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Mr. Jozsef Dioszeghy, P.Eng.
District of North Vancouver
355 West Queens Rd.
North Vancouver, B.C.
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Dear Sir,

RE: RUNOUT ANALYSIS FOR HYPOTHETICAL SLIDE AT 2191/2205 BERKLEY AVENUE

This letter presents the results of detailed runout modelling for a hypothetical landslide initiating from the property boundary between 2191 and 2205 Berkley Avenue, North Vancouver.

BACKGROUND

A landslide appears to have originated from the crest of the Berkley-Riverside escarpment near the property boundary between 2205 and 2217 Berkley Avenue in December of 1979. On January 19, 2005, another landslide originated from the back yard of 2175 Berkley, located about 60 m to the south of the 1979 landslide. Klohn (1980) reported cracking extended from the 1979 headscarp to the area of the 2005 landslide headscarp.

In a letter to the District of North Vancouver, dated June 28, 2005, BGC indicated there exists the potential for a similar failure to initiate between these two landslides. Based on slope stability modelling and comparison with the adjacent landslides, BGC estimated that a slide was likely to occur if groundwater levels exceeded those measured by piezometers on March 21, 2005 by about 1.8 m. The initial failure volume was estimated at between 250 and 500 m^3. An estimate of the annual likelihood of failure was not provided.

By visual inspection, it appeared that a number of properties situated at the bottom of the escarpment could be impacted by slide debris, should the hypothetical landslide occur. BGC was retained to carry out a detailed runout analysis to gain further insight on which properties would likely be impacted. Two methods were used: computer simulation using a three-dimensional landslide runout model; and, a geometric assessment using runout angles.

3-D Landslide Runout Modelling

The observed runout behaviour of the January 19, 2005 landslide was used to calibrate a three-dimensional landslide runout model developed by the Earth and Ocean Science Department at UBC. This tool uses a number of different mechanical model types to simulate material entrainment and flow behaviour.

Detailed 1 m contour topographic information acquired between the 1979 and 2005 landslides from the crest to the base of the escarpment was merged with 5 m contour data that was available for beyond the base of the escarpment.

A 20 m wide failure with a volume of 500 m^3, initiating from the 132 m contour line was analysed. Landslide entrainment rate was held constant between the 132 and 120 m contours. A frictional resistance with an internal friction angle of 35° and a basal friction angle of 19° was used.

The landslide material entrainment and flow behaviour along the merged topographic surface was simulated. The results suggest the slide would entrain material until reaching a maximum volume of about 1,500 m^3.

The model predicts that the landslide width would increase rapidly as the debris flowed down the slope along an approximate bearing of 300°. Near the bottom of the escarpment, the slope aspect changes slightly, directing the landslide debris a bit to the south.

The model predicts the landslide would runout to an angle of about 23°, as measured from the toe of the debris to the crest of the escarpment. This is similar to that observed for the January 19, 2005 landslide, although during that event some woody debris, organic soil and water travelled further, coming to rest at a runout angle of about 21 to 22°.

Results of the modelling are shown in plan and perspective views (Figure 1, 2 and 3). These views were generated by draping a recent orthophoto and the modelling results overtop of a digital elevation model for the escarpment.

Runout Angles

A runout angle refers to the angle measured from the limit of slide debris that travelled the farthest to the initiation point at the top of the landslide. Steep angles imply short runout distance, while shallow angles imply long runout distance.

The January 2005 landslide had a runout angle of about 22°, although some water and organic soil travelled further, corresponding to a runout angle of about 21°.

Runout angles from the hypothetical landslide initiating at the boundary of 2191 and 2205 Berkley Avenue were calculated and also plotted on Figure 1, 2 and 3.

Interpretation

Three-dimensional runout modelling appears to provide a good prediction of the direction of

the hypothetical slide flow path and the limits of runout for mineral soil.

During the January 2005 landslide, some structural damage occurred to a house in the slide path sitting about 23° from the initiation zone, while a house sitting at an angle slightly steeper than 25° from the initiation zone was completely destroyed. Thus, the angle made between the location of a house and the location of the initiation zone of a potential landslide can provide some indication of the potential for damage, should a slide occur.

Based on data from the January 2005 landslide, we make the following interpretation regarding the likelihood of structural damage for houses situated at different angles below a slide initiation zone:

- steeper than 25° = very high likelihood (perhaps a 95% chance);
- between 23 and 25° = high likelihood (perhaps a 75% chance);
- between 21 and 23° = moderate likelihood (perhaps a 25% chance);
- between 19 and 21° = low likelihood (perhaps a 5% chance, mostly nuisance flooding); and,
- less than 19° = very low likelihood (perhaps less than a 1% chance).

Damage occurring to houses located at runout angles of less than 21° would likely be caused by trees that were entrained by the landslide, as these often tend to travel further than the mineral soil, and often with enough momentum to cause structural damage.

Based on the three-dimensional runout modelling and the runout angle calculations, it appears that the following properties have at least a moderate likelihood of being impacted by slide debris, should a landslide with an initial volume of about 500 m^3 initiate from the crest of the escarpment near the boundary between 2191 and 2205 Berkley Avenue:

- 2318 Treetop Lane
- 2430 Chapman Way
- 2440 Chapman Way
- 2274 Chapman Way
- 2290 Chapman Way
- 2296 Chapman Way

The analyses suggest the following houses have a high likelihood of sustaining structural damage should a slide occur:

- 2274 Chapman Way
- 2290 Chapman Way
- 2318 Chapman Way

If a new house were to be constructed at 2440 Chapman Way, it would have a very high likelihood of sustaining structural damage.

The house at 2296 Chapman Way appears to have a moderate to low likelihood of sustaining structural damage should a landslide occur.

LIMITATIONS

The discussion on slope stability and landslide runout in this report is based on factual information gathered from site investigations, monitoring and laboratory testing, as well as on geotechnical engineering judgment. Further detailed geotechnical investigations on the subject properties or within several hundred metres around them could lead to the discovery of information that will materially influence the slope stability analyses reported here. This is a reality in geotechnical engineering practice, which stems from the need to characterize geological uncertainty at specific reporting junctures with limited information. The reader must accept that this is the standard of geotechnical engineering practice, and its inherent limitations are not unique to the study reported here.

BGC prepared this letter for the District of North Vancouver. The material in it reflects the judgment of BGC staff in light of the information available to BGC at the time of report preparation. Any use of this report, or reliance which is placed on this report by anyone other than the District of North Vancouver, is the responsibility of that person or party. BGC accepts no responsibility for damages, if any, suffered by any person or party, other than the District of North Vancouver, as a result of decisions made or actions taken based on this report. BGC also does not assume any liability for possible losses in property value that may result from this report.

Yours sincerely,
BGC ENGINEERING INC.
per:

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