



# **Soil Engineers Ltd.**

CONSULTING ENGINEERS

**GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE**

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March 20, 2019  
(Revision to Letter Report dated December 22, 2016)

Reference No. 1608-S094  
Page 1 of 8

2462357 Ontario Inc.  
30 Wertheim Court  
Building A, Unit 3  
Richmond Hill, Ontario  
L4B 1B9

Attention: Mr. Peter Sciavilla

**Re: Revised Slope Stability Study Addendum  
Proposed Residential Development  
1745, 1765 and 1775 Thorny Brae Place  
City of Mississauga**

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Dear Sir:

Further to the Soil Report issued in October 2016 and the Slope Stability Study Addendum issued in December 2016 for the captioned site, we have reviewed the comments from the Credit Valley Conservation (CVC) dated June 8, 2018, requesting additional slope sections to be analyzed along the drainage channel at the southern limit of the site. In autumn 2018, a storm sewer pipe was installed and connected to the existing headwall within the channel. A series of erosion and sediment control (ESC) schemes have since been implemented downstream of the outlet to the outfall at the Credit River. In determining the applicable development setbacks and the Long-Term Stable Slope Line (LTSSL), the analysis presented in this letter illustrates the channel condition prior to construction and restoration. Furthermore, all slope sections were modeled to mimic a high water table.



### **Long-Term Stable Slope**

The stability study focuses both on the valley slope at the eastern limit of the site (the western bank of Credit River) as well as on the drainage ditch that extends from the southeast corner of the site towards the river. Visual inspection of the slope in 2016 revealed that the upper portion of the valley slope (within the zone of the overburden) is generally well vegetated with trees, shrubs and weeds. Shallow shale bedrock outcrops were observed along the face of the river bank. The upper stretch of the channel is relatively gentle and stable. However, minor surface erosion along steeper sections of the side slopes as well as sloughing along the centerline of the channel was observed downstream to the existing concrete pipe headwall and gabion mat treatment. The bottom of the channel was lined with shale debris. Overall, no sign of deep-seated failure was noted. No active toe erosion was observed along the Credit River.

The Credit River bank has an overall height ranging from  $13.0 \pm$  to  $15.0 \pm$  m, measured from the bottom of slope to the tableland or staked top of bank as established by the CVC (referenced on a sketch dated February 23, 2004), with gradients ranging from 1 vertical: $0.5 \pm$  to 2.0+ horizontal. The depth of the drainage channel is approximately  $3 \pm$  to  $4 \pm$  m, with slope gradients of 1V: $2.0 \pm$  H.

Three cross-sections, Cross-Sections A-A to C-C, as presented on Drawing Nos. 2 to 4, inclusive, were selected for analysis at various steep sections of the Credit River bank slopes. Two cross-sections, Cross-Sections D-D and E-E, located along the north side of the drainage feature as identified by the CVC were added to the analysis and are presented on Drawing Nos. 5 and 6. The locations are shown on Drawing No. 1. The surface profile of each cross-section is interpreted from the contour and spot elevations on the Topographic Plan prepared by Schaeffer Dzaldov Bennett Ltd., dated February 5, 2018. The subsurface profile is interpreted from the Borehole Logs from our Soil Report dated October 2016.



Based on the borehole findings, normal groundwater condition (NGC) was modeled after the dry condition observed upon completion of the field work. In considering that seasonal high groundwater data was not available for use, an assumed elevated groundwater condition (EGC) was added at approximately 1.5 m below surface grade in this study.

The slope stability was analyzed using force-moment-equilibrium criteria of the Bishop Method with the soil strength parameters shown in the following table. The shale has been modeled as bedrock with infinite strength.

<b><u>Strength Parameters For Slope Stability Analysis</u></b>			
	<b>Unit Weight <math>\gamma</math> (kN/m<sup>3</sup>)</b>	<b>Effective Cohesion <math>c</math> (kPa)</b>	<b>Effective Internal Friction Angle <math>\phi</math> (degrees)</b>
Silty Clay Till	22.0	5	30
Earth Fill (Silty Sands)	20.0	0	28

According to the Ontario Ministry of Natural Resources (OMNR) guideline requirements and the CVC's Slope Stability Definition and Determination Guideline 2014 for active land use, the required minimum Factor of Safety (FOS) under NGC is 1.5, and the FOS stipulated by the CVC under EGC is 1.3. The resulting FOS and corresponding setbacks for the various cross-sections are presented in the following table.



Cross-Section	FOS under Existing Slope Condition		FOS under Geotechnically Stable Condition	Geotechnically Stable Gradient	LTSSL Setback from TOB <sup>c</sup> (m)
	Normal <sup>a</sup>	Elevated <sup>b</sup>	Elevated <sup>b</sup>		
A-A	1.286	1.286	1.834	1V:1.4H shale 1V:1.7H silty clay 1V:2.5H earth fill	12.0
B-B	4.2	4.2	2.243		5.9
C-C	3.46	3.46	2.622		1.1
D-D	2.137	1.998	-	1V:2.0H	0.7
E-E	2.194	1.874	-	1V:2.2H	1.1

<sup>a</sup> Normal groundwater condition

<sup>b</sup> Elevated groundwater condition

<sup>c</sup> LTSSL setback is shown from the Staked Top of Bank as defined by CVC on February 23, 2004, or from the physical top of slope, whichever is closer to the slope.

The results from the analyses indicate that the existing slope at Cross-Section A-A has a factor of safety (FOS) of 1.29 under both NGC and EGC, which does not meet the aforementioned minimum FOS. Therefore, the stability of the slope at Cross-Section A-A is considered to be geotechnically unacceptable. In order to achieve the required FOS, geotechnically stable gradients of 1V:1.4H and 1V:1.7H are recommended for use in the shale bedrock and silty clay till overburden, respectively. The remodeled slope, yielding a FOS of 1.834 which satisfies the OMNR and CVC requirements, is presented on Drawing No. 2C.

The existing slopes at the locations of Cross-Sections B-B, C-C, D-D and E-E have FOS of 1.5+ under both NGC and EGC, which satisfy the OMNR and CVC requirements for active land use. The result of analyses is presented on Drawing Nos. 3 to 6 (A and B), inclusive. Although the slopes at Cross-Sections B-B and C-C are considered to be geotechnically stable in their current condition, environmental degradation of the exposed shale bedrock should be anticipated and accounted for. Therefore, the geotechnically



stable gradients listed in the above table are applied and the sections are remodeled. In earth fill, a stable gradient of 1V:2.5H is used. The remodeled slopes, yielding FOS of 2.243 and 2.622 for Cross-Sections B-B and C-C, respectively, are presented on Drawing Nos. 3C and 4C.

In the absence of an adequate flood plain, the Credit River meanders at the toe of slope. Since no active erosion was observed, a 2 m toe erosion allowance is recommended along the river valley where it consists of shale bedrock. The resulting LTSSL, incorporating the specified stable gradient component and toe erosion setback (where necessary), is established on Drawing No. 1. Where the LTSSL generally coincides with the existing top of slope around the drainage channel, it is aligned with either the physical top of slope or the staked top of bank by CVC, whichever is further inland.

Lastly, a development setback buffer for man-made and environmental degradation of the bank will be required. This is subject to the discretion of the CVC.

### **Storm Sewer Construction**

As previously mentioned, the construction of a new storm sewer through the drainage channel and the restoration work associated with the outfall at the Credit River was completed in 2018. Upon completion of the installation, the channel was backfilled with engineered fill to match existing ground. Based on the design shown on the Storm Outfall drawing (Drawing No. PP-03 by Cole Engineering Group Ltd.), the disturbed channel slopes were regraded to 1V:3H, which is considered geotechnically stable and acceptable for use in the subject soil stratigraphy. Subsequent mitigation and restoration measures were implemented to ensure the stability of the channel and sewer outfall; the details can be referenced to The Restoration Plan, prepared by Alexander Budrevics & Associates Limited and dated January 12, 2018, which was approved by the City of Mississauga and the CVC under the Site Servicing Subdivision Application No. T-09002M. The upper



reaches of the Credit River Bank outside of the construction zone remained unaltered. As summarized in our opinion letter dated March 1, 2017, the overall construction of the storm sewer pipe and outlet will not impose an adverse effect on the stability of the existing natural slope.

### **Future Precautions**

In order to prevent the disturbance of the existing stable slope along the western bank of Credit River, and when warranted, enhance the stability of the bank for the proposed project, the following geotechnical constraints should be stipulated. The drainage ditch slopes are protected by multiple ESC schemes in place, and are therefore not bounded by these constraints.

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the bank of the rooting system that is reinforcement against soil erosion by weathering. If for any reason the vegetation cover is stripped during construction, it must be reinstated to its original, or better than its original, protective condition. Restoration with selective native plantings including deep rooting systems which would penetrate the original buried topsoil must be carried out after the development to ensure bank stability.
2. The topsoil cover on the bank face should not be disturbed, since this provides an insulation and screen against frost wedging and rainwash erosion. All new slopes created by cutting into the existing slope must be graded at 1V:2.5H or gentler for stability. The slope surface must be properly vegetated. Where new slopes are created with a gradient ranging from 1V:2 to 2.5H, they will be subject to surface erosion and minor surface sloughing even when they are vegetated. Therefore, a permanent erosion control mat together with proper vegetation must be installed on the surface of the slopes to prevent surface



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- erosion. The respective manufacturers should be consulted for the proper installation of the erosion control mats. A new slope with a gradient steeper than 1V:2H should not be allowed.
3. Grading of the land adjacent to the bank must be such that concentrated runoff is not allowed to drain onto the bank face. Landscaping features which may cause runoff to pond at the top of the bank, as well as saturation of the crown of the bank, must not be permitted.
  4. Where the construction is carried out near the top of the bank, stripping of topsoil or vegetation and dumping of loose fill over the bank must be prohibited.

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

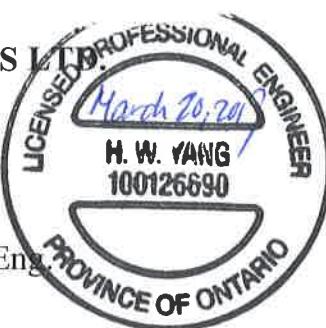
All other recommendations stated in the original soil report remain applicable without revision.

We trust this letter report is to your satisfaction. However, should any queries arise, please feel free to contact this office.

Yours truly,

**SOIL ENGINEERS LTD.**

Hui Wing Yang, P.Eng.  
HWY/BL:cy



Bernard Lee, P.Eng.



- c. Soil Engineers Ltd. (Mississauga)  
Attn.: Mr. Benjamin Lee



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March 20, 2019

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## ENCLOSURES

Borehole and Cross-Section Location Plan .....	Drawing No. 1
Cross-Section A-A (Existing/Normal Groundwater Condition) .....	Drawing No. 2A
Cross-Section A-A (Existing/Elevated Groundwater Condition) .....	Drawing No. 2B
Cross-Section A-A (Stable/Elevated Groundwater Condition).....	Drawing No. 2C
Cross-Section B-B (Existing/Normal Groundwater Condition).....	Drawing No. 3A
Cross-Section B-B (Existing/Elevated Groundwater Condition).....	Drawing No. 3B
Cross-Section B-B (Stable/Elevated Groundwater Condition) .....	Drawing No. 3C
Cross-Section C-C (Existing/Normal Groundwater Condition).....	Drawing No. 4A
Cross-Section C-C (Existing/Elevated Groundwater Condition).....	Drawing No. 4B
Cross-Section C-C (Stable/Elevated Groundwater Condition) .....	Drawing No. 4C
Cross-Section D-D (Existing/Normal Groundwater Condition) .....	Drawing No. 5A
Cross-Section D-D (Existing/Elevated Groundwater Condition) .....	Drawing No. 5B
Cross-Section E-E (Existing/Normal Groundwater Condition) .....	Drawing No. 6A
Cross-Section E-E (Existing/Elevated Groundwater Condition) .....	Drawing No. 6B

## EGLINTON AVENUE WEST

(BY TOWN OF MISSISSAUGA BY-LAW No. 9377, INST. No. 189656VS)  
(FORMERLY BASE LINE ROAD, ROAD ALLOWANCE BETWEEN OLD AND NEW SURVEYS, MUNICIPAL SURVEY No. 84  
PIN 13195-0077)

SCP 075760392

PLAN OF SURVEY OF  
PART OF LOT 1 AND  
ALL OF LOT 2  
REGISTERED PLAN 498 AND  
PART OF LOTS 3 AND 4, RANGE 5  
NORTH OF DUNDAS STREET,  
(GEOGRAPHIC TOWNSHIP OF TORONTO)  
CITY OF MISSISSAUGA  
REGIONAL MUNICIPALITY OF PEEL  
SCALE 1:300

## NOTES

□	DENOTES	PLANTED MONUMENT
■	"	FOUND MONUMENT
SIB	"	STANDARD IRON BAR
IB	"	IRON BAR
SSIB	"	SHORT STANDARD IRON BAR
P	"	PLAN 43R-31060
P1	"	PLAN 43R-18467
P2	"	PLAN 43R-16785
P3	"	REGISTERED PLAN 498
R	"	REPLACED FOUND IB(680) WITH SSIB
M	"	MEASURED
WIT	"	WITNESS
OU	"	ORIGIN UNKNOWN
680	"	C. PEAT, O.L.S.
922	"	SCHAEFFER DZALDOV BENNETT LTD.
1493	"	YOUNG & YOUNG SURVEYING INC.
1225	"	DAVID B. SEARLES SURVEYING LTD.
1629	"	B.A. JACOBS SURVEYING LTD.
1280	"	A. KIKAS LIMITED
NNS	"	NANFARA & NG SURVEYORS INC.
923	"	W.P. TARASICK, O.L.S.
RIB	"	ROUND IRON BAR
BF	"	BOARD FENCE

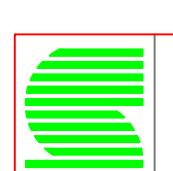
BEARINGS ARE UTM GRID, DERIVED FROM SPECIFIED CONTROL POINTS  
075125016 AND 075760392, UTM ZONE 17, NAD83 (ORIGINAL).  
DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY  
MULTIPLYING BY A COMBINED SCALE FACTOR OF 0.999713

SPECIFIED CONTROL POINTS (SCPs): UTM ZONE 17, NAD83 (ORIGINAL) COORDINATES TO URBAN ACCURACY PER SEC. 14(2) OF O.REG. 216/10		
POINT ID.	NORTHING	EASTING
SCP 075125016	4824783.177	605284.687
SCP 075760392	4825175.088	605623.335
COORDINATES CANNOT, IN THEMSELVES, BE USED TO RE-ESTABLISH ELEVATION OR DOMINANT ELEVATION THROUGH TIME.		

## SURVEYOR'S CERTIFICATE

SURVEYOR'S CERTIFICATE  
I CERTIFY THAT:  
1. THIS SURVEY AND PLAN ARE CORRECT AND IN ACCORDANCE WITH THE SURVEYS ACT, THE SURVEYORS ACT AND THE REGULATIONS MADE UNDER THEM.  
2. THE SURVEY WAS COMPLETED ON THE 26th DAY OF JANUARY 2018.

DATE: FEBRUARY 5, 2018. \_\_\_\_\_  
CPWID: NLRZALDGM



**SCHAEFFER DZALDOV BENNETT LTD.**  
**ONTARIO LAND SURVEYORS**

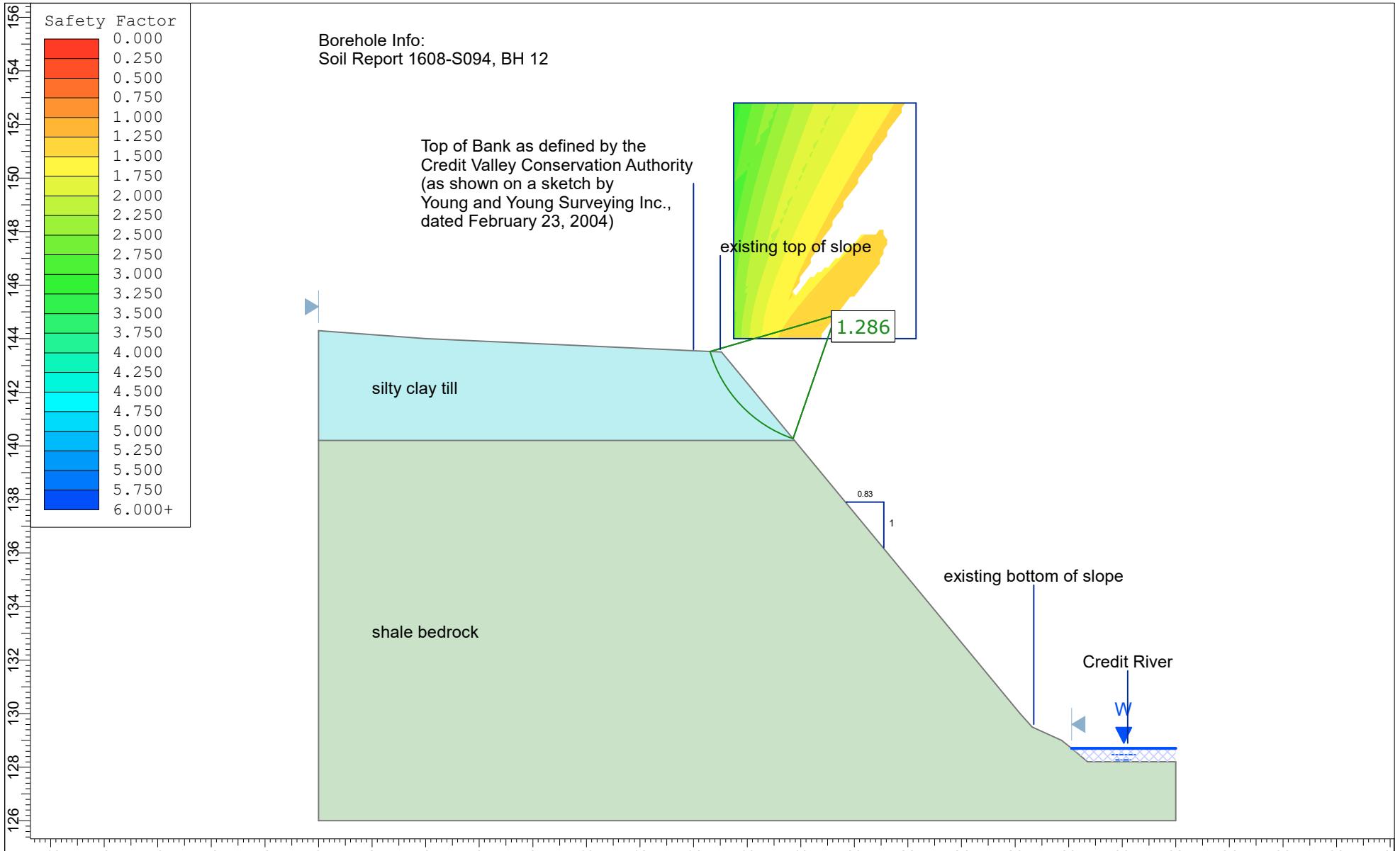
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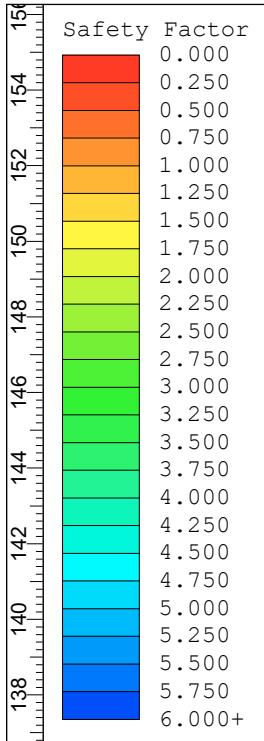
#### BOREHOLE AND CROSS SECTION LOCATION

**SITE 1745, 1765 AND 1775 THORNY BRAE PLACE, MISSISSAUGA**

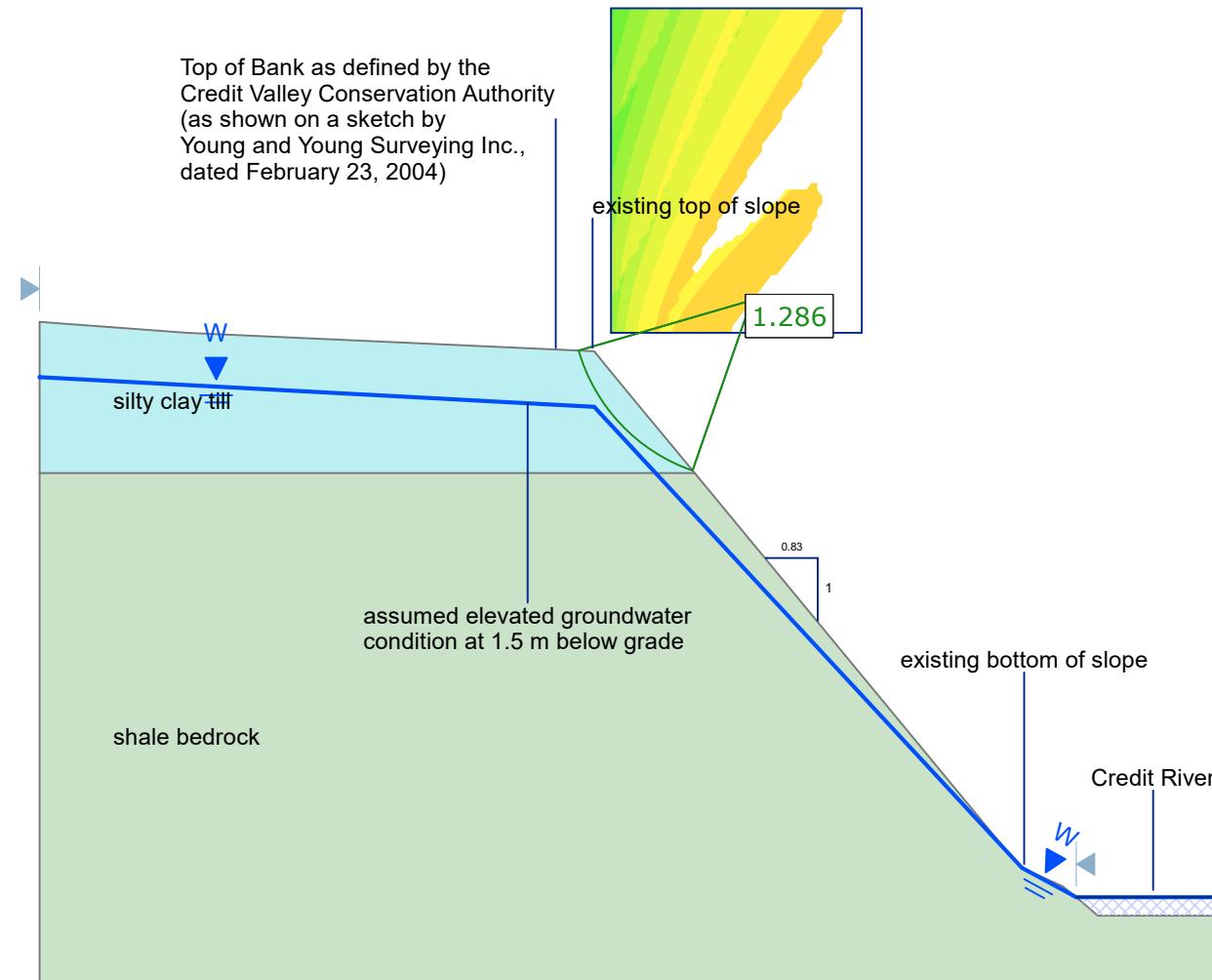
DESIGNED BY	CHECKED BY	DWG NO.	1
SCALE 1:300	REF. NO.	MARCH 2019	REV 1



Project Title			Load Case		Normal Groundwater Condition (Dry)	
Soil Engineers Ltd.			Cross-Section A-A - Existing Condition			
CONSULTING ENGINEERS GEOTECHNICAL   ENVIRONMENTAL   HYDROGEOLOGICAL   BUILDING SCIENCE 90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335	Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga			Revision	1
Drawn By HWY	Checked By BL	Scale 1:200	Date March 2019	Reference No. 1608-S094	Drawing No.	2A



Borehole Info:  
Soil Report 1608-S094, BH 12

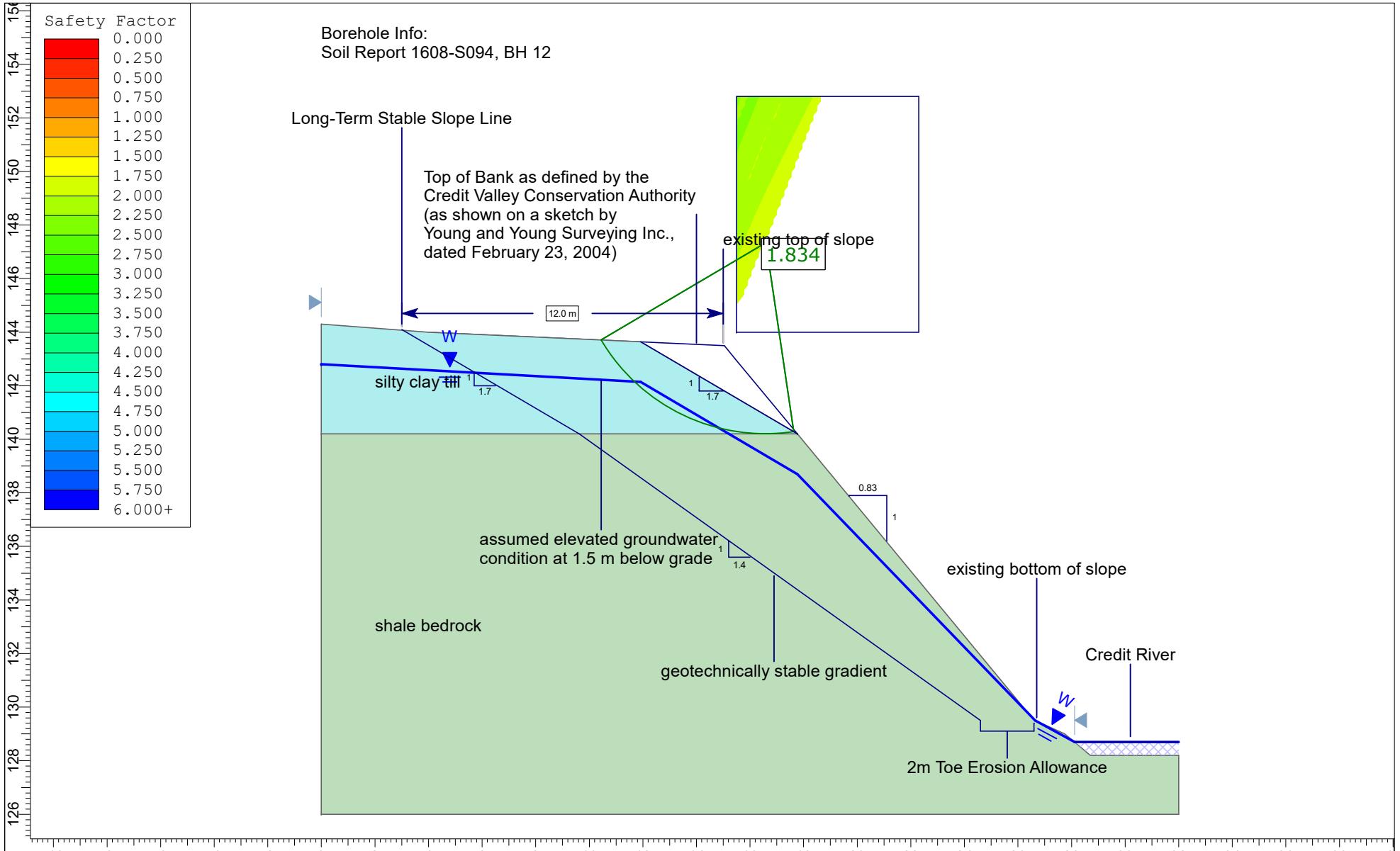


Project Title		Cross-Section A-A - Existing Condition		Load Case
Location		1745, 1765 and 1775 Thorny Brae Place, Mississauga		Elevated Groundwater Condition
Drawn By	HWY	Checked By	BL	Scale
Date	March 2019	Reference No.	1608-S094	Revision
		Drawing No.	2B	

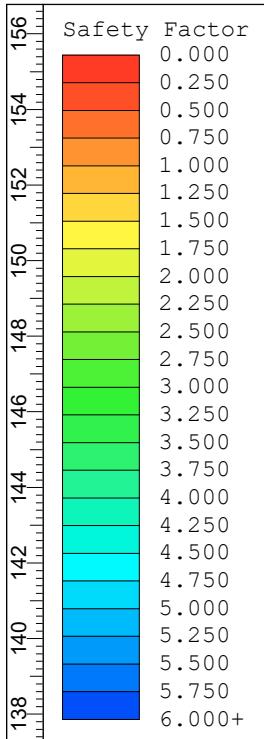


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Project Title		Load Case	
Cross-Section A-A - Geotechnically Stable Condition		Elevated Groundwater Condition	
Drawn By	Checked By	Scale	Revision
HWY	BL	1:200	-
Date	Reference No.	Drawing No.	
March 2019	1608-S094	2C	



Borehole Info:  
Soil Report 1608-S094, BH 11

Top of Bank as defined by the  
Credit Valley Conservation Authority  
(as shown on a sketch by  
Young and Young Surveying Inc.,  
dated February 23, 2004)

4.200

existing top of slope

earth fill

silty clay till

shale bedrock

5.36

1

2.06

1

0.54

1

existing bottom of slope

Credit River

-8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

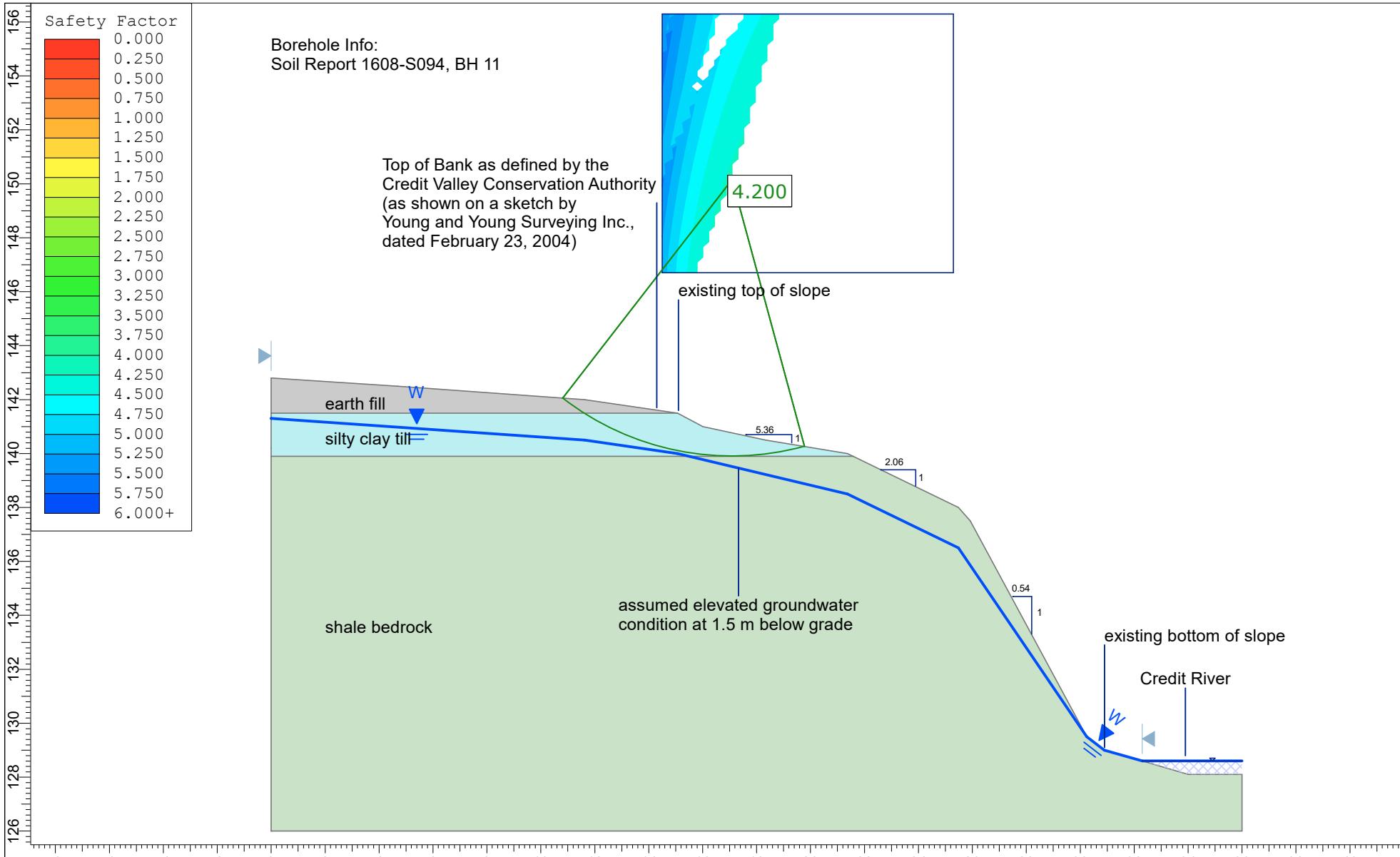
Project Title		Load Case		Normal Groundwater Condition (Dry)
Cross-Section B-B - Existing Condition				
Location				
1745, 1765 and 1775 Thorny Brae Place, Mississauga				
Drawn By	Checked By	Scale	Revision	
HWY	BL	1:200	1	
Date	Reference No.			Drawing No.
March 2019	1608-S094			3A



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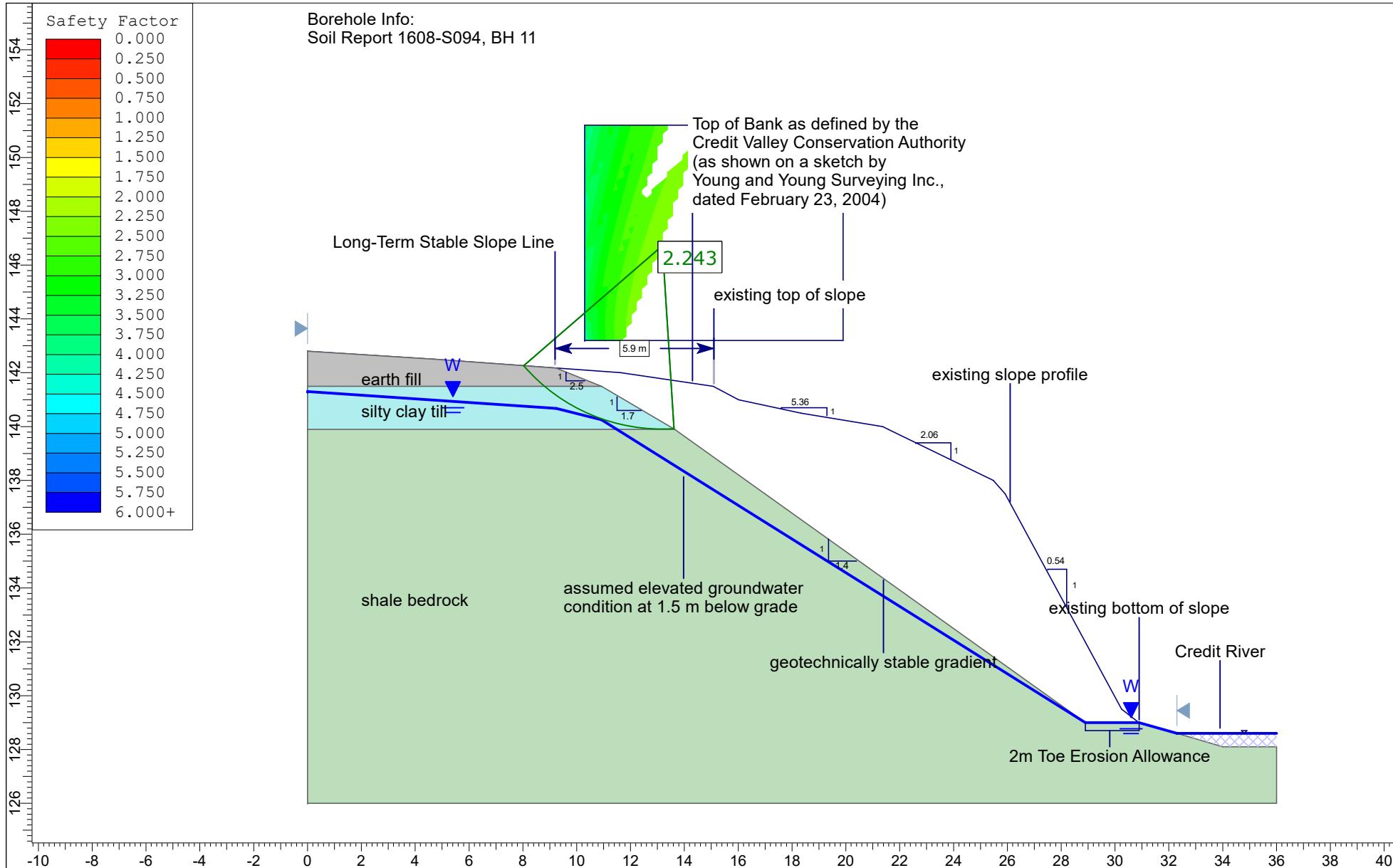
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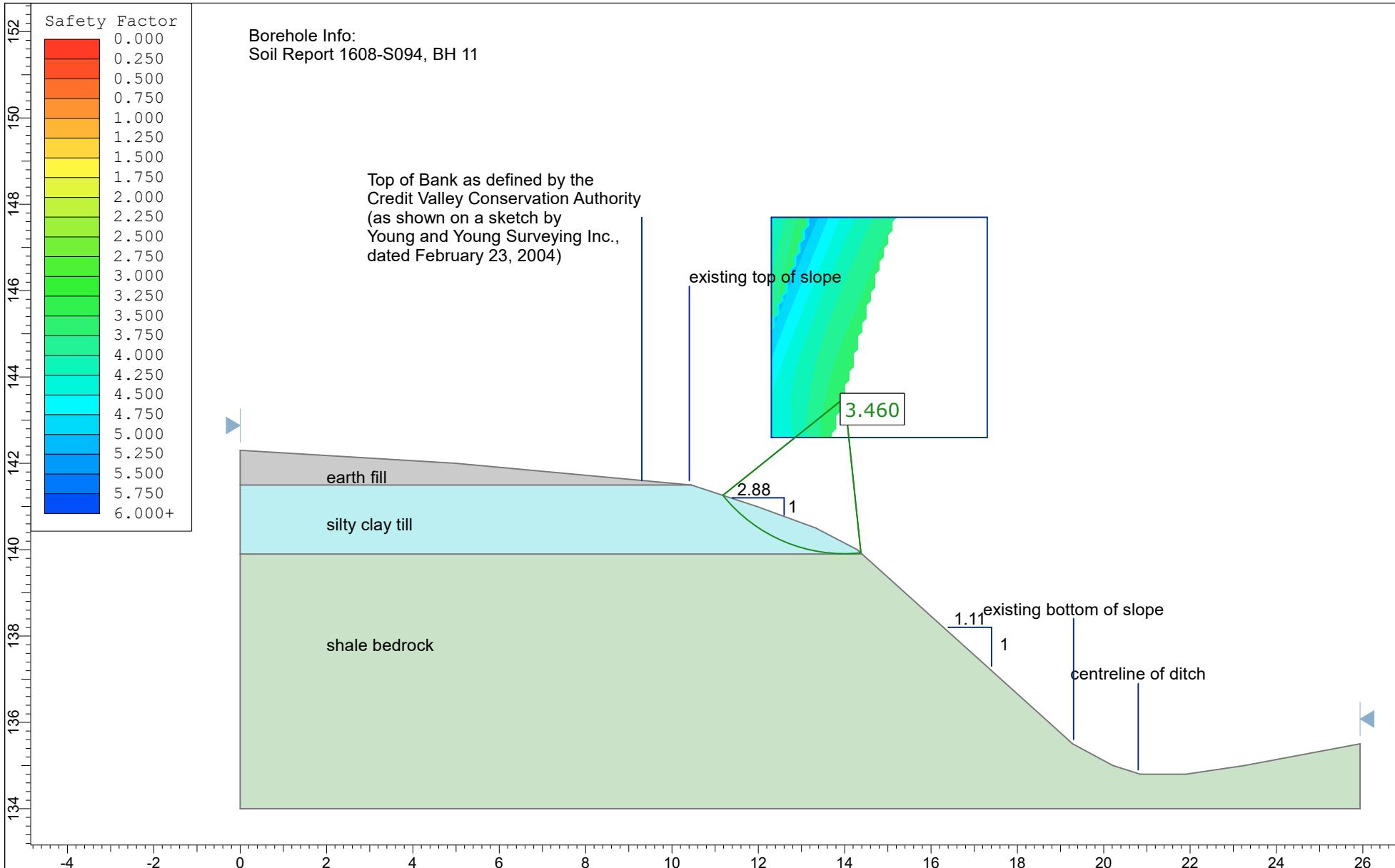


		Project Title	Cross-Section B-B - Existing Condition		Load Case
		Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga		Elevated Groundwater Condition
Drawn By	Checked By	Scale			Revision
HWY	BL	1:200			-
Date March 2019		Reference No.	1608-S094		Drawing No.
					3B

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 <p><b>Soil Engineers Ltd.</b> CONSULTING ENGINEERS GEOTECHNICAL   ENVIRONMENTAL   HYDROGEOLOGICAL   BUILDING SCIENCE 90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335</p>	Project Title	Cross-Section B-B - Geotechnically Stable Condition			Load Case
	Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga			
	Drawn By	HWY	Checked By	BL	Scale
			1:200		Revision
Date		March 2019		Reference No.	1608-S094
				Drawing No.	3C

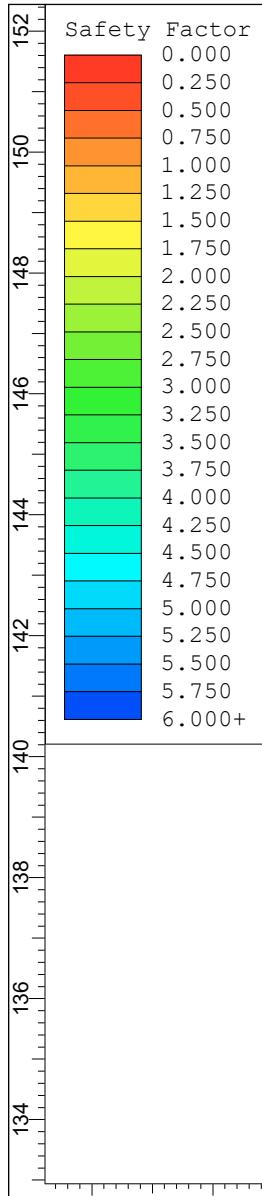


		Project Title	Cross-Section C-C - Existing Condition		Load Case	Normal Groundwater Condition (Dry)
		Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga			
Drawn By	HWY	Checked By	BL	Scale	1:125	Revision
Date	March 2019		Reference No.	1608-S094	Drawing No.	4A



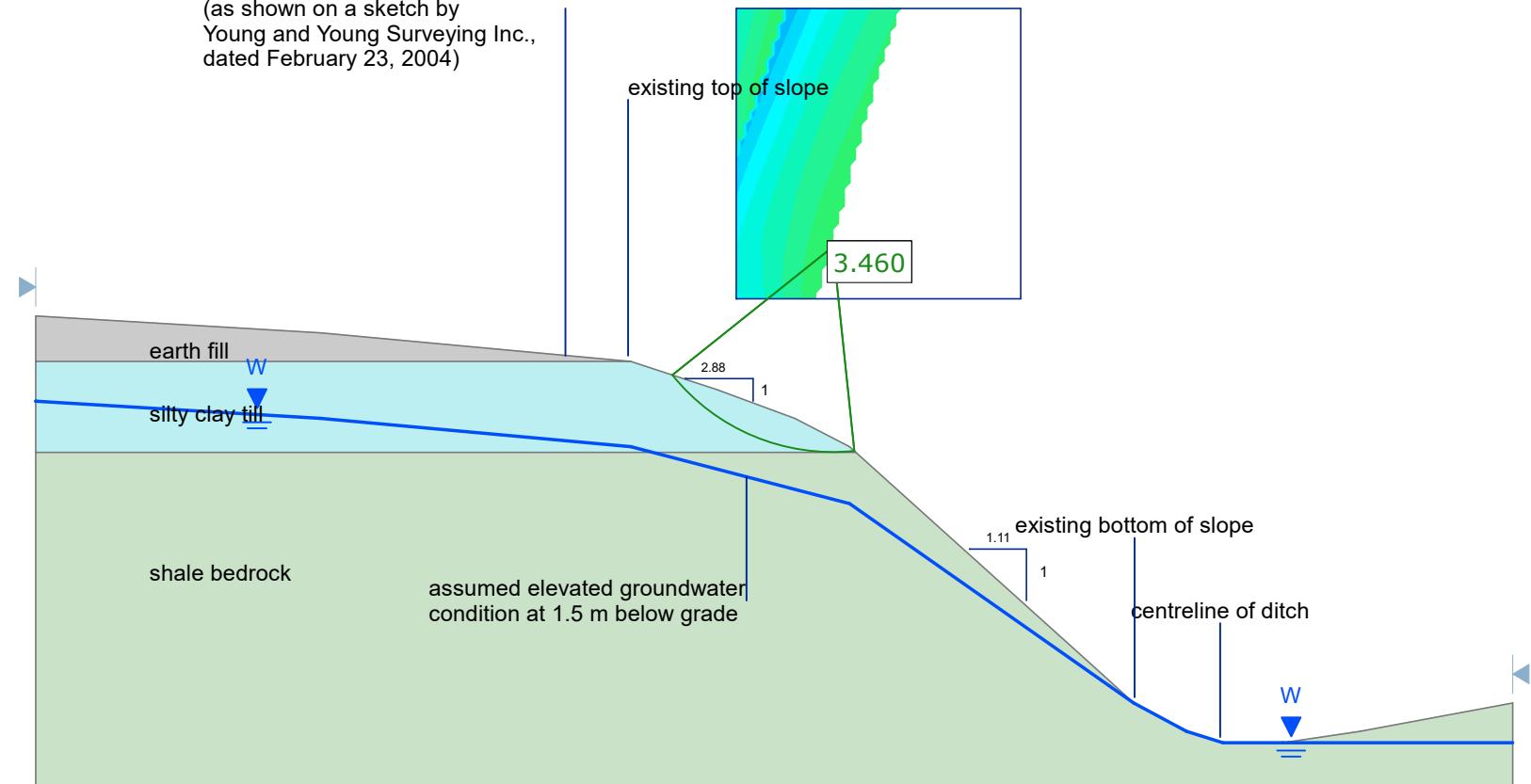
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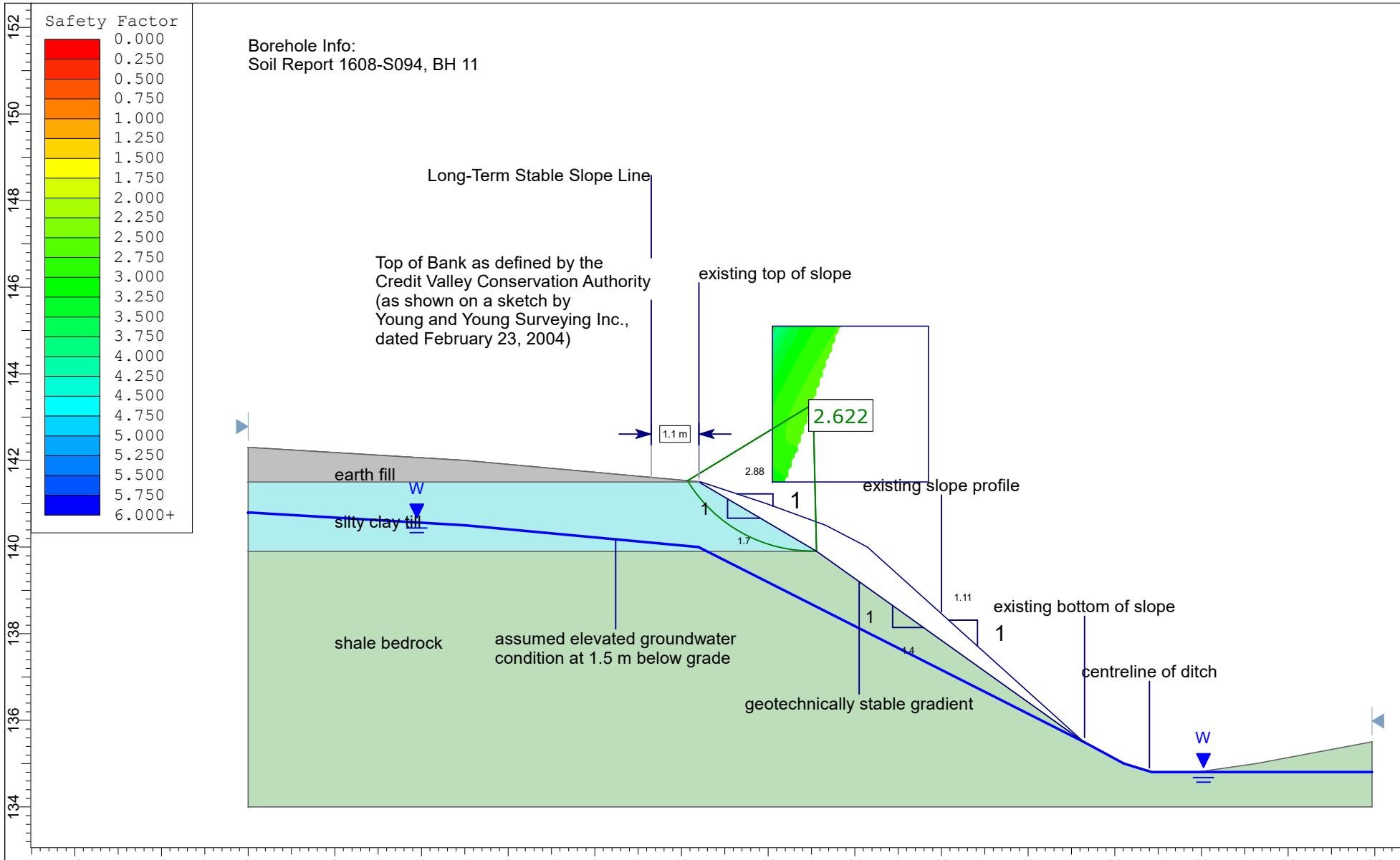
Borehole Info:  
Soil Report 1608-S094, BH 11

Top of Bank as defined by the  
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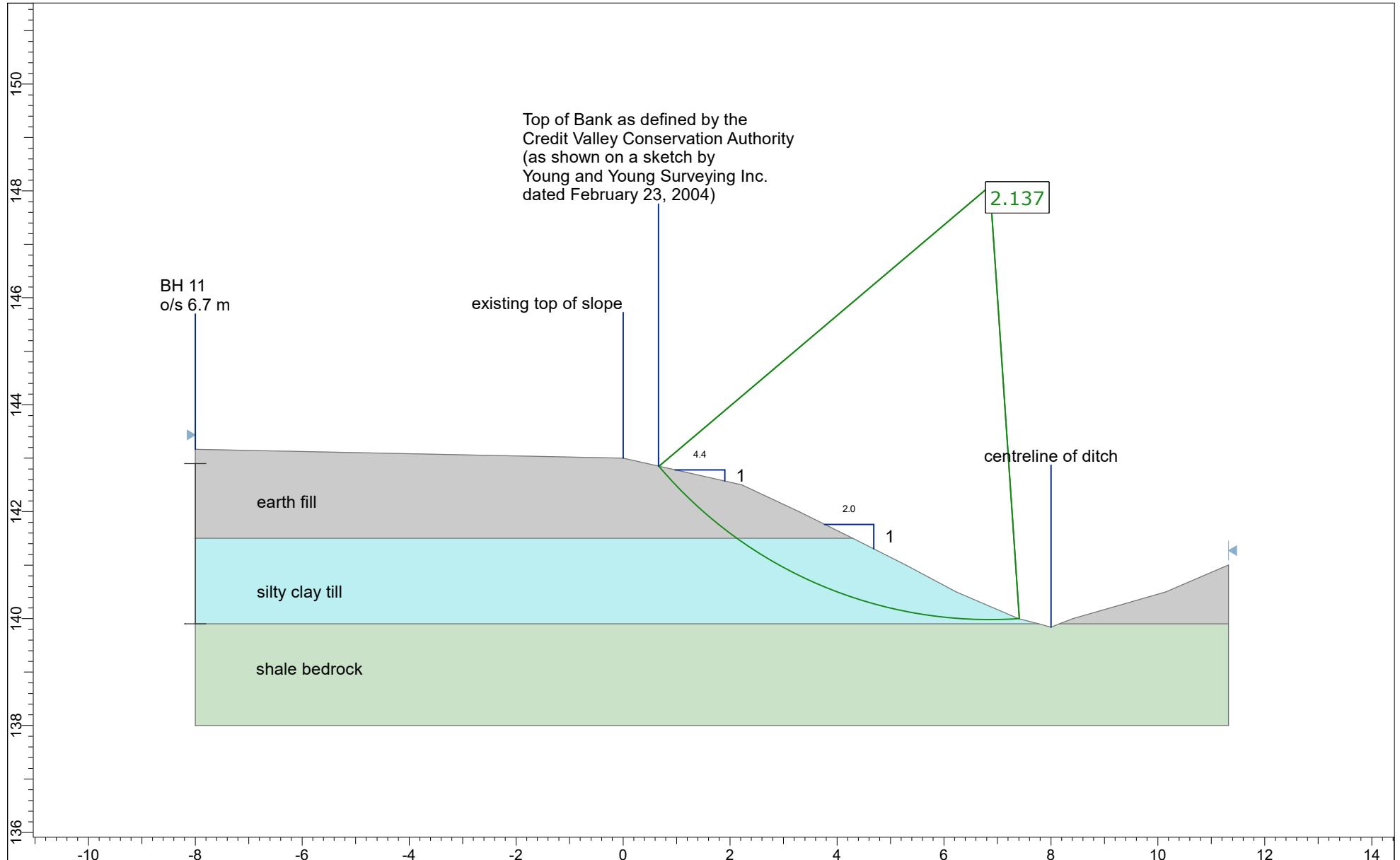


		Project Title	Cross-Section C-C - Existing Condition		Load Case
		Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga		Elevated Groundwater Condition
Drawn By	Checked By	Scale			Revision
Date		Reference No.	March 2019		Drawing No.
			1608-S094		4B

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Soil Engineers Ltd.		Project Title		Load Case	
CONSULTING ENGINEERS		Cross-Section C-C - Geotechnically Stable Condition		Elevated Groundwater Condition	
GEOTECHNICAL   ENVIRONMENTAL   HYDROGEOLOGICAL   BUILDING SCIENCE					
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335		Drawn By	HWY	Checked By	BL
		Date	March 2019	Scale	1:125
				Revision	-
				Reference No.	1608-S094
				Drawing No.	4C

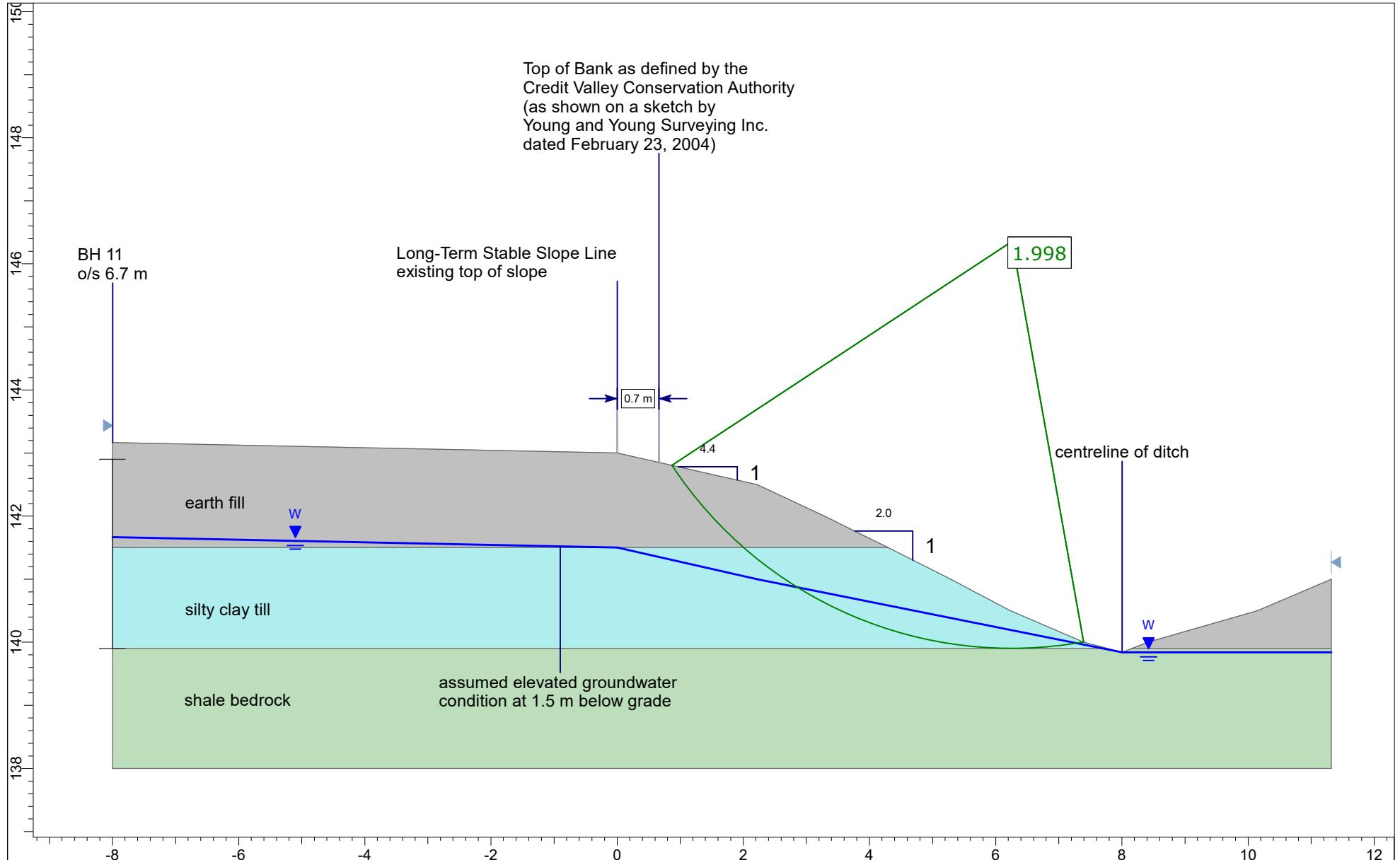


Project Title	Cross-Section D-D - Existing Condition			Load Case Normal Groundwater Condition (Dry)
Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga			
Drawn By HWY	Checked By BL	Scale 1:100	Revision -	
Date March 2019	Reference No. 1608-S094	Drawing No. 5A		

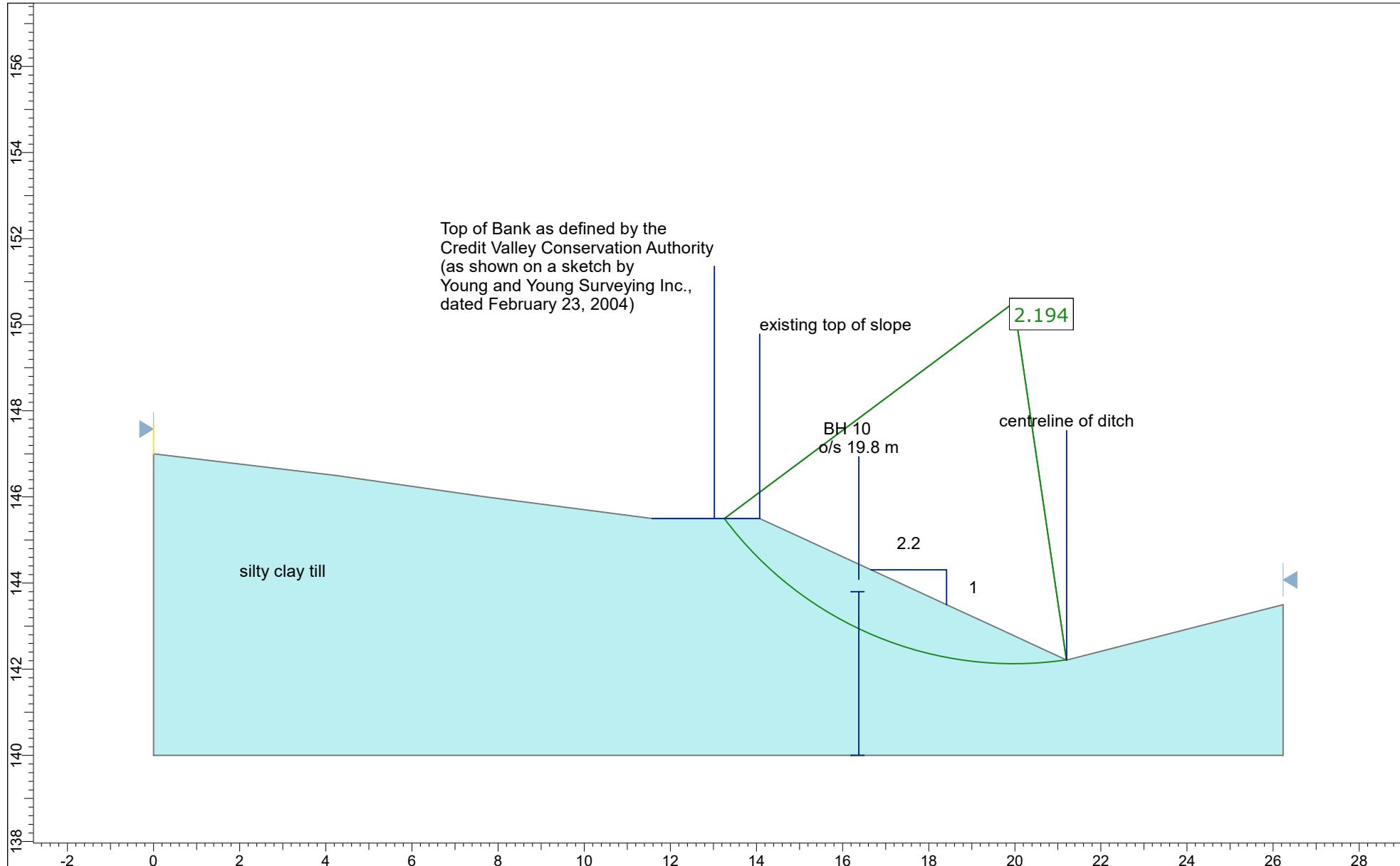


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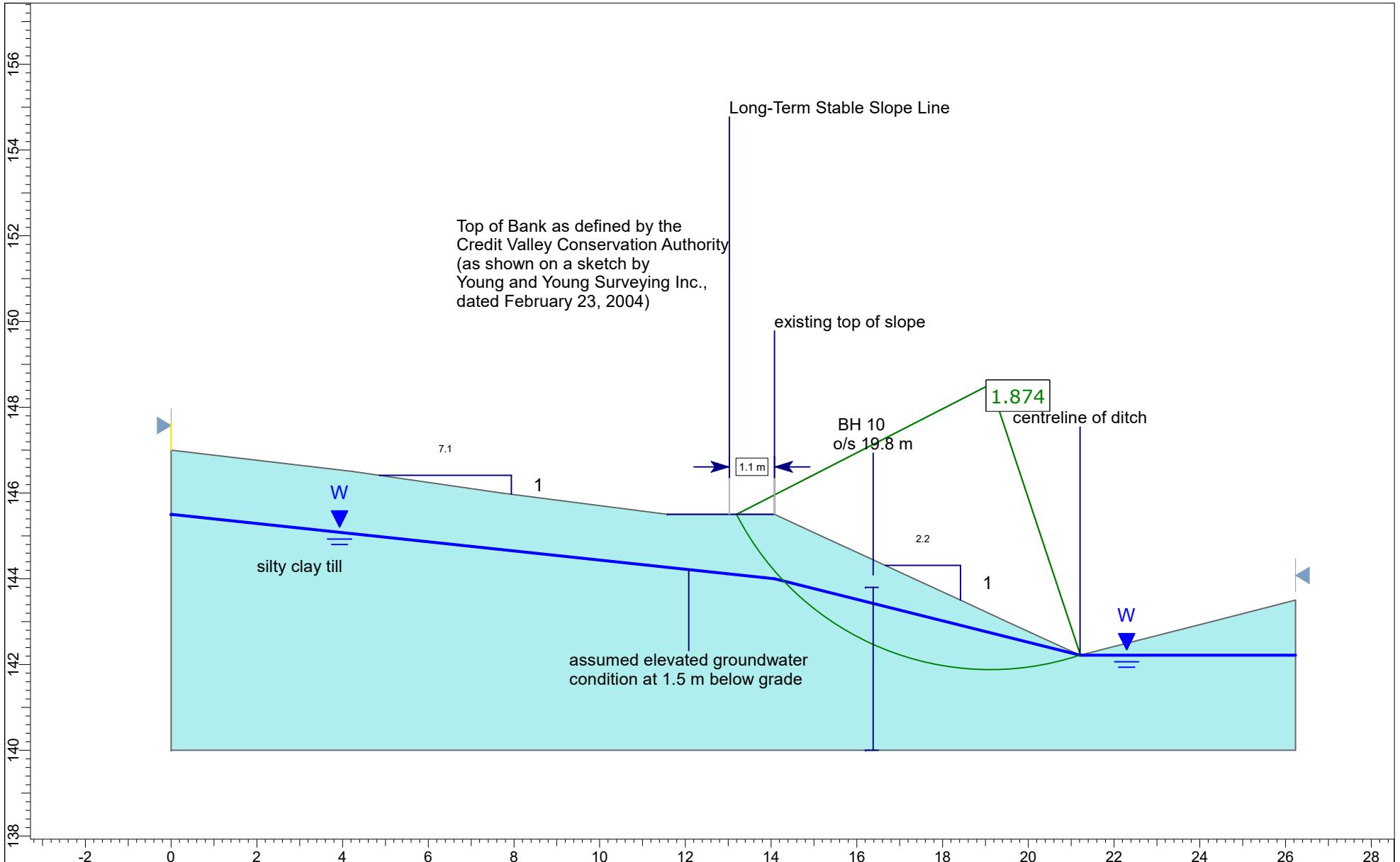
CONSULTING ENGINEERS  
GEOTECHNICAL | ENVIRONMENTAL | HYDROGEOLOGICAL | BUILDING SCIENCE  
90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335



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	Cross-Section D-D - Existing Condition			Elevated Groundwater Condition
	Location			1745, 1765 and 1775 Thorny Brae Place, Mississauga
	Drawn By	HWY	Checked By	BL
	Date	March 2019		Scale 1:85
		Reference No. 1608-S094		Revision -
		Drawing No. 5B		



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	Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga				
	Drawn By	HWY	Checked By	BL	Scale	1:125
	Date	March 2019		Reference No.	1608-S094	



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	Location	1745, 1765 and 1775 Thorny Brae Place, Mississauga			Elevated Groundwater Condition
	Drawn By	HWY	Checked By	BL	Scale
	Date		March 2019		Revision
			Reference No.		Drawing No.
			1608-S094		6B