
Project Memorandum

To:	QuantumPlace Developments	Doc. No.:	
Attention:	Chris Ollenberger	cc:	
From:	Sarah Kimball, Matthias Jakob	Date:	June 19, 2017
Subject:	Stewart Creek Phase 3 Geohazard Assessment - FINAL		
Project No.:	1531002		

1.0 INTRODUCTION

BGC Engineering Inc. (BGC) understands that Three Sisters Mountain Village Properties Ltd. (TSMV) is developing an area located between Three Sisters Creek and Pigeon Creek, in an area referred to as Stewart Creek Phases 1 to 3 (Drawing 01). Stewart Creek Phases 1 through 3 fall within a steep creek study area boundary and therefore require a hazard and risk assessment as per the Town of Canmore's (Canmore) steep creek policy (Town of Canmore 2016).

Given this steep creek policy, QuantumPlace Development Ltd. (QPD), on behalf of TSMV, requested that BGC conduct a detailed hazard and risk assessment for subdivisions near Stewart Creek. This assessment supports the development and sale of properties in this area and fulfills Canmore's steep creek risk assessment policy requirements. The work was organized into the following phases:

1. Preliminary hazard assessment for the Stewart Creek Phase 1, 2 and 3 subdivisions.
2. Detailed hazard and risk assessment at the subdivision level of detail.

Both phases of work are meant to guide the development plans such that future development in Stewart Creek Phase 1, 2 and 3 will not exceed risk levels considered tolerable by Canmore.

The first phase of work was carried out in 2015 (BGC 2015). The reader should refer to that report for background description of the physical and hydroclimatic setting of Stewart Creek. For a description of the June 2013 debris flood event on Stewart Creek and short-term mitigation measures implemented shortly there-after, the reader should refer to BGC 2014 (available at Canmore's Town Hall).

This memo summarizes the results of the assessment for Lots 15 to 30 in advance of completion of the more detailed report on the work, to expedite disclosure to home buyers. This memo only provides key summary information on results of the work, a compendium report will provide details on the methodology employed by BGC and will also address hazards and risks to the TRIO subdivision (townhouses) (i.e., Stewart Creek Phase 2) and undeveloped property at the west end of the storm pond (Lot 5, Block 15, Plan 0610834) (i.e., Stewart Creek Phase 1).

The work was based on BGC's proposal and work plan dated March 3, 2017 (BGC, 2017b).

1.1. Level of Study

This work follows the risk management framework described in BGC (2015), which is based on an international risk assessment standard and stakeholder consultation as per the work recently conducted in Canmore and the adjacent Municipality District (MD) of Bighorn. The work is completed in accordance with the Draft Alberta Guidelines for Steep Creek Risk Assessments (Version 2) (the Guidelines), (BGC 2017c).

A Level 2 study per the Guidelines was determined to be the appropriate level of assessment for Stewart Creek. While the overall value of the properties to be developed likely exceeds \$10 million and is greater than 10 units (Level 3), BGC interpreted at the onset of the study that a high life loss potential is not present. This conclusion was based on the preliminary hazard mapping and initial debris-flood modeling carried out prior to the field visit. The decision to use a Level 2 study suggests that a return period of 100 to 300 years be applied for the design event of flooding hazards. Debris floods of greater magnitude will occur; however, the residual risk with such an event is relatively low and will not lead to a substantial increase of life loss potential.

Avulsion scenarios leading to flooding of the built up portion of Lots 15 to 30, as anticipated in the work plan, were found to be unnecessary as the creek already flows towards and past the proposed development with sufficient bank height that flood levels would not reach areas proposed for structures. Thus, this assignment pertains to bank erosion in rear yards only.

1.2. Site Visit

As part of this project, lower sections of Stewart Creek in and around Stewart Creek Phases 1, 2 and 3 were visited by Dr. Matthias Jakob, P.Geo. and Sarah Kimball, P.Geo. of BGC on March 9 and 10, 2017. Andy Esarte, P.Eng., and Felix Camire, P.Eng., from Canmore were present at the time of the March 10 site visit. The details of the site visit are described in the compendium report (BGC 2017a).

2.0 EROSION ASSESSMENT

2.1. Introduction

The Stewart Creek Phase 3 lots are located along a kame¹ terrace that appears to be locally overlain by till. These lots include a slope that extends to the constructed channel of Stewart Creek. The surficial materials along the kame terrace edge are interpreted to be a mixture of glaciofluvial materials, in places overlain by till. This was interpreted from brushing off snow from the side slopes. A detailed assessment of the material distribution was not possible at Lots 15 to 25 at the time of the BGC field visit due to continuous snow cover. It is thus conservatively assumed that erodible materials prevail at these lots. However, for Lots 15 to 25, erosion along Stewart Creek is expected to be low as the present creek grade is very shallow and even reversed in the vicinity of the box culvert south of Lot 26 where the eastern culvert outlet is 6 cm higher than the western inlet. Similarly, an elevation obtained by IBI Group Geomatics (April 17, 2017) at the thalweg south of Lot 27 is 11 cm higher than an elevation immediately west of the western culvert outlet. This indicates flow westward in this vicinity until ponding water has reached a level whereby it is forced to continue downstream (eastward). Lots 26 to 30 are in proximity to the channel and the channel is relatively deep, therefore an assessment of erosion potential was warranted. Soils observed on the channel banks in this reach consisted of fluvial gravels and possibly interbedded till. As the site visit occurred in March during snowy conditions, a detailed examination of the soils on Lots 26 to 30 could not be accomplished.

2.2. Limits of Disturbance

Canmore has established a “limits of disturbance area”, which prohibits construction for certain areas within the Stewart Creek Phase 3 development. This setback, will be shown in the compendium report (BGC 2017a). The limits of disturbance for Lots 26 to 30 is set back approximately 11.5 m to 22 m from the top of bank on the north side of Stewart Creek. Furthermore, the proposed building footprints are located an additional 6.5 to 12.5 m towards the front (north) of the lot beyond the “limits of disturbance area” suggesting that constructed homes will likely be set back further from the top of bank of Stewart Creek² than what is required by the “limits of disturbance area”.

2.3. Erosion Potential for Lots 26 to 30

For Lots 26 to 30, erosion was assessed quantitatively based on the channel characterization from the 2015 and 2017 field assessments, as well as the numerical flow modeling. A

¹ A landform that developed at the end of the last ice age when the valley was still glacier covered where meltwater flowed along the glacial margins and left fluvial gravels forming terraces once the ice had receded.

² According to QPD, it is unlikely for homes to be constructed at the back of the lot since this would require an additional lift station within the homes; an expensive and higher maintenance solution that homeowners are expected to avoid.

physically-based model was used to estimate the threshold flow (Q_f) required to initiate erosion, as well as the magnitude of erosion during events exceeding this threshold. The methods are described in the compendium report (BGC 2017a).

Model results are shown in Table 2-1.

Table 2-1. Physically-based erosion estimates for the 80 m reach adjacent to the Phase 3 development.

Return Period (years)	Discharge (m^3/s)	Formative Depth (m)	Predicted Erosion (m)
30 to 100	9	1.7	0
100 to 300	15	1.7	0

Model results indicate that no erosion is expected to occur for return period events up to 300 years. While localized erosion could occur in areas with reduced soil grain size, BGC estimates that such erosion could only amount to approximately 1 m along the lower channel even during high flows.

Given the interpreted apparent cohesion of channel bank soils observed at sites where snow was brushed off during the March 2017 field visit, BGC believes that the banks would initially be oversteepened by erosion to angles close to vertical and then subsequently fail through small rotational slides or sluffs. This process would introduce sediment to the channel bottom. This sediment would be transported proportional to the introduced grain sizes, with larger grains remaining and smaller ones being entrained. This process could, over time, elevate the channel bed at this location. However, given the existing approximately 5.5 m incision of the present channel, this potential aggradation will not result in flooding of Lots 26 to 30 during a single flood event.

BGC measured several steep slope angles on slopes with similar surficial geology as the slopes below Lots 26 to 30 that were stable and found an approximate stable long-term slope angle of 34°. BGC used published methods (Cruden et al. 1989, De Lugt et. al. 1993) to determine a minimum setback for structures from the crest of the bank slope based on 1 m of horizontal bank erosion (single design event). This analysis yielded an estimated setback from the crest of the slope of 2.5 m (Figure 2-1).

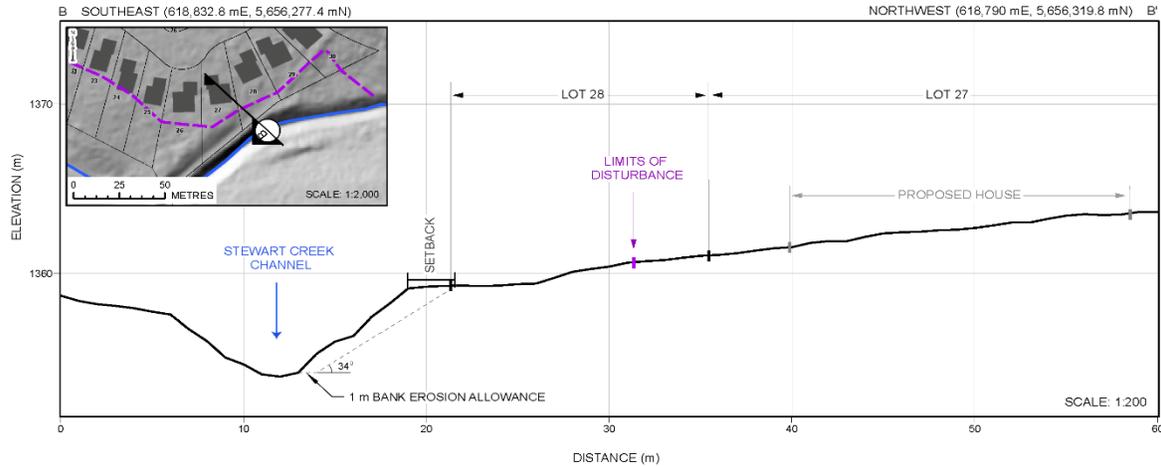


Figure 2-1. Profile through Stewart Creek Phase 3 showing setback guideline.

3.0 SUMMARY AND CONCLUSIONS

Buildings on Lots 15 to 30 are not assessed as susceptible to flood or debris flood inundation for up to the 300-year return period debris flood events as they will have sufficient freeboard. Buildings on Lots 15 to 25 are unlikely to be affected by erosion during a 100 to 300-year return period debris flood given the slow flow velocities and the required non-disturbance zone setback prescribed by Canmore. Lots 26 to 30 are potentially subject to some minor erosion of the creek channel during peak flow events. Erosion is unlikely to occur due to exceedance of a critical shear stress threshold, but rather by progressive sloughing as cohesion is lost in wetting and drying cycles. BGC estimates that, over time, erosion could reach 2.5 m into the existing properties, measured at the slope crest. Therefore, the “limits of disturbance area” that will limit development in immediate proximity to the slope crest provide an adequate protection against erosion that could affect structures.

4.0 CLOSURE

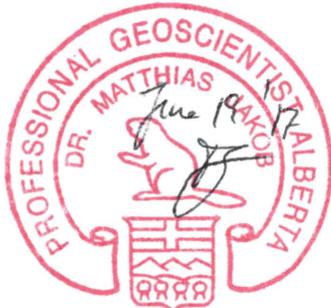
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Yours sincerely,

BGC ENGINEERING INC.

per:



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A handwritten signature in blue ink that reads "S. Kimball".

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SK/MJ/HW/map/mm

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