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October 22, 2021 File: 64913.01

Olico Builders Inc.
996-BV St. Augustin Road
Embrun, Ontario, K0A 1W0

Attention: Matthew Rocheleau, Project Manager

**Re: Slope Stability Assessment**
**Proposed Retaining Wall**
**5497 Manotick Main Street**
**Manotick (Ottawa), Ontario**

## INTRODUCTION

This letter presents the results of a global stability assessment carried out for the construction of a proposed retaining wall at 5497 Manotick Main Street in Manotick (Ottawa), Ontario.

## BACKGROUND

The property is located on the north side of Manotick Main Street in Manotick (Ottawa) and slopes downwards towards the west channel of the Rideau River. GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) carried out a previous slope stability assessment for the proposed development. The results are provided in the report titled, “Slope Stability Assessment, 5497 Manotick Main Street, Manotick (Ottawa), Ontario”, dated May 24, 2019. This letter should be read in conjunction with our previous report.

A commercial building and paved parking area are currently located on the property. As indicated in the updated plan, a new multipurpose building will be constructed. GEMTEC understands that a proposed retaining wall is to be located at the rear of the building to allow for grade separation between the building and the amenity area. The retaining wall is located out of the hazard limit of the slope analyzed in the previous report by GEMTEC.

In accordance with the Slope Stability Guidelines for Development Applications in the City of Ottawa, a slope stability assessment is required for sites that involve a retaining wall greater than 1 metre high; as such, the global stability of the proposed wall must be assessed.

## DESCRIPTION OF PROPOSED RETAINING WALL

The following background information was provided to GEMTEC:

- Site Grading Plan Drawing, Revision No. 2, prepared by Blanchard Letendre Engineering Ltd., dated August 6, 2021.
- RisiStone Retaining Wall Systems SienaStone Retaining Wall Design Report for New Multipurpose Development, (approval stage submission), dated September 28, 2021.

Based on the information, the following is understood about the proposed retaining wall (according to the manufacturer / designer's documentation):

- The wall will be a precast modular block retaining wall system with a length of 26.6 metres. The tallest panel height is 1.67 metres. The thickness of the stone panel is 0.5 metres. The panel unit weight is 22.8 kN/m$^3$.
- The proposed top elevation of the retaining wall is 87.4 metres and the bottom elevation is 86.0 metres. The wall inclination is about 83 degrees.
- The site grade will be raised by fill material behind and in front of the retaining wall. The proposed grass area behind the wall is to be sloped downwards away from the building at 2 degrees, resulting in a horizontal distance of about 3 metres between the building and the wall. The proposed grass area in front of the wall is to be sloped downwards away from the wall at 7 degrees.
- Geogrid reinforcement will be placed behind the wall with a maximum length of 1.6 metres. OPSS Granular B Type 2 will be filled to reinforcement behind the retaining wall.
- A compacted base of about 0.2 metres consisting of OPSS Granular A will be placed below the wall base.

## DESCRIPTION OF SITE

The description of site was provided by GEMTEC in the previous slope stability assessment letter, dated May 24, 2019. The site condition has not changed significantly since then – based on a review of available aerial imagery of the site. A summary of the site reconnaissance and observed ground conditions at that time is provided below.

### Site Reconnaissance

As part of GEMTEC's initial slope stability assessment, a site reconnaissance was carried out by a member of our engineering staff on April 25, 2019. The geometry of the existing slope was measured at two (2) locations (Sections A-A' and B-B') using our Trimble R10 GPS equipment. The locations of the cross sections are provided on the Site Plan, Figure 1.

The following observations were made at the time of the site reconnaissance:

- The slopes at the property are relatively flat and are vegetated with grass and large trees.
- No signs of active erosion or instability were observed at the subject site (i.e., tension cracks, rotational failures, etc.) at the time of the site reconnaissance.

It is noted that at the time of the site reconnaissance the Ottawa area was experiencing high water levels and, based on a review of aerial photographs, the river's edge had advanced up the toe of the slope. The approximate location of the river's edge at the time of the site reconnaissance is shown on Figure 1, which is at significant distance from the location of the proposed retaining wall, and therefore not likely to impact the global stability of the proposed retaining wall.

**Subsurface Conditions**

In order to determine the shallow subsurface conditions at the site, two (2) hand augerholes, numbered AH19-1 and AH19-2 (shown in Figure 1), were advanced at the site on April 25, 2019 by GEMTEC personnel. The subsurface conditions encountered in the augerholes were determined based on tactile examination of the material recovered on the flights of the auger. Details of the hand augerholes advanced at the site are as follows:

- Augerhole AH19-1 was advanced at the crest (top) of the slope along Section B-B' and encountered about 100 millimetres of brown, sandy topsoil overlying grey brown sand (possible fill material). Silty clay was encountered at a depth of about 0.3 metres below ground surface. The hand augerhole was terminated at a depth of about 1.4 metres below the ground surface in the silty clay. Groundwater seepage was observed at a depth of about 300 millimetres below the ground surface.
- Augerhole AH19-2 was advanced at the toe (bottom) of the slope along Section B-B' and encountered about 100 millimetres of brown, sandy topsoil overlying grey brown silty sand and sand and gravel. Refusal to hand augering was encountered at a depth of about 0.8 metres below ground surface.

The level of investigation is considered appropriate for the site conditions and complexity of the proposed retaining wall, in combination with available geotechnical maps and our previous engineering experience.

**Review of Available Geology Maps**

Surficial geology maps of the Ottawa area indicate that the site is underlain by silt and clay. Bedrock geology maps indicate that the bedrock is composed of dolostone of the Oxford formation at depths ranging between about 5 to 15 metres below ground surface.

Ministry of the Environment, Conservation and Parks (MECP) Water Well Records in the area indicate that the site is underlain by clay to depths of about 6 to 7 metres.

The conditions observed in the hand-auger holes showed reasonable agreement with the mapped subsurface (soil) conditions.

## SLOPE STABILITY ASSESSMENT

### Global Stability of Proposed Retaining Wall

The slope stability analyses of the proposed retaining wall were performed using SLIDE, a two-dimensional limit equilibrium slope stability commercial program by RocScience. The retaining wall and slope were modeled using the information above. The global stability was analyzed by considering our assessment of the worst case scenario (based on the available information):

- The tallest wall section (Section 2 in the Retaining Wall Design Report) was applied in the model. Since Section B-B' perpendicularly intersects the Section 2, the stability analyses was carried out at Section B-B'.
- The surcharge loading of the building is 15 kPa.
- The slope is fully saturated with the groundwater level at (or near) to the ground surface.
- The retaining wall system, including stone panels, Geogrid Reinforcement, reinforcement fill, embedment fill, engineered fill, etc., was modeled as an entire unit with a weight of 22 kN/m$^3$.
- The cross-section accounts for the future grade raise filling at the site by inclusion of earth fill to the proposed levels shown on the available plans.

The Bishop Simplified Method was used for the stability analyses.

Both static and pseudo-static conditions were considered. For the pseudo-static (seismic) condition, a horizontal seismic coefficient ($k_h$) of 0.14 was used, which is half of the Peak Ground Acceleration (PGA) for Ottawa according to the Ontario Building Code 2015.

The creek at the end of the property is not near to the retaining wall and is therefore not visible in the analyses cross-section.

### Input Parameters

The soil conditions used in the slope stability analysis were based on our observations of the existing soil conditions, in combination with our experience in the vicinity of the subject site and surficial geology maps of the area. GEMTEC has assumed that the slope is composed entirely of silty clay, consistent with the available information.

The slope stability analyses were carried out using silty clay strength parameters typical for the Ottawa area. It is noted that the undrained strength parameters of soil should be used for the pseudo-static (seismic) condition. The strength parameters for undrained silty clay and fill material were used based on the experience of GEMTEC (which is a reasonable lower bound estimate for the upper portion of the silty clay, and is consistent with the design assumption for the retaining wall design). The proposed retaining wall is assumed as infinite strength (to consider global stability conditions). The input material parameters used in the analyses are summarized in Table 1.

**Table 1 - Summary of Input Parameters**

| Material Type | Internal Friction Angle, $\phi$ (°) | Cohesion, $c$ (kPa) | Unit Weight, $\gamma$ (kN/m$^3$) |
|---|---|---|---|
| Silty Clay (Drained) | 32 | 10 | 17.5 |
| Silty Clay (Undrained) | 0 | 50 | 17.5 |
| Fill Material | 34 | 0 | 19.0 |
| Retaining Wall (Infinite strength) | - | - | 22.0 |

**Existing Factor of Safety**

The global stability analyses were carried out using material parameters, groundwater conditions and a slope profile that attempt to model the slope in question, but do not exactly represent the actual conditions. For the purposes of this study, a computed factor of safety of less than 1.0 to 1.3 is considered to represent a slope bordering on failure to marginally stable, respectively; a factor of safety of 1.3 to 1.5 is considered to indicate a slope that is less likely to fail in the long term and provides a degree of confidence against failure ranging from marginal (1.3) to adequate (1.4 and greater) should conditions vary from the assumed conditions. A factor of safety of 1.5, or greater, is considered to indicate adequate long term stability.

Based on the results of our global stability analyses, GEMTEC provides the following comments:

- The slope stability analyses show that the proposed retaining wall at Section B-B', under the current configuration, has a minimum factor of safety of 2.2 for the static condition i.e. greater than the minimum required value of 1.5, indicating adequate long term stability (refer to Figure A1 in Attachment A).
- The results indicate that the proposed retaining wall at Section B-B' has a minimum factor of safety of 1.4, i.e. greater than minimum required value of 1.1 for the pseudo-static (seismic) condition, which is considered acceptable (refer to Figure A2 in Attachment A).

Therefore, the proposed retaining wall is considered stable in the long term.

## ADDITIONAL CONSIDERATIONS

The above slope stability assessment was carried out based on the information provided in the Site Grading Plan and the Retaining Wall Design Report. Any changes in configuration, including but not limited to site grading, wall geometries, building materials, soil profiles, etc., will affect the results of slope stability assessment. GEMTEC should be provided with details of any changes to the overall wall / site grading configuration to verify that the results of our assessment have not been materially affected.

GEMTEC's assessment is limited to the global stability of the proposed retaining wall. It should be noted that GEMTEC did not verify the internal and external stability (overturning and sliding etc.) of the reinforced earth system. It is understood that this is the responsibility of the wall designer.

Updated / finalised plans and designs for any proposed development involving the slope and the proposed retaining wall should be reviewed by GEMTEC to ensure the comments in this letter remain appropriate.

## CLOSURE

We trust that this letter is sufficient for your purposes. If you have any questions concerning this information or if we can be of further assistance to you on this project, please contact the undersigned.

Feitao Zeng, Ph.D.
Geotechnical Engineer-in-Training


Lauren Ashe, M.A.Sc., P.Eng.
Geotechnical Engineer

FZ/DC/LA

Attachments:

Figure 1 – Site Plan
Attachment A – Slope Stability Analyses, Figures A1 and A2

RIDEAU RIVER

APPROXIMATE LOCATION OF THE RIVER'S EDGE AT THE TIME OF THE RECONNAISSANCE

APPROXIMATE PROPERTY BOUNDARY

APPROXIMATE LOCATION OF EROSION HAZARD LIMIT

AH 19-2
84.07

AH 19-1
86.76

A

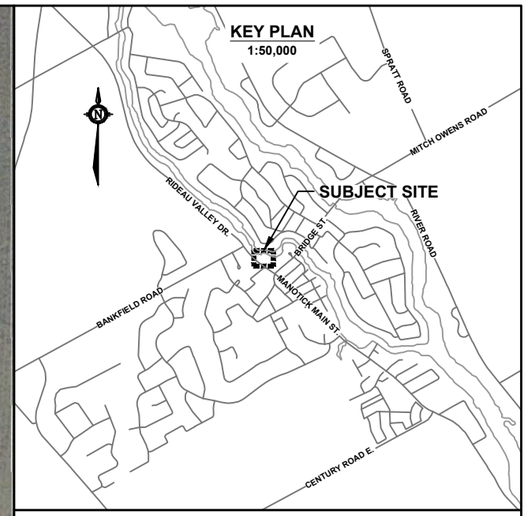
A'

B

B'

MANOTICK MAIN STREET

## KEY PLAN
1:50,000




## LEGEND

**AUGER HOLE LOCATION IN PLAN**
(current investigation by GEMTEC)

AH # — AUGER HOLE ID

XX.XX — GROUND SURFACE ELEVATION, IN METRES GEODETIC DATUM

A A'

**SLOPE CROSS SECTION LOCATION IN PLAN**
(current investigation by GEMTEC)

Scale 1:500

0 10 20 30m

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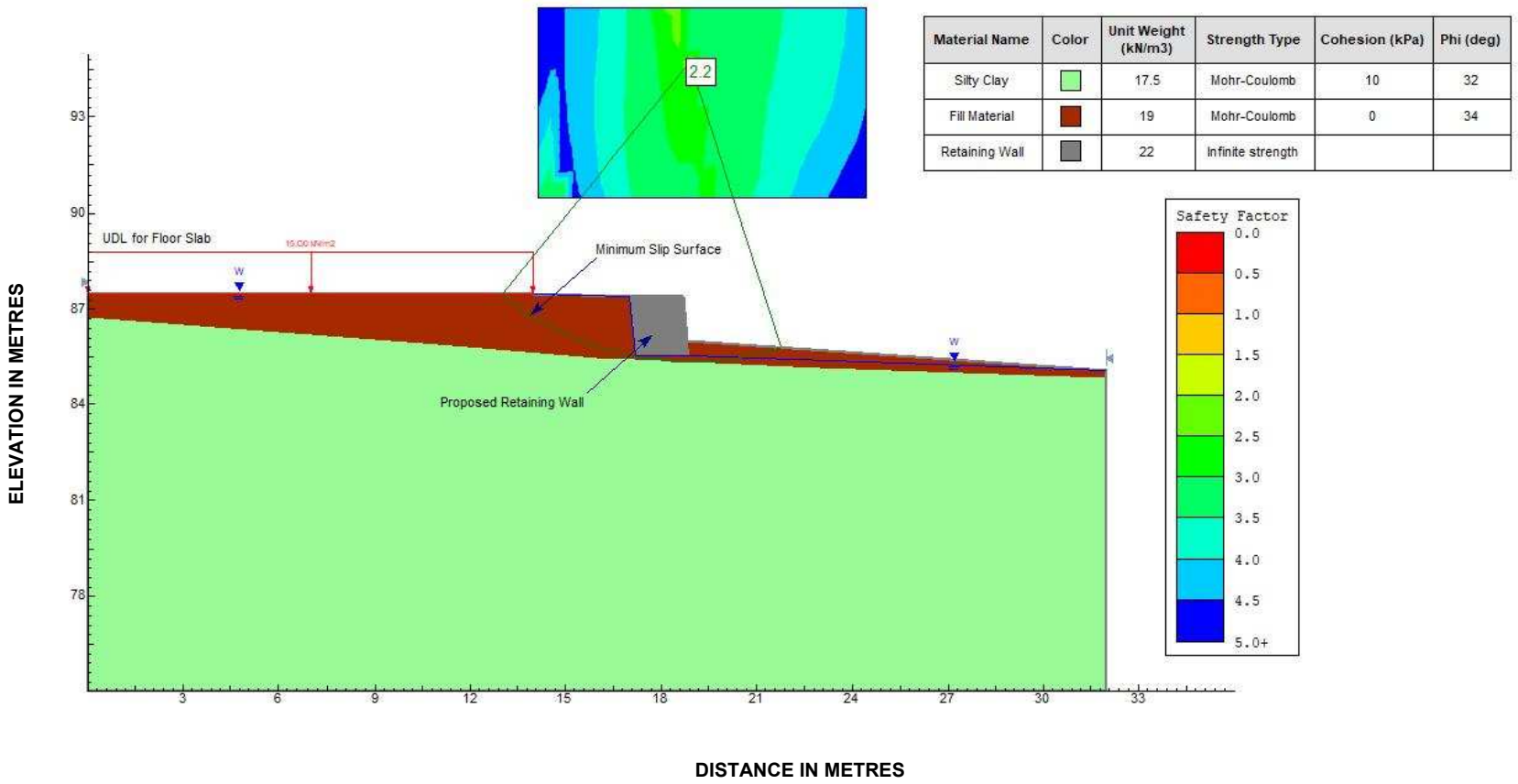
| | |
|---|---|
| Client | OLICO BUILDERS INC. |
| Project | 64913.01 |
| Location | 5497 MANOTICK MAIN STREET MANOTICK, ON |
| Drwn by | S.L. |
| Chkd by | L.A. |
| | SITE PLAN |
| Date | OCTOBER, 2021 |
| Rev. | 0 |

**FIGURE 1**

# ATTACHMENT A

Slope Stability Analyses

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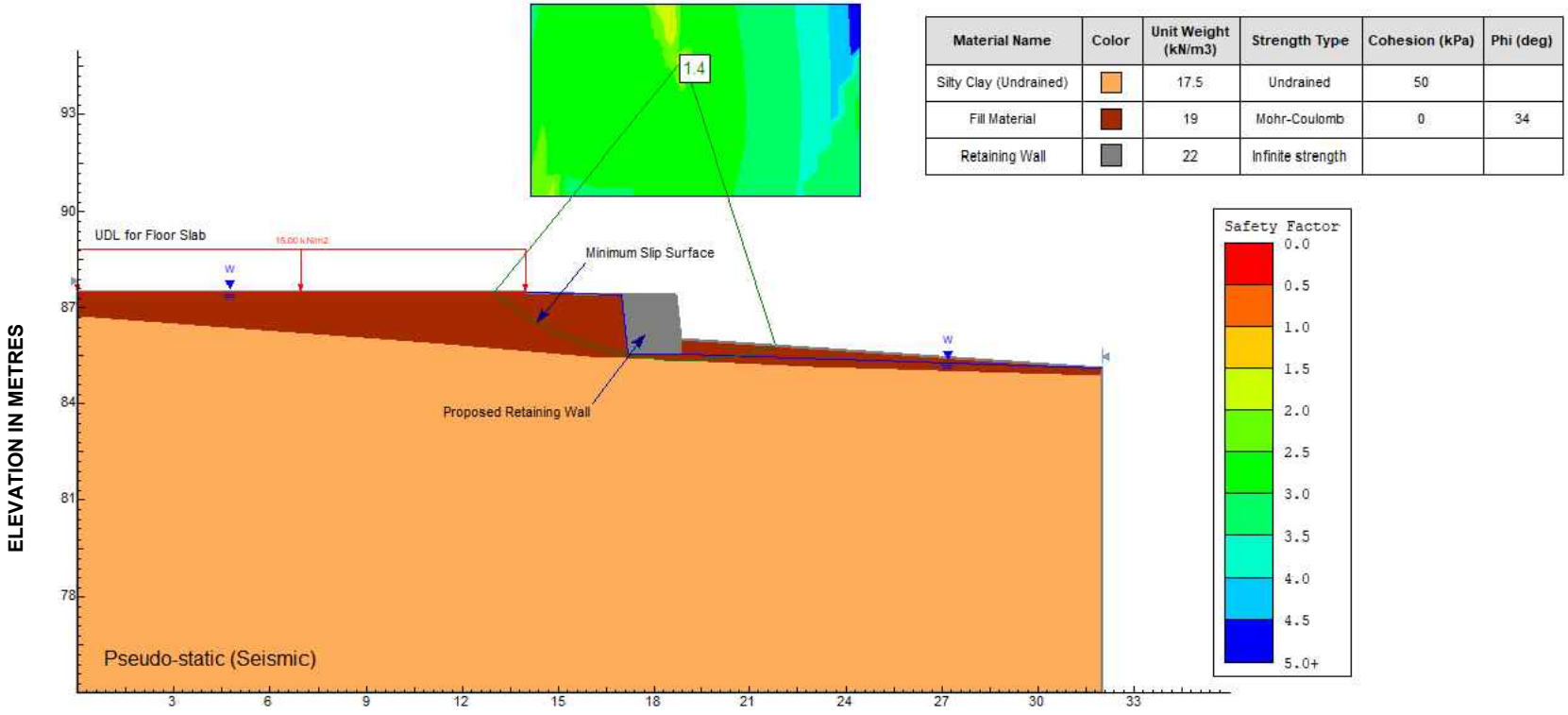
| Project | Drwn By | Chkd By | Date | Drawing |
|---|---|---|---|---|
| SLOPE STABILITY ANALYSIS<br>PROPOSED RETAINING WALL<br>5497 MANOTICK MAIN STREET<br>MANOTICK, ONTARIO | S.L. | L.A. | OCTOBER, 2021 | SECTION B-B<br>PROPOSED |
| | File No. 64913.01 | Revision No. 0 | **FIGURE A1** | |




| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) |
|---|---|---|---|---|---|
| Silty Clay (Undrained) | | 17.5 | Undrained | 50 | |
| Fill Material | | 19 | Mohr-Coulomb | 0 | 34 |
| Retaining Wall | | 22 | Infinite strength | | |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Project
SLOPE STABILITY ANALYSIS
PROPOSED RETAINING WALL
5497 MANOTICK MAIN STREET
MANOTICK, ONTARIO

| Drwn By | Chkd By | Date |
|---|---|---|
| S.L. | L.A. | OCTOBER, 2021 |

| File No. | Revision No. |
|---|---|
| 64913.01 | 0 |

**FIGURE A2**

Drawing
SECTION B-B
PROPOSED