5 m	5-30 m	> 30 m
Hard Rock (granite)	0 - 2 m	0 m	0 m	1 m
Soft Rock (shale, limestone), Cobbles, Boulders	2 - 5 m	0 m	1 m	2 m
Stiff / Hard Cohesive Soil (clays, clayey silt)	5 - 8 m	1 m	2 m	4 m
Soft/Firm Cohesive Soil Fine Granular (sand, silt) Fills	8 - 15 m	1 - 2 m	5 m	7 m

Notes:

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

*** Competent Flow velocity; the flow velocity that the bed material in the stream can support without resulting in erosion or scour.

Consideration must also be given to potential future meandering of the watercourse channel.

Source: ‘*Geotechnical Principles for Stable Slopes’* (Terraprobe, June 1998), prepared for: Ontario Ministry of Natural Resources, Lands and Natural Heritage Branch.

As noted previously, the water course was noted to be typically 1 to 2 m wide and formed in clayey silt till and/or weathered shale bedrock. It is noted that there was evidence of active erosion along the west bank of the water course. In consideration of the above referenced guideline, a minimum erosion allowance of 5 m is recommended.

6.2 Stable Slope Allowance

The following average soil properties were assumed for the soil strata in the slope stability analysis of the valley slope.

Table 4: Soil Strength parameters for drained (long-term) conditions

Stratigraphic Unit	Unit Weight (kN/cu.m)	Effective Shear Resistance, c' (kPa)	Effective Angle of Internal Friction φ' (degrees)
FILL: silty clay, stiff	18	0	28
FILL: silty sand, loose to compact	18	0	28
Silty Sand, compact to very dense	19.5	0	36
Clayey Silt Till, hard	18	4	36
Queenston Formation Weathered Shale Bedrock	Infinite Strength		

Cross-sections of the shoreline slope were derived from the topographic survey information provided by Guido V. Consoli, O.L.S. The results of the slope stability analyses are presented in Appendix D.

Based on the results of the analyses, it is our opinion that a stable slope profile of 2 horizontal to 1 vertical for long-term conditions would be appropriate for the valley slope. The location of the long-term stable top of slope, determined on this basis is shown on Drawings 2 and 4.

6.3 Regulatory Setback

Conservation Halton requires an additional setback from the long-term stable top of slope. The intent is to control top of bank land use that could potentially impact slope stability and to ensure that future development is not impacted by slope deformations. This setback also provides a means of access to the slope. Policies for this component of the setback have been established by Conservation Halton Policy Document, dated April 27, 2006 (Last amended June 21, 2024).

The policies that pertain specifically to new buildings or redevelopment on the property are outlined under Policy #2.26, where it is stated:

'New buildings may be permitted within 15 metres of any riverine flooding or erosion hazard, subject to the following:

a) *The building and site grading is designed to mitigate hazard risks and does not create new hazards and aggravate existing hazards on neighbouring properties; and,*

b) *The building and any associated structures are located a minimum of 6 metres from all hazards.'*

7 Geotechnical Design

The following discussion is based on our interpretation of the factual data obtained during this investigation and is intended for the use of the design engineer only. Comments made regarding the construction aspects are provided only in as much as they may impact on design considerations. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

7.1 Foundation Design

The following discussion is provided with the understanding that any and all buildings proposed for the site will be designed in conformance to the current Ontario Building Code (OBC) or other regulatory bodies within the jurisdiction. This section addresses the feasibility of constructing conventional spread and/or strip footings, as well as drilled piers at the site.

7.1.1 Conventional Spread & Strip Footings

Boreholes BH 1 to BH 5 were located within the approximate building envelope for the proposed residential dwelling. In summary, these boreholes penetrated existing fill to depths of up to 2.3 metres below the existing ground surface, overlying strata of silty sand, clayey silt till and weathered shale bedrock. Based on the results of the boreholes it is considered feasible to support the building foundations on conventionally designed spread or strip footings bearing in the undisturbed silty sand and/or clayey silt till strata. The existing fill is unsuitable for the support of building foundations.

All foundations designed to bear on the undisturbed silty sand and/or clayey silt till strata can be designed using a factored bearing resistance at Ultimate Limit States (ULS) of 225 kPa and a bearing reaction of 150 kPa at Serviceability Limit States (SLS). Higher design bearing resistances are feasible on the weathered shale bedrock; however, any change to the design bearing resistance given above should be discussed with our office.

A minimum footing width of 450 mm is recommended for strip footings and a minimum footing width of 900 mm should be considered for spread footings. The total and differential settlement (short term and long term) of spread footings established on the undisturbed soil strata at the above design bearing pressures is expected to be less than 25 mm.

All spread footing foundations exposed to freezing temperatures must be provided with a minimum of 1.2 metres of earth cover for frost protection or alternative equivalent insulation. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided.

Some variability in the consistency and depth of the native undisturbed strata is expected. Deeper excavations may be required locally and for this reason, it is important that all of the foundation excavations be inspected by Englobe to confirm that the surficial strata have been fully penetrated and to identify any preparatory work required prior to placing the footing concrete. Where deeper excavations are required, the footings should be lowered in a series of steps with maximum vertical increments of 600 mm and with a rise to run ratio of 1:2.

7.2 Site Classification for Seismic Site Response

Seismic hazard is defined in the 2012 Ontario Building Code (OBC 2012) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 s, 0.5 s, 1.0 s and 2.0 s and a probability of exceedance of 2% in 50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g., shear wave velocity (vs), Standard Penetration Test (SPT) resistance, and undrained shear strength (su)) in the top 30 meters of the site stratigraphy below the foundation level, as set out in Table 4.1.8.4A of the Ontario Building Code (2012). There are 6 site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable soils). The site class is then used to obtain peak ground acceleration (PGA), peak ground velocity (PGV) site coefficients Fa and Fv, respectively, used to modify the UHS to account for the effects of site-specific soil conditions.

Based on the above noted information, it is recommended that the site designation for seismic analysis be 'Site Class C', as per Table 4.1.8.4.A of the Ontario Building Code (2012). The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.B. to 4.1.8.4.I of the OBC 2012, as amended January 1, 2020, using linear interpolation for intermediate values of PGA.

7.3 Slab on Grade Design Parameters

The subgrade for floor slab on grade construction at the basement level will consist of undisturbed silty fine sand soils. The exposed subgrade should be inspected by the geotechnical engineer, to identify any loose or weak zones requiring remedial work (i.e. re-compaction of the existing subgrade prior to placing the underfloor fill materials and local sub excavation of weak soils). The sub-excavated areas may be restored using select excavated soil from the site or imported OPSS Type 1 Granular B. Final construction beneath slabs on grade should consist of 200 mm of Granular A uniformly compacted to 98 percent of standard Proctor maximum dry density (SPMDD).

If moisture sensitive floor finishes are proposed, a capillary moisture barrier and drainage layer will be required beneath the slab. This can be achieved by providing a minimum 200mm thick layer of clear crushed stone compacted to a dense state. Where slabs on grade are constructed on a sand or sandy subgrade, filter cloth should be used to separate the subgrade and clear stone to prevent in the ingress of fine particles into the drainage layer. General drainage recommendations for the below grade levels of the proposed development are discussed in the following Section 7.4.

All slabs on grade should be structurally separate from foundation walls and columns. Interior load bearing walls should not be founded on the slab but on spread footings as outlined above.

7.4 Basement Drainage

The foundation/basement walls must be provided with damp-proofing provisions in conformance to Section 9.13.2 of the Ontario Building Code (2012). Backfill along the foundation wall must consist of Granular 'B' Type 1 (OPSS 1010) for a minimum lateral distance of 600 mm out from the foundation wall. Alternatively, if a filtered cellular drainage media is provided adjacent to the foundation wall, the backfill may consist of common earth fill.

7.5 Earth Pressure Design Considerations

The following discussion pertains to the design of walls that will be subjected to unbalanced earth loading. The parameters used in the determination of earth pressures acting on walls retaining earth are defined below. The appropriate values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

Table 5: Appropriate Values for Parameters Used in Determining Earth Pressures

Stratum/Parameter	Φ (°)	γ (kN/m^3)	K_a	K_o	K_p
Granular Fill	32	20	0.31	0.47	3.25
Common Earth Fill	28	19	0.36	0.53	2.77

Walls subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$P = K [\gamma (h-h_w) + \gamma' h_w + q] + \gamma_w h_w$$

where,

P = the horizontal pressure at depth, **h** (m)
K = the earth pressure coefficient (depends on the rigidity of the wall)
$\mathbf{h_w}$ = the depth below the ground water level (m)
γ = the bulk unit weight of soil, (kN/m^3)
γ' = the submerged unit weight of the exterior soil, (γ - 9.8 kN/m^3)
q = the complete surcharge loading (including live loading, kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, acting in conjunction with the earth pressure, this equation can be simplified to:

$$P = K [\gamma h + q]$$

The factored geotechnical resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction (**R**) depends on the normal load on the soil contact (N) and the frictional resistance of the soil (**tan φ**) expressed as: **R = N tan φ**. This is an unfactored resistance. The factored resistance at ULS is **Rf = 0.8 N tan φ**. The K value to be used for the design will depend on the rigidity of the wall.

8 Design Considerations for Constructability

8.1 Excavations

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III – Excavations, Sections 222 through 242. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes at this site, the existing fill and native silty sand strata are considered Type 3 Soils. The clayey silt till is considered a Type 2 Soil.

Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates safe slopes of excavation by soil type as follows:

Table 6: Soil Classification for Excavations

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes.

Depending on the actual ground water conditions at the time of construction, seepage from surface drainage and seepage from any preferentially permeable features in the soil should be expected. For the range in excavation depths expected, the volume of water anticipated is such that temporary pumping from properly filtered sumps located as required in the excavations should suffice to control ground water.

It should be noted that surplus excavated soil resulting from the construction that is to be disposed of off-site, will require chemical analyses to assess the disposal site requirements. No soil quality analyses have been completed in conjunction with this investigation.

8.2 Site Servicing

The invert elevations for any service trenches are expected to be within the undisturbed sandy silt to sandy silt to silty sand, however based on the variable grades on the site it may be possible that some services may have invert elevations within the clayey silt till. It is also possible that the excavation for some services would terminate in loose surficial soil strata. In this event, it will be necessary to sub-excavate the loose soil and replace it with engineered fill to ensure the service is properly supported and to minimize the potential of settlement. Engineered fill should consist of OPSS 1010 Granular A or Granular B Type II material placed and uniformly compacted to 98 percent of standard Proctor maximum dry density. Consideration could also be given to the use of lean concrete to restore the grade to the proposed invert elevation.

8.2.1 Bedding

The bedding materials should be adequately compacted to provide support and protection to the service pipes. Provided the base area for the sewer pipes and watermain are free of all soft and deleterious materials, the pipe bedding should comply with a Class B bedding configuration as per the requirements of OPSD 802.030 (rigid pipe) and/or OPSD 802.010 (flexible pipe). Where disturbance of the trench base has occurred, due to the presence of soft fine-grained soils, ground water seepage and the like, the disturbed soils should be sub-excavated and replaced with suitably compacted granular fill.

8.2.2 Backfill

Based on the results of the boreholes, it is assumed that the majority of excavated soil at the site from the construction of service trenches will consist of silty sand.

Service trench backfill should consist of clean earth, free of excessively wet or frozen soil and should be placed in lifts of 300 mm thickness or less and uniformly compacted to at least 95 percent of standard Proctor maximum dry density at placement water contents within 2 percent of the corresponding laboratory optimum water content for compaction. The upper 1m of the backfill forming the pavement subgrade, should be uniformly compacted to 98 percent of standard Proctor maximum dry density.

8.3 Erosion Control Measures for Drainage Feature

As noted in Section 2.1.2, there is an existing gabion wall along the west bank of the unregulated drainage feature which has experienced some deformation. Consideration should be given to removing the gabion wall in its entirety as it has the potential to obstruct the natural flow of water through the drainage feature. It is expected that any embankments disturbed by the proposed works would be flattened to an overall inclination of about 3 horizontal to 1 vertical or flatter.

If erosion protection is to be considered, suitable rip-rap protection can be placed along the west bank of the drainage feature. The size and thickness of the rip-rap should be determined by a qualified specialist on the basis of the stream velocity and other factors. The reuse of existing gabion stone for this purpose could be considered but must be similarly evaluated by a qualified specialist. The rip-rap should be separated from the native soils or embankment material with a suitable geotextile filter fabric or a filter zone of granular material.

8.4 Site Work

The soil at this site is medium to fine grained and may become weakened or loosened when subjected to construction traffic. If site work is carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. The disturbance caused by the traffic can result in the removal of disturbed soil and use of fill material for site restoration or underfloor fills that is not intrinsic to project requirements.

The timing of the major grading works on the site is critical to the performance of the work. It may not be feasible to carry out fill operations during wet or freezing conditions. The schedule must provide adequate time to complete the work, allowing for delays due to adverse weather.

The subgrade at this site is considered to be frost susceptible. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the exposed soil will be required.

Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project development

8.5 Quality Control

All foundation installations must be reviewed in the field by Englobe, the geotechnical engineer, as they are constructed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical engineering design function and is required by Section 4.2.2.2 of the Ontario Building Code.

9 Statement of Limitations

The geotechnical recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known at the time of report preparation, we recommend that we be retained during the final design stage to verify that the geotechnical recommendations have been correctly interpreted in the design. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of the project, Englobe should be contacted. We recommend that we be retained during construction to confirm that the subsurface conditions do not deviate materially from those encountered in the test holes and to ensure that our recommendations are properly understood. Quality assurance testing and inspection services during construction are a necessary part of the evaluation of the subsurface conditions.

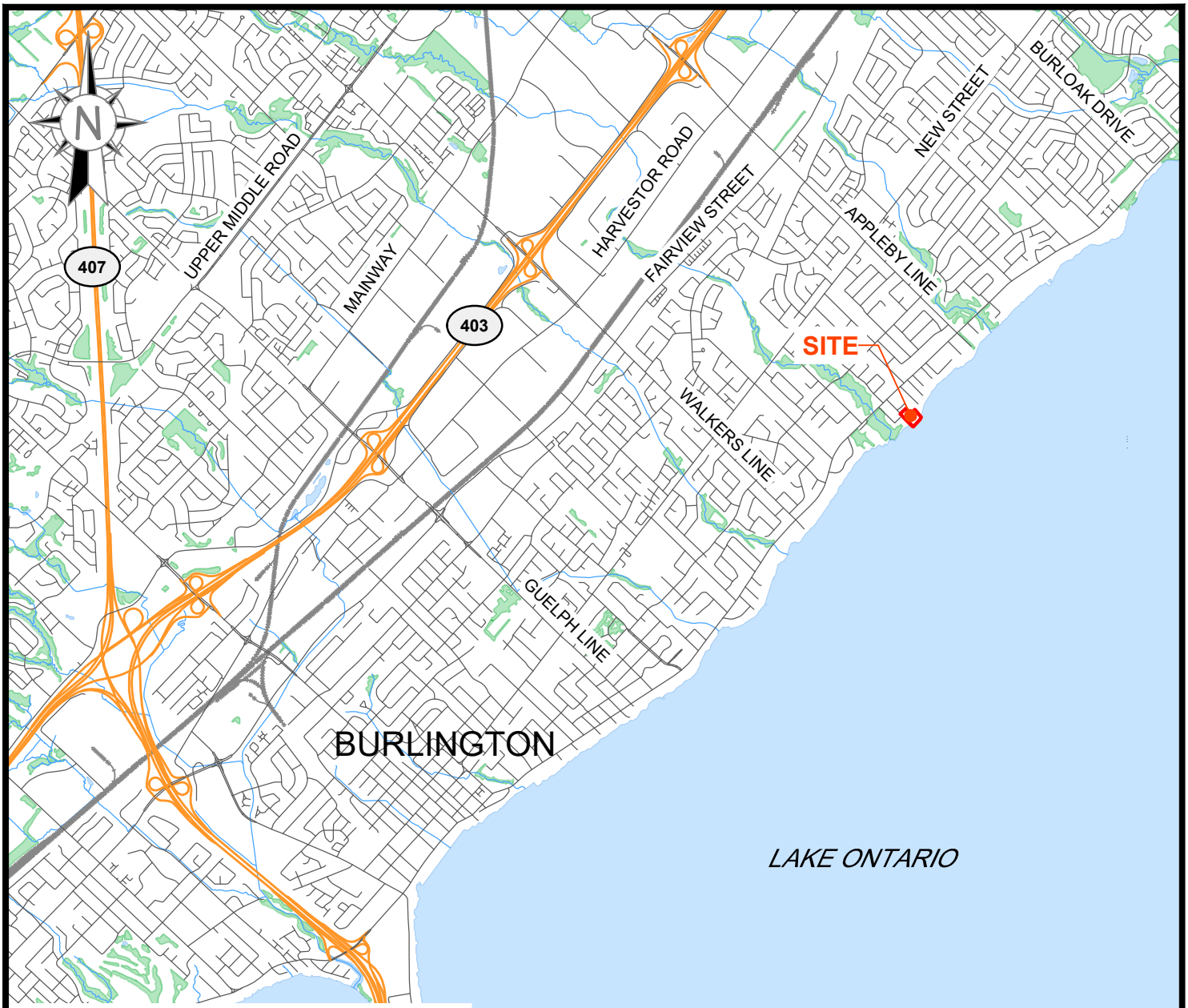
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It should be noted that the soil boundaries indicated on the borehole logs are inferred from noncontinuous sampling and observations during drilling and should not be interpreted as exact planes of geological change. These boundaries are intended to reflect approximate transition zones for the purpose of geotechnical design. Also, the subsoil and groundwater conditions have been determined at the borehole locations only.

Appendix A
Drawings



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NOTES:

1. **REFERENCES: ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY; LAND INFORMATION ONTARIO.**
2. **Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.**

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Client

Aventus Development Corp

Project

105 Avondale Court

Burlington, Ontario

Title

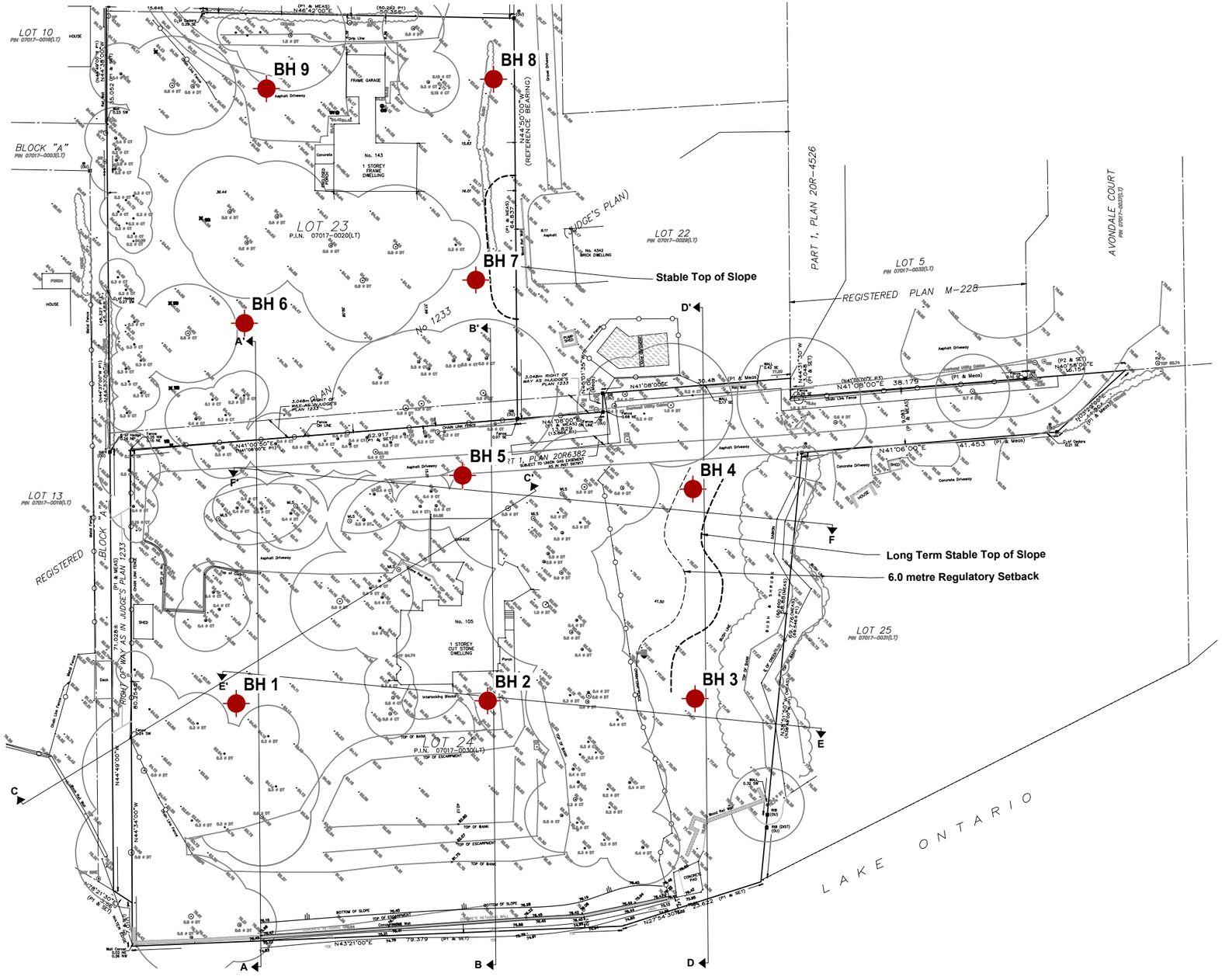
Site Location Plan

Englobe Corp.
903 Barton Street, Unit 21, 22 & 23
Stoney Creek, ON L8E 5H5
T 905 643-7560

Discipline: Geosciences		Prepared by: LK	Checked by: PC
Scale: 1:50 000		Drawn by: LK	Approved by: PC
Date: 24/10/2024		Figure N°: 01 of 05	
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Scale

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1:750

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Project

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Title

Site Plan

LEGEND:

BH-NN — **BOREHOLE-NUMBER**

Long Term Stable Top of Slope - Valley Land

7.5 metre Regulatory Setback

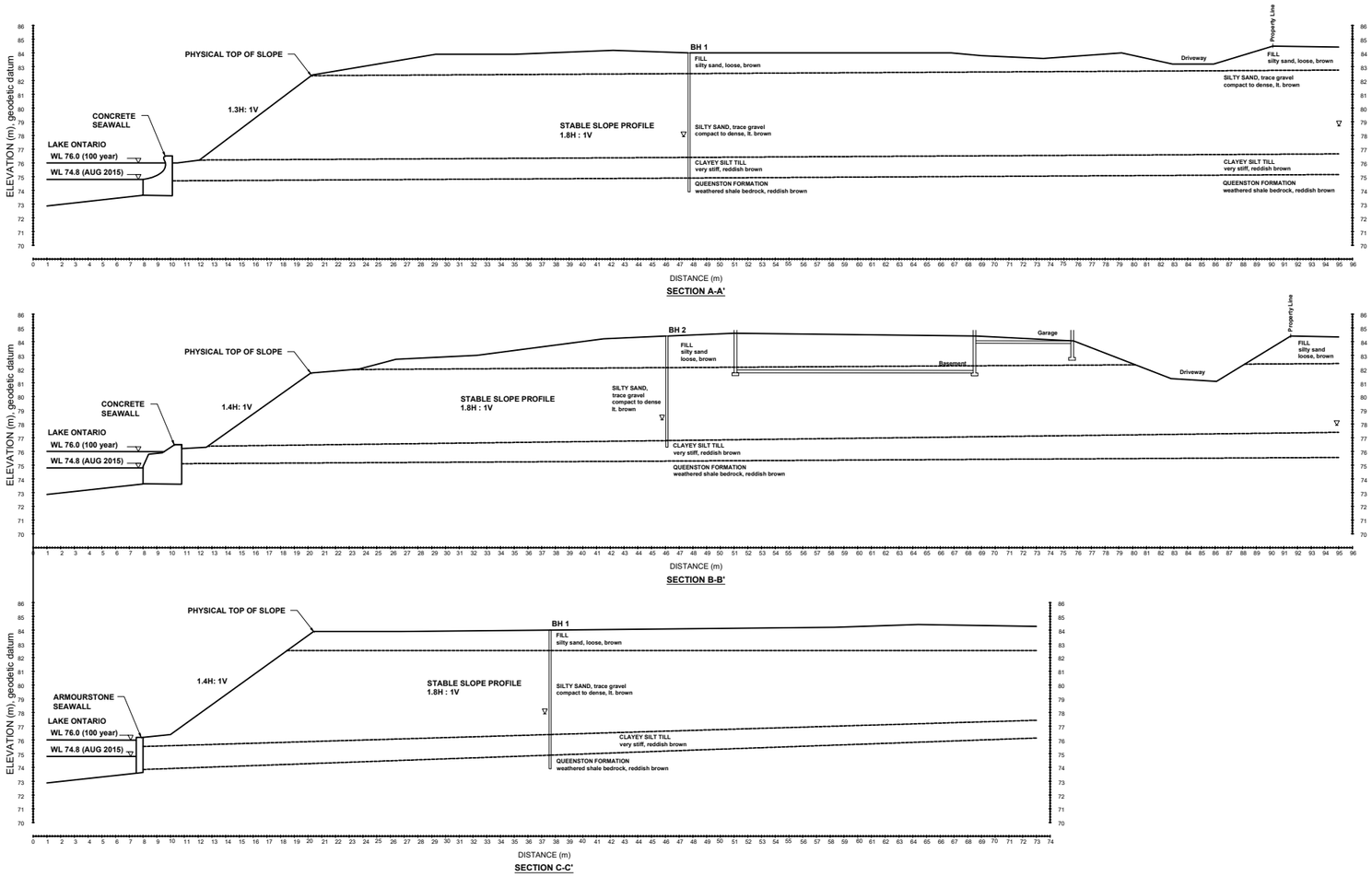
NOTES:

1. **REFERENCES: SURVEYOR'S REAL PROPERTY REPORT - PART 1, LOTS 23, 24 AND BLOCK "B", JUDGE'S PLAN 1233, IN THE CITY OF BURLINGTON BY GUIDO V. CONSOLI, ONTARIO LAND SURVEYOR.**
2. **Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.**

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SECTION A-A'

SECTION B-B'

SECTION C-C'

NOTES:

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Seal

Scale

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1:400

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Project

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Burlington, Ontario

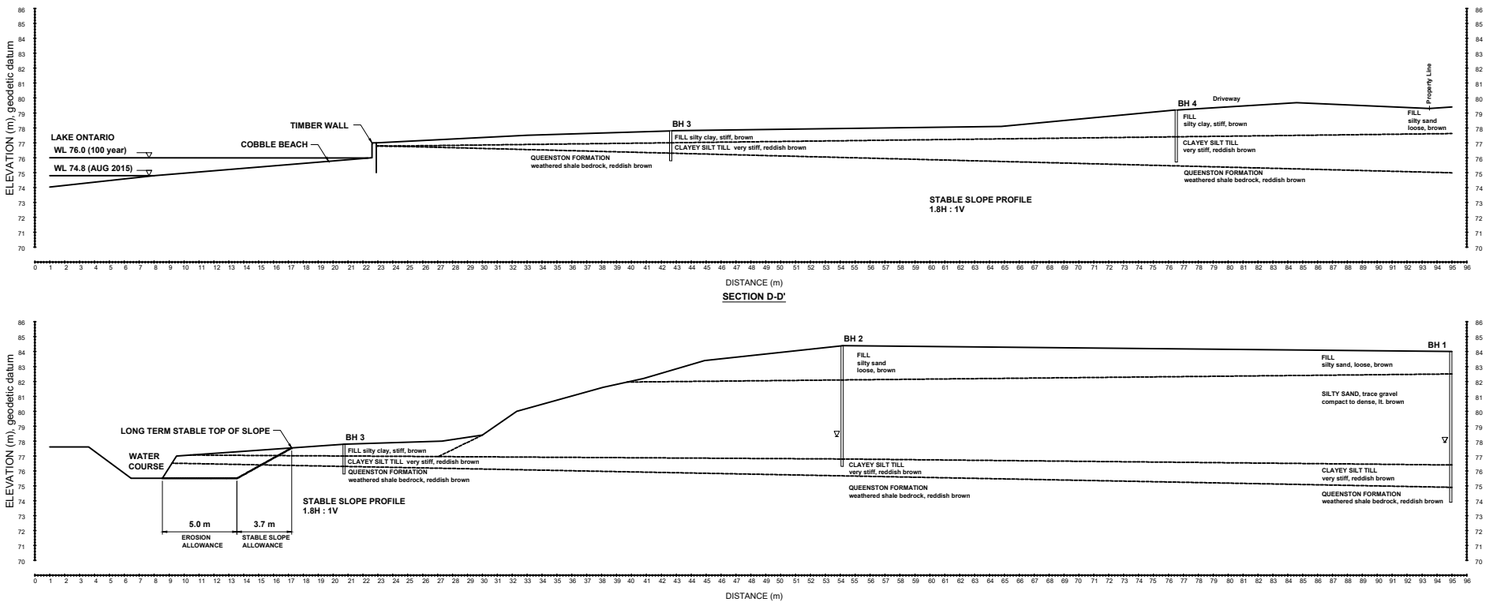
Title

Sections A-A', B-B', C-C'

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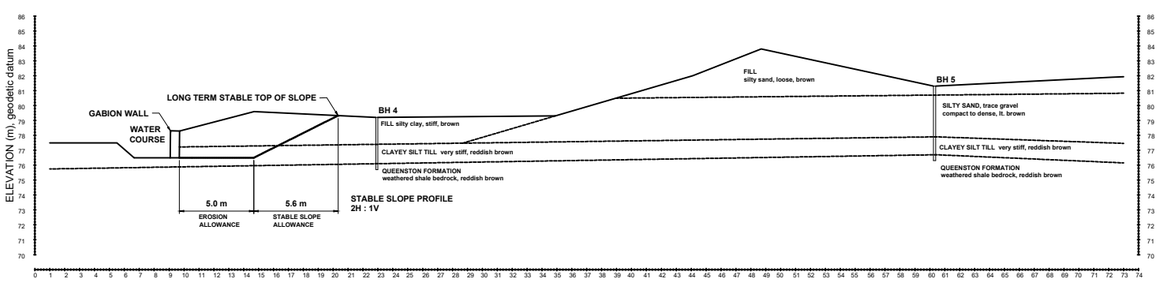
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SECTION D-D'

SECTION E-E'



SECTION F-F'

NOTES:

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Scale

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Sections D-D', E-E', F-F'

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LEGEND:

BH-NN — **BOREHOLE-NUMBER**

Long Term Stable Top of Slope - Valley Land

7.5 metre Regulatory Setback

NOTES:

1. **REFERENCES: Figure 1, 105 Avondale Crt. Burlington, Project #22-3717 by SHOREPLAN.**
2. **Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.**

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Seal

Scale

0 5 10 15 20 30 37.5 m

1:750

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Project

105 Avondale Court

Burlington, Ontario

Title

Proposed Development Plan

Discipline: Geosciences		Prepared by: LK	Checked by: PC
Scale: 1:750		Drawn by: LK	Approved by: PC
Date: 24/10/2024		Figure N°:	05 of 05
Page setup: 0005	Paper format: ANSI full bleed B (17,00 x 11,00 Inches)	Register N°:	

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Appendix B
Photographs



ENGLOBE



Photograph 1



Photograph 2



Photograph 3



Photograph 4



Photograph 5



Photograph 6



Photograph 7



Photograph 8



Photograph 9



Photograph 10



Photograph 11



Photograph 12



Photograph 13



Photograph 14



Photograph 15



Photograph 16



Photograph 17



Photograph 18



Photograph 19



Photograph 20



Photograph 21



Photograph 22



Photograph 23



Photograph 24

Appendix C
Borehole Logs



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List of Abbreviations

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

Sample Types		Soil Test and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic Limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid Limit
WC	Water Content Sample	I_L	Liquidity Index
TP	Thinwall, Piston	I_p	Plastic Index
		PP	Pocket Penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60˚ cone a distance 300 mm (12 in.) The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	Sampler advanced by weight of hammer
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure

Soil Description		
Cohesionless Soils Compactness Condition	**SPT N-Value** (blows per 0.3 m)	**Relative Density (D_r** (%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	Over 50	80 to 100
Cohesive Soils Consistency	**Undrained Shear Strength (C_u kPa**	**psf**
Very Soft	Less than 12	Less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L<30
APL	About plastic limit	Medium Plasticity, 30< W_L<50
WTPL	Wetter than plastic limit	High Plasticity, W_L>50

LOG OF BOREHOLE 1

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

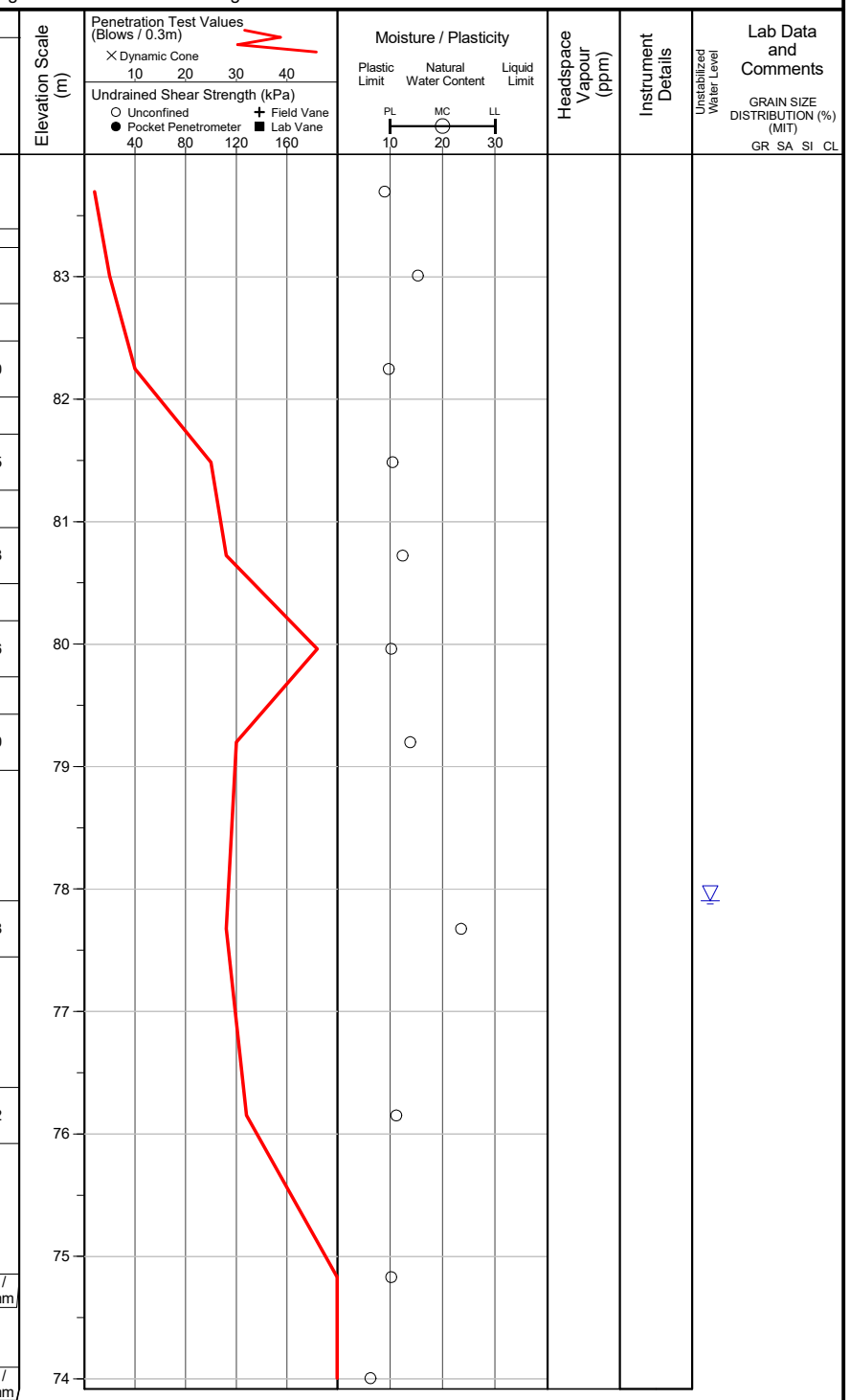
Position : E: 601366, N: 4800873 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	84.0	**GROUND SURFACE**				
	83.8	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, loose, brown		1	SS	2
1				2	SS	5
	82.5					
	1.5	**SILTY SAND**, trace gravel, compact to dense, light brown		3	SS	10
2				4	SS	25
3				5	SS	28
4				6	SS	46
				7	SS	30
5						
6		...becoming wet at 6.1m depth		8	SS	28
7						
	76.4					
	7.6	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff, reddish brown (GLACIAL TILL)		9	SS	32
8						
9	74.9					
	9.1	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		10	SS	50 / 50mm
10	73.9			11	SS	50 / 25mm
	10.1					

END OF BOREHOLE

Unstabilized water level measured at 6.1 m below ground surface; borehole was open upon completion of drilling.



file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 2

Terraprobe

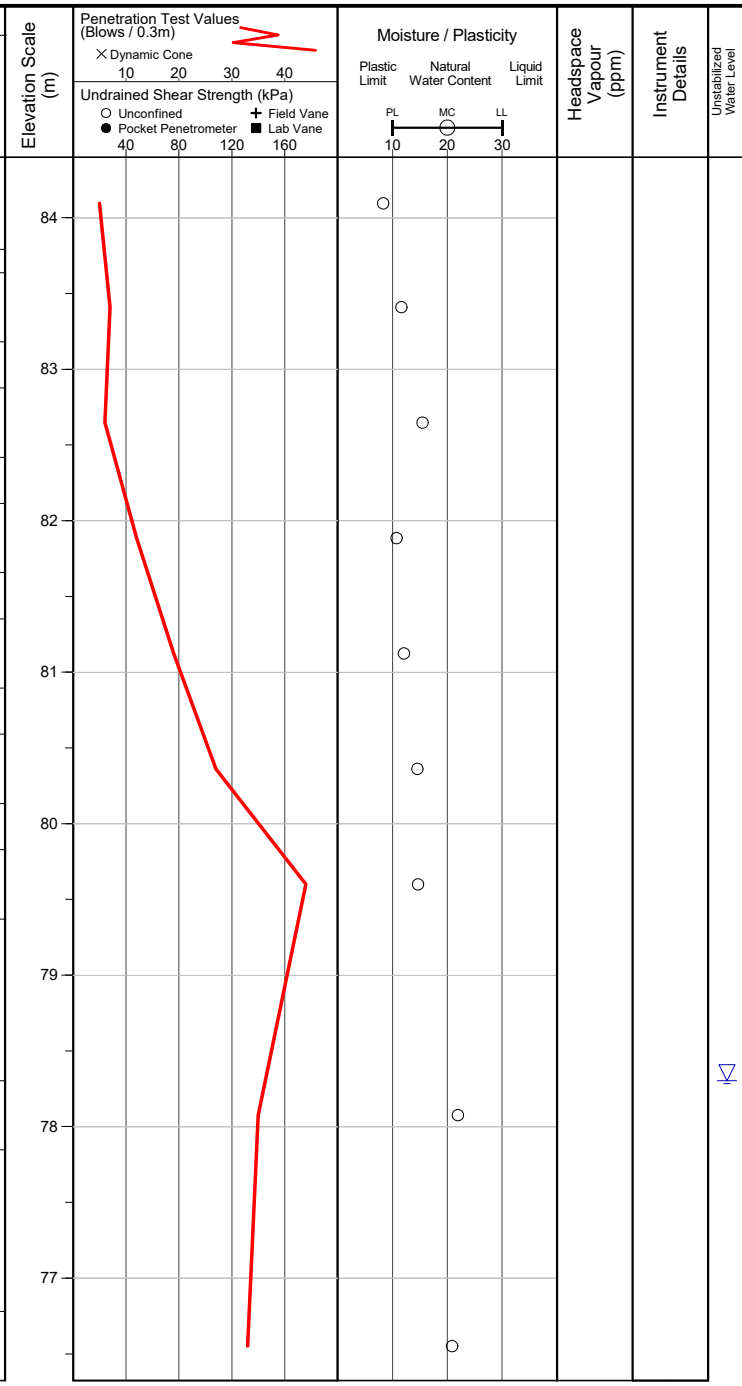
Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601385, N: 4800891 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	84.4	**GROUND SURFACE**				
	84.2	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, loose, brown		1	SS	5
1				2	SS	7
2				3	SS	6
	82.1					
	2.3	**SILTY SAND**, trace gravel, compact to dense, light brown		4	SS	12
3				5	SS	19
4				6	SS	27
				7	SS	44
5						
6				8	SS	35
7						
	76.8					
	7.6	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff, reddish brown (GLACIAL TILL)		9	SS	33
8	76.3					
	8.1	**END OF BOREHOLE**				

Unstabilized water level measured at 6.1 m below ground surface; borehole was open upon completion of drilling.



file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 3

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601410, N: 4800926 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	77.8	**GROUND SURFACE**				
0	77.0 0.8	**FILL**, silty clay, trace wood fragments, stiff, brown		1	SS	8
1	76.3 1.5	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff, reddish brown (GLACIAL TILL)		2	SS	15
	75.8 2.0	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		3	SS	72 / 275mm

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 77, 76

Penetration Test Values (Blows / 0.3m): Dynamic Cone 10 20 30 40

Undrained Shear Strength (kPa): Unconfined, Pocket Penetrometer, Field Vane, Lab Vane 40 80 120 160

Moisture / Plasticity: Plastic Limit, Natural Water Content, Liquid Limit — PL, MC, LL 10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 4

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601387, N: 4800936 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	79.2	**GROUND SURFACE**				
0		**FILL**, silty clay, trace wood fragments, stiff, brown		1	SS	16
				2	SS	16
1						
				3	SS	9
	77.4					
	1.8	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff to hard, reddish brown (GLACIAL TILL)				
2				4	SS	47
	76.2					
3	3.0	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		5	SS	64
	75.7					
	3.5	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.

Elevation Scale (m): 79, 78, 77, 76

Penetration Test Values (Blows / 0.3m) — Dynamic Cone: 10, 20, 30, 40

Undrained Shear Strength (kPa) — Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40, 80, 120, 160

Moisture / Plasticity — Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL): 10, 20, 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) — GR SA SI CL

file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 5

Terraprobe

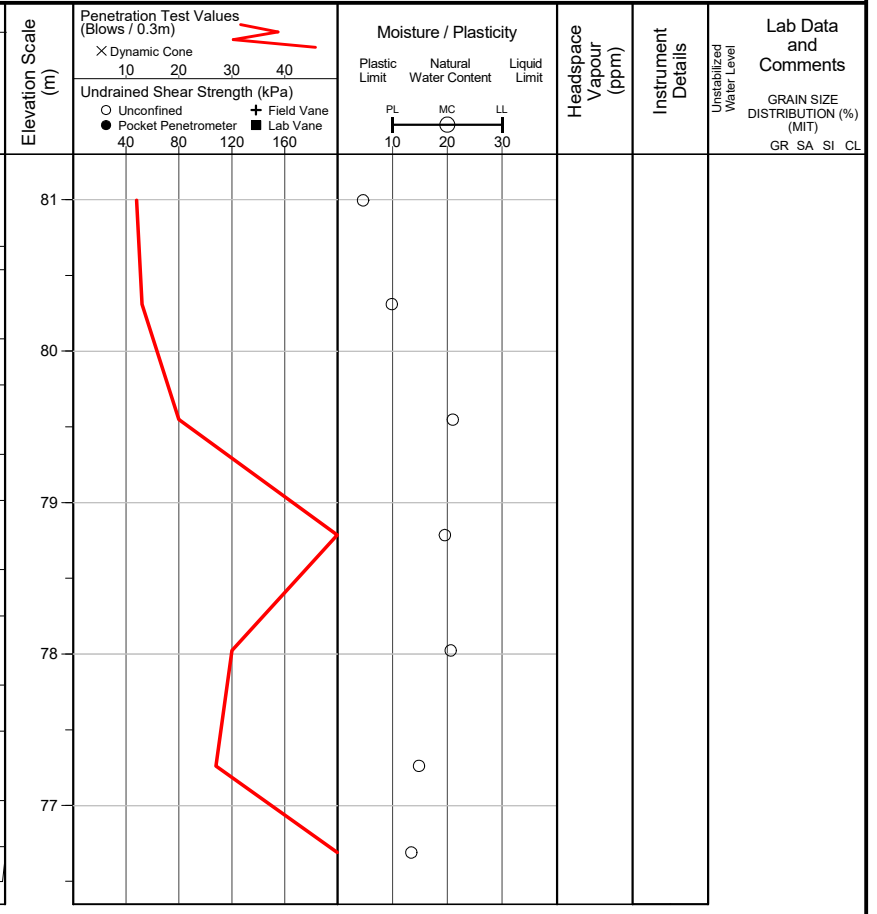
Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601354, N: 4800891 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	81.3	**GROUND SURFACE**				
		50mm **TOPSOIL**				
		FILL, silty sand, compact, brown		1	SS	12
	80.7					
	0.6	**SILTY SAND**, trace gravel, compact to dense, brown		2	SS	13
1						
				3	SS	20
2						
				4	SS	57
3						
				5	SS	30
	77.9					
	3.4	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff to hard, reddish brown (GLACIAL TILL)				
4				6	SS	27
	76.7					
	4.6	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		7	SS	50 / 75mm
	76.3					
	5.0	**END OF BOREHOLE**				

Borehole was dry and open upon completion of drilling.



LOG OF BOREHOLE 6

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

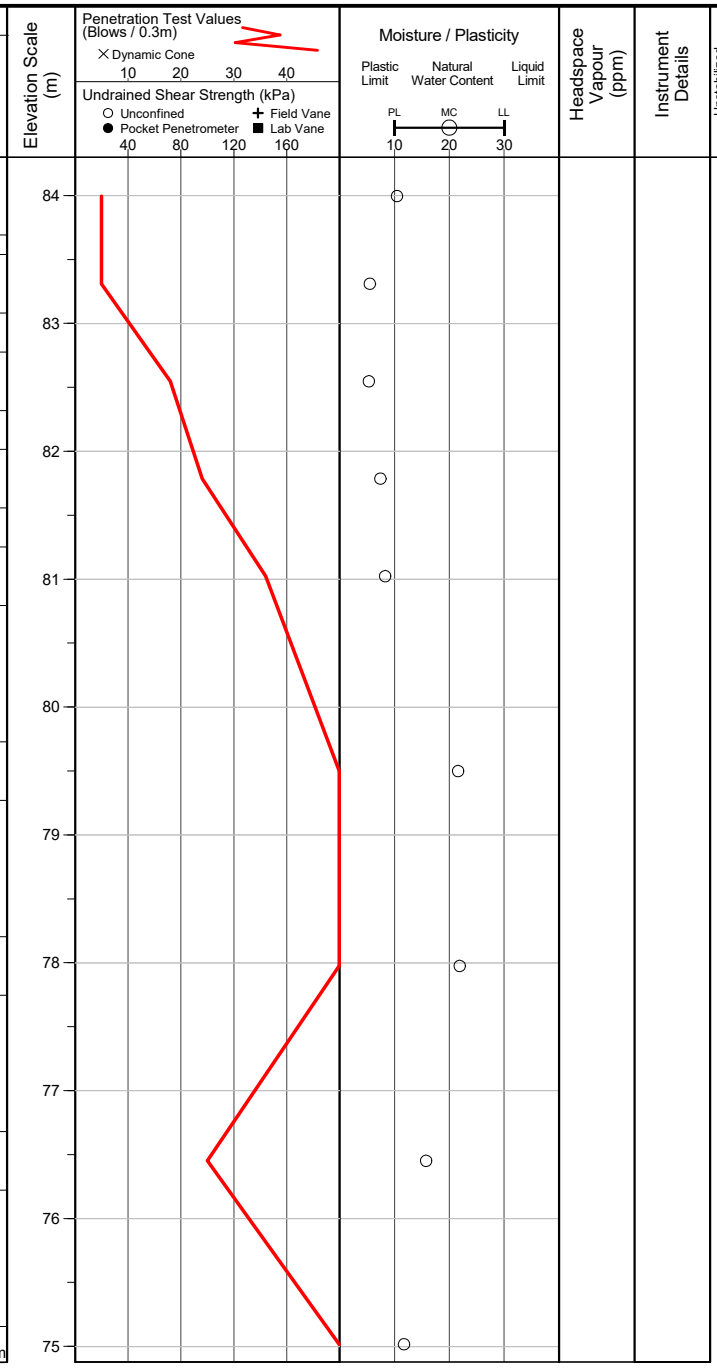
Position : E: 601330, N: 4800893 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	84.3	**GROUND SURFACE**				
0	84.1	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, loose, brown		1	SS	5
1				2	SS	5
	82.8					
	1.5	**SILTY SAND**, trace gravel, compact to dense, brown		3	SS	18
2				4	SS	24
3				5	SS	36
4						
				6	SS	62
5						
6				7	SS	70
	76.7					
	7.6	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff to hard, reddish brown (GLACIAL TILL)		8	SS	25
7						
8						
	75.2					
9	9.1	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		9	SS	50 / 125mm
	74.9					
	9.4					

END OF BOREHOLE

Unstabilized water level measured at 6.1 m below ground surface; borehole was open upon completion of drilling.



file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 7

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601321, N: 4800933 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
	84.0	**GROUND SURFACE**				
0	83.8	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, loose, brown		1	SS	6
1				2	SS	5
	82.5					
	1.5	**SILTY SAND**, trace gravel, compact to dense, brown		3	SS	17
2				4	SS	42
3				5	SS	48
4						
				6	SS	51
5						
6						
	77.6			7	SS	12
	6.4	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff to hard, reddish brown (GLACIAL TILL)				
7						
	76.2			8	SS	50 / 75mm
	7.8	**END OF BOREHOLE**				

Elevation Scale (m): 83, 82, 81, 80, 79, 78, 77

Penetration Test Values (Blows / 0.3m) — Dynamic Cone: 10 20 30 40

Undrained Shear Strength (kPa) — Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40 80 120 160

Moisture / Plasticity — Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL): 10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Unstabilized water level measured at 6.1 m below ground surface; borehole was open upon completion of drilling.

file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 8

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601316, N: 4800960 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
0	83.6	**GROUND SURFACE**				
	83.4	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, trace brick fragments, loose, brown		1	SS	3
1				2	SS	4
	82.1					
	1.5	**SILTY SAND**, trace gravel, compact to very dense, brown		3	SS	27
2				4	SS	20
3		...becoming wet at 3.0m depth		5	SS	24
4						
5				6	SS	57
6						
	77.2			7	SS	10
	6.4	**CLAYEY SILT**, embedded sand, gravel and shale, very stiff to hard, reddish brown (GLACIAL TILL)				
7	76.0					
	7.6	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)		8	SS	50 / 75mm
8						
9	74.3			9	SS	50 / 125mm
	9.3	**END OF BOREHOLE**				

Elevation Scale (m): 83, 82, 81, 80, 79, 78, 77, 76, 75

Penetration Test Values (Blows / 0.3m)
Dynamic Cone: 10 20 30 40
Undrained Shear Strength (kPa)
Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40 80 120 160

Moisture / Plasticity
Plastic Limit, Natural Water Content, Liquid Limit
PL MC LL
10 20 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Unstabilized water level measured at 3.0 m below ground surface; borehole caved to 7.6 m below ground surface upon completion of drilling.

file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

LOG OF BOREHOLE 9

Terraprobe

Project No. : 71-15-5064	Client : Bluewater Place Development	Originated by : AF
Date started : August 25, 2015	Project : Bloomfield Developments Inc.	Compiled by : AC
Sheet No. : 1 of 1	Location : Burlington, Ontario	Checked by :

Position : E: 601315, N: 4800914 (UTM 17T) Elevation Datum : "Geodetic"

Rig type : Marl-M2, track-mounted Drilling Method :

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Sample Number	Sample Type	SPT 'N' Value
	84.2	**GROUND SURFACE**				
0	84.0	150mm **TOPSOIL**				
	0.2	**FILL**, silty sand, trace topsoil, trace brick fragments, loose, brown		1	SS	3
1				2	SS	6
				3	SS	9
2	81.9					
	2.3	**SILTY SAND**, trace gravel, loose, brown		4	SS	4
3	81.2					
	3.0	**SILTY SAND**, trace gravel, compact to very dense, brown		5	SS	11
4						
				6	SS	67
5						
6				7	SS	66
7						
				8	SS	30
8	75.7					
	8.5	**WEATHERED SHALE**, reddish brown (QUEENSTON FORMATION)				
9	75.0			9	SS	50 / 50mm
	9.2	**END OF BOREHOLE**				

Elevation Scale (m): 84, 83, 82, 81, 80, 79, 78, 77, 76

Penetration Test Values (Blows / 0.3m) — Dynamic Cone: 10, 20, 30, 40

Undrained Shear Strength (kPa) — Unconfined, Pocket Penetrometer, Field Vane, Lab Vane: 40, 80, 120, 160

Moisture / Plasticity — Plastic Limit (PL), Natural Water Content (MC), Liquid Limit (LL): 10, 20, 30

Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT) — GR SA SI CL

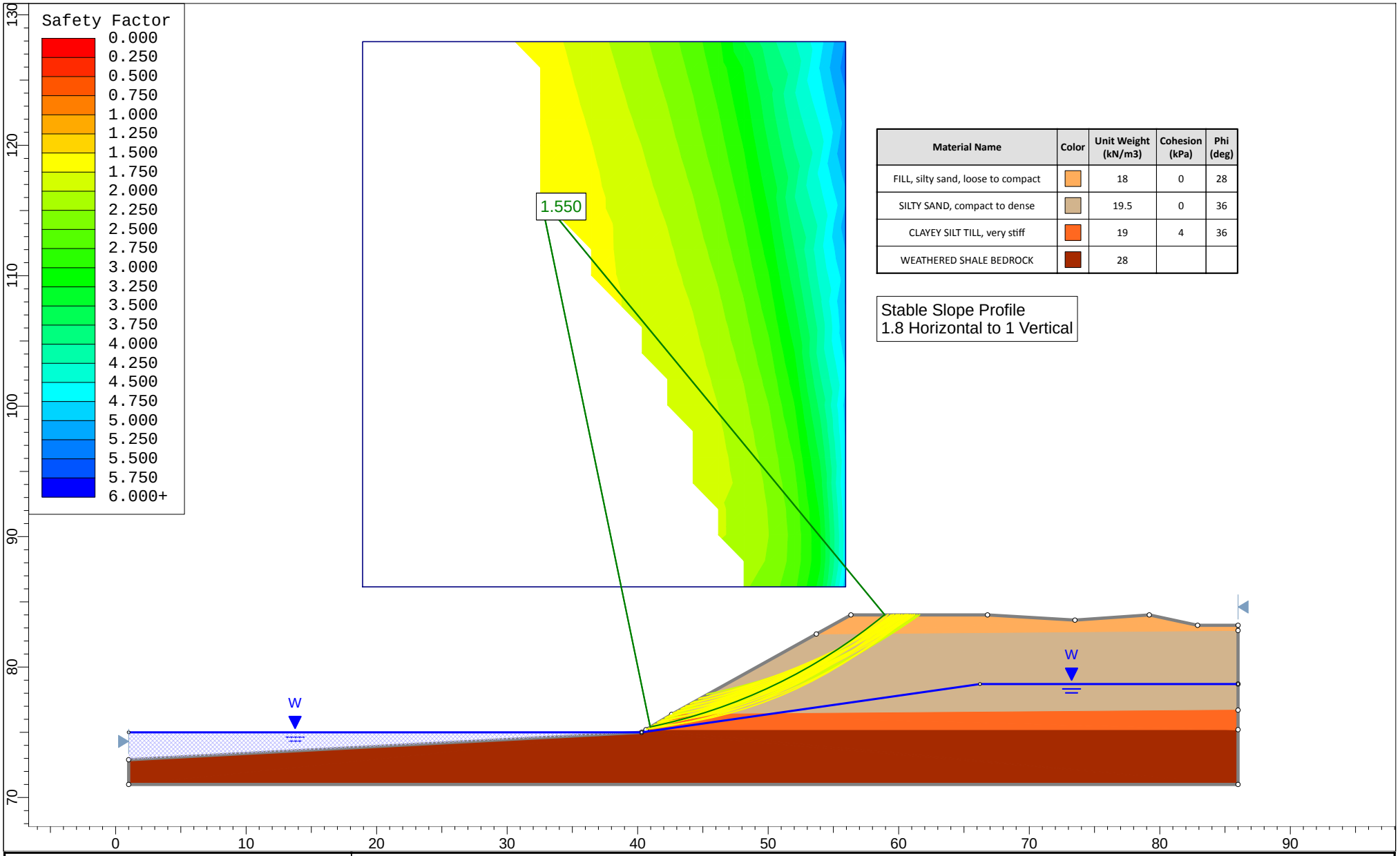
Unstabilized water level measured at 6.1 m below ground surface; borehole was open upon completion of drilling.

file: 71-15-5064-105 avondale court - 143 bluewater place.gpj

Appendix D
Slope Stability Analyses Results



ENGLOBE



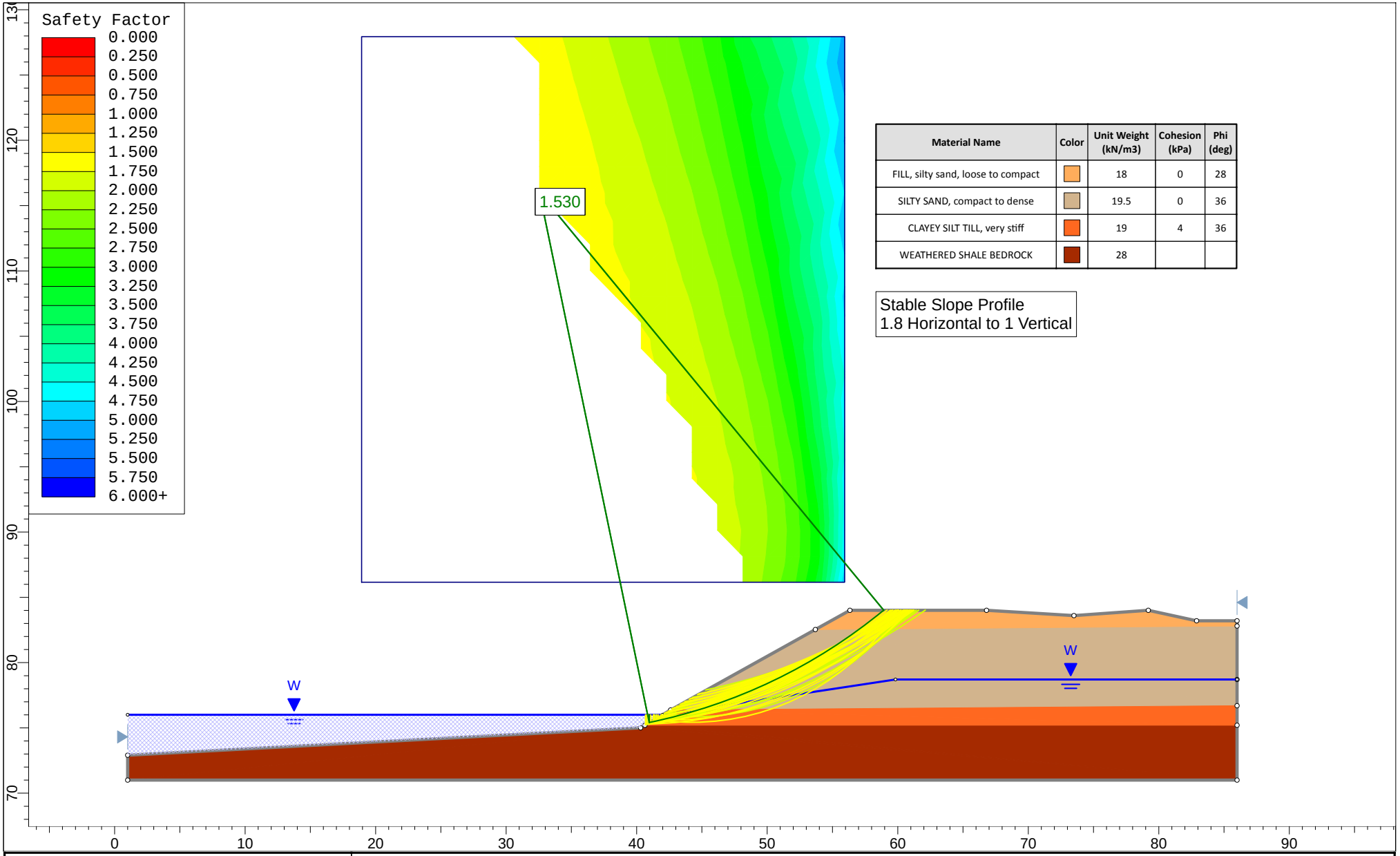
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
FILL, silty sand, loose to compact		18	0	28
SILTY SAND, compact to dense		19.5	0	36
CLAYEY SILT TILL, very stiff		19	4	36
WEATHERED SHALE BEDROCK		28		

Stable Slope Profile
1.8 Horizontal to 1 Vertical

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 6.029

Project	**Bluewater Place, Burlington**		
Analysis Description	Stable Slope Analyses - Section A-A' (WL 75.0m)		
DB: P.Cannon	Scale: 1:400	Reference	
Date: 11/4/2015		File Name	71-15-5064 Stable Slope Analyses Section A-A.slim



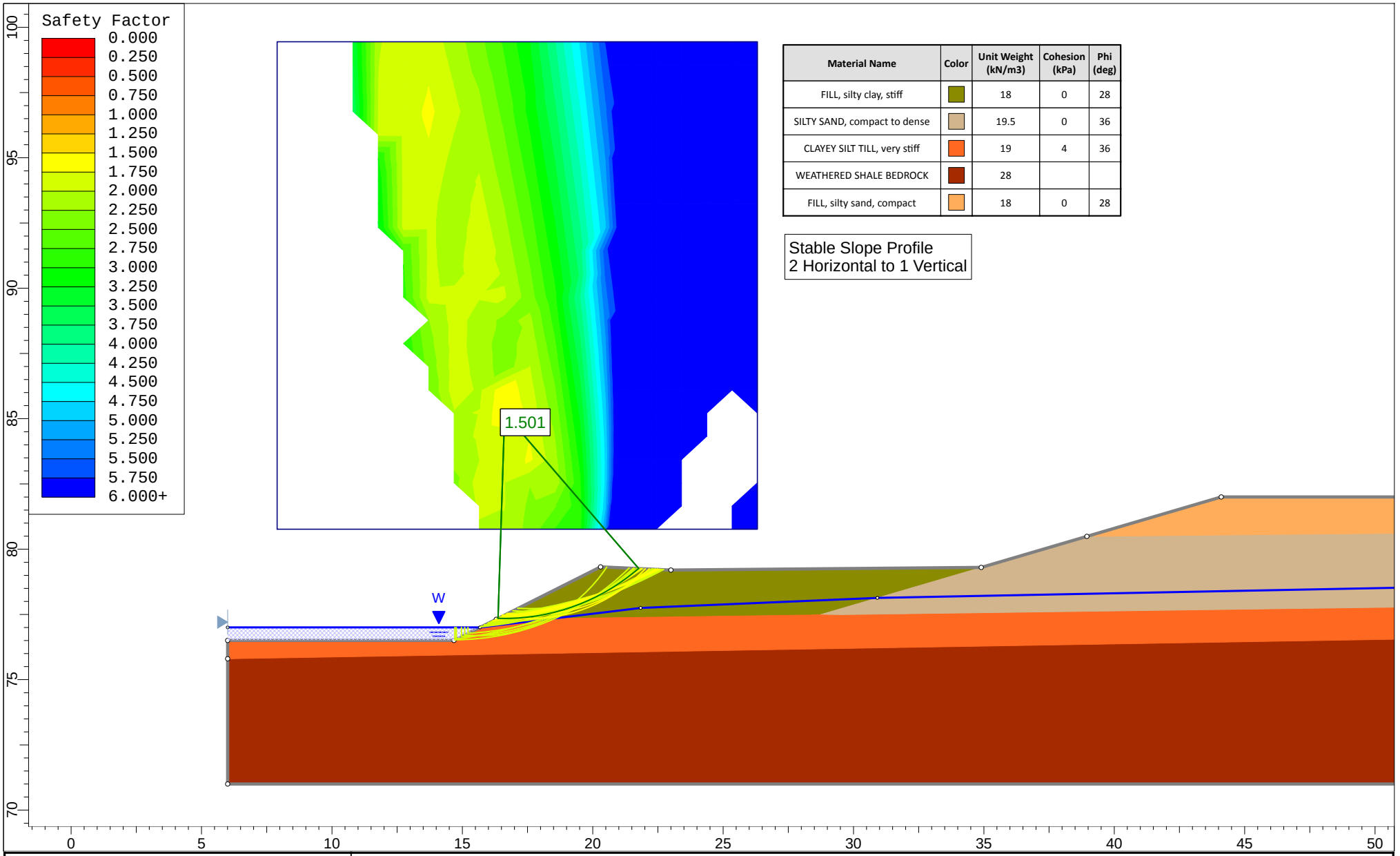
Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
FILL, silty sand, loose to compact		18	0	28
SILTY SAND, compact to dense		19.5	0	36
CLAYEY SILT TILL, very stiff		19	4	36
WEATHERED SHALE BEDROCK		28		

Stable Slope Profile
1.8 Horizontal to 1 Vertical

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 6.029

Project	**Bluewater Place, Burlington**		
Analysis Description	Stable Slope Analyses - Section A-A' (WL 76.0m)		
DB: P.Cannon	Scale: 1:400	Reference	
Date: 11/4/2015		File Name: 71-15-5064 Stable Slope Analyses Section A-A.slim	



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
FILL, silty clay, stiff		18	0	28
SILTY SAND, compact to dense		19.5	0	36
CLAYEY SILT TILL, very stiff		19	4	36
WEATHERED SHALE BEDROCK		28		
FILL, silty sand, compact		18	0	28

Stable Slope Profile
2 Horizontal to 1 Vertical

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

SLIDEINTERPRET 6.029

Project	**Bluewater Place, Burlington**		
Analysis Description	Stable Slope Analyses - Section F-F'		
DB: P.Cannon	Scale: 1:200	Reference	
Date: 11/4/2015		File Name	71-15-5064 Stable Slope Analyses Section F-F.slim