SOIL-MAT ENGINEERS & CONSULTANTS LTD.

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PROJECT NO.: SM 177692-G September 27, 2017

THINKGIRAFFE ENVIRONMENTAL DESIGN
16 Sulphur Springs Road
Ancaster, Ontario
L9G 1L8

Attention: Marina Fensham

SLOPE STABILITY ASSESSMENT
PROPOSED MULTI-STOREY APARTMENT BUILDING
4063 UPPER MIDDLE ROAD
BURLINGTON, ONTARIO

Dear Ms. Fensham,

Further to your authorization, SOIL-MAT ENGINEERS & CONSULTANTS LTD. has completed the fieldwork, slope stability analysis, and report preparation in connection with the above noted project. This slope stability assessment was conducted in general accordance with our email correspondence, dated July 26, 2017. Our comments and recommendations based on our field observations and analyses are presented in the following paragraphs.

INTRODUCTION

We understand that the proposed project will include the construction of a multi-storey condominium building, with a single basement level, at 4063 Upper Middle Road in Burlington Ontario. As the property slopes down to the northeast towards creek valley lands under the jurisdiction of the Conservation Halton [CH], permit approval will be required from CH for any construction near the slope.. In order to support permit approval for the proposed construction, a slope stability assessment including the determination of the long-term top of stable slope location is required. It is noted that our office has previously conducted a site specific geotechnical investigation for the proposed building [SM 135055-G, dated May 16, 2013]. The subsurface soil information from that investigation has been referenced in preparing this slope assessment report.

The purpose of this slope stability assessment was to evaluate the stability of the existing slope, and determine the top of stable slope location, in general accordance with the applicable guideline policies of CH. Our comments and recommendations, with respect to the stability of the existing slope and the proposed construction, from a

geotechnical point of view, are presented herein. This work has been conducted in general accordance with the guideline policies of CH, including the Natural Hazards Technical Guide by MNR and the supporting document "Geotechnical Principles for Stable Slopes".

PROCEDURE

The fieldwork consisted of a visual evaluation of the subject slope and the measurement of three representative slope profiles. The slope profiles were measured from the above the physical crest to beyond the toe of the slope. The locations of the slope profiles have been illustrated on the attached Drawing Nos. 1 and 1A, Slope Profile Location Plans, while the slope profiles themselves are illustrated in the attached Drawing Nos. 2, 3, and 4, Slope Profiles A-A, B-B, and C-C. The start of the slope profiles was assigned an assumed elevation of 100.00 metres for convenience.

In addition, a Slope Stability Rating Chart, as per the Ontario Ministry of Natural Resources publication "Geotechnical Principles for Stable Slopes" [Geotechnical Principles publication] was completed and indicated a Rating Value of 22, which indicates a slight potential for slope instability [site inspection, preliminary study, report letter]. A copy of the Slope Stability Rating Chart has been attached to this letter report.

SITE DESCRIPTION AND SUBSURFACE CONDITIONS

The subject property is located at 4063 Upper Middle Road in Burlington, Ontario. The property is currently vacant, with an excavation near the roadway from where the foundations from a single family dwelling was demolished. The property is relatively even with the roadway, generally flat over the majority of the site, with a slight fall to the north. To the northeast the property slopes down to valley lands, and eventually to the creek beyond.

The subsurface conditions encountered in the boreholes from our referenced previous investigation were found to consist of clayey silt overburden soils, overlying Queenston shale at a depth of approximately 4 metres. A review of available published information [Quaternary Geology of Ontario, Southern Sheet Map 2556] indicate the subsurface soils to consist of Halton till, comprised predominantly of silt and clay. This is consistent with the conditions noted above during our investigation and our experience in the area, which has found the overburden soils to consist typically of clayey silt to silty clay, generally stiff to very stiff in consistency.

SLOPE CONDITIONS AND STABILITY ASSESSMENT

The subject slope was noted to have a height of approximately 3.6 metres and an overall inclination of approximately 1.8 to 3.8 horizontal to 1 vertical. The slope is well vegetated with young to mature trees as well as scrub vegetation. There was no evidence of failure scars, past landslides, or other instability of the slope noted at the time of our evaluation.

As with all slopes, there is a reduction in 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 degeneration of the slope angle is a very slow process as is evident by the condition of the existing slope. The slope has evidently remained stable for a long period of time with only imperceptibly slow flattening.

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 boreholes of our previous investigation, and have been summarised as follows:

Soil	Unit weight, γ	Friction angle, ϕ	Cohesion , c
Clayey Silt	19.0 kN/m^3	34°	10 kPa
Queenston Shale	20.0 kN/m^3	40°	10 kPa

Based on our analyses, the subject slope was found to have minimum factors of safety for Profiles A-A, B-B, and C-C on the order of 3.36, 6.23, and 2.70, respectively, for normal conditions, and on the order of 2.82, 5.94, and 2.38 for elevated groundwater conditions. Sample results of these analyses are attached to the end of this report.

The Ministry of Natural Resources "Geotechnical Principles for Stable Slopes" publication, Table 7.2 lists a minimum Factor of Safety of 1.3 to 1.5 for Active Land Use application [habitable or occupied structures]. As the calculated factors of safety were found to far exceed this range, the subject slope is considered stable in its present condition in the short and long-term.

TOP OF STABLE SLOPE

The top of stable slope location is determined by the application of an erosion allowance at the toe and a stable slope inclination through the slope. In this case, considering the creek is not near the toe, and there are no signs of active erosion, a conservative erosion allowance of 2 metres has been applied at the toe. Table 4.3 of the Ministry of Natural Resources publication "Geotechnical Principles for Stable Slopes" indicates stable slope inclinations through clays and silts as steep as 2.0 to 4.0 horizontal to 1.0 vertical. Based on the subsurface soil conditions, as described in our report to consist of a very stiff to hard clayey silt, a conservative stable slope allowance of 2.2 horizontal to 1 vertical has been considered. Applying the erosion allowance and stable slope inclination from the 'toe' of the slope provides for a conservative long term top of stable slope location coincidental with the physical crest at Profile B-B, and approximately 2.5 and 4.6 metres 'uphill' from the physical crest, at profiles A-A and C-C, respectively. The top of stable slope line across the property should be interpolated by these 3 points, linearly approaching the physical crest at B-B from both A-A and C-C.

CONSTRUCTION CONSIDERATIONS

As the slope has been established as stable in the short and long-term, with factors of safety exceeding the required acceptable range of 1.3 to 1.5, the proposed construction of a new multi-storey structure uphill of the long term top of stable slope would not be expected to negatively impact the stability of the slope, from a geotechnical engineering point of view.

The following recommendations should be considered in the design and construction of the proposed dwelling:

- Excavated soil and/or heavy construction equipment should not be placed or travel near the crest of the slope. In this regard it is recommended that a silt fence be placed along, or slightly 'uphill' from, the established top of stable slope location for the duration of construction. This will act as a barrier for construction activity and also prevent sediment runoff during construction.
- 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 on and in the vicinity of the slope should be protected from damage. No alterations should be made to trees without retaining the services of an arbourist. As well, vegetation on and above the crest of the slope should be protected as

much as possible, and re-instated or improved as part of the construction in order to further limit the potential for surface erosion.

- All footings must be provided with 1.2 metres of earth cover or equivalent insulation for frost protection. Foundations for the new dwellings must be designed and constructed in accordance with the requirements of the current Ontario Building Code. It is also recommended that all footings be founded at or below a line drawn up at 3 horizontal to 1 vertical from the 'toe' referenced in the determination of the top of stable slope. This will prevent or limit any stress transfer from the load of the new foundations to the face of the slope.

We trust that this geotechnical 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, P. Eng.
Project Engineer

Ian Shaw, P.Eng.
Senior Engineer

Enclosures: Slope Stability Rating Chart
Drawings No. 1 and 1A, Slope Profile Location Plans
Drawing Nos. 2, 3, and 4, Slope Profile A-A, B-B, and C-C
Slope/W analyses results

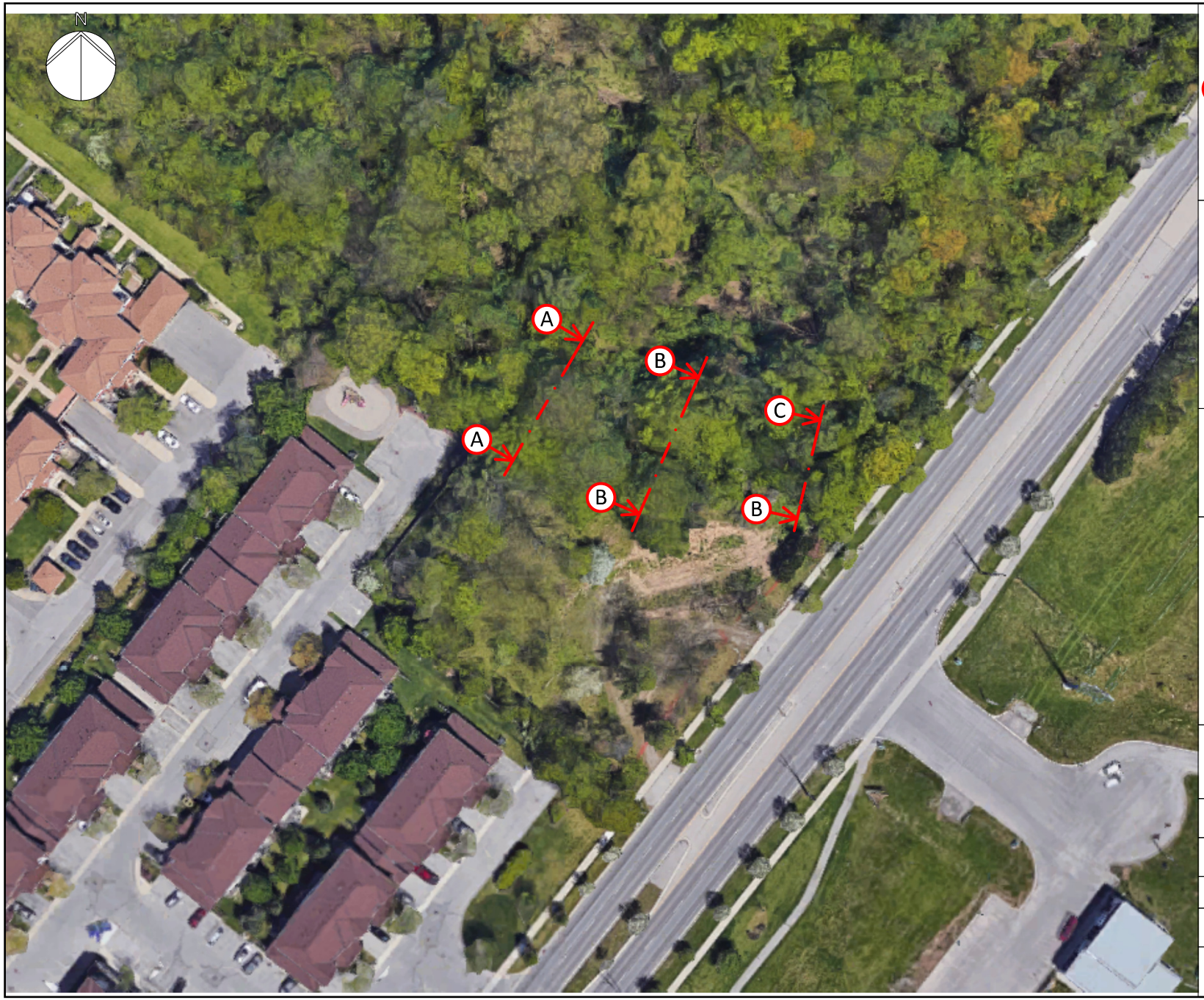
Distribution: thinkGiraffe Environmental Design [1, plus pdf]

TABLE 8.1 - SLOPE STABILITY RATING CHART

Site Location: 4063 Upper Middle File No. 177692
Property Owner: Inspection Date:
Inspected By: Weather:

				Rating Value
1.	**SLOPE INCLINATION**			
		degrees	**horiz. : vert.**	
	a)	18 or less	3 : 1 or flatter	
	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** 22
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.



LEGEND

A A Slope Profile Location

NOTES

1. This drawing should be read in conjunction with SOIL-MAT ENGINEERS & CONSULTANTS LTD. Report No. SM 177692-G.

2. Slope profile location is approximate.

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Slope Stability Assessment
Multi-Storey Apartment Building
4063 Upper Middle Road
Burlington, Ontario

Slope Profile Location Plan

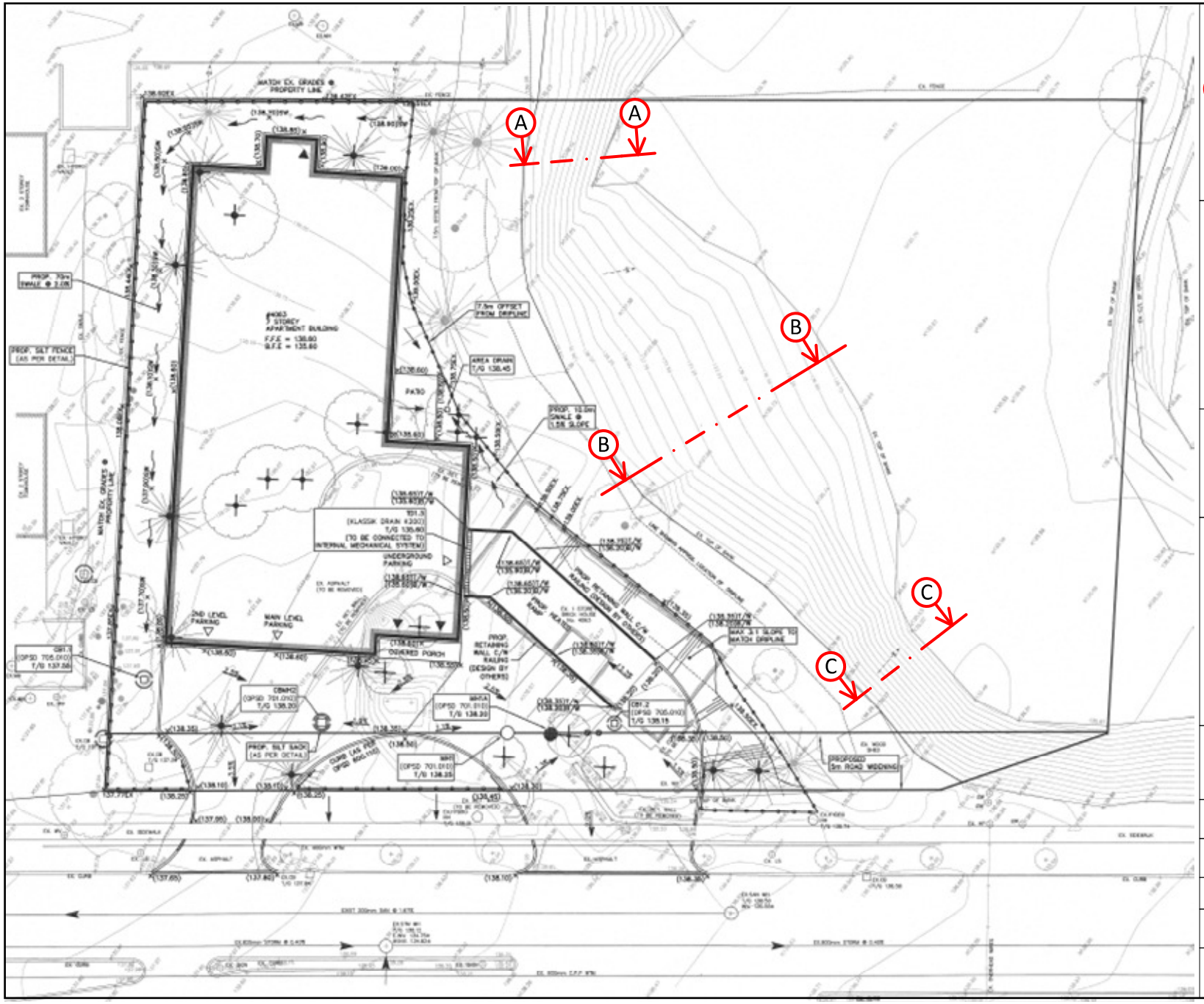
Project No. SM 177692-G

Date: August 2017

Drawn: ML | Checked: IS

SM 177692-G Slope Profile Location Plan

Drawing No. 1



LEGEND

A A Slope Profile Location

NOTES

1. This drawing should be read in conjunction with SOIL-MAT ENGINEERS & CONSULTANTS LTD. Report No. SM 177692-G.

2. Slope profile location is approximate.

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Slope Stability Assessment
Multi-Storey Apartment Building
4063 Upper Middle Road
Burlington, Ontario

Slope Profile Location Plan

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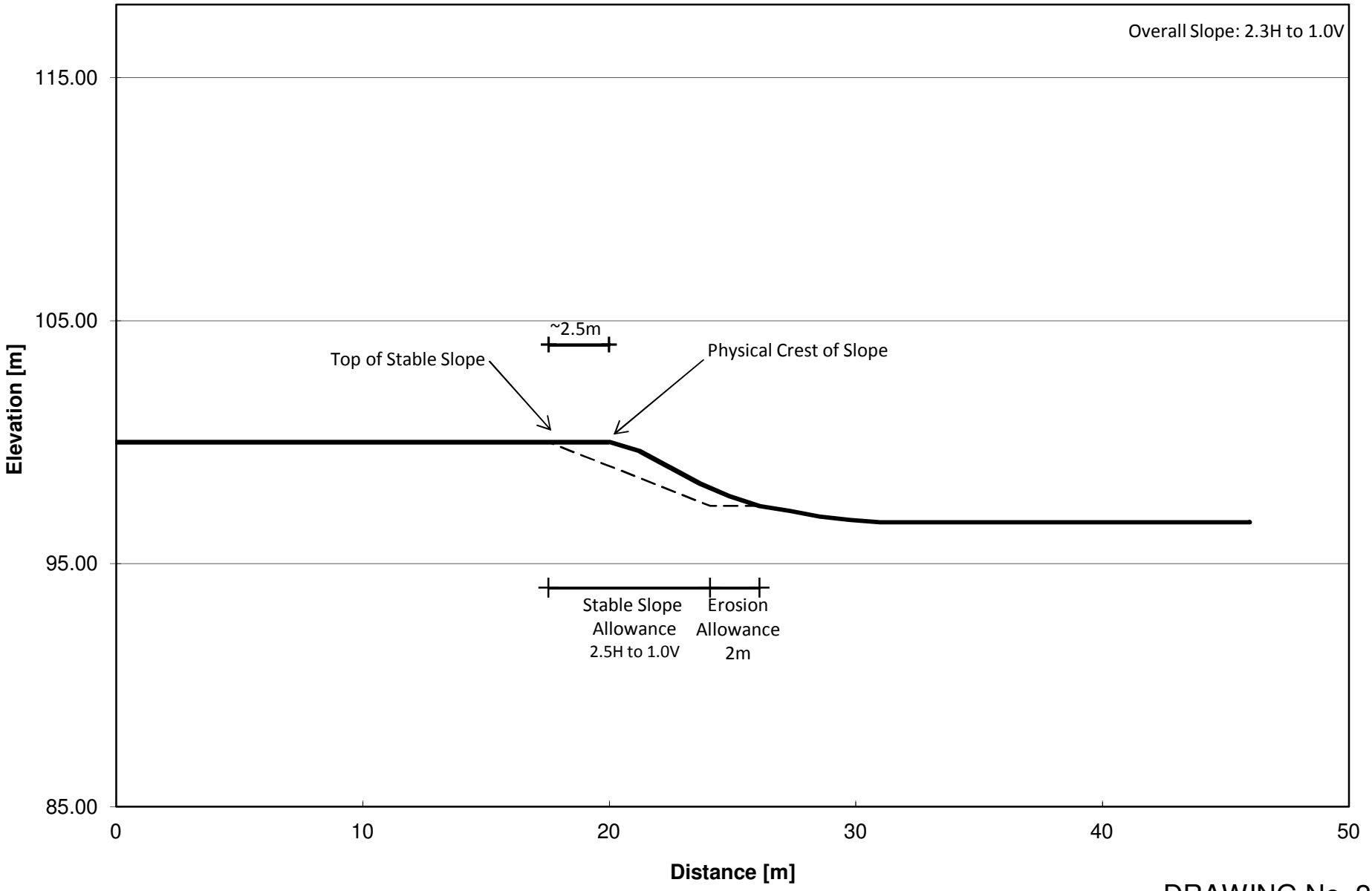
Date: August 2017

Drawn: ML	Checked: IS

SM 177692-G Slope Profile Location Plan1A

Drawing No. 1A

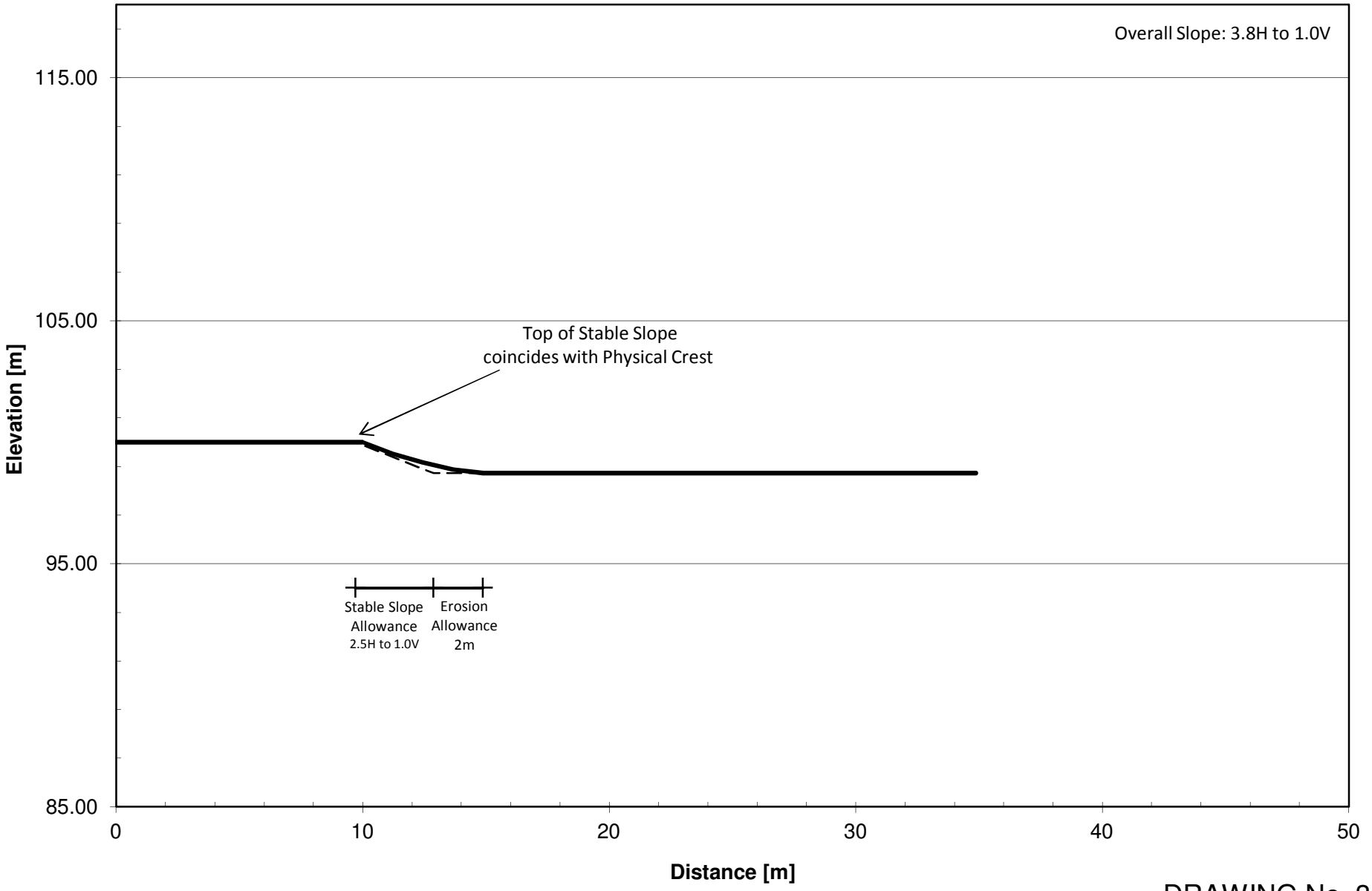
Slope Stability Analysis
4063 Upper Middle Road
Burlington, Ontario
Slope Profile A-A



Project No.: SM 177692-G

DRAWING No. 2

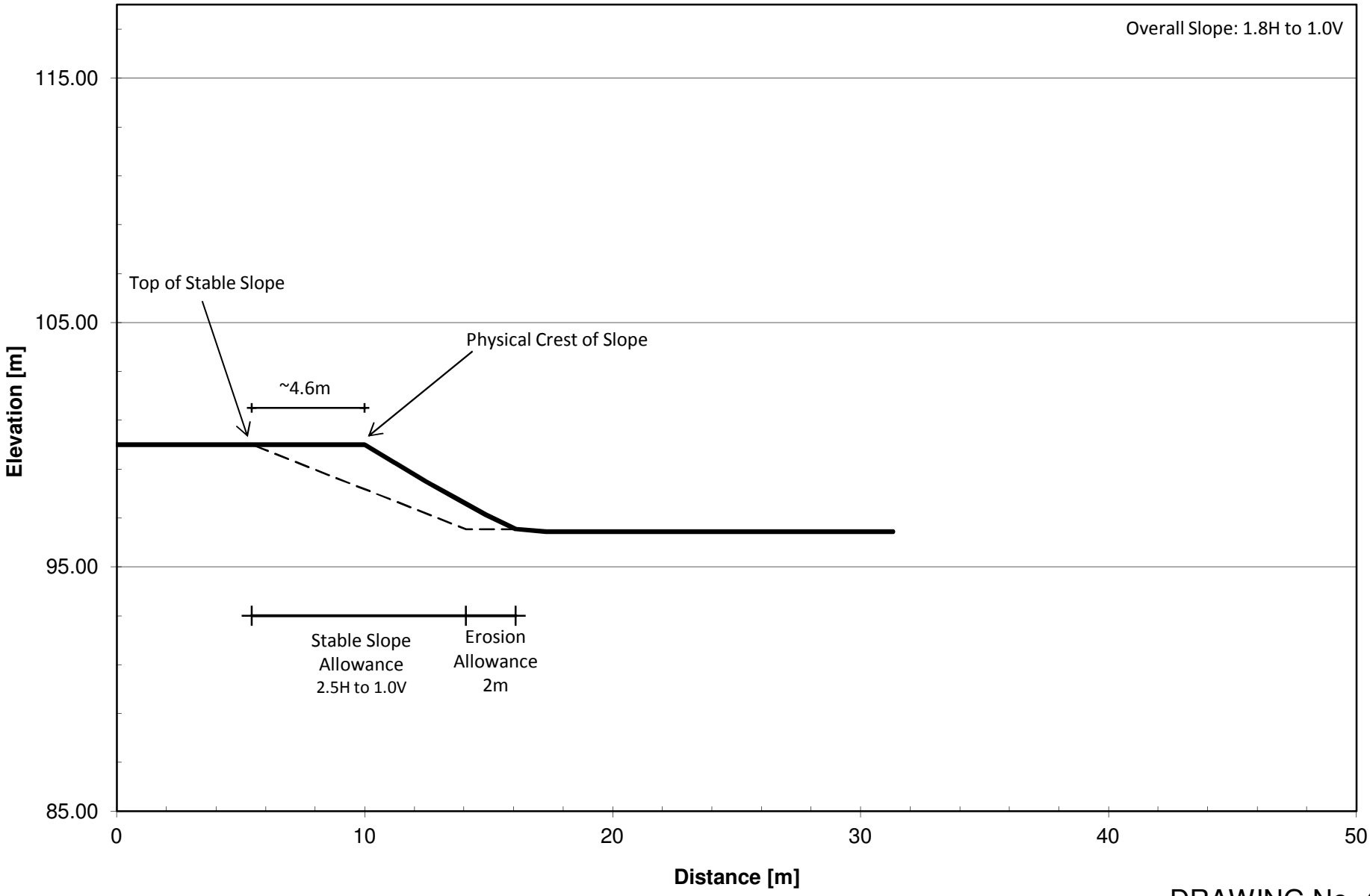
Slope Stability Analysis
4063 Upper Middle Road
Burlington, Ontario
Slope Profile B-B



Project No.: SM 177692-G

DRAWING No. 3

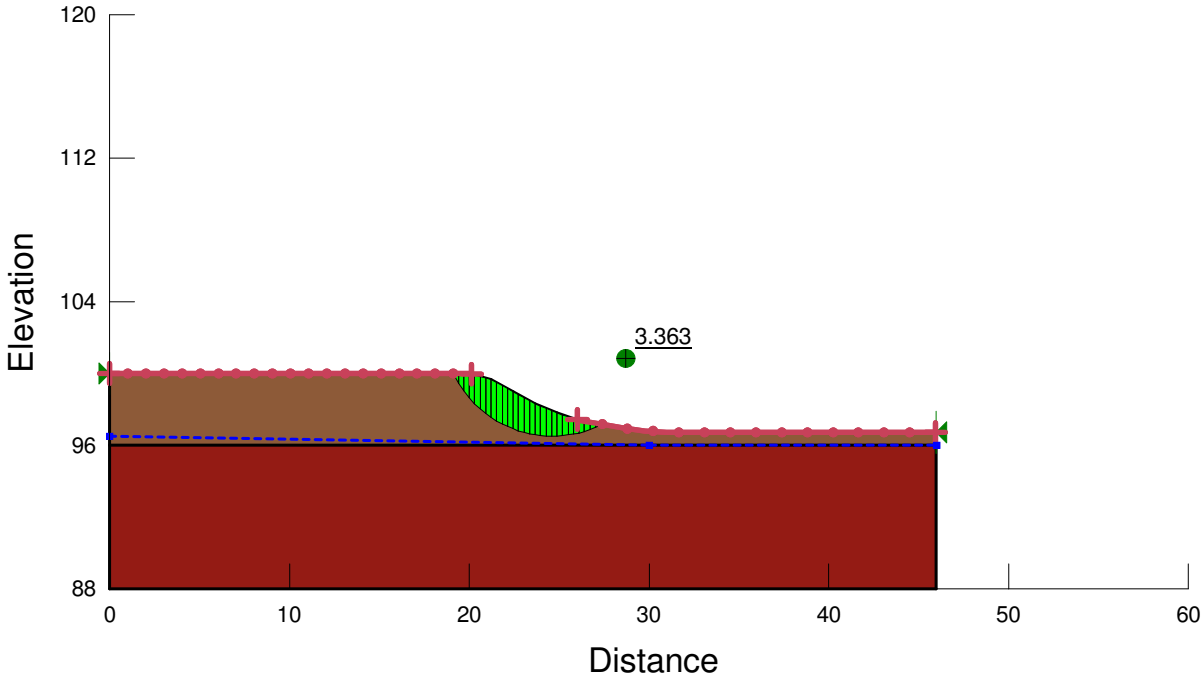
Slope Stability Analysis
4063 Upper Middle Road
Burlington, Ontario
Slope Profile C-C



Project No.: SM 177692-G

DRAWING No. 4

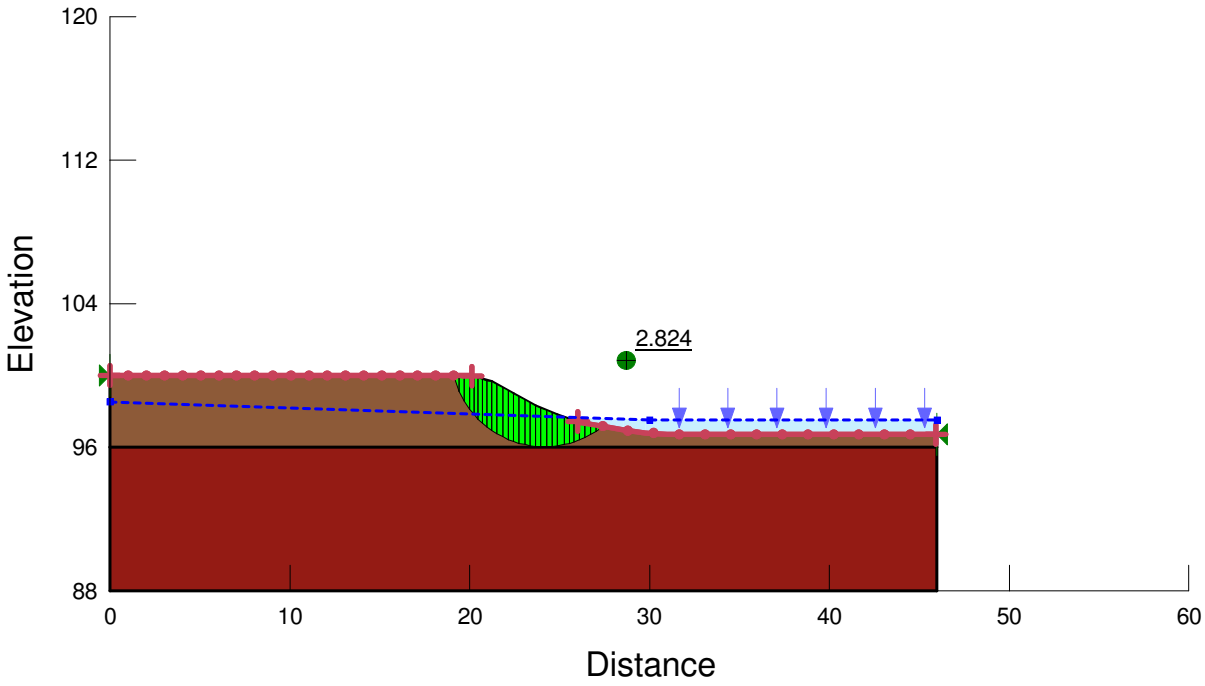
Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile A-A



Name: Clayey Silt
Unit Weight: 19 kN/m³
Cohesion: 10 kPa
Phi: 34 °

Name: Queenston Shale
Unit Weight: 20 kN/m³
Cohesion: 10 kPa
Phi: 40 °

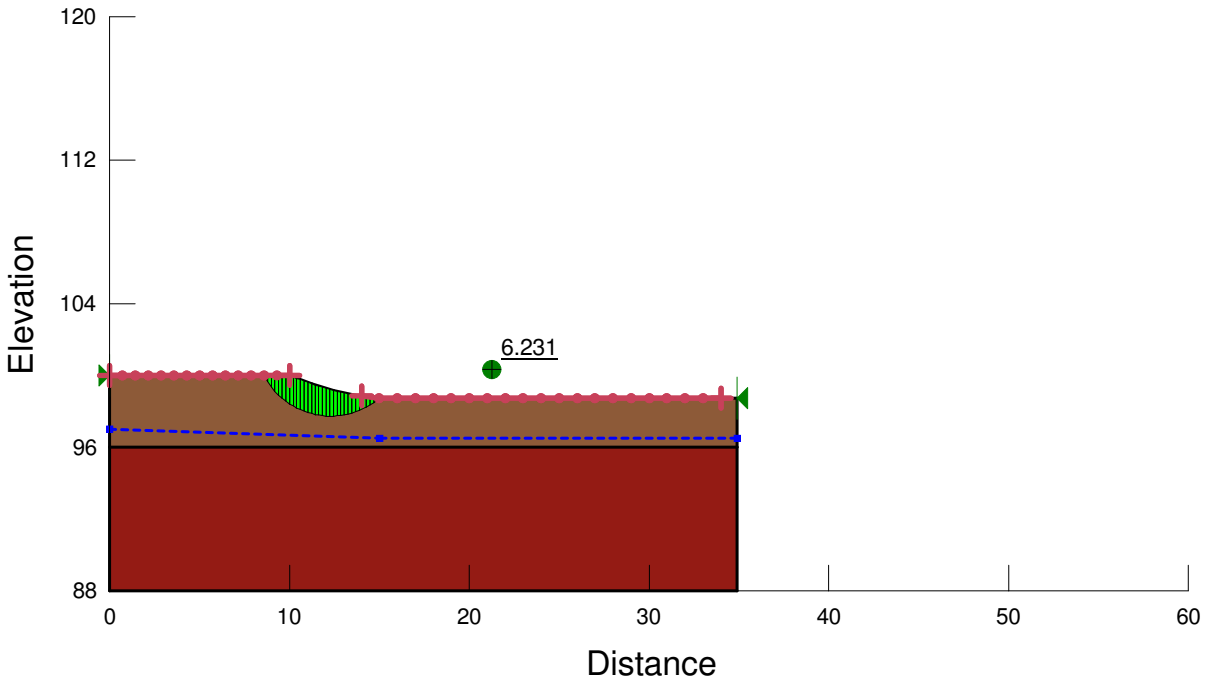
Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile A-A



Name: Clayey Silt
Unit Weight: 19 kN/m³
Cohesion: 10 kPa
Phi: 34 °

Name: Queenston Shale
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Cohesion: 10 kPa
Phi: 40 °

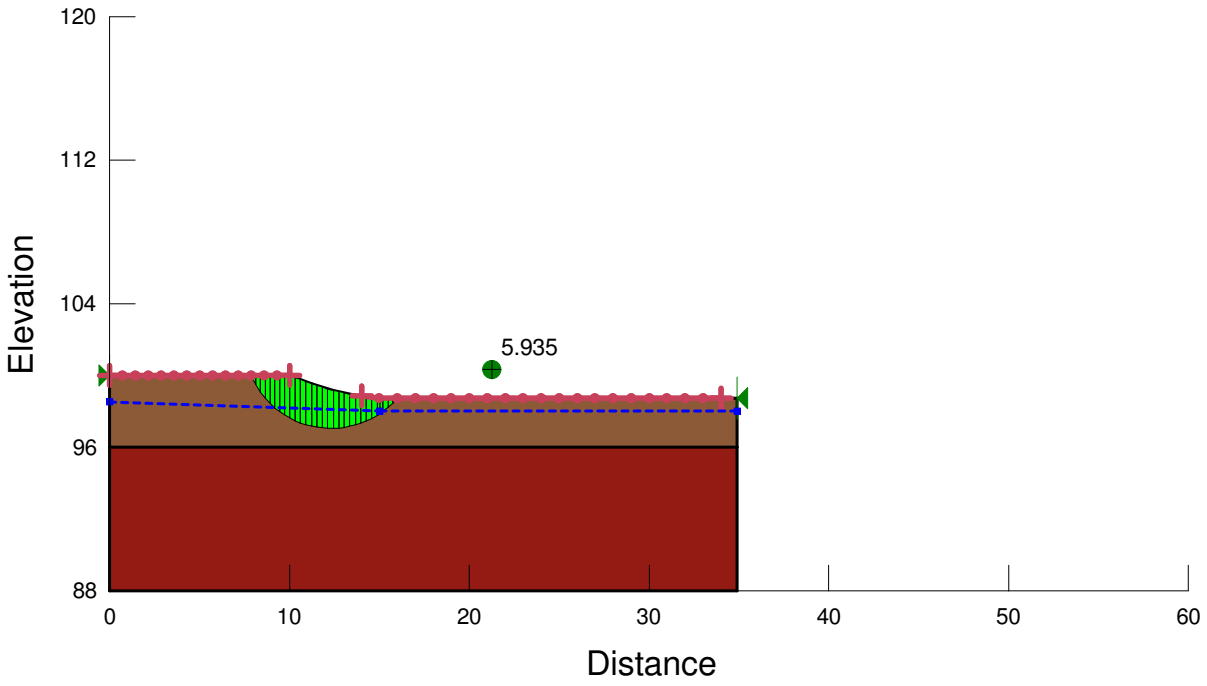
Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile B-B



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Cohesion: 10 kPa
Phi: 34 °

Name: Queenston Shale
Unit Weight: 20 kN/m³
Cohesion: 10 kPa
Phi: 40 °

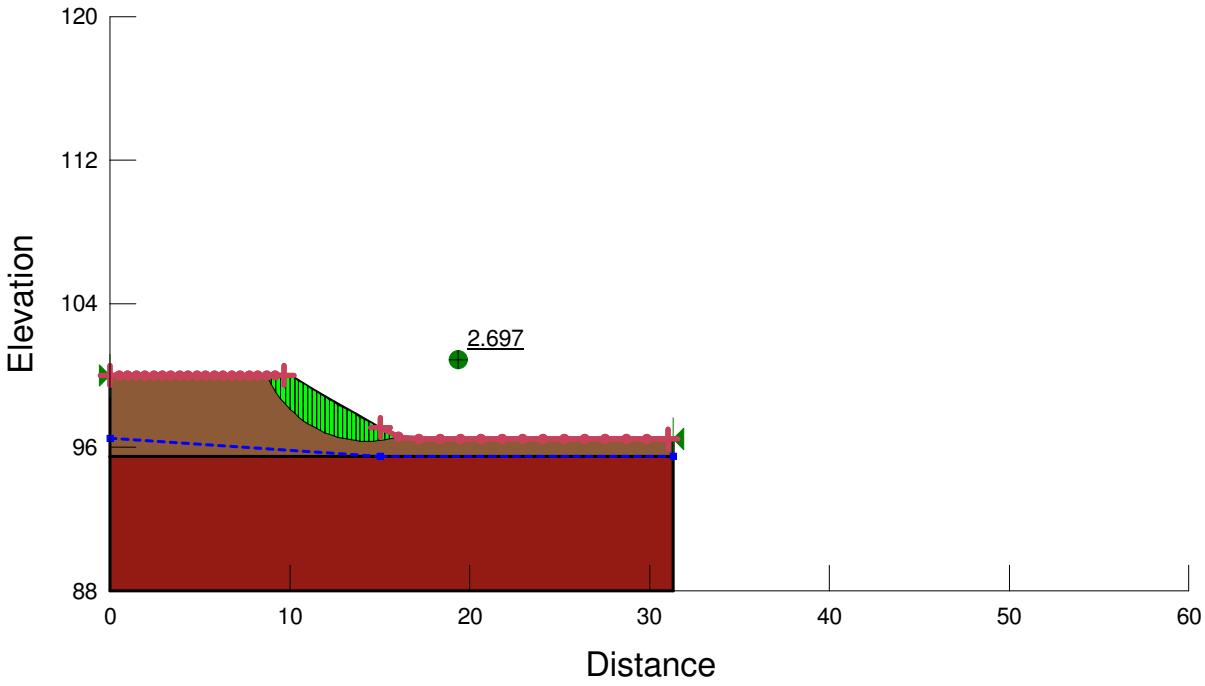
Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile B-B



Name: Clayey Silt
Unit Weight: 19 kN/m³
Cohesion: 10 kPa
Phi: 34 °

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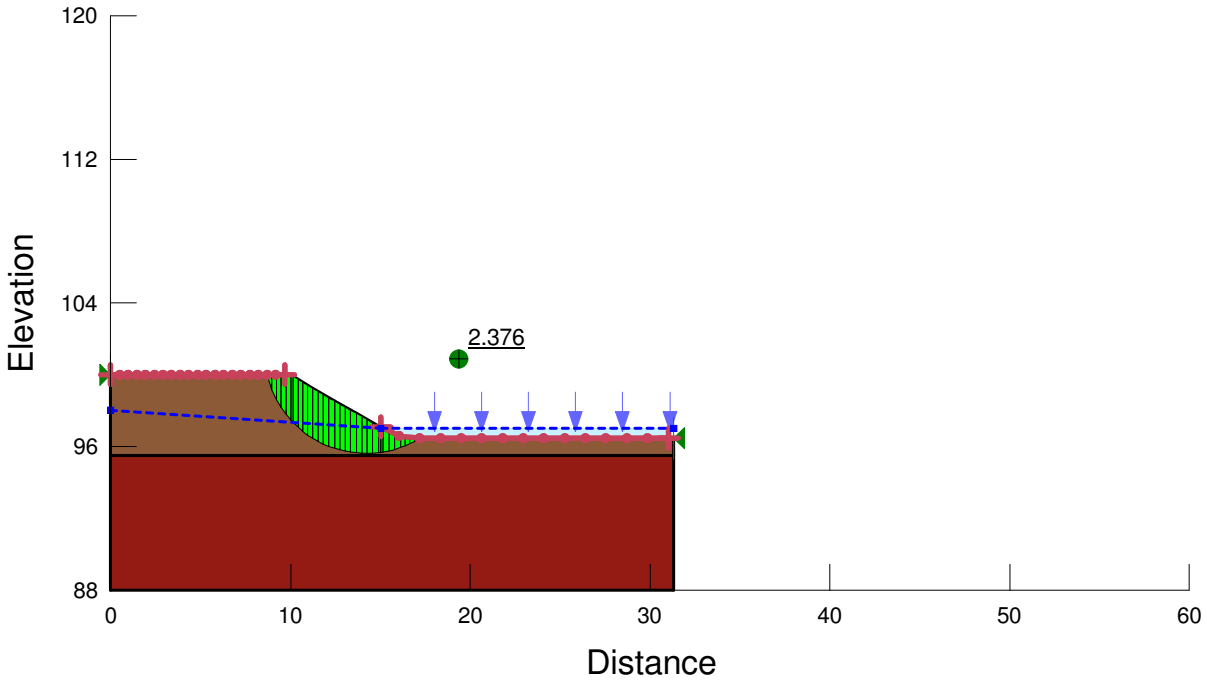
Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile C-C



Name: Clayey Silt
Unit Weight: 19 kN/m³
Cohesion: 10 kPa
Phi: 34 °

Name: Queenston Shale
Unit Weight: 20 kN/m³
Cohesion: 10 kPa
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Slope Stability Assessment
4063 Upper Middle Road
Burlington, Ontario
Profile C-C



Name: Clayey Silt
Unit Weight: 19 kN/m³
Cohesion: 10 kPa
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Name: Queenston Shale
Unit Weight: 20 kN/m³
Cohesion: 10 kPa
Phi: 40 °