PROJECT NO: SM 156011-G

MAY 15, 2015

GEOTECHNICAL INVESTIGATION
PROPOSED HOTEL AND COMMERCIAL DEVELOPMENT
525 YORK ROAD
NIAGARA-ON-THE-LAKE, ONTARIO

PREPARED FOR:

VRANCOR DEVELOPMENTS

Soil-Mat

BY

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 LANCING DRIVE
HAMILTON, ONTARIO
L8W 3A1

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PROJECT NO.: SM 156011-G May 15, 2015

Vrancor Developments
368 King Street West
Hamilton, Ontario
L8P 1B3

Attention: Mr. Darko Vranich

GEOTECHNICAL INVESTIGATION
PROPOSED HOTEL AND COMMERCIAL DEVELOPMENT
525 YORK ROAD
NIAGARA-ON-THE-LAKE, ONTARIO

Dear Mr. Vranich,

We have completed the fieldwork, laboratory testing and slope assessment of the above noted property. This work was completed in general accordance with our proposal P5660, dated February 9, 2015. Our comments and recommendations, based on our field observations and stability analysis are presented in the following paragraphs.

1. INTRODUCTION

We understand that it is proposed to construct two six storey hotel buildings with no basement levels, as well as five single story restaurant buildings with no basements. The project will also include associated asphalt paved roadways and parking areas, as well as underground municipal services. The purpose of this geotechnical investigation work was to determine the subsurface soil conditions at twelve borehole locations, and to interpret the results with respect to the design and construction of the foundations and related earthworks for the project, from a geotechnical point of view.

As the property slopes down to the west to an existing drainage course, a slope stability assessment was also conducted The purpose of this slope assessment was to determine the stability of the existing slope and location of the long-term top of stable slope, from a geotechnical point of view. The slope assessment work has been conducted in general accordance with the guideline policies of the Niagara Peninsula Conservation Authority [NPCA], including the "Natural Hazards Technical Guide" by the Ministry of Natural Resources and the supporting document "Geotechnical Principles for Stable Slopes".

This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, this office must be consulted to review the new design with respect to the results of this investigation. The information contained in this report does not reflect upon the environmental aspects of the site, which therefore have not been addressed in this document.

2. PROCEDURE

The fieldwork was completed on March 2 and 3, 2015 under the direction and supervision of a representative of SOIL-MAT ENGINEERS & CONSULTANTS LTD. The boreholes were advanced using a track-mounted drill rig with continuous flight power auger equipment to depths of approximately 3.5 to 9.6 metres below the existing ground surface at the locations illustrated in the attached Drawing No. 1, Borehole and Slope Profile Location Plan. Upon completion of drilling, the boreholes were backfilled in general accordance with Ontario Regulation 903 and the ground surface was reinstated even with the surrounding grade.

Representative samples of the subsoils were recovered from the boring at selected depth intervals using split barrel sampling equipment driven in accordance with the requirements of the ASTM test specification D1586, Standard Penetration Resistance Testing. After undergoing a general field examination, the soil samples were preserved and transported to the SOIL-MAT laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests, were performed on all soil samples recovered from the borings.

As well the slope along the west of the property was visually evaluated, and two representative slope profiles were measured at the locations illustrated in the attached Drawing No. 1, Borehole and Slope Profile Location Plan. The corresponding slope profiles are illustrated in the attached Drawing Nos. 2 and 3, Slope Profiles A-A and B-B, respectively.

The boreholes and slope profile locations were located in the field by a representative of SOIL-MAT ENGINEERS. The ground surface elevation at the boreholes and at the slope profiles was surveyed to a site specific benchmark described as the finished floor slab of the Purolator building. This benchmark was noted to have an elevation of 118.12 metres from the drawing entitled "Master Site Plan MSP-100" dated October 21, 2014 provided to our office by our client.

3. Site Description and Subsurface Conditions

The subject site is located at 525 York Road in Niagara-on-the-Lake, Ontario. The property is predominantly surfaced with maintained grasses and is bounded to the north by vacant lands with private residences beyond fronting onto Queenston Road, to the east by Counsell Street, to the south by York Road, and to the west by Glendale Avenue.

The western edge of the site is defined by a wooded slope decreasing in grade from east to west and terminating at a small north-south flowing drainage feature. The well-vegetated slope is approximately 4 metres in height and exhibits little sign of erosion or previous slope failures

The subject property with the exception of the drainage feature demonstrates a generally undulating topography with an overall topographic relief across the study area of approximately 3.3 metres.

The subsurface conditions encountered at the borehole locations are summarised as follows:

Topsoil

A surficial veneer of topsoil approximately 150 to 250 millimetres in thickness was encountered at the borehole locations. It is noted that the depth of topsoil may vary across the site and from the depths measured at the borehole locations. It is also noted that the term 'topsoil' has been used from a geotechnical point of view, and does not necessary reflect the materials nutrient content or ability to support plant life.

Silty Clay

Native silty clay was encountered beneath the topsoil at all borehole locations. The native cohesive soil was weathered and had a 'reworked' appearance in the upper level, with traces of fine gravel. The silty clay was noted to be generally stiff to very stiff in consistency, and was proven to termination at depths of approximately 3.5 to 9.6 metres below the existing ground surface.

Groundwater Observations

All boreholes were recorded as 'dry' upon completion of drilling. It is noted that the groundwater level would not have had time to stabilize in the open boreholes during drilling. Based on our site observations and findings at the borehole locations, the static groundwater level is estimated to be at a depth of perhaps 4 to 6 metres below the existing grade.

4. FOUNDATION CONSIDERATIONS

The subsurface soil conditions encountered in the boreholes are considered suitable to support the proposed structures on conventional spread footings founded on the undisturbed native silty clay, below any weathered or otherwise disturbed material. Spread footings founded in the native silty clay can be designed using a factored Ultimate Limit State [ULS] bearing capacity of 400 kPa [~8,000 psf]. The allowable bearing stress at Serviceability Limit State [SLS] should be limited to 250 kPa [~5,000 psf], based on the total and differential settlements not exceeding 25 and 20 millimetres, respectively.

It is noted that the SLS value represents the Serviceability Limit State, which is governed by the tolerable deflection [settlement] based on the proposed building type, using unfactored load combinations. The ULS value represents the Ultimate Limit State and is intended to reflect an upper limit of the available bearing capacity of the founding soils in terms of geotechnical design, using factored load combinations. There is no direct relationship between ULS and SLS, rather they are a function of the soil type and the tolerable deflections for serviceability, respectively. The above dissertation assumes a typical building. Evidently, the bearing capacity values would be lower for very settlement sensitive structures and larger for more flexible buildings.

The native cohesive soils are sensitive to moisture and disturbance, such as from construction traffic. It would be advisable to protect the base of excavations with the placement of a thin, lean-mix concrete product 'mud slab'. This will serve to protect the founding soils from disturbance and provide a clean working surface for the placement of reinforcing steel, formwork, etc. In any event, the 'mud slab' or foundation concrete should be placed over the prepared founding surface as soon as possible, ideally within the same day it is excavated. All loose and disturbed material, along with any ponded water, must be removed from the founding surface prior to placement of concrete.

The support conditions afforded by the founding soils are generally not uniform across the site, neither are the loads on the various foundation elements. It is therefore recommended that the footings and foundation walls be reinforced to account for potential variable support and loading conditions.

In areas where it will be necessary to provide adjacent footings at different founding elevations, the lower footing should be constructed before the higher footing is constructed, if possible, and the higher footing should be set below an imaginary line drawn up from the edge of the lower footing at 10 horizontal to 7 vertical. This practice will limit stress transfer from the higher footings to lower footings.

All footings exposed to the environment must be provided with a minimum of 1.2 metres of earth cover or equivalent insulation to protect against frost damage. This equivalent frost protection would also be required for the exposed founding soils if construction were undertaken during the winter months. All footings and foundations should be designed and constructed in accordance with the current Ontario Building Code.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this report and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the Borehole locations.

5. SEISMIC DESIGN CONSIDERATIONS

The structure shall be designed according to Section 4.1.8 of the Ontario Building Code, Ontario Regulation 332/12. Based on the subsurface soil conditions encountered in this investigation the applicable Site Classification for the seismic design is Site Class D – Stiff Soil, based on the average soil characteristics for the site.

The seismic data, from Supplementary Standard SB-1 of the Ontario Building Code, for nearby St. Catharines is as follows.

$S_a(0.2)$	$S_a(0.5)$	$S_a(1.0)$	$S_a(2.0)$	PGA
0.340	0.190	0.069	0.023	0.200

6. EXCAVATIONS

Excavations for the installation of building foundations and underground services are generally expected to extend to depths of up to about 1.5 to 3 metres below the existing grade. Excavations through the native silty clay soils should be relatively straightforward, with the sides remaining stable for the short construction period at 60 degrees to the horizontal or steeper. Nevertheless, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act must be supported or a trench box must be provided, and a senior geotechnical engineer from this office should monitor the work.

As noted above the static groundwater level is estimated at a depth of approximately 4 to 6 metres, which is below the anticipated depths of construction. Nevertheless minor infiltration of groundwater through the more permeable seams, as well as surface runoff into open excavations, should be anticipated. It should be possible to adequately control groundwater infiltration for the short construction period using conventional construction dewatering methods, such as pumping from sumps in the base of the excavation. More groundwater control should be anticipated when connections are made to existing services. Surface water should be directed away from the excavations.

The base of the excavations in the hard to stiff silty clay encountered in the upper levels of the boreholes should generally remain firm and stable. Therefore, standard pipe bedding may be provided, as typically specified by the Ontario Provincial Standard Specification will be satisfactory, compacted to 95 per cent of its standard Proctor density [SPMDD]. Should excavation bases encounter any soft or firm silty clay layers, some additional work may be required to stabilise the excavation base, such as placing a layer of coarse clear stone and 'punching' it into the 'softened' soils, or provision of additional ballast stone. Special attention should be paid to compaction under the pipe haunches.

7. BACKFILL CONSIDERATIONS

The majority of the excavated soils will consist of the native silty clay as described above. This material is generally considered suitable for use as engineered fill, service trench backfill, etc. provided that the material is free of organics or otherwise deleterious materials, and that the moisture content can be controlled to within 3 per cent of its standard Proctor optimum value.

The native cohesive soils are sensitive to moisture conditions and will become practically impossible to effectively compact when wet. Any wet or softened material after a period of heavy precipitation should be allowed to air dry or be removed and discarded. It is noted that the cohesive silty clay soils are not free draining and should not be used where this characteristic is necessary. It is also noted that the silty clay will present difficulties in achieving effective compaction where access with compaction equipment is restricted. The use free draining, well-graded granular material, such as an Ontario Provincial Standard Specification [OPSS] Granular B, Type II [crushed limestone] is recommended for use as backfill against foundation walls or to raise the interior grade to the design subgrade level. This material is readily compacted in restricted access areas, is less sensitive to 'wet' conditions and generally presents a more positive support condition for interior floor slabs and exterior concrete sidewalks and asphalt pavement.

We note that where backfill material is placed near or slightly above its optimum moisture content, the potential for long term settlements due to the ingress of groundwater and collapse of the fill structure is reduced. Correspondingly, the shear strength of the 'wet' backfill material is also lowered, thereby reducing its ability to support construction traffic. If the soil is well dry of its optimum value, it will appear to be very strong when compacted, but will tend to settle with time as the moisture content in the fill increases to equilibrium condition. It is therefore very important that the placement moisture content of the backfill soils be within 3 per cent of its standard Proctor optimum moisture content during placement and compaction.

A representative of SOIL-MAT should be on-site during the backfilling and compaction operations to monitor uniform compaction of the backfill material to project specification requirements. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs'. All structural fill should be compacted to 100 per cent of its standard Proctor maximum dry density [SPMDD]. Backfill within service trenches, areas to be paved, etc., should be compacted to a minimum of 95 per cent of its SPMDD, and to 100 per cent of its SPMDD in the upper one metre below the design subgrade level. The appropriate compaction equipment should be employed based on soil type, i.e. pad-toe for cohesive soils and smooth drum/vibratory plate for granular soils. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

8. MANHOLES, CATCHBASINS AND VALVE CHAMBERS

Where manholes, catch basins, valve chambers, etc. are founded in the native silty clay, with excavation bases carefully prepared to remove all loose and disturbed material, the bearing surfaces should be practically non-yielding under the anticipated loads. Proper preparation of the founding soils will therefore accentuate the protrusion of these structures above the pavement surface if compaction of the fill around these structures is not adequate, causing settlement of the surrounding paved surfaces. Conversely, the pavement surfaces may rise above the valve chambers under frost action. To alleviate the potential for these types of differential movements, free draining, non-frost susceptible material should be provided as backfill around the structures located within the paved roadway limits, and compacted to 100 per cent of its standard Proctor maximum dry density. A geofabric separator should be provided between the free draining material and the on-site fine cohesive soils to prevent the intrusion of fines.

Where thrust blocks are to be founded in the stiff to very stiff silty clay they may be conservatively sized as recommended by the applicable Ontario Provincial Standard Specification using an allowable bearing pressure of 200 kPa [~4,000 psf]. Any backfill required behind the blocks should be a crushed limestone product and should be compacted to 100 per cent of its standard Proctor maximum dry density.

9. FLOOR SLABS AND PERMANENT DRAINAGE

Building floor slabs may be constructed using conventional slab-on-grade techniques on a prepared subgrade. The subgrade should be stripped of all topsoil and any otherwise disturbed or deleterious materials and proofrolled in the presence of a representative of SOIL-MAT ENGINEERS. Any 'soft spots' delineated by this must be sub-excavated and replaced with quality backfill material compacted to 100 per cent of its standard Proctor maximum dry density [SPMDD].

As with all concrete floor slabs, there is a tendency for the floor slab to crack. The slab thickness, concrete mix design, the amount of steel and/or fibre reinforcement and/or wire mesh placed into the concrete slab, if any, will therefore be a function of the owner's tolerance for cracks in, and movements of, the slabs-on-grade, etc. The 'saw-cuts' in the concrete floors, for crack control, should extend to a minimum depth of 1/3 of the thickness of the slab and be cut between 6 to 24 hours of the concrete being placed.

A moisture barrier will be required under the floor slabs to act as a capillary break. A recommended moisture barrier consists of at least 200 millimetres of well-compacted 20 millimetre clear crushed stone. At a minimum the moisture barrier material should contain no more than 10 per cent of material passing the No. 4 sieve. Where 'non-damp' floor slabs are required, as for instance under sheet vinyl floor coverings, etc., extra efforts will be required to damp proof the floor slab, as with the additional provisions of a heavy 'poly' sheet, damp proofing sprays/membranes, drainage board products, etc. Where 'poly' sheets are used care should be taken to prevent puncturing and tearing and/or sufficiently heavy gauge sheeting specified. Alternatively a proprietary product, such as Delta-MS Underslab or WR Meadows membrane, may be considered in lieu of the 'poly' sheets.

Curing of the slab-on-grade must be carefully specified to ensure that slab curl is minimised. This is especially critical during the hot summer months of the year when the surface of the slab tends to dry out quickly while high moisture conditions in the moisture barrier or water trapped on top of any 'poly' sheet at the saw cut joints and cracks, and at the edges of the slabs, maintains the underside of the slab in a moist condition.

It is also important that the concrete mix design provide a limiting water/cement ratio and total cement content, which will mitigate moisture related problems with low permeance floor coverings, such as debonding of vinyl and ceramic tile. It is equally important that excess free water not be added to the concrete during its placement as this could increase the potential for shrinkage cracking and curling of the slab.

It is recommended that a permanent perimeter drainage tile system be provided around the structures where the interior floor slab elevation is less than 300 millimetres above the final exterior grade to prevent the buildup of water under the slab-on-grade and against the foundation walls. The perimeter drainage systems should consist of 150 mm diameter perforated pipe, surrounded with 200 millimetres of 20 millimetres clear stone, and the clear stone in turn encased by a heavy filter geotextile product. The suppliers of the filter geotextile should be consulted as to the type best suited for this project.

This office should examine the installation of the drainage systems. Even a small break in the filtering materials could result in loss of fines into the drains with attendant performance difficulties, including settlements of the ground surface. The perimeter drains should outlet to a gravity sewer connection or a sump pit a minimum of 150 millimetres below the underside of finished floor. The exterior grade around the structure should be sloped away from the structure to prevent the ponding of water against the foundation walls.

10. PAVEMENT CONSIDERATIONS

The roadway and parking areas should be stripped of any existing topsoil in addition to any otherwise deleterious materials. The exposed subgrade should be proofrolled with 3 to 4 passes of a loaded tandem truck or large smooth drum roller in the presence of a representative of this office immediately prior to the placement of the sub-base material. Any areas of distress revealed by this or other means must be subexcavated and replaced with suitable backfill material compacted to 100 per cent of its standard Proctor maximum dry density.

The need for the treatment of softened subgrade will be reduced if construction is undertaken during the dry summer months and if careful attention is paid to the compaction operations. The fill overlying shallow utilities cut into or across roadways [i.e. telephone lines, hydro, gas, etc.] must also be placed and compacted in a controlled manner to 100 per cent of its standard Proctor maximum dry density.

Good drainage provisions will optimise the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and prevent softening of the subgrade material. Surface water should not be allowed to pond adjacent to paved areas.

The most severe loading conditions on the subgrade typically occur during the course of construction, therefore precautionary measures should be taken to ensure that the subgrade is not unduly disturbed by construction traffic. These measures would include minimising the amount of heavy traffic travelling over the subgrade, such as during the placement of granular base layers.

If construction is conducted under adverse weather conditions, it should be anticipated that additional subgrade preparation will be required, such as additional depth of Granular B, Type II sub-base course material. It is also important that the sub-base and base course granular layers of the pavement structure be placed as soon after exposure and preparation of the subgrade as practical. Depending on the prevailing weather conditions, the use of a purpose-built gravel construction roadway/lay down area might be considered to avoid damaging the condition of the subgrade soils.

The suggested pavement structures outlined in Table A, below, are based on subgrade parameters estimated on the basis of visual and tactile examinations of the on-site soils and past experience. The outlined pavement structure may be expected to have an approximate ten-year life, assuming that regular maintenance is performed. Should a more detailed pavement structure design be required, then site specific traffic information would be needed, together with detailed laboratory testing of the subgrade soils.

TABLE A

RECOMMENDED PAVEMENT STRUCTURES

LAYER DESCRIPTION	COMPACTION REQUIREMENTS	LIGHT DUTY SECTIONS	HEAVY DUTY [TRUCK ROUTE]
Asphaltic Concrete Wearing course OPSS HL 3 or HL 3A	97 per cent Marshall	65 millimetres	40 millimetres
Binder Course OPSS HL 8	97 per cent Marshall		65 millimetres
Base Course OPSS Granular A	100% SPMDD	150 millimetres	150 millimetres
Sub-base Course OPSS Granular B Type II	100% SPMDD	200 millimetres	350 millimetres

* SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698.

Depending on the arrangement of light duty and heavy duty pavement sections, the transition between sections may present some difficulty for contractors. In this regard, consideration might be given to a slightly increased light duty pavement structure consisting of 50 millimetres of HL8 binder course and 40 millimetres of HL3 surface course asphaltic concrete. This structure will provide for a continuous depth of surface course asphalt allowing for ease of construction. As well such a structure would have an improved performance over an increased design life. Such an arrangement of asphalt layers would also allow for future rehabilitation with a 'mill and pave' type operation.

To minimise segregation of the finished asphalt mat, a uniform asphalt temperature must be maintained throughout the mat during placement and compaction. Frequently, significant temperature gradients exist in the delivered and placed asphalt with cooler portions of the mat resisting compaction and presenting a 'honey combed' surface. As the spreader moves forward, a responsible member of the paving crew should monitor the pavement surface, to ensure smoothness and uniformity. The contractor can mitigate the surface segregation by 'back-casting' or scattering shovels of the full mix material over the segregated areas and raking out the coarse particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the 'back-casting' to be performed.

11. SLOPE CONSIDERATIONS

SLOPE CONDITION

During the fieldwork a slope stability rating chart, as found in the Ontario Ministry of Natural Resources publication "Geotechnical Principles for Stable Slopes" was completed and indicated a rating value of 25, corresponding to a 'slight potential' for slope instability. The scope of evaluation consisted of a site inspection and measurement of representatives slope profile, as well as the subsurface soils investigation, analysis, and detailed reporting. A copy of the slope stability rating chart has been attached to the end of this report.

Two representative slope profiles were measured on the slope to the southwest of the subject property. The slope profiles were measure at the locations illustrated in the attached Drawing No. 1, Borehole and Slope Profile Location Plan and are depicted in the attached Drawing Nos. 2 and 3, Slope Profiles A-A and B-B, respectively. The slope is approximately 2 to 5 metres in height and varies in inclination from approximately 2 horizontal to 1 vertical to flatter than 3 horizontal to 1 vertical.

The slope was visually evaluated and was noted to be covered with scrub vegetation and small trees, and did not exhibit evidence of recent instability, such as tension cracks, significant settlements, etc. As with all slopes, there is a reduction in surficial shearing resistance attributed to the effects of freezing and thawing, wetting and drying, burrowing animals, etc. With time, the surface of the slope will degenerate and tend to reach equilibrium within its stress and ambient environment, including vegetative cover. However this type of degeneration is a very slow process, as is evident by the observed stable condition of the existing slope. As such the slope is considered to be stable in its present condition.

SLOPE STABILITY

A stability analysis of the existing slope was performed with a computerized modeling program [SLOPE/W 2007] utilising multiple methods of analysis to determine the minimum factor of safety for a series of trial slip surfaces of different radii at varying centres, exposed to typical and elevated groundwater conditions. The subsurface soil conditions were based on the borehole information as described above. The following soil parameters were assigned based on the conditions encountered at the borehole locations.

Silty Clay: $\gamma = 19.5\ kN/m^3$; $\phi = 32^o$; $c = 5\ kPa$

The stability analyses yield a factor of safety for the existing slope on the order of 2.4 to 3.2, with respect to the physical crest of the slope, and approximately 1.9 to 2.8 where a temporary high water level is considered. Table 7.2 of the Geotechnical Principles for Stable Slopes [Ministry of Natural Resources] lists a Design Minimum Factor of Safety of between 1.30 and 1.50 for 'Active' land use properties [habitable or occupied structures near slope]. As the factors of safety far exceed the minimum acceptable factors of safety, the slope can be considered stable in the long and short term.

TOP OF STABLE SLOPE

The top of stable slope is determined by the application of an erosion allowance at the toe and a stable slope inclination through the slope. In this case, as there is a watercourse within 15 metres of the toe of the slope a conservative erosion allowance of 4 metres has been applied. Stable slope inclinations in the stiff to hard silty clay as steep as 1.5 to 2.0 horizontal to 1 vertical are presented in Table 4.3 of the "Geotechnical Principles for Stable Slopes" publication. For this case, given our experience in the area and observations during the field work, a stable slope allowance of 2.0 horizontal to 1 vertical was conservatively used. Applying the appropriate erosion and stable slope allowances provides for the location of the top of stable slope at approximately 12.6 and 7.4 metres uphill from the toe of the slope on Profiles A-A and B-B, respectively. It is noted that on Profile B-B the top of stable slope is downhill of the physical crest, however as the slope is at an inclination of well flatter than 3 horizontal to 1 vertical it would be considered stable effectively at any point along its face.

DESIGN AND CONSTRUCTION CONSIDERATIONS

As the slope has been established as stable in the short and long-term, the proposed new development may be constructed uphill of the Top of Stable Slope, as determined above, without any negative impact on the stability of the slope. The following recommendations should be incorporated into the design and construction of the proposed structures.

1. New building foundations should be at sufficient depth to extend below a line drawn up from the toe of the slope at 3 Horizontal to 1 Vertical. In this fashion load transfer from the footings to the slope would be minimised or eliminated, thus limiting any impact on the stability of the slope.
2. Heavy construction equipment, such as excavators, should not come any closer to the slope than the established Top of Stable Slope. A temporary silt fence should be erected along, or just downhill of the Top of Stable Slope line to delineate the work area and prevent sediment runoff during construction.
3. Excavated soil or other fill may not be placed near or over the crest of the slope, or closer than the Top of Stable Slope line.
4. Any drainage, and/or surface runoff should be directed away from the slope, or towards the slope in a controlled fashion, such as sheet flow through well-established grass or vegetation, so as to not alter the natural drainage over the slope or create concentrated flows onto the slope.
5. Any surficial damage to the face of the sloped caused during construction should be repaired and appropriate grass/vegetation be re-established.

12. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are only intended to describe conditions at the borehole locations. Contractors placing bids or undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will effect their operations.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

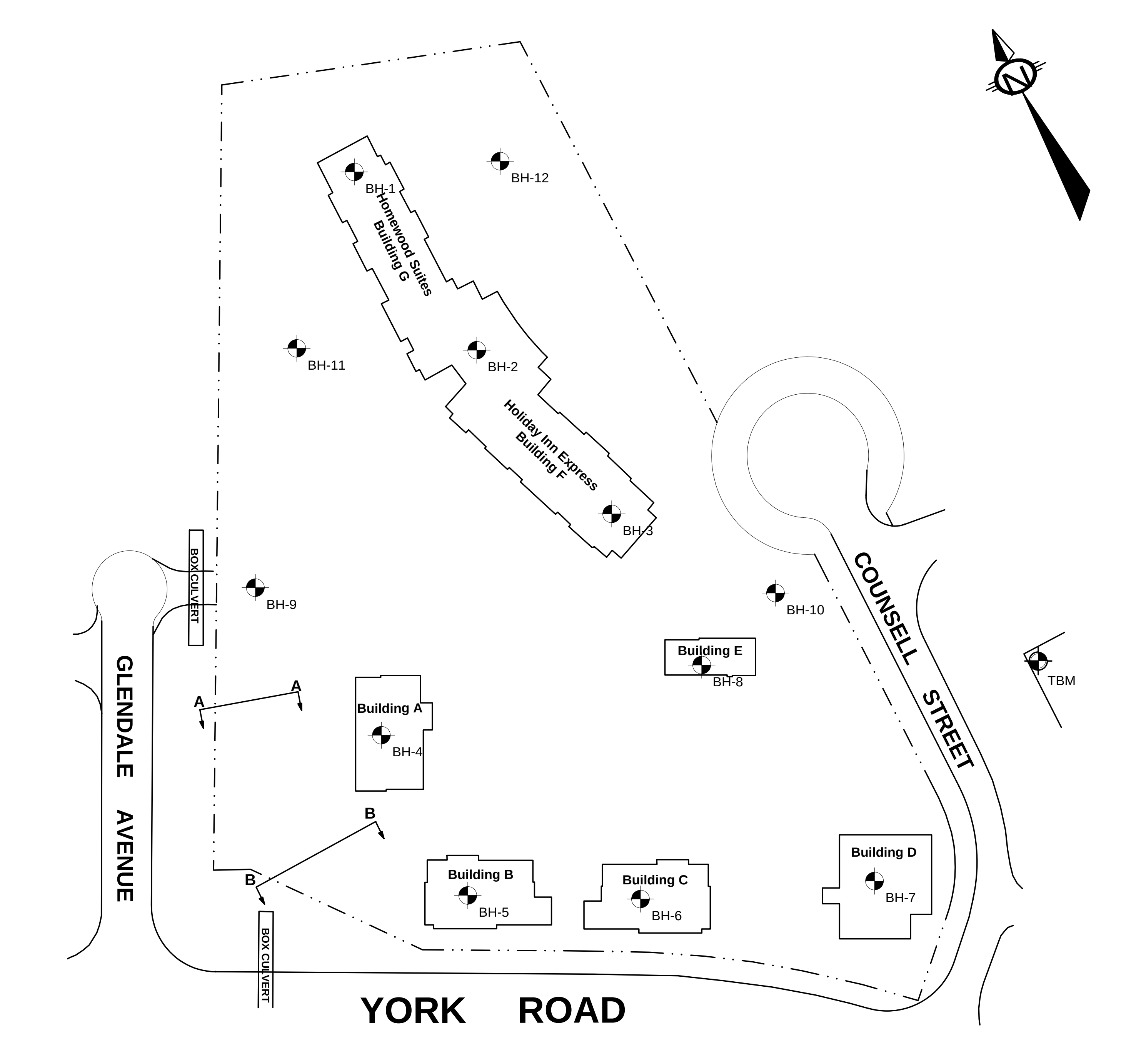
Matt LiVecchi, B.Eng., EIT

Stephen R. Sears, B. Eng. Mgmt., P. Eng.
Senior Engineer

Ian Shaw, B. Eng., P. Eng.
Review Engineer

Enclosures: Drawing No. 1, Borehole and Cross-Section Location Plan
Drawing No. 2, Top of Stable Slope Location Plan
Log of Borehole Nos. 1 to 12, inclusive
Drawing Nos. 3 and 4, Slope Profiles A-A and B-B
Sample Slope Analysis Printouts

Distribution: Vrancor Developments [2, plus pdf]



LEGEND

BH-# Borehole

TBM Temporary Benchmark [Finished Floor Slab of Purolator Bldg. geodetic elevation of 118.12 metres]

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. supplemental report number SM 156011-G
2. Borehole locations are approximate.
3. Soil samples will be discarded after 3 months unless directed otherwise by client.

Soil-Mat
Engineers & Consultants Ltd.

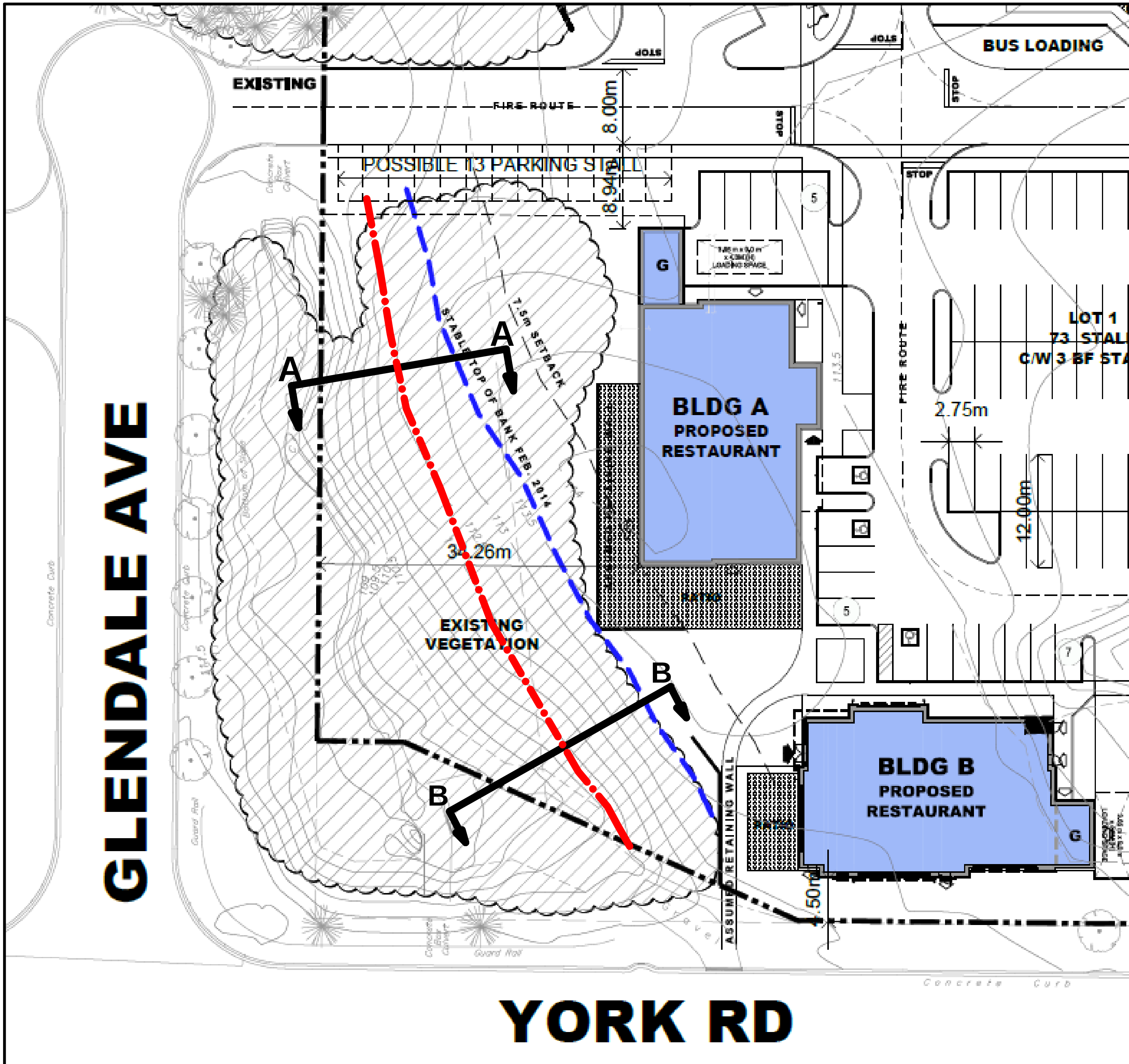
CLIENT
Vrancor Developments

PROJECT TITLE
Geotechnical Investigation
Proposed Hotel & Restaurant Development
525 York Road
Niagara-on-the-Lake, Ontario

DRAWING TITLE
Borehole and Cross-Section Location Plan

PROJECT No.	SM 156011-G
SCALE	N.T.S.
DATE	February 2015
CHECKED	-
DRAWN	SRS
FILENAME	156011-G Borehole Location Plan.kcw

DRAWING No. 1



LEGEND

Top of Stable Slope [February 2014]

Top of Stable Slope [May 2015]

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. report number SM 156011-G
2. Slope section and Top of Stable Slope locations are approximate.

Soil-Mat
Engineers & Consultants Ltd.

CLIENT
Vrancor Developments

PROJECT TITLE
Geotechnical Investigation
Proposed Hotel & Restaurant Development
525 York Road
Niagara-on-the-Lake, Ontario

DRAWING TITLE
Top of Stable Slope
Location Plan

PROJECT No.	SM 156011-G
SCALE	N.T.S.
DATE	May 2015
CHECKED	SRS
DRAWN	ML
FILENAME	156011-G Stable Slope Location Plan.kcw

DRAWING No. 2

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 1

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Elevation [m]	Description
115.35	Ground Surface
115.10	***Topaoil*** Approximately 250 millimeters of topsoil over,
	Silty Clay Brown,trace fine gravel, reworked in the upper level, hard to stiff,
105.75	End of Borehole

NOTES:

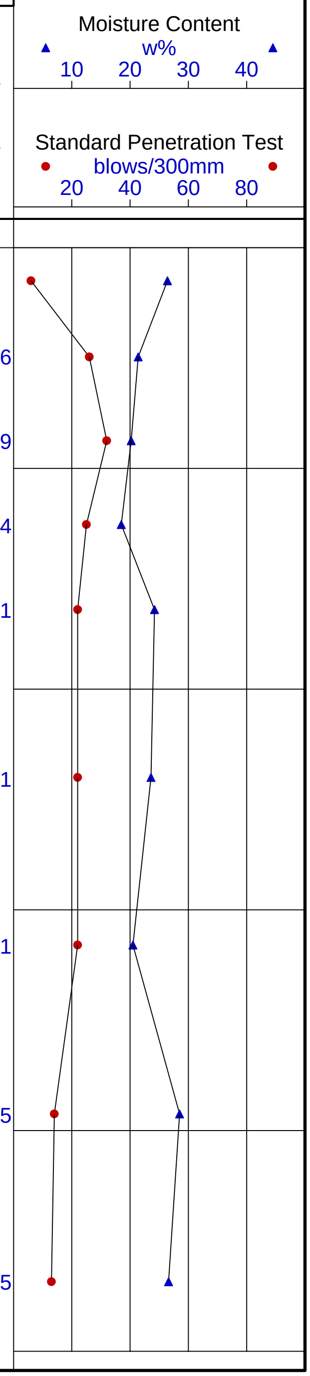
1. Borehole was advanced using solid stem auger equipment on March 3, 2015 to termination at a depth of 9.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,3,3,5	6			
SS	2	4,10,16	26		>4.5	19.6
SS	3	10,14,18	32			19.9
SS	4	8,12,13	25			20.4
SS	5	8,10,12	22			19.1
SS	6	6,10,12	22			19.1
SS	7	6,10,12	22			19.1
SS	8	3,7,7	14			18.5
SS	9	2,5,8	13			18.5



Drill Method: Solid Stem Augers

Drill Date: March 3, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 2

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Elevation [m]	Symbol	Description	Well Data
0	0	115.95		Ground Surface	
		115.75		***Topsoil*** Approximately 200 millimeters of topsoil over,	
				Silty Clay Brown,trace fine gravel, reworked in the upper level, hard to stiff.	
		106.35		End of Borehole	

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8

NOTES:

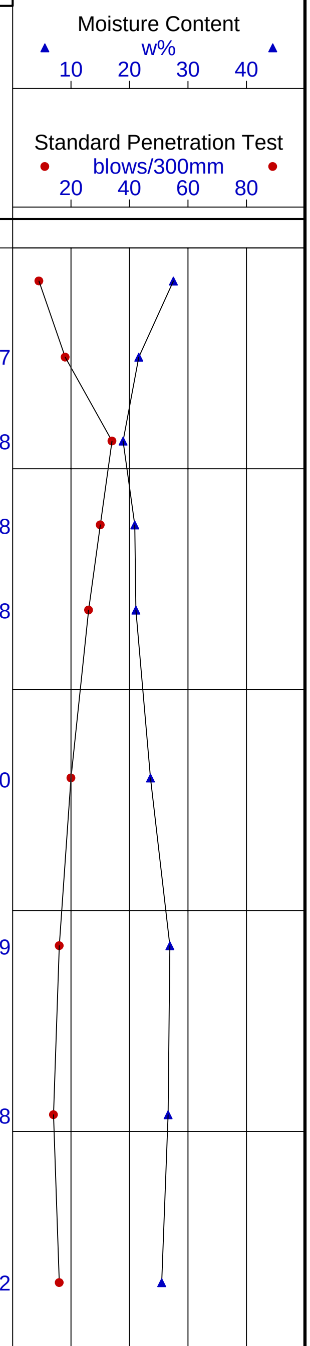
1. Borehole was advanced using solid stem auger equipment on March 3, 2015 to termination at a depth of 9.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,6,3,4	9			
SS	2	4,6,12	18		>4.5	19.7
SS	3	10,14,20	34			19.8
SS	4	10,14,16	30			19.8
SS	5	10,12,14	26			19.8
SS	6	5,8,12	20			19.0
SS	7	5,8,8	16			18.9
SS	8	3,6,8	14			18.8
SS	9	4,6,10	16			19.2



Drill Method: Solid Stem Augers

Drill Date: March 3, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 3

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Depth	Elevation [m]	Description
0 ft / 0 m	115.60	Ground Surface
	115.35	***Topsoil*** Approximately 250 millimeters of topsoil over,
		Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to very stiff.
32 ft	106.00	End of Borehole

NOTES:

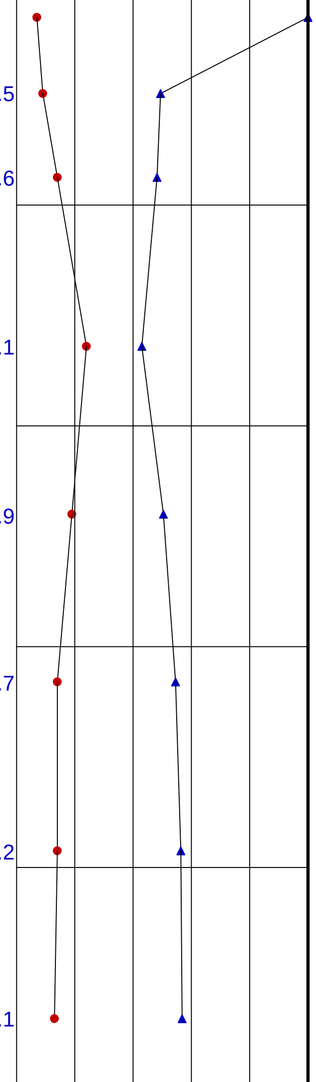
1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 9.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,3,4,4	7			
SS	2	4,4,5	9			18.5
SS	3	3,6,8	14			18.6
SS	4	5,11,13	24		>4.5	20.1
SS	5	5,8,11	19			18.9
SS	6	3,6,8	14			18.7
SS	7	3,6,8	14			18.2
SS	8	4,6,7	13			18.1



Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 4

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Depth (m)	Elevation [m]	Description
0	115.18	Ground Surface
0		***Topsoil*** Approximately 150 millimeters of topsoil over,
		Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to hard.
	108.62	End of Borehole

NOTES:

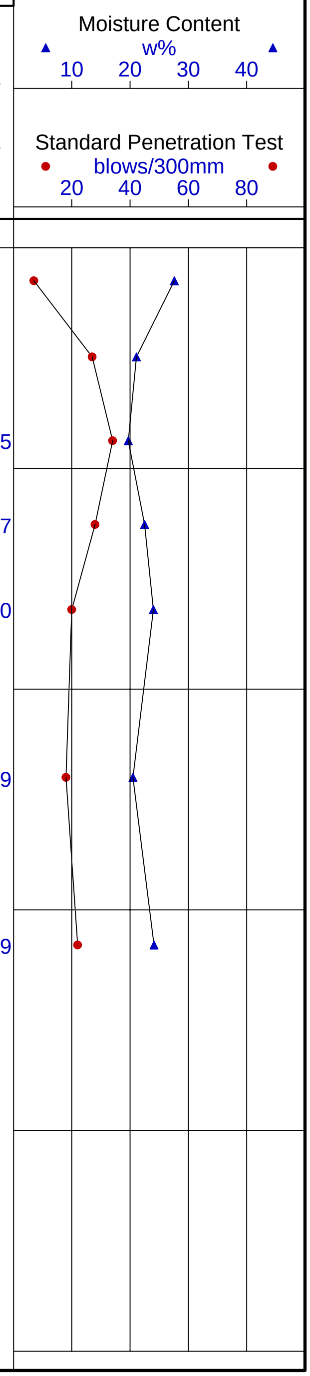
1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,3,4,6	7			
SS	2	9,12,15	27			
SS	3	10,15,19	34			19.5
SS	4	8,12,16	28		>4.5	19.7
SS	5	4,8,12	20			19.0
SS	6	5,7,11	18			19.9
SS	7	5,9,13	22			18.9



Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 5

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

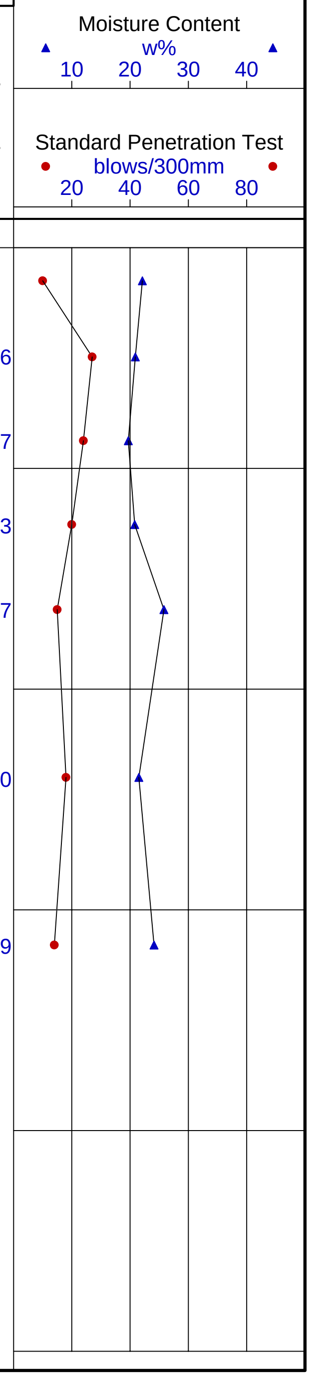
Soil-Mat

SUBSURFACE PROFILE

Depth (ft / m)	Elevation [m]	Description
0 / 0	114.17	Ground Surface
0 – 0.15 m		***Topsoil*** Approximately 150 millimeters of topsoil over,
0.15 – 6.6 m		***Silty Clay*** Brown,trace fine gravel, reworked in the upper level, firm to very stiff.
6.6 m	107.61	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,4,6,8	10		
SS	2	7,11,16	27		19.6
SS	3	7,11,13	24		19.7
SS	4	4,6,12	20	>4.5	19.3
SS	5	3,6,9	15		18.7
SS	6	3,7,11	18		19.0
SS	7	3,6,8	14		18.9



NOTES:

1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 6

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Elevation [m]	Description
		115.20	Ground Surface
0	0		***Topsoil*** Approximately 175 millimeters of topsoil over,
			Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to hard.
21.5	6.6	108.64	End of Borehole

NOTES:

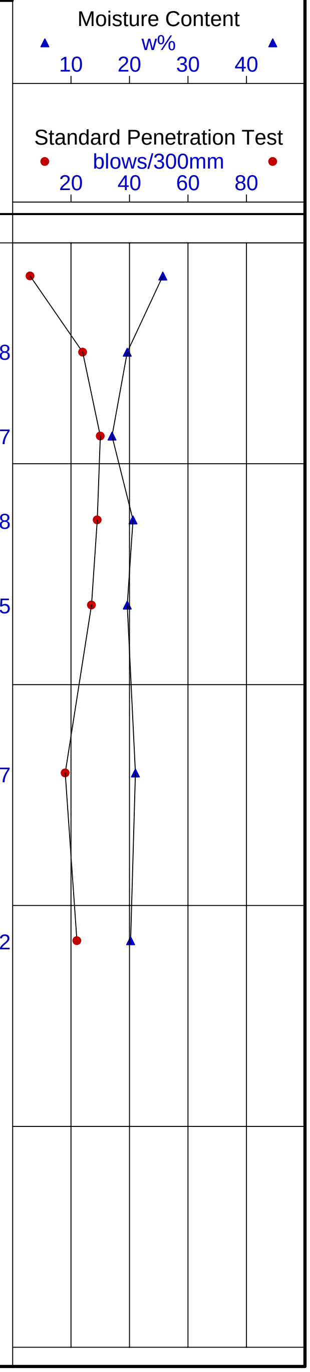
1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,3,3,5	6			
SS	2	9,10,14	24			19.8
SS	3	12,14,16	30			19.7
SS	4	10,12,17	29		>4.5	19.8
SS	5	7,11,16	27			19.5
SS	6	3,7,11	18			18.7
SS	7	3,9,13	22			19.2



Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 7

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

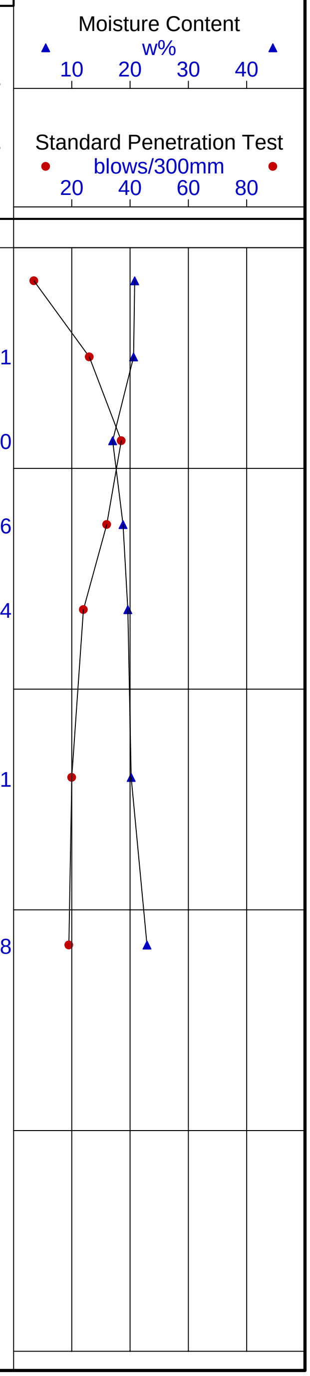
: **::**

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0	115.77		Ground Surface								
			Topsoil Approximately 175 millimeters of topsoil over,		SS	1	3,3,4,7	7			
			Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to hard.		SS	2	7,11,15	26			19.1
					SS	3	12,15,22	37		>4.5	20.0
					SS	4	9,15,17	32			19.6
					SS	5	6,10,14	24		>4.5	19.4
					SS	6	4,8,12	20			19.1
	109.21				SS	7	4,9,10	19			18.8
			End of Borehole								

Depth scale: ft 0–32; m 0–8



NOTES:

1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 8

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE

Depth	Elevation [m]	Description
0	115.62	Ground Surface
	115.42	***Topsoil*** Approximately 200 millimeters of topsoil over,
		Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to very stiff.
	109.06	End of Borehole

NOTES:

1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 6.6 metres.

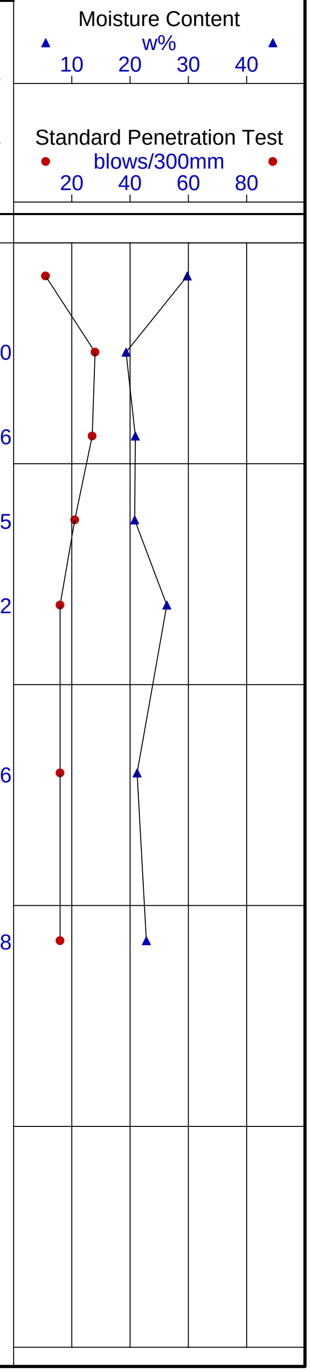
2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Depth scale: ft 0–32; m 0–8

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	7,7,4,4	11			
SS	2	8,13,15	28			20.0
SS	3	7,12,15	27		>4.5	19.6
SS	4	4,9,12	21			19.5
SS	5	4,7,9	16			19.2
SS	6	3,7,9	16		3.5	19.6
SS	7	4,7,9	16			18.8



Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 9

Project Manager: S.R. Sears, P. Eng.

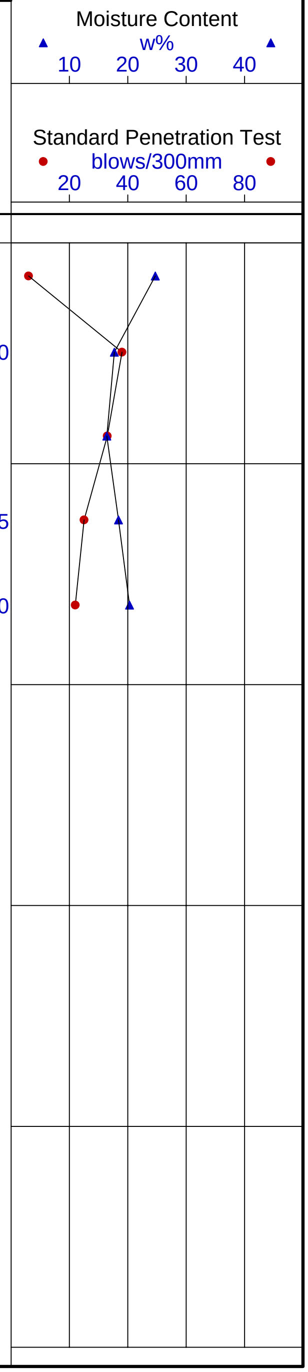
Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0	112.67		Ground Surface								
	112.47		**Topsoil** Approximately 200 millimeters of topsoil over,		SS	1	6,3,3,4	6			
			Silty Clay Brown,trace fine gravel, reworked in the upper level, firm to hard.		SS	2	10,15,23	38			20.0
					SS	3	9,15,18	33		>4.5	
					SS	4	9,12,13	25			19.5
	109.17				SS	5	4,9,13	22			19.0
			End of Borehole								



Depth scale: ft 0–32; m 0–8

NOTES:

1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 3.5 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 10

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

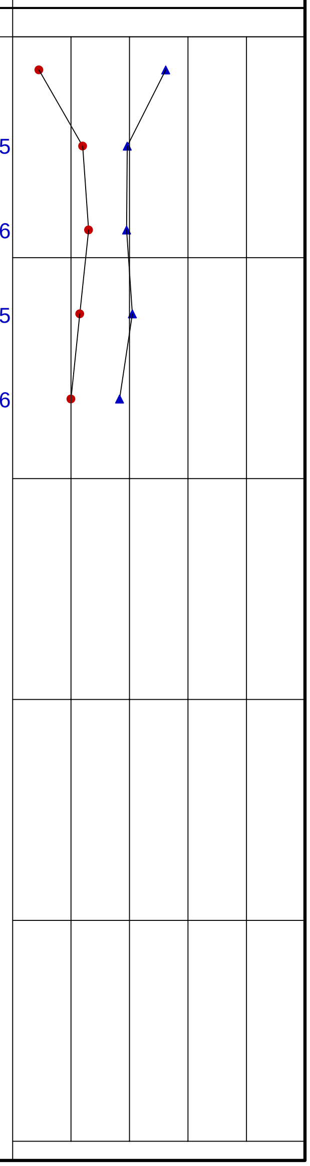
Soil-Mat

SUBSURFACE PROFILE

Depth (m)	Elevation [m]	Description
0	115.32	Ground Surface
0 – 0.22	115.10	***Topsoil*** Approximately 225 millimeters of topsoil over,
0.22 – 3.50	111.82	***Silty Clay*** Brown,trace fine gravel, reworked in the upper level, stiff to very stiff.
3.50		End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,4,5,6	9			
SS	2	8,11,13	24			19.5
SS	3	8,11,13	26			19.6
SS	4	8,11,15	23			19.5
SS	5	12,9,11	20		>4.5	19.6



Depth scale: ft 0–32; m 0–8

NOTES:

1. Borehole was advanced using solid stem auger equipment on March 2, 2015 to termination at a depth of 3.5 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: March 2, 2015

Hole Size: 150mm

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Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 11

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

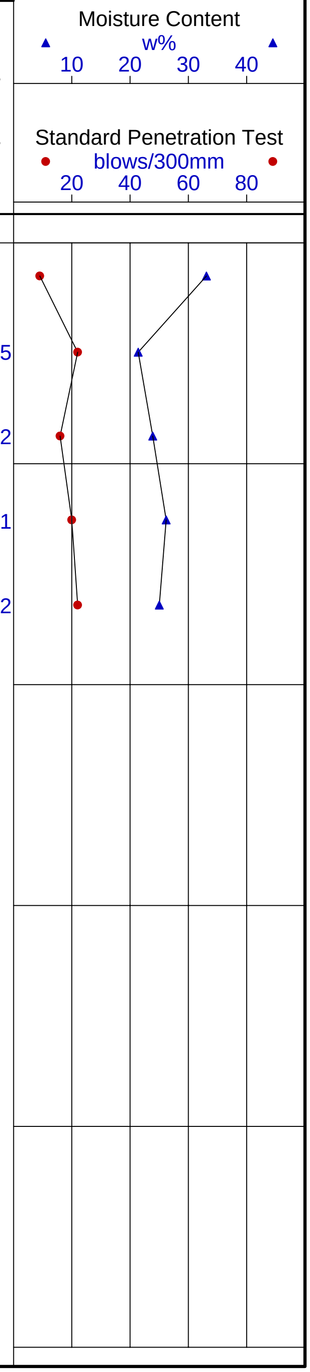
SUBSURFACE PROFILE

Depth (ft / m)	Elevation [m]	Symbol	Description
0 / 0	114.16		Ground Surface
	113.91		**Topsoil** Approximately 250 millimeters of topsoil over,
	110.66		**Silty Clay** Brown,trace fine gravel, reworked in the upper level, stiff to very stiff.
			End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,3,6,7	9			
SS	2	8,10,12	22			19.5
SS	3	6,8,8	16			19.2
SS	4	6,8,12	20		4.0	19.1
SS	5	6,10,12	22			19.2

Well Data



NOTES:

1. Borehole was advanced using solid stem auger equipment on March 3, 2015 to termination at a depth of 3.5 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8

Drill Method: Solid Stem Augers

Drill Date: March 3, 2015

Hole Size: 150mm

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Sheet: 1 of 1

Project No: SM 156011-G

Project: 525 York Road

Location: Niagara-on-the-Lake, Ontario

Client: Vrancor Developments

Log of Borehole No. 12

Project Manager: S.R. Sears, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

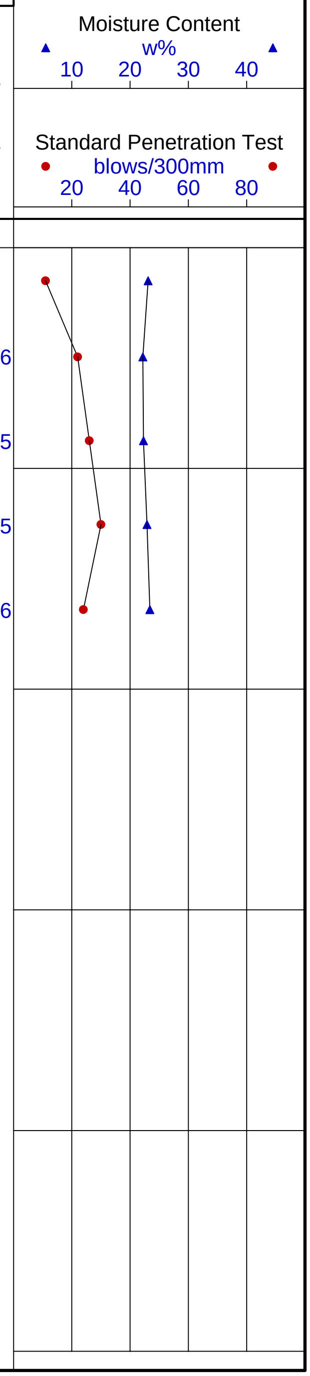
Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	115.74		Ground Surface								
	115.49		***Topsoil*** Approximately 250 millimeters of topsoil over,		SS	1	7,7,4,4	11			
			Silty Clay Brown,trace fine gravel, reworked in the upper level, stiff to hard.		SS	2	6,10,12	22			19.6
					SS	3	10,12,14	26			19.5
					SS	4	10,14,16	30		>4.5	19.5
	112.24				SS	5	10,12,12	24			19.6
			End of Borehole								

Depth scale: ft 0–32; m 0–8.

Moisture Content w% (10, 20, 30, 40) / Standard Penetration Test blows/300mm (20, 40, 60, 80)



NOTES:

1. Borehole was advanced using solid stem auger equipment on March 3, 2015 to termination at a depth of 3.5 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid Stem Augers

Drill Date: March 3, 2015

Hole Size: 150mm

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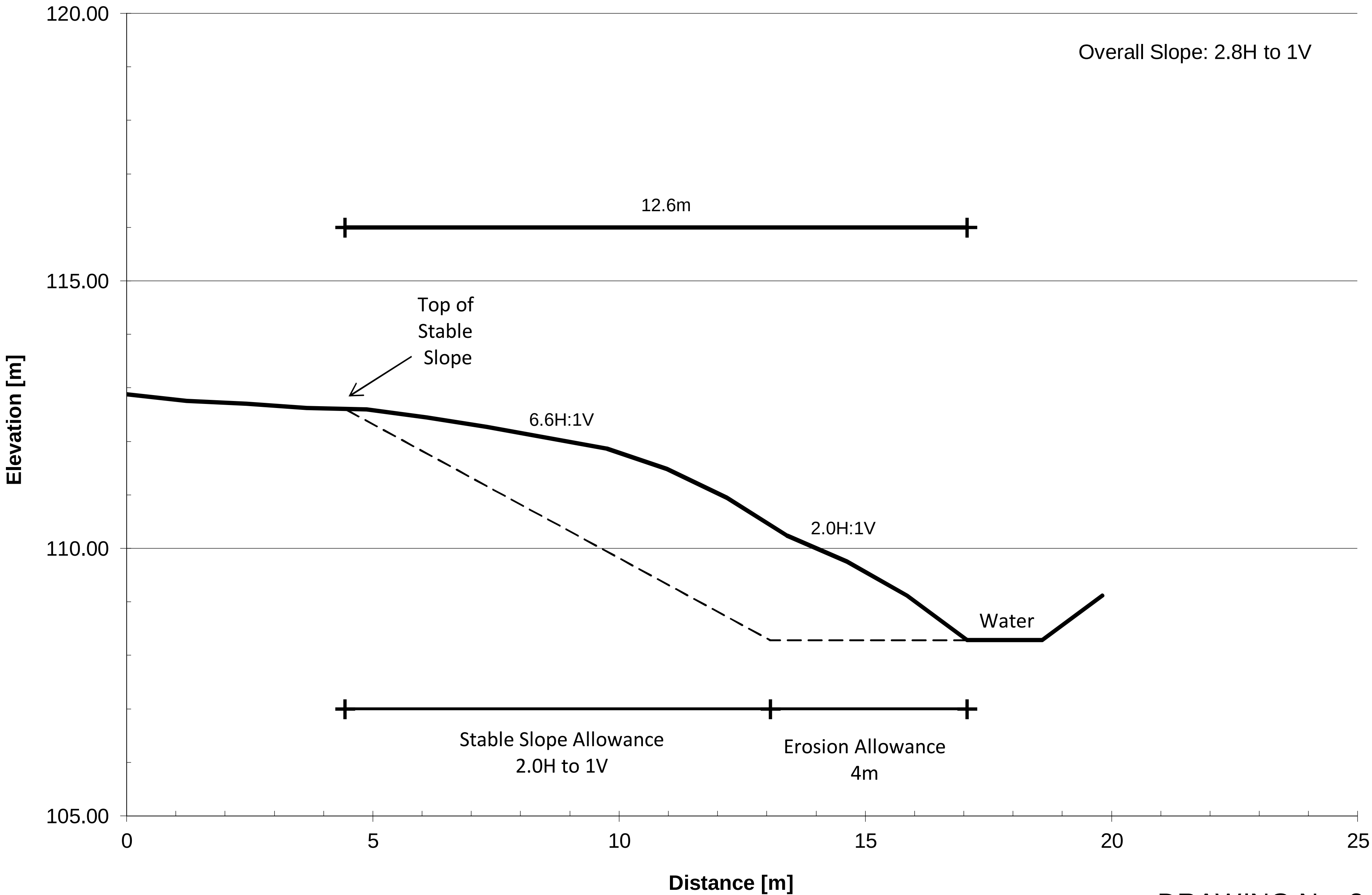
Sheet: 1 of 1

Slope Stability Analysis
525 York Road
Niagara-on-the-Lake, Ontario
Slope Profile A-A

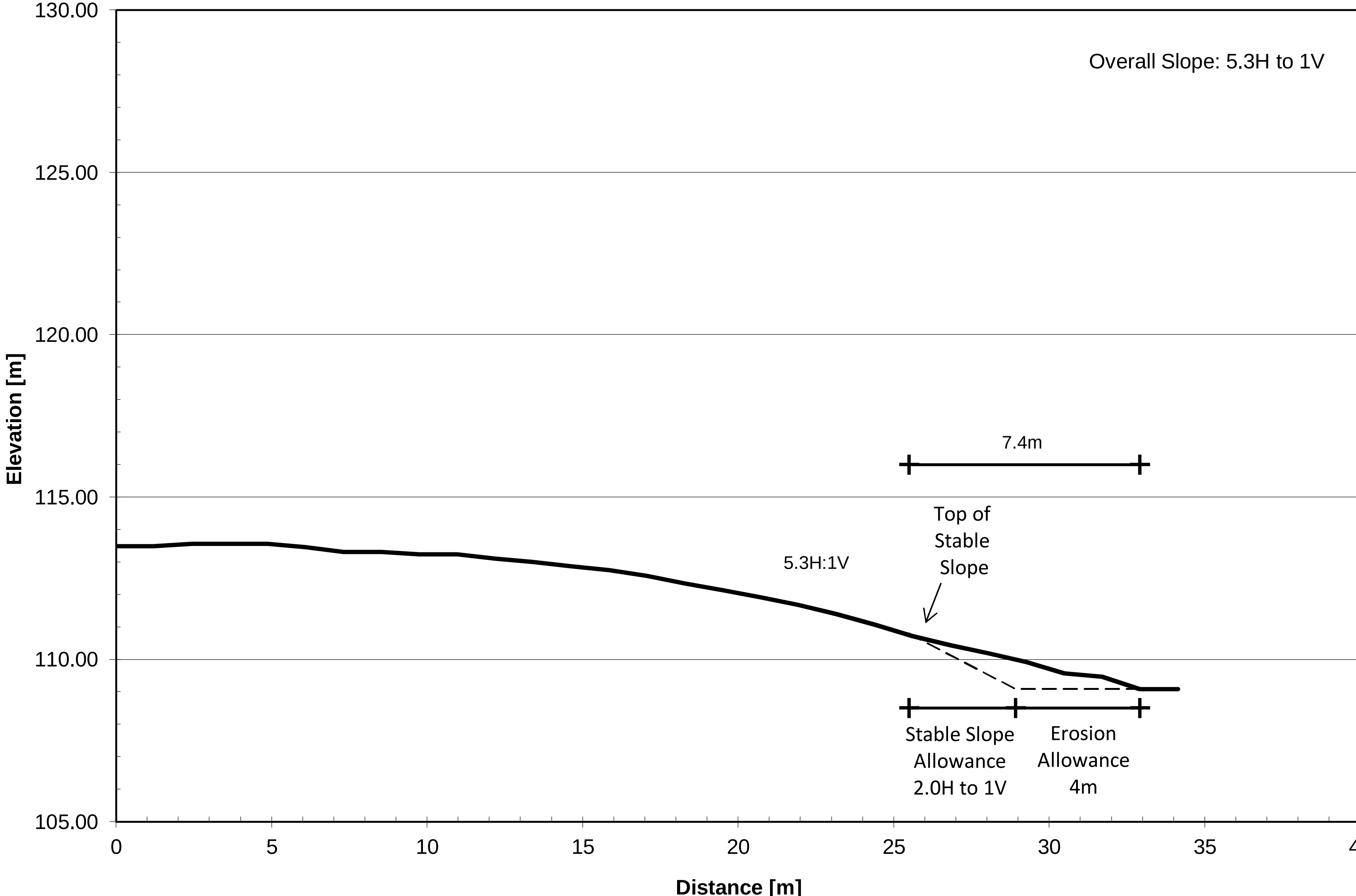


Project No.: SM 156011-G

DRAWING No. 3

Slope Stability Analysis
525 York Road
Niagara-on-the-Lake, Ontario
Slope Profile B-B

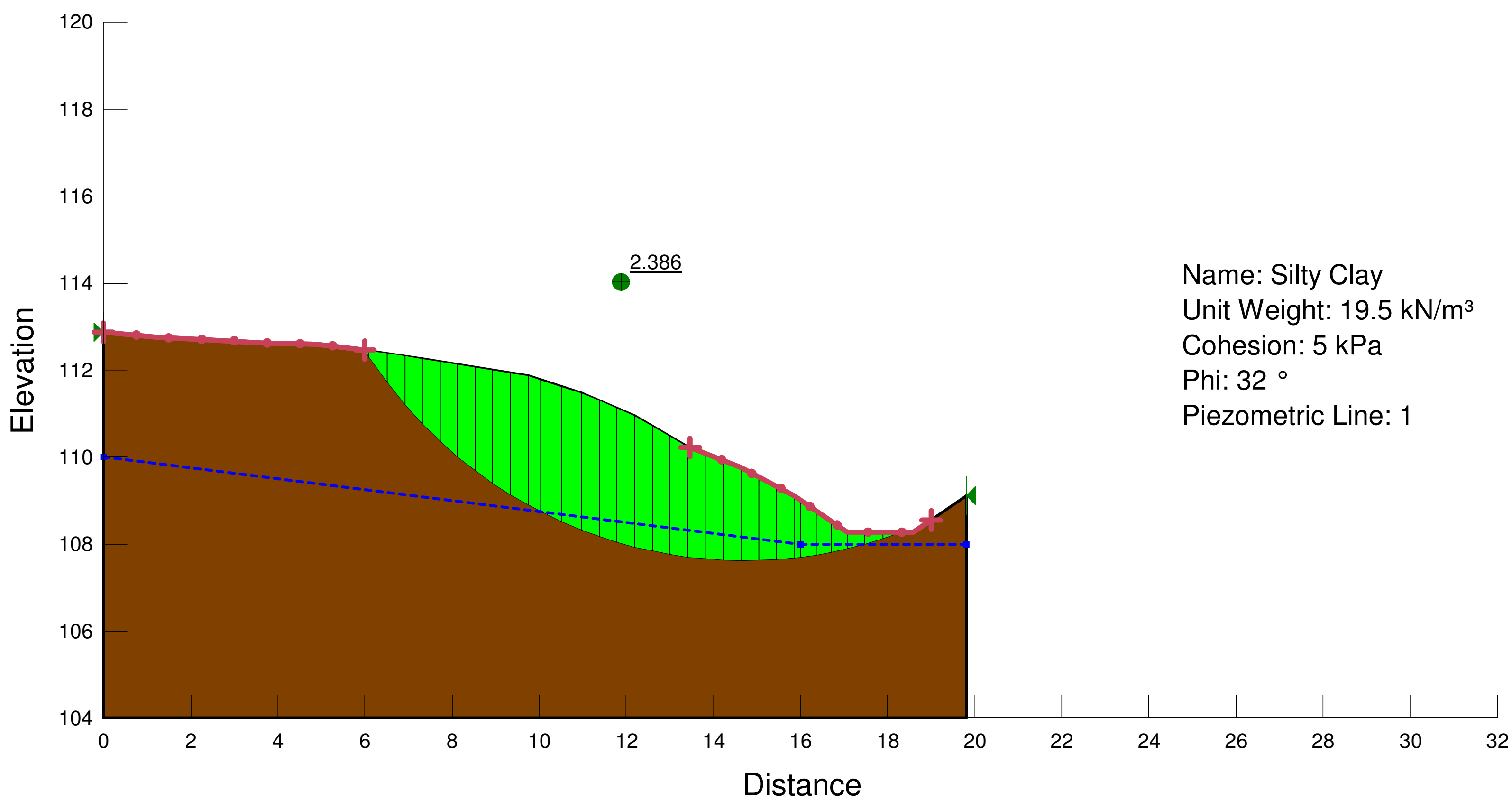
Soil-Mat



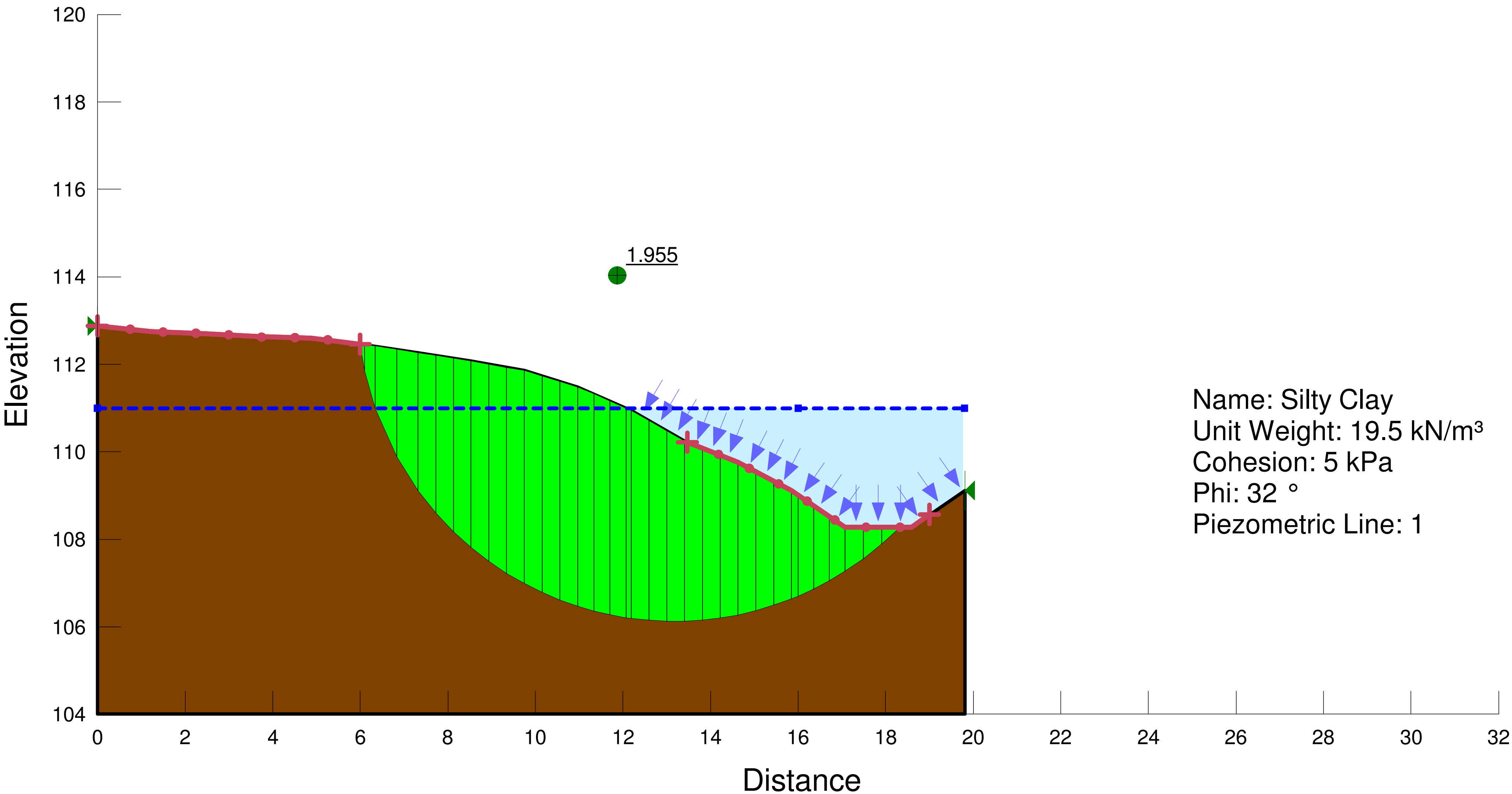
Project No.: SM 156011-G

DRAWING No. 4

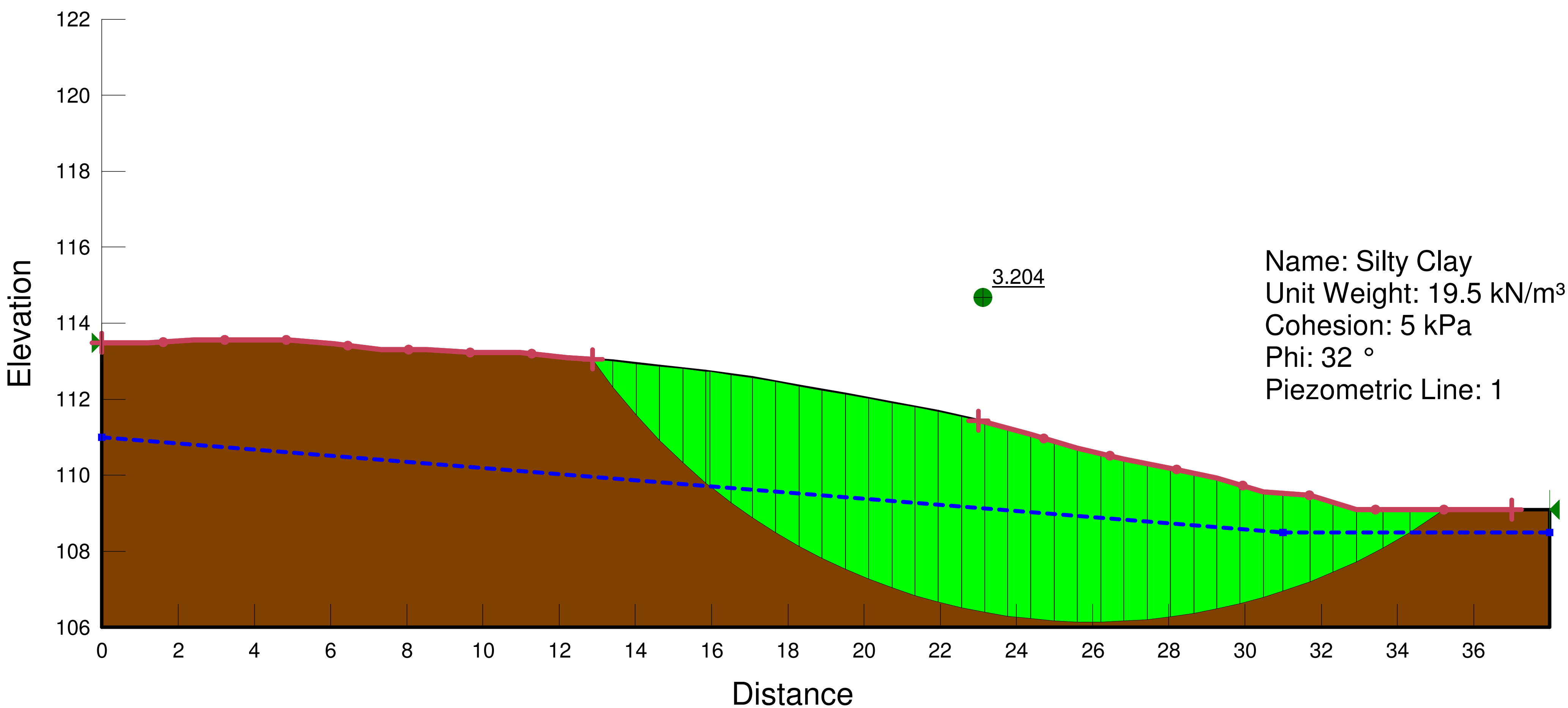
525 York Road
Niagara-on-the-Lake, Ontario
Slope Section A-A



525 York Road
Niagara-on-the-Lake, Ontario
Slope Section A-A



525 York Road
Niagara-on-the-Lake, Ontario
Slope Section B-B



525 York Road
Niagara-on-the-Lake, Ontario
Slope Section B-B