Soil Engineers Ltd.
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

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	MUSKOKA	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

December 13, 2023 Reference No. 2308-S165
(Revision of report dated September 12, 2023) Page 1 of 4

Kaneff Group of Companies
8501 Mississauga Road,
Brampton, Ontario
L6Y 5G8

Attention: Mr. Kevin Freeman

Re: Slope Stability Assessment
Proposed Stormwater Management Pond
353 Townline Road
Town of Niagara-on-the-lake

Dear Sir:

As requested, Soil Engineers Ltd. has reviewed the following documents and herein provides a slope stability assessment for the captioned project:

- *Geotechnical Investigation Report (Project No.: 2020-161-G), prepared by Bendigo Consulting Inc., dated December 22, 2020.*
- *Preliminary Slope Stability Assessment (Project No.: 2020-161-G), prepared by Bendigo Consulting Inc., dated February 12, 2021.*
- *Preliminary Site Servicing Plan (Project No.: 369-6730), Drawing No.: C102, prepared by Crozier Consulting Engineers, dated June 14, 2023*
- *Preliminary Site Grading Plan (Project No.: 369-6730), Drawing No.: C103, prepared by Crozier Consulting Engineers, dated June 14, 2023*
- *Preliminary SWM Pond Section (Project No.: 369-6730), Drawing No.: C105, prepared by Crozier Consulting Engineers, dated December 13, 2023*

Based on the review of the Preliminary SWM Pond Section, prepared by Crozier Consulting Engineers, it is understood that the SWM outlet, having an invert at El. 114.96 m, is located to the northeast of the pond, which the water will be discharge onto a spillway, which will be constructed by cutting into the existing slope. The spillway will have a gradient of 2% sloping towards the creek, with side slopes of the spillway maintained at a 3H:1V gradient. In addition,

vegetative silt socks will be provided within the spillway for erosion and flow control. At the end of the spillway, the water will flow onto an existing slope and ultimately into the creek.

Niagara Peninsula Conservation Authority (NPCA) has expressed its concerns related to the overland flow onto the existing valley slope. Thus, a slope stability assessment was requested to evaluate whether the water flow from the spillway will have an adverse effect on the stability of the existing slope.

SWM Pond Design

The SWM pond is proposed at the mid portion of the site near the east property boundary, abutting the valley slope and the watercourse. Details of the pond design are provided in Drawing Nos. C105 prepared by Crozier Consulting Engineers, and summarized below:

Bottom of Pond Elevation (m):	114.0
Top of Pond Elevation (m):	116.7 to 118.5
Interior Side Slope Gradients (H:V):	5:1
Permanent Pool Level (m):	115.0
100 Year Storm Water Level (m):	116.5

Findings from External Geotechnical Report

Based on the geotechnical report, the investigation has disclosed that beneath a layer of topsoil and earth fill, the site is underlain by a stratigraphy consisting of stiff to very stiff silty clay till.

The boreholes were checked for the presence of groundwater upon completion of borehole drilling. No groundwater was encountered and the boreholes remained dry upon completion.

Slope Stability Analysis

A slope stability analysis was carried out on the proposed grading condition at Cross-Section 1-1. The cross-section was prepared by Crozier Consulting Engineers and location is shown on the enclosed Drawing No.1. Details of the slope section are shown on Drawing No. 2.

The slope stability analysis will be carried out using SLIDE, created by Rocscience Inc. While the provided geotechnical investigation report does not provide any shear strength parameters of the disclosed soil, the following effective soil shear strength parameters are interpreted from the borehole findings and are used during the slope stability analysis. The soil parameters are summarized in the table below:

Soil Type	Unit Weight, γ (kN/m^3)	Cohesion, c'	Angle of Internal Friction, ϕ'
Silty Clay Till	21.5	5	28°

Where the pond water exceeds the Permanent Pool Level, the excess water will be discharged through the outlet onto the spillway. As such, the flow path and the existing slope will be modeled under submerged condition for the slope stability analysis. In order to satisfy the stability requirement for slope under submerged condition, the resulting factor of safety (FOS) should meet a minimum of 1.30.
The analysis at Cross-Section 1-1 yielded a FOS of 1.55, which meets the minimum FOS of 1.30 and is considered acceptable. The result is presented on Drawing No. 2.

Risk Management of the Slope

In order to prevent further disturbance of the existing slope beyond the spillway, the following geotechnical constraints should be stipulated:

1. The prevailing vegetative cover must be maintained, since its extraction would deprive the slope 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.
2. The topsoil cover on the slope face should not be disturbed, since this provides insulation and screen against frost wedging and rainwash erosion.
3. Grading of the land adjacent to the slope must be such that concentrated runoff is not allowed to drain onto the slope face. Landscaping features which may cause runoff to pond at the top of the slope, as well as saturation of the crown of the slope, must not be permitted.
4. Where the construction is carried out near the top of the slope, dumping of loose fill over the slope from topsoil stripping or vegetation removal activities must be prohibited. Topsoil stripping and vegetation removal along the slope are also prohibited.
5. In case of any removal of vegetation during the course of construction, restoration with selective native plantings, including deep rooting systems which would penetrate the original topsoil, shall be carried out after the development to ensure slope stability.

Provided that all the above recommendations are followed, the proposed SWM Pond and its spillway discharge should not have an adverse effect on the stability of the slope. The above recommendations should be reviewed and are subject to the approval of NPCA.

We trust this letter satisfies your present requirements; however, should any queries arise, please feel free to contact this office.

Yours truly,
SOIL ENGINEERS LTD.

Cedric Ramos, B.A.Sc.

Kin Fung Li, P.Eng.
CR/KFL:

LICENSED PROFESSIONAL ENGINEER
Dec 13, 2023
K. F. LI
100169280
PROVINCE OF ONTARIO

ENCLOSURES

Cross-Section Location Plan ..... Drawing No. 1
Slope Stability Analysis ..... Drawing No. 2

KEY PLAN
NTS

Part 4, Plan 30R-

25.6m-900mmø STM @ 3.9% REVERSE PIPE

15.4m-900mmø STM @ 1.3%

MH21

HW.2

HW.3

100YR=116.70

P.P.=115.00

BOT.=114.00

SEDIMENT FOREBAY

FOREBAY WEIR

BOTTOM OF BANK

TOP OF SLOPE

NO FENCE

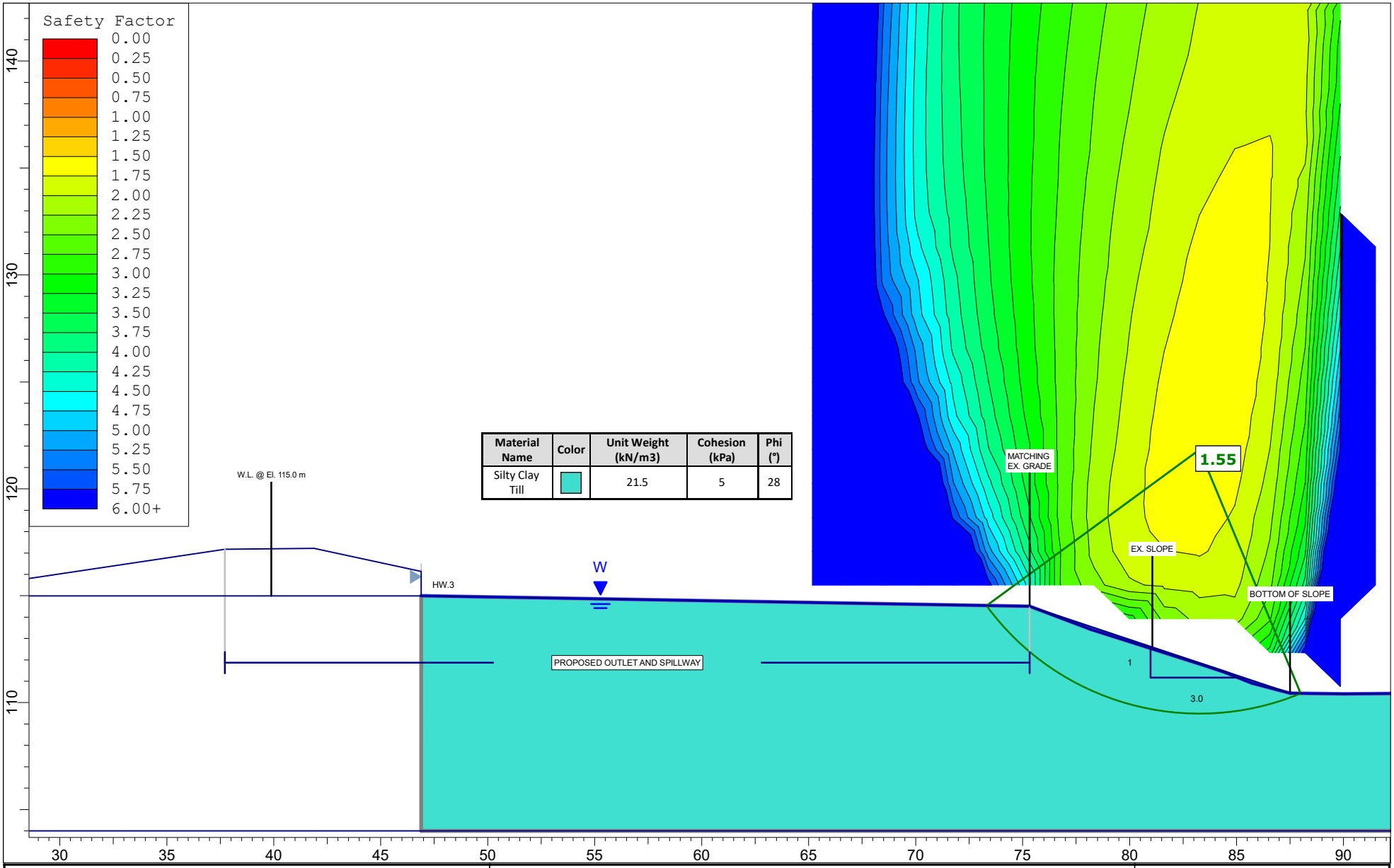
6 MILE CREEK

(FROM AERIAL IMAGERY)

Soil Engineers Ltd.
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

Cross-Section Location Plan

SITE: 353 Townline Road, Town of Niagara-on-the-lake			
DESIGNED BY: C.R.	**CHECKED BY:** K.F.L.	**DWG NO.:** 1	
SCALE: 1:600	**REF. NO.:** 2308-S165	**DATE:** December 2023	**REV** 1



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (°)
Silty Clay Till		21.5	5	28

Soil Engineers Ltd.
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

Project Title: Cross-Section 1-1			Load Case: Proposed Condition
Location: 353 Townline Road, Town of Niagara-on-the-Lake			
Drawn By: C.R.	Checked By: K.F.L.	Scale: 1:250	Revision: 1
Date: December 2023		Reference No.: 2308-S165	Drawing No.: 2