GEONORTH ENGINEERING LTD.

3975 18th Avenue
Prince George, B.C., V2N 1B2
Phone 250-564-4304
Fax 250-564-9323
E-mail mail@geonorth.ca

January 29, 2020

Mr. Keven Braet
1253 5th Avenue
Prince George BC V2L 3L3

File No. K-5302

Dear Mr. Braet:

Re: Geotechnical Assessment,
4244 Foothills Boulevard, Prince George, B.C.

1.0 Introduction

We understand you are submitting a rezoning application for 4244 Foothills Boulevard in Prince George, B.C. prior to selling the property. City of Prince George requested a geotechnical slope stability assessment be carried out as part of the application. You commissioned our firm to carry out the assessment based on the scope of work and cost estimate we provided you, dated October 21, 2019.

The property is located adjacent to Foothills Boulevard, about 1.2 km northeast of the intersection of North Nechako Road and Foothills Boulevard. It is "L" shaped, with the long axis oriented north to south and measuring about 290 m and the short axis measuring 215 m, oriented east to west at the north end of the long axis. Currently, the east part of the property is zoned Agriculture & Forestry (AF) and the west part is zoned Greenbelt (AG). You would like to expand the AF zoning over a larger part of the property. A plan showing the site location and current zoning is on Drawing 5302-A1, attached.

This report presents the results of the assessment, and provides recommendations for a suitable development setback from an existing slope on the west side of the property and a recommended revised zone boundary.

2.0 Background Information

The property is in the north part of Prince George, B.C., within the Nechako Lowlands of the Central Plateau physiographic region, characterised by low to moderate relief. Prince George has a humid continental climate with an average annual temperature of 5.3°C and 558 mm of precipitation, based on climate normals recorded between 1981 and 2010 (Government of Canada). A document titled Climate Change in Prince George (Pacific Climate Impacts

Consortium, 2009) indicates the Prince George area is located in a zone of strong climate variability and trends resulting from El Nino/Southern Oscillation and the Pacific Decadal Oscillation. Prince George has experienced an average warming trend of 1.3°C over the last century with a higher percentage of precipitation falling as rain rather than snow. Annual temperatures in the region are projected to increase an average of 1.6 to 2.5°C by the middle of the 21st century, with precipitation projected to increase by 3 to 10%.

Geological mapping shows the project area is within the footprint of Glacial Lake Prince George that existed for several hundred years at the end of the last glacial period, about 10,000 to 12,000 years ago. Landforms on the property are a result of deposits from a large meltwater stream that entered the glacial lake from the northwest. The stream carried large quantities of silt and sand, that was likely deposited as a large delta at the edge of the lake. Large blocks of ice became buried in the delta sediments which resulted in depressions known as kettles after the ice melted, and ridges known as kames where sediment was deposited between blocks. Subsequent erosion in the area resulted in the rugged topography that is typical of the Hart area.

3.0 Geomorphology, Surficial and Slope Stability Conditions

To assess the geomorphology of the site, we reviewed aerial photographs, Light Detecting and Ranging (LiDAR) data and 1 m interval contour maps available on the City of Prince George website. On October 29, 2019 we carried out a field assessment that included measuring slope gradients, noting vegetation types, observing soil and groundwater conditions in natural exposures and hand-dug test pits, and checking for signs of instability such as tension cracks, slide scarps and slide debris.

Contour maps show terrain below the east part of the property is relatively flat, between elevations 662 and 665 m. The west part of the property is located partly over the toe of a conical shaped hill, a kame, with moderate to steep gradients that extends up to elevation 722 m. The slope is 100 m long, has a concave profile and shows no signs of sliding. The lower part of the slope has moderate gradients between 35 and 50%, the mid part of the slope has moderately steep to steep gradients between 50 and 70%, and the top part of the slope is steep with gradients over 75%. A skid trail circles the hill and accesses a flat pad constructed at the top of the slope. The trail was constructed by excavating and side casting fill over the natural slope, resulting in a nearly vertical 3 m high pitch at the top of the slope. Behind the slope crest, the ground slopes west, away from the project area at a gentle gradient. A hillshade image is shown on Drawing 5302-A2, attached.

Cross sections from hip-chain and clinometer readings taken during the site assessment and from ground contour information from the City of Prince George website are shown on Drawing 5302-A3, attached.

The slope is forested with large, widely spaced, mature Douglas fir and spruce trees with minor amounts of poplar and birch. There are shrubs and grasses growing below the trees and across the slope, except at the location of recreational vehicle trails and along the skid trail at the top of the steep slope. Mineral soil is exposed in the trails.

Soil conditions encountered in hand dug test pits and visible in exposures generally consist of layered sand and silt. The nearly vertical cut at the crest of the slope is primarily comprised of silt, held in place by capillary tension. The steep slopes can be destabilized where they are subjected to surface water, seepage or a rise in groundwater, or where they are undermined by erosion or excavation. There are signs that flowing water has eroded the slope where it is concentrated on the skid trail and on recreational vehicle trails. Trees near the slope crest frequently have a buildup of mineral soil against the upslope face of tree trunks, indicating downslope soil migration. Aerial photos dated between 1993 and 2018 show the slope shape has not significantly changed over that period.

Slope stability conditions can change with time as a result of climatic changes associated with high rainfall or rainfall on snow events, and due to dry summer conditions that could contribute to a forest fire. A fire would damage vegetation and roots, which would reduce root cohesion, transpiration and interception of precipitation, and could cause hydrophobicity. Development that modifies slope geometry or increases drainage to the crest could increase the rate of erosion or cause sections of the steeply sloped silt to collapse or topple. All of these conditions increase the potential for instability.

4.0 Discussion and Recommendations

As noted above, there are no indications of previous shallow or deep-seated instability upslope of the area proposed for house construction, but there are indications of surface soil erosion at the crest of the 100 m long slope. The erosion is a result of runoff along wheel ruts in the access trail leading to the top of the slope. The 3 m high, nearly vertical pitch at the crest of the slope could fail as a slump or blocks could topple, but the debris runout is unlikely to have sufficient kinetic energy to reach the toe of the slope. There is no evidence of intact blocks of silt, nor are there indications of previous debris flow activity on the slope.

Future changes to the slope as a result of harvesting activities to remove diseased trees or due to a forest fire could reduce stability conditions, particularly if hydrophobic conditions develop following an intense forest fire. In this condition, the intense heat of a forest fire can create a waxy substance that is derived from the burned plant material. Under this condition there is limited soil absorption and no interception of rainfall and snow melt, which can result in rapid and erosive runoff. At this site, the catchment above the proposed house location is limited

and the potential for damage to buildings caused by runoff and sedimentation can be mitigated by leaving a space between proposed occupied structures and the toe of the slope. We recommend a setback for residential buildings of no less than 10 m measured from the toe of the slope.

The transition in zoning between AG and AF at the time of writing does not follow a property line, a drainage, or terrain feature and seems to be arbitrary. From a geotechnical perspective, we recommend revising the zone boundary to that shown on Drawing 5302-A2.

5.0 Closure

Development of the property is confined to the relatively flat east part of the property, where it is unlikely that construction activity would undermine and cause instability of the steep slope at the west property boundary. We believe rezoning and developing the property will not contribute to instability of the slope.

This report was prepared by GeoNorth Engineering Ltd. for the use of Mr. Keven Braet, City of Prince George and their consultants. The material in it reflects GeoNorth Engineering's judgement in light of the information available to us at the time of preparation. Any use which Third Parties make of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. GeoNorth Engineering Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Please contact the writers if any part of this report needs to be clarified.

Yours truly,
GeoNorth Engineering Ltd.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
W. J. LANENGA
38633

Per: W.J. Lanenga, P.Eng.

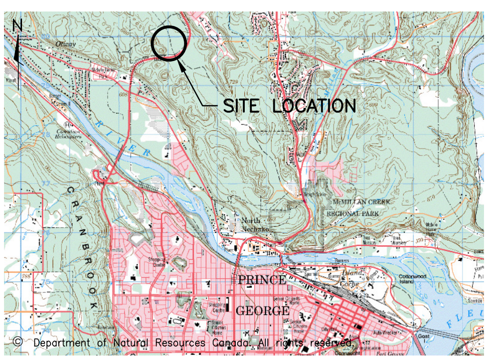
Reviewed by,
GeoNorth Engineering Ltd.

Per: D.J. McDougall, M.Eng., P.Eng.

Enclosures: Site Plan, Drawing K-5302-A1
Site Plan Showing LiDAR Data, Drawing K-5302-A2
Cross Sections, Drawing K-5302-A3

NOTE:

SITE PLAN BASED ON DIGITAL INFORMATION FROM CITY OF PRINCE GEORGE WEBSITE. ORTHOPHOTO DATED 2018. ACCURACY CANNOT BE GUARANTEED.



KEY MAP

NTS Map – 93 G/15 Scale – 1:100,000

Note: Drawing is included for information purposes only and is to be interpreted with the corresponding Geotechnical Report.

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MR. KEVEN BRAET
GEOTECHNICAL ASSESSMENT
4244 FOOTHILLS BOULEVARD, PRINCE GEORGE, B.C.
SITE PLAN

SCALE:	1:2000
DATE:	2020/01/29
DRAWN BY:	LU
REVIEWED BY:	WJL
APPROVED:	
DRAWING NO:	5302-A1
REVISION:	–
PROJECT NO:	K-5302

NOTE:

SITE PLAN BASED ON DIGITAL INFORMATION FROM CITY OF PRINCE GEORGE WEBSITE. ORTHOPHOTO DATED 2018. ACCURACY CANNOT BE GUARANTEED.

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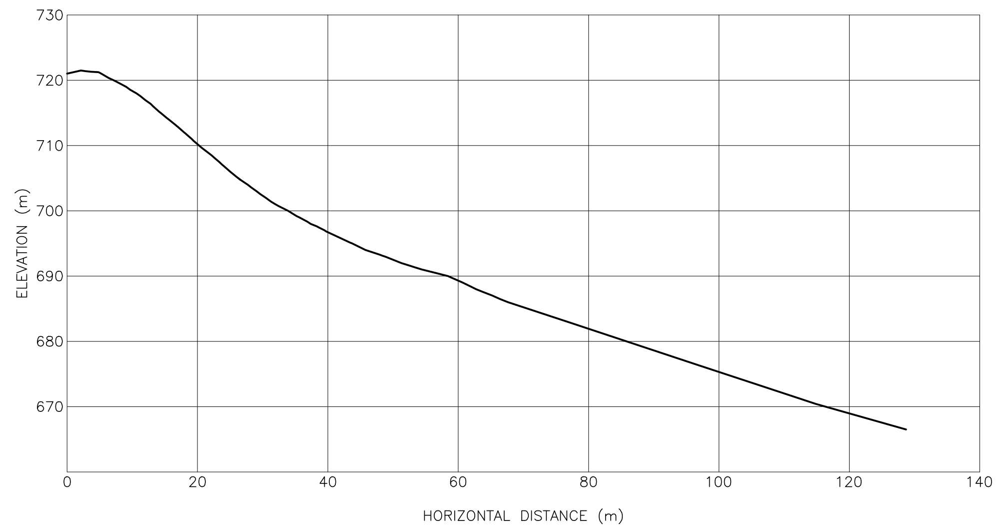
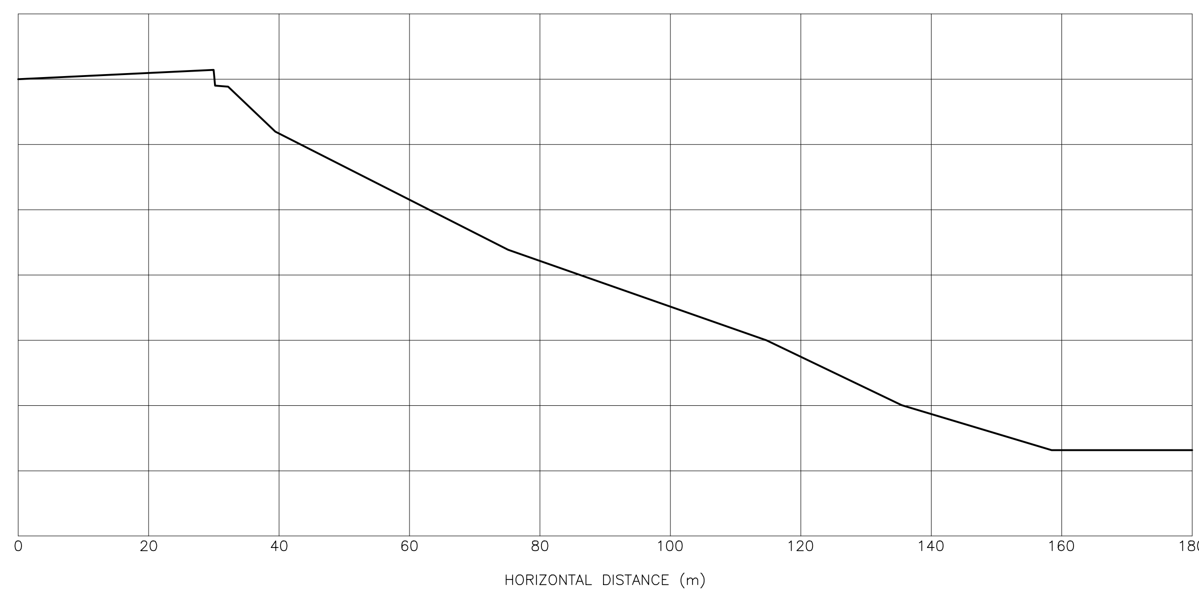
MR. KEVEN BRAET
GEOTECHNICAL ASSESSMENT
4244 FOOTHILLS BOULEVARD, PRINCE GEORGE, B.C.
SITE PLAN SHOWING LIDAR DATA

SCALE: 1:2000	APPROVED:
DATE: 2020/01/29	
DRAWN BY: LU	
REVIEWED BY: WJL	
DRAWING NO: 5302-A2	REVISION: –
	PROJECT NO: K-5302



CROSS SECTION A–A



CROSS SECTION B–B

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4244 FOOTHILLS BOULEVARD, PRINCE GEORGE, B.C.
CROSS SECTIONS

SCALE: 1:750	APPROVED:	
DATE: 2020/01/29		
DRAWN BY: LU		
REVIEWED BY: WJL		
DRAWING NO: 5302–A3	REVISION: –	PROJECT NO: K–5302