

P.MACHIBRODA ENGINEERING LTD.

CONSULTING GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERS AND GEOSCIENTISTS

806-48th STREET EAST SASKATOON, SK S7K 3Y4 P: 306.665.8444 F: 306.652.2092 E: pmel.sk@machibroda.com

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Member of the Association of Consulting Engineering Companies/Canada

May 7, 2020

Town of Outlook Box 518 Outlook, Saskatchewan SOL 2N0

ATTENTION: HUGUETTE LUTZ, CAO

RE: SLOPE STABILITY STUDY – OVERLAY MAPS EAST BANK – SOUTH SASKATCHEWAN RIVER OUTLOOK, SASKATCHEWAN PMEL PROJECT NO. 16030

1 INTRODUCTION

The following letter has been prepared in response to your request that P. Machibroda Engineering Ltd. (PMEL) review all background studies that we have conducted along the East Bank of the South Saskatchewan River and prepare a drawing(s) showing areas with a low to high risk of potential slope instability within the corporate limits of the Town of Outlook.

The intent of the drawings is to provide a visual aid to assist with the management of current and future development of the properties in and around the riverbank. It should be noted that the attached drawings are our best interpretation of the existing data and may not be exact.

P. Machibroda Engineering Ltd. (PMEL) previously completed the following slope stability studies:

- PMEL Report No. S08-6559, dated November 19, 2008;
- PMEL Report No. 9551, dated August 31, 2015; and
- PMEL Report No. 12451, dated October 26, 2017.

The most recent slope monitoring had been summarized in PMEL Letter No. 16030, dated September 17, 2019.

2 METHODOLOGY

The methodology on determining the areas at risk of slope instability consisted of reviewing the past slope stability reports, previous slope stability analyses and current slope conditions.

As noted in previous studies, the landslide(s) are large soil masses with multiply failure blocks that are likely moving at different rates. The shear zones in which the landslide blocks are sliding along are at different elevations and typically in the clay shale.

Due to the large and complex make-up of the landslides, it is very difficult to accurately predict the rate of future movement of existing landslide blocks and where a future landslide would form. The below noted zones with differing levels of risk were estimated based on the current slope conditions (where slope movement has been observed and where it is occurring upslope of the crest of slope) and analyzing different slope stability models to estimate the risk of where future slope movement may regress to.

3 RECOMMENDATIONS

Based on the stability review/analyses, three zones have been defined. The three zones are as follows:

- Zone A: The zone with historical/active landslide activity. This area is known to have experienced slope movement and has a very high risk of slope movement impacting properties, if not so already.
- Zone B: This zone is outside known landslide activity but is considered to have a moderate to high risk of future slope movement impacting properties in the long-term due to its proximity to the crest of slope.
- Zone C: This zone is well outside the known areas with landslide activity but is considered to have a low risk of future slope movement impacting in the long-term.

Further explanation on the three zones have been presented below. The zones have been shown on attached Drawing Nos. 16030-1, 2 and 3.

3.1 ZONE A

Zone A consists of the area between Line A and the river. This zone is within historical and active landslide areas and is experiencing slope movement. Many structures (i.e., houses, bridge, pool, pumping station, etc.) within this zone have experienced differential movement due to slope movement and as a result have experienced differing degrees of damage. As such, this zone is considered at a very high risk of further slope movement and property owners should be aware that this could result in damage to properties and structures.

Considering the slow slope movement recorded to date, a catastrophic failure of a structure in this zone is not anticipated to happen suddenly. However, the ongoing slope movement may cause significant damage to structures and eventual failure if damages are not repaired/managed.

The following recommendations and precautions have been offered for properties/structures in Zone A:

- Owners of existing properties located in this zone should be made aware of the risk to their properties and/or structures (i.e., houses);
- New major development is prohibited (i.e., new houses, large house additions, etc.);
- Minor development of existing properties should not negatively change the conditions of the slope and a Geotechnical Engineer should be consulted. Owners should be aware even if any minor developments are designed, not to negatively change the slope conditions, slope movement could still cause damage.



3.2 ZONE B

Zone B consists of the area approximately between the crest of slope (Line A) and 35 m upslope (Line B). This zone does not appear to be within a historical landslide area and there are no obvious signs of current slope movement impacting properties in this zone. Though the slope movement has generally been observed along the slope (downslope of the crest of slope), there is one known area in which a landslide block has formed upslope of the crest of slope (along Tuft Crescent). As such, it is considered that there is a moderate to high risk of slope movement potentially occurring within Zone B in the long-term.

Considering the slow slope movement recorded to date, if the landslide(s) regresses into Zone B, a catastrophic failure of a structure in this zone is not anticipated to happen suddenly. However, future slope movement may cause significant damage to structures and eventual failure if damages are not repaired/managed.

The following recommendations and precautions have been offered for properties/structures in Zone B:

- Owners of existing properties located in this zone should be made aware of the risk to their properties and/or structures (i.e., houses);
- New major development is prohibited (i.e., new houses, large house additions, etc.);
- Minor development of existing properties should not negatively change the conditions of the slope and a Geotechnical Engineer should be consulted. Owners should be aware even if any minor developments are designed, not to negatively change the slope conditions, slope movement could still cause damage if the landslide regresses into Zone B.

3.3 ZONE C

Zone C consists of the area approximately between 35 m (Line B) and 100 m (Line C) from the crest of slope. This zone is generally well outside the historical landslide area and there are no signs of current slope movement impacting properties in this zone. The risk of slope movement potentially occurring within this zone is considered low. Due to the distance from the existing active/historical landslide areas, it is anticipated that any new landslide blocks would form within Zone B prior to impacting any properties in Zone C.

The following recommendations and precautions have been offered for properties/structures in Zone C:

- Owners of existing properties located in this zone should be made aware of the risk to their properties and/or structures (i.e., houses);
- Major developments involving multi-residential buildings, commercial buildings, etc., should have a Geotechnical Engineer complete a geotechnical and slope stability investigation. The slope stability should demonstrate that the development does not negatively impact the slope stability and the location will not be impacted from slope instability in the long-term.



- Major development involving existing single-family residential properties (i.e., new houses, large house additions, etc.) should consult a Geotechnical Engineer and demonstrate that the development does not negatively impact the slope stability;
- No restrictions on minor development of existing properties.

4 GEOTECHNICAL AND SLOPE STABILITY REQUIREMENTS

A geotechnical report in regard to slope stability and development in the above described Zones, should include the following:

- Should be completed by a professional engineer with appropriate specialization in geotechnical engineering and licensed to practice in the Province of Saskatchewan.
- The type of proposed development should be outlined in the geotechnical report.
- A review of previous slope stability studies done for the area (from Town of Outlook).
- Depending on type of development, complete site specific geotechnical investigation to determine soil and groundwater conditions on property and demonstrate slope geometry has been accurately surveyed.
- Consider the stability of the whole slope including areas of active movement and previous instability, and impact of slope stability to the development site and neighbouring properties.
- Demonstrate that the proposed development will not negatively impact the stability of the slope. They should consider grading, landscaping, new building loads, etc.
- In case of a development on a vacant lot/previously developed site, demonstrate that the development site is suitable for development as defined as having a minimum Factor of Safety of 1.5 for major developments (i.e., new houses, large house additions, etc.) and 1.3 for minor developments (i.e., small house additions, etc.). The factor of safety is defined as the ratio of available resistance to the available resistance to the minimum resistance required to maintain stability.
- If the development site is in an existing developed residential lot and in an area with active movement and/or at high risk of slope movement, the engineering design should demonstrate that the potential for future slope movement has been considered (i.e., foundations, utility connections, etc.).
- In addition, the engineer shall complete a site visit to inspect the property to assess the existing conditions and demonstrate that the risks of the development are fully understood and communicated to the client/owner.

5 CLOSURE

The stability review and slope stability overlay maps has been completed as requested. Due to the large size and complexity of the landslides it is very difficult to fully assess when and if the landslide will regress upslope from the current extents of the active landslide(s). Owners should monitor their properties carefully for signs of slope movement (i.e., tension cracks, differential movement of foundations, leaning trees, etc.) and consult a Geotechnical Engineer immediately if these conditions are observed.



This report has been prepared for the exclusive use of Town of Outlook. and their agents for specific application to the stability review and overlay maps along the East Bank of the South Saskatchewan River in the Town of Outlook, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party, makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Party. Any other unspecified subsequent development would be considered Third Party and would, therefore, require prior review by PMEL. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this meets your requirements at this time. If you have any questions or require additional information, please contact our office.

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Graham Baxter, P.Eng.

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Kelly Pardoski, P.Eng. GB/KP:zz

ENCLOSURES:

Drawings



DRAWINGS





NOTE:

. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN. 2. THIS DRAWING WAS COMPILED USING AN AERIAL PHOTOGRAPH PROVIDED BY ISC.

ZONE A: AREA OF HISTORICAL AND ACTIVE LANDSLIDES. AREA HAS/IS EXPERIENCING SLOPE MOVEMENT.

ZONE B: AREA WITH NO OBVIOUS CURRENT SLOPE MOVEMENT BUT CONSIDERED AT MODERATE TO HIGH RISK OF SLOPE MOVEMENT IN FUTURE.

ZONE C: AREA WITH NO SLOPE MOVEMENT AND CONSIDERED TO HAVE A LOW RISK OF SLOPE MOVEMENT OCCURRING IN FUTURE.



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DATE: SEPTEMBER, 2019 SCALE: AS SHOWN	DRAWING NUMBER: 16030-1



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