SOIL-MAT ENGINEERS & CONSULTANTS LTD.

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PROJECT NO.: SM 166905-G March 24, 2017

LANDFORM DEVELOPMENT GROUP INC.
980 Fraser Drive, Suite 205
Burlington, Ontario
L7L 5P5

Attention: Mr. Andrew Bear, CPA, CA

SUPPLEMENTAL GEOTECHNICAL INVESTIGATION
SLOPE STABILITY ASSESSMENT
PROPOSED MULTI-STOREY BUILDING
401 TO 417 MARTHA STREET
BURLINGTON, ONTARIO

Dear Mr. Bear,

Further to your authorisation, SOIL-MAT ENGINEERS & CONSULTANTS LTD. has completed the fieldwork, slope stability analysis, and report preparation in connection with the above noted project. This report should be read in conjunction with our previous geotechnical investigation report for the project site [SM 166905-G, dated September 29, 2016]. Our comments and recommendations, based on our findings at the two [2] borehole locations and slope cross-sections are presented herein.

1. INTRODUCTION

We understand that the project will involve the construction of a twelve to fifteen [12-15] storey condominium building, including as many as four to five [4-5] underground parking levels. As noted above, SOIL-MAT ENGINEERS previously undertook a geotechnical investigation on the site in 2016. The scope of our investigation work at that time was limited due to the presence of existing occupied dwellings. As such, additional investigation work, as well as the measurement of representative slope profiles, was conducted at the time of this supplemental work based on increased accessibility to the site. The conditions encountered during our initial geotechnical investigation were found to be consistent with those encountered more recently. As such, our comments and recommendations provided in our initial geotechnical investigation report are considered valid and should be adhered to.

The grade of the property slopes down to Rambo Creek to the east, and as such it is prudent to assess the stability of the existing slope with respect to the proposed construction. It is our understand that this section of Rambo Creek does not fall under the jurisdiction of Conservation Halton [CH], however, our stability assessment has been conducted in general accordance with the guideline policies of CH, including the Natural Hazards Technical Guide by Ministry of Natural Resources [MNR] and the supporting document "Geotechnical Principles for Stable Slopes".

2. PROCEDURE

A total of two [2] sampled boreholes [Borehole Nos. 101 and 102] were advanced at the locations illustrated on the enclosed Drawing No. 1, Slope Profile and Borehole Location Plan. The boreholes were advanced using continuous flight power auger equipment on February 9, 2017, under the direction and supervision of a representative of SOIL-MAT ENGINEERS, to sampling spoon refusal at depths of approximately of 3.5 and 1.7 metres beneath the existing ground surface. Upon completion of drilling, the boreholes were backfilled in general accordance with Ontario Regulation 903.

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 recovered from the borehole 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.

Additionally, two [2] representative slope profiles of the subject slope were measured at the locations illustrated in the Slope Profile and Borehole Location Plan. The slope profiles have been illustrated in the attached Drawing Nos. 2 and 3, Slope Profiles A-A and B-B. A Slope Stability Rating Chart, as outlined in the Geotechnical Principles for Stable Slopes document was completed for the subject slope, which indicated a Rating Value of 32, corresponding to a slight potential for slope instability. A copy of the Slope Stability Rating Chart has been appended to the end of this report.

The ground surface elevation at the borehole and slope profile locations has been referenced to a site specific benchmark, described as the manhole cover located in front of 417 Martha Street, as indicated on the Slope Profile and Borehole Location Plan. This temporary benchmark has been assigned an elevation of 100.00 metres for convenience.

Details of the conditions encountered in the borehole, together with the results of the field and laboratory tests, are presented in Log of Borehole No. 101 and 102 following the text of this report. It is noted that the boundaries of soil types indicated on the borehole log are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed at the exact depths of geological change.

3. SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The project site is located in Burlington, Ontario and includes 401 to 417 Martha Street. With Martha Street taken as running north-south, the study area is bound to the east by the valley lands of Rambo Creek, to the south by a multi-story apartment building, to the west by Martha Street, and to the north by the Waterfront Trail. The properties that constitute the subject site are currently occupied by vacant 1-2 storey single family residential dwellings facing onto Martha Street. The subject lands are relatively flat and even with Marth Street, sloping down from Martha Street east to the creek valley.

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

Topsoil

A surficial layer of topsoil approximately 100 to 150 millimetres in thickness was encountered at both borehole locations. It is noted that the depth of topsoil might vary across the site and from the depths encountered at the borehole locations. It should also be noted that the term 'topsoil' has been used from a geotechnical point of view, and does not necessarily reflect the material's nutrient content or ability to support plant life.

Silty Sand Fill

Silty sand fill was encountered beneath the topsoil at both borehole locations. This fine grained fill material was brown in colour, contained traces of gravel and construction debris, and was generally in a loose to very loose condition. The silty sand was proven to depths of approximately 2.5 and 1.0 metres beneath the existing ground surface in Borehole Nos. 101 and 102, respectively.

Queenston Shale

Queenston Shale was encountered beneath the fill deposit at both borehole locations. The Shale was red, severely weathered in the upper levels, becoming sounder with depth, and containing occasional more resistant grey layers. The degree of weathering in the upper levels of the Queenston Shale is such that it tends to exhibit the properties of a hard cohesive soil, or weak rock, as evidenced by the ability to penetrate the bedrock with the solid stem augers of the drill.

Groundwater Observations

Both boreholes were recorded as 'dry' upon completion of drilling. It should be noted that insufficient time would have passed for the static groundwater level to stabilise in the open boreholes. Based on the measurements from the monitoring well installed during the initial geotechnical investigation work, the static groundwater level is estimated at depths of approximately 5 metres below the ground surface at the roadway, gradually falling to the level of Rambo Creek at the rear of the property.

4. SLOPE CONDITIONS AND STABILITY ASSESSMENT

The subject slope was noted to have a height of approximately 3.1 to 3.3 metres, measured from the back of the existing houses to the creek level. Local inclinations on the slope range from as steep as 1.1 horizontal to 1 vertical to flatter than 3.0 to 1.0, with overall inclinations ranging from approximately 2.4 horizontal to 1.0 vertical to greater than 6.0 horizontal to 1.0 vertical. The slope is well vegetated with some young to mature trees and scrub vegetation.

Slope Profile A-A was noted to have an overall inclination of approximately 2.4 horizontal to 1 vertical, but to be as steep as 1.1 horizontal to 1 vertical. Slope Profile B-B was noted to have an overall inclination of approximately 6.5 horizontal to 1.0 vertical, with a very gradual drop in elevation to the level of Rambo Creek. It is noted that slopes in native soils at inclinations flatter than 3 horizontal to 1 vertical are generally regarded as being inherently stable.

Isolated evidence of minor surficial movement was noted along the face of the slope, as well as occasional bowing and tilting of trees. No active erosion was observed from drainage over the face of the slope. No significant slump scars or evidence of landslide activity were noted. As the slope appears to have constructed by the placement of relatively uncontrolled fill material, minor movements should be anticipated over time as the slope flattens to inclinations of approximately 2.5 horizontal to 1.0 vertical, or flatter.

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. It should be noted that this type of degeneration is a very slow process, as is evident by the observed condition of the existing slope.

Stability analyses of the subject slope were performed with a computerized modeling program [SLOPE/W 2007] considering appropriate material parameters and elevated groundwater conditions, and considering multiple potential failure planes. Conservative soil parameters were assigned to the soil strata encountered based on our finding in the borehole, and have been summarised as follows:

Soil	Unit weight, γ	Friction angle, ϕ	Cohesion , c
Silty Sand Fill	19.0 kN/m^3	26°	0 kPa
Weathered Queenston Shale	20.0 kN/m^3	45°	10 kPa

Stability analyses were completed considering both a typical and elevated groundwater conditions. These analyses yielded minimum factors of safety on the order of approximately 1.14 and 1.03 for Slope Profile A-A under normal conditions, and considering an elevated groundwater condition. Results for Profile B-B yielded factor of safety of well over 3, consistent with the relatively flat inclination of the slope at that section. It is noted that theoretical surficial failures planes would exist with lower calculated factors of safety, however, these insignificant failure plans do not account for the stabilising effect of vegetation and would not impact the global stability of the slope. Sample results of these analyses are appended to this report.

Table 7.2 of the Geotechnical Principles for Stable Slopes [Ministry of Natural Resources] lists a Design Minimum Factor of Safety of between 1.3 and 1.5 for 'Active' land use properties [habitable or unoccupied structures near slope]. As much of the slope is notably flatter than 3.0 Horizontal to 1.0 Vertical, the slope would predominately be considered to be stable in the short and long term. Steeper sections of the slope, such as measured in Slope Profile A-A with minimum factors of safety on the order of 1.03 to 1.14 as noted above, are noted to fall below this range, and would be considered as meta-stable, and would be expected to see slow continual degradation of the slope over time.

5. SLOPE STABILISATION RECOMMENDATIONS

It is anticipated that the majority of the slope will be reconstructed as part of the construction of the proposed development. Given the established condition of the slope, with loose deposits of evidently uncontrolled silty sand fill, it would be prudent to employ stabilisation measures to limit future movements and increase stabilisation of the slope, including the construction of retaining wall structure, soil anchors, or reinforced earth embankments.

RETAINING WALL STRUCTURES

In the event that the proposed development would not allow for grading of the slope in its current state at stable slope inclinations, the slope may be stabilised with the installation of a retaining wall system where necessary. Such systems would consist of a cast in place reinforced concrete structure, segmental pre-cast concrete or armour stone units, or a reinforced earth section incorporating imported granular material and a geo-grid product. The provision of proper drainage and base preparation will be essential to the long-term performance of any retaining structure.

The base of the retaining wall will need to extend below the fill materials and be founded on the weathered Queenston shale bedrock. The foundations for the retaining walls founded on weathered Queenston shale may be designed on the basis of 500 kPa [~10,000 psf] SLS and 750 kPa [~15,000 psf] ULS. The retaining wall design should also consider an active earth pressure coefficient of k_a = 0.33 and a backfill unit weight of 20.0 kN/m^3. Following design of the retaining wall system, the global stability of the retaining wall should be assessed by this office.

ENGINEERED EARTH EMBANKMENT

Alternatively, the slope may be reconstructed as an engineered earth embankment. This approach would involve the removal of the fill materials and replacement of the sub-excavated material with an engineered fill mass. The engineered fill should be properly compacted in lifts to a minimum of 98 percent of standard Proctor maximum dry density, to achieve long-term stable inclination of as much as 2 horizontal to 1 vertical. Where steeper inclinations are required, this may be achieved by incorporating reinforcing geogrid products [and drainage layers] into the fill mass. Such geogrid reinforced engineered embankment systems are generally proprietary in nature; as such the product suppliers should be contacted to aid in the development of a detailed design. The face of the complete embankment should be properly vegetated, making use of

available geotextile and matting systems to aid in the establishment and maintenance of vegetation.

It is noted that an engineered earth embankment option would have the benefit of providing an essentially 'green' finished slope face. Geogrid materials over the surface of the slope provide support to establish new vegetation, even at slope inclinations as steep as 1 horizontal to 1 vertical. Once vegetation is established the stabilising systems would be essentially invisible. Once the preferred slope stabilisation option has been selected this office should be contacted to review and comment on the detailed design, to ensure that the geotechnical comments and recommendations provided in this report have been properly considered.

6. CONSTRUCTION CONSIDERATIONS

It is our opinion, based on our assessment, that the existing slope is considered to be generally stable in the short term, but would be prone to localised movement and failures due to the condition of the silty sand fill soils. As such it would be prudent to incorporate stabilisation efforts as part of construction of the proposed multi-storey building. The following recommendations should be considered in the proposed development with respect to the slope:

- 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. This would be readily achieved with the provision of a single basement level below the existing roadway, with a founding level extending into the Queenston Shale.
- Drainage towards the slope should be unaltered as much as possible. Any surface flows towards the slope should be in a controlled manner, such as through established grass, to avoid increased or concentrated flows onto the slope.
- Trees and vegetation in the vicinity of the slope, away from the portions to be reconstructed, should be protected from damage. No alterations should be made to existing trees without retaining the services of a qualified arbourist.
- This office should be retained to review the final retaining wall or engineered embankment design to confirm conformance with the recommendations of this report, and conduct applicable global stability checks.

We trust that this slope assessment report is sufficient for your present requirements. Should there be any questions regarding the content or comments within this report please do not hesitate to contact our office.

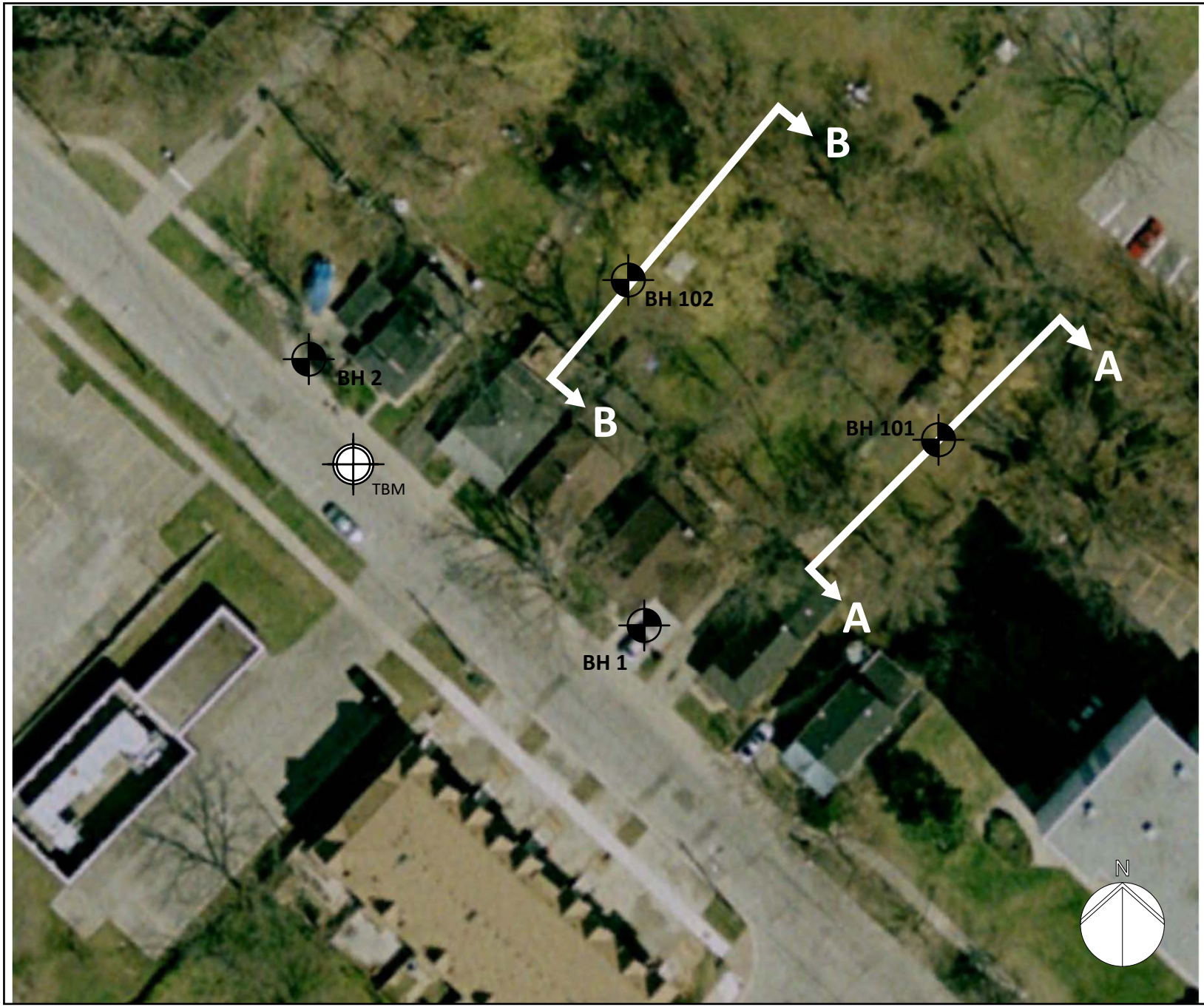
Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

Matt LiVecchi, B.Eng., EIT

Ian Shaw, P. Eng.
Senior Engineer

Enclosures: Drawing No. 1, Borehole and Slope Profile Location Plan
Borehole Log Nos. 101 and 102
Drawing No. 2 and 3, Slope Profiles A-A and B-B
Slope Stability Rating Chart
Slope/W analyses Results

Distribution: Landform Development Group Inc. [1, plus pdf]



LEGEND

BH# Borehole Location

Slope Profile Location

TBM Temporary Benchmark

NOTES

1. This drawing should be read in conjunction with SOIL-MAT ENGINEERS & CONSULTANTS LTD. Supplemental Report No. SM 166905-G.

2. Slope profile and borehole locations are approximate.

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Supplemental Slope Stability Assessment
Proposed Condominium Building
401 - 417 Martha Street
Burlington, Ontario

Slope Profile and Borehole Location Plan

Project No. SM 166905-G

Date: March 2017

Drawn: ML	Checked: IS

SM 166905-G Slope Profile and Borehole Location Plan

Drawing No. 1

Project No: SM 166905-G

Project: Slope Stability Assessment

Location: 401-417 Martha St., Burlington, ON

Client: Landform Development Group Inc.

Log of Borehole No. 101

Project Manager: Ian Shaw, P.Eng.

Borehole Location: See Drawing No. 1

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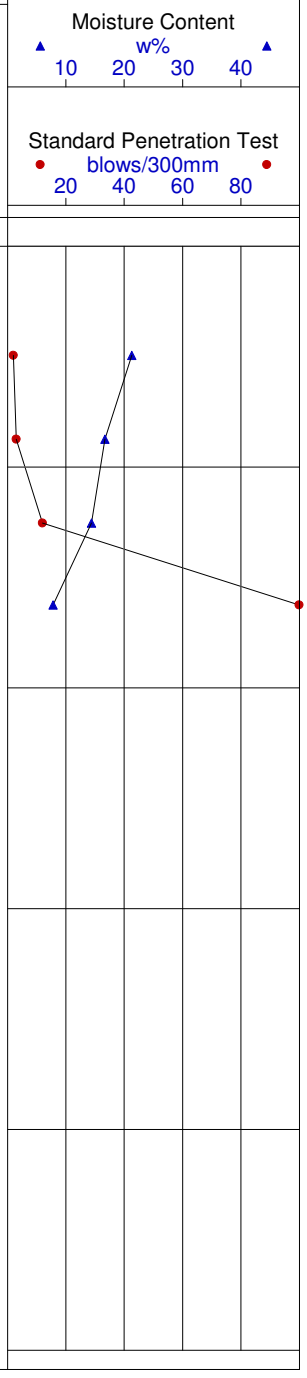
SUBSURFACE PROFILE

SAMPLE

Depth (ft)	Depth (m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
		97.65		Ground Surface								
0	0			**Topsoil** Approximately 100 millimetres of overlying topsoil.								
2				**Silty Sand Fill** Brown, with trace gravel, brick, and debris, very loose to loose.		SS	1	1,1,1	2			
4												
6	2					SS	2	2,1,2	3			
8		95.10				SS	3	3,5,7	12			
10				**Queenston Shale** Red, severely weathered in the upper level, becoming more sound with depth, with occasional more resistant grey layers, hard in terms of soil.								
12	4	94.20		End of Borehole		SS	4	40,24, 50/3"	100			
14												
16												
18												
20	6											
22												
24												
26	8											
28												
30												
32												



NOTES:

1. Borehole was advanced using solid stem auger equipment on February 9, 2017 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: February 9, 2017
Hole Size: 150mm
Drill Contractor: Determination

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Datum: Temporary Benchmark
Field Logged by: RM
Checked by: IS
Sheet: 1 of 1

Project No: SM 166905-G

Project: Slope Stability Assessment

Location: 401-417 Martha St., Burlington, ON

Client: Landform Development Group Inc.

Log of Borehole No. 102

Project Manager: Ian Shaw, P.Eng.

Borehole Location: See Drawing No. 1

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SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Elevation [m]	Description	Well Data
0	0	96.70	Ground Surface	
			Topsoil Approximately 150 millimetres of overlying topsoil.	
		95.70	**Silty Sand Fill** Brown, with trace clay, gravel, and debris, loose.	
		95.00	**Queenston Shale** Red, severely weathered in the upper level, becoming more sound with depth, with occasional more resistant grey layers, hard in terms of soil.	
			End of Borehole	

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	17,24,44	68			
SS	2	25,50/2"	100			

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 February 9, 2017 to termination at a depth of 1.7 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: February 9, 2017

Hole Size: 150mm

Drill Contractor: Determination

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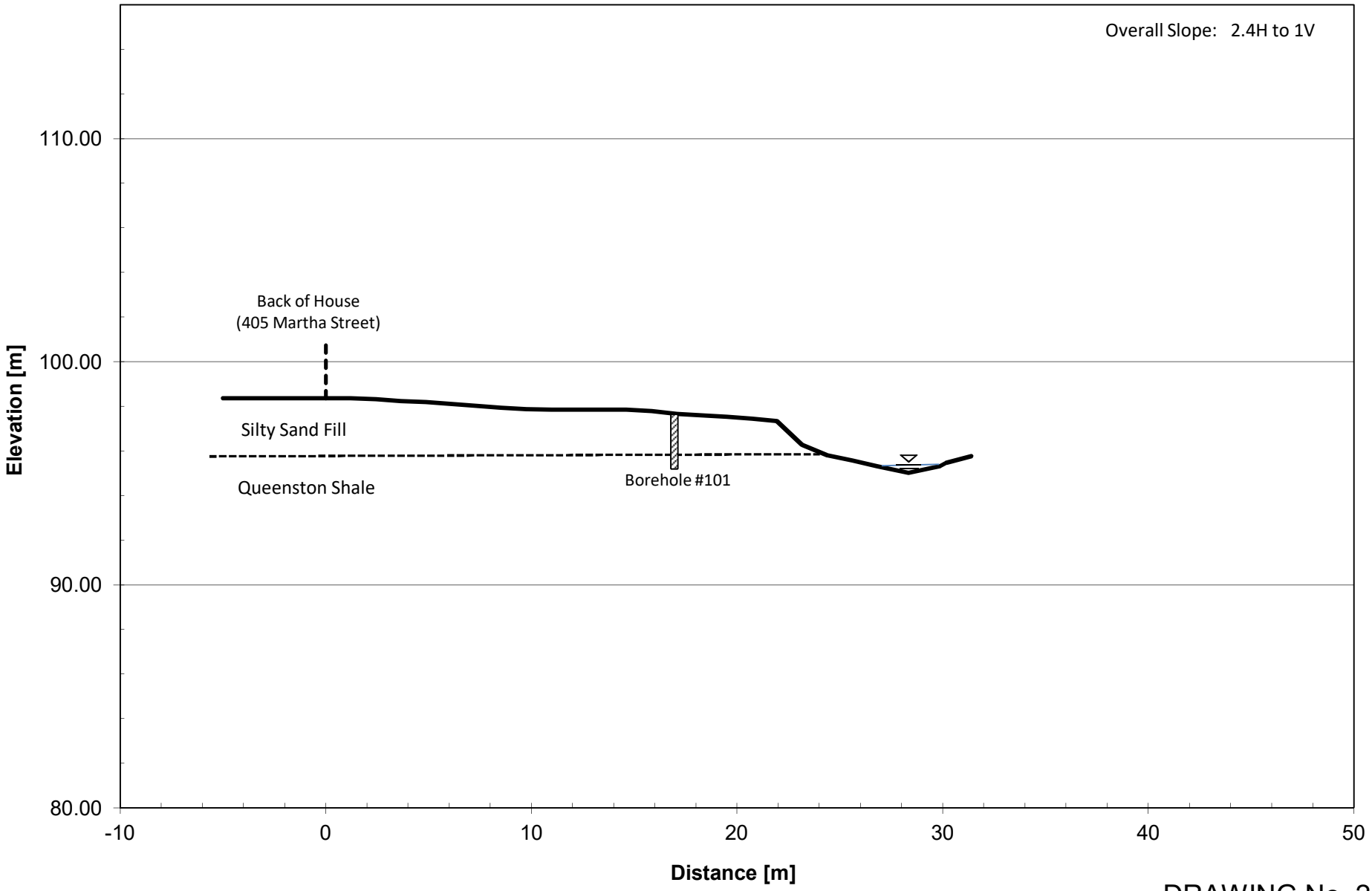
Datum: Temporary Benchmark

Field Logged by: RM

Checked by: IS

Sheet: 1 of 1

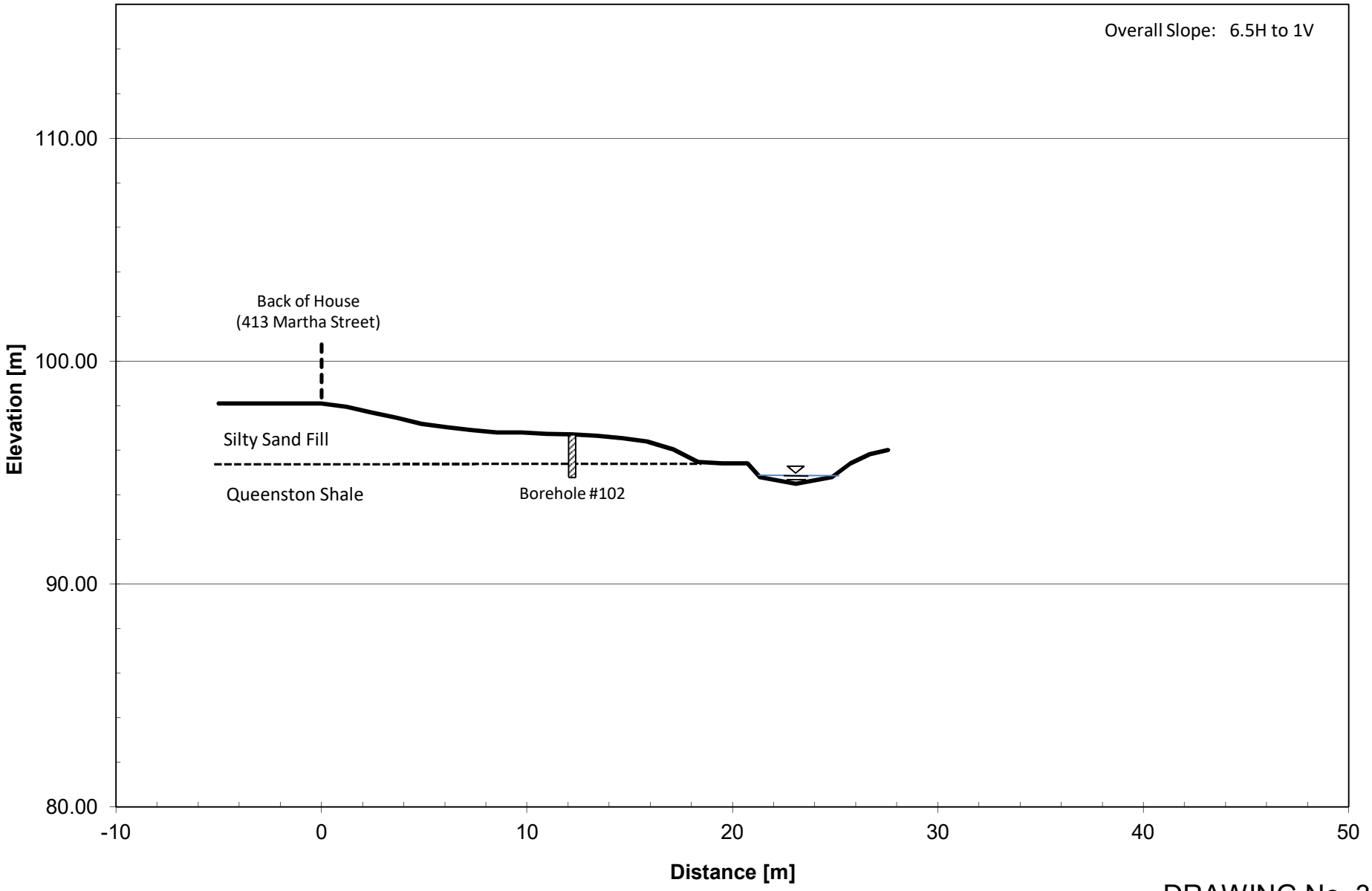
Slope Stability Analysis
Proposed Condominium Building
401 - 417 Martha Street, Burlington
Slope Profile A-A



Project No.: SM 166905-G

DRAWING No. 2

Slope Stability Analysis
Proposed Condominium Building
401 - 417 Martha Street, Burlington
Slope Profile B-B



Project No.: SM 166905-G

DRAWING No. 3

TABLE 8.1 - SLOPE STABILITY RATING CHART

Site Location: 401~417 Martha Street, Burlington File No.
Property Owner: Inspection Date: Feb 9, 2017
Inspected By: Weather:

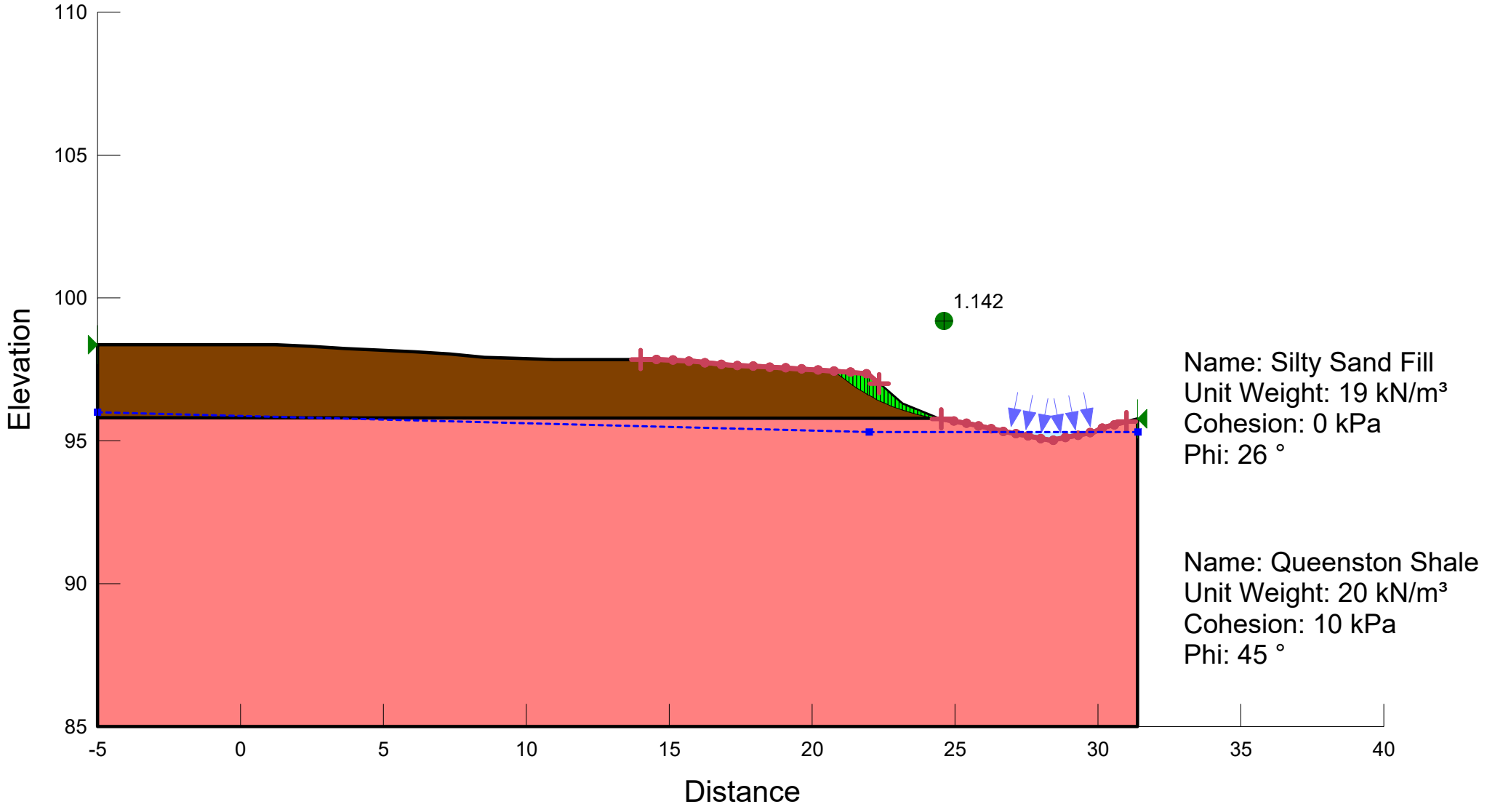
				Rating Value
1.	**SLOPE INCLINATION**			
		degrees	**horiz. : vert.**	
	a)	18 or less	3 : 1 or flatter	0
	b)	18 - 26	2 : 1 to more than 3 : 1	(6)
	c)	more than 26	steeper than 2 : 1	16
2.	**SOIL STRATIGRAPHY**			
	a)	Shale, Limestone, Granite (Bedrock)		0
	b)	Sand, Gravel		6
	c)	Glacial Till		9
	d)	Clay, Silt		12
	e)	Fill		(16)
	f)	Leda Clay		24
3.	**SEEPAGE FROM SLOPE FACE**			
	a)	None or Near bottom only		(0)
	b)	Near mid-slope only		6
	c)	Near crest only or, From several levels		12
4.	**SLOPE HEIGHT**			
	a)	2 m or less		0
	b)	2.1 to 5 m		(2)
	c)	5.1 to 10 m		4
	d)	more than 10 m		8
5.	**VEGETATION COVER ON SLOPE FACE**			
	a)	Well vegetated; heavy shrubs or forested with mature trees		(0)
	b)	Light vegetation; Mostly grass, weeds, occasional trees, shrubs		4
	c)	No vegetation, bare		8
6.	**TABLE LAND DRAINAGE**			
	a)	Table land flat, no apparent drainage over slope		0
	b)	Minor drainage over slope, no active erosion		(2)
	c)	Drainage over slope, active erosion, gullies		4
7.	**PROXIMITY OF WATERCOURSE TO SLOPE TOE**			
	a)	15 metres or more from slope toe		0
	b)	Less than 15 metres from slope toe		(6)
8.	**PREVIOUS LANDSLIDE ACTIVITY**			
	a)	No		(0)
	b)	Yes		6

SLOPE INSTABILITY RATING	**RATING VALUES TOTAL**	**INVESTIGATION REQUIREMENTS**	**TOTAL**
			32

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	Boreholes, piezometers, lab tests, surveying, detailed report.

NOTES: a) Choose only one from each category; compare total rating value with above requirements.
b) If there is a water body (stream, creek, river, pond, bay, lake) at the slope toe; the potential for toe erosion and undercutting should be evaluated in detail and, protection provided if required.

Slope Stability Assessment
Proposed Condominium Building
401- 417 Martha Street, Burlington,ON
Profile A-A



Slope Stability Assessment
Proposed Condominium Building
401- 417 Martha Street, Burlington,ON
Profile A-A