Britannia Creek Hazard Assessment

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1| Executive Summary

Hazard Assessment plays a crucial role in urban planning by collecting data and analyzing the potential impact of a severe incidence on infrastructure, wildlife, and human safety for a specific region. This report focused on determining the flooding and erosion risk of Britannia Creek (located 10km from Squamish BC.) during a 100 year flooding event. A dual analysis was completed to compare simulated results to field data collected on site. Simulated results were found using recorded data from Fitzimmons Creek. This data was then used to calculate the 100-year flood magnitude and was converted to represent a 100-year flood event at Britannia Creek. Using the calculated discharge, channel slope, and width (obtained from Google Earth) along with Manning's roughness coefficient, flow depth and sediment mobility was calculated. In the field, flow depth was determined by using a Stadia Rod and Automatic Level. Measurements were collected at a given transect to get an average depth across the channel. The Wolman Pebble Count and gravelometer were used to measure grain size. Measurements of 100 random particles were collected along the stream. The stream width and slope were calculated using a measuring tape, Stadia Rod and Automatic Level. The Results displayed that the calculated flow depth was 0.56m, the D_{50} grain size was 340mm and the D_{max} grain size was 680mm. The field measurements displayed that the flow depth was 0.56m, the D_{50} grain size was 30.59mm, and the D_{max} grain size was 74.75mm. It was determined that Britannia Creek was engineered large enough to handle a 100-year flooding event and the bed course would not be able to resist full mobility but this is because of the bias gravelometer. Based on findings through research and calculation, it is evident that potential development throughout the Britannia Creek area is safe.

2| Introduction

2.1 Project Motivation

The motivation of this project was to perform a Hazard Assessment at Britannia Creek in order to determine the flooding and erosion risk of a 100-year flooding event.

2.2 Project Objectives

The project objects are to compare both simulated calculations of a 100-year flooding event at Britannia Creek, to field measurements obtained at Britannia Creek. With this information it is possible to determine the accuracy of Hazard Assessment simulations. Finally, using the field data collected recommendations will be provided for Britannia Beach Infrastructure, wildlife, and human safety components.

2.3 Project Scope

The main components of this project are as follows:

Simulated Calculations:

- To determine a 100-year flood using Fitzsimmons Creek as a reference.
- To determine and calculate sediment mobility.
- To determine and calculate flow

Field Calculations:

- To determine channel bank height depth, width, and slope.
- To determine the Manning's Roughness Coefficient.
- To determine grain size.

depth.

- To compare simulated calculated data to field measurements
- Provide recommendations for the Britannia Beach area based on data collected

3| Watershed Characteristics

3.1 Physiology

Britannia Creek has a drainage area of roughly 23.8km^2. The topographic relief of the creek is sea level to a height of approximately 2000 meters and the channel gradient is roughly -9.46% (Google Earth).

3.2 Climate and Hydrology

Britannia Creek's hydrology is directly influenced by the fluctuations in the wet Pacific Northwest climate and the snowmelt in the spring and summer from the North Shore Mountains. Flows are influenced by the steady and large amounts of precipitation as roughly 2,500 millimeters of rainfall a year in the region. Peak flows occur from rainfall, snowmelt, and glacier melt and this watershed likely experiences peak flows due to a combination of these events. The general pattern of flow discharge largely follows the average precipitation pattern throughout the year because of its coastal setting. Low flows are expected in late summer, while higher flows are continuous through the winter and spring (Eaton and Moore).

3.3 Land Use

Today there are logging roads adjacent to Britannia Creek and its tributaries. The main road in use is Copper Drive. Logging in Britannia Range is a key form of resource extraction in the region. Towards the mouth of Britannia Creek there is the Britannia Beach community with roughly 300 residents. There has been no mining activity since 1974 in the region and the water has had pollution issues in decades following the mining activities. Due to the pollution there has been a water treatment plant installed in the area in 2006.

3.4 History of Area

In the 20th century there was one major flood related disasters that took place in the region. In 1921 after a period of heavy rainfall a large body of water formed behind a dam of logs and rocks and eventually burst. This flood cost thirty-six members of the Britannia Beach community their lives. After much concern of another potentially catastrophic flood caused by sediment build up behind Tunnel Dam, the government has decommissioned all dams in the watershed and Britannia Creek flows naturally now.

3.5 Figure of Watershed

Britannia Creek Watershed

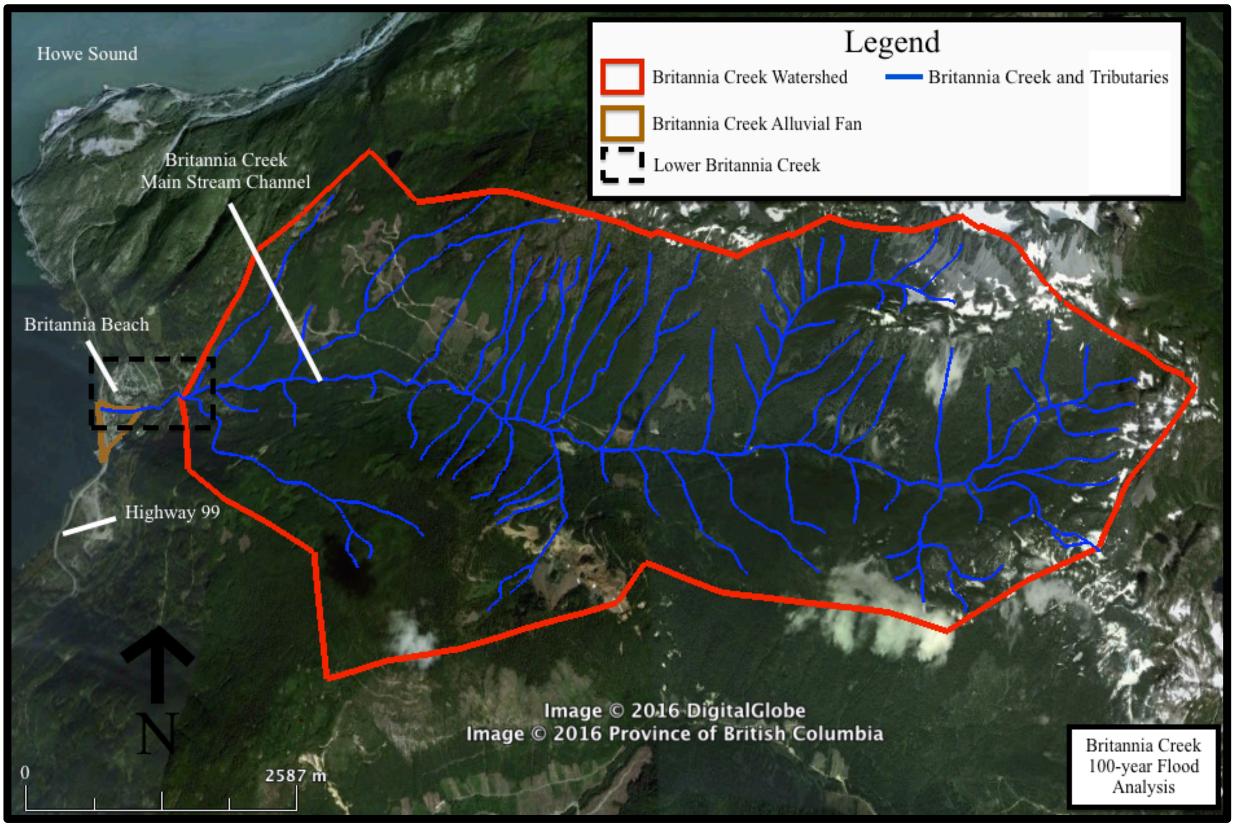

Figure 1. A map of the Britannia Creek Watershed: May 2016.
Source: Google Earth, http://geogratis.gc.ca/site/eng/extraction

4| Methods

4.1 Estimation of 100-Year Flood Magnitude

Due to the lack of data for Britannia Creek, Fitzsimmons Creek was used to calculate a 100-year flood and the data was converted to represent Britannia Creek. We choose Fitzsimmons Creek because it is similar to Britannia Creek in a number of aspects: it is roughly similar in size (89.7km^2), it does not have any flow regulation, it is nearby (70.8km away), it has 24 years of accessible data, and has a similar hydrological regime (both rivers have glacial influences due to there mountain locations. The instantaneous peak flows from Fitzsimmons Creek were ranked and the return interval was calculated. This data was then plotted on Gumbel paper to determine a 100-year flood for Fitzsimmons Creek. This data was then adjusted to represent Britannia Creek.

4.2 Flow Depth, Channel Width and Slope

<u>Simulation Flow Depth:</u>

In order to calculate the simulation flow depth we used:

- 100-year flood discharge previously calculated
- The channel width determined from Google Earth
- The channel slope determined from Google Earth
- Manning's roughness coefficient for Britannia Creek

Field Flow Depth:
In order to calculate the field flow depth we used:

- A Stadia Rod and collected data at five different locations taking multiple measurements at a given transect to get an average depth across the channel.
- By visually analyzing the creek, a comparison can be made about the physical nature of Britannia Creek to an established chart in order to determine Manning's roughness coefficient.

Simulation Channel Width:
In order to calculate the simulation channel width we used:

- Google Earth

Field Channel Width:
In order to calculate the field channel width we used:

- A 30m measuring tape to measure the creek bankfull width. Measurements were taken at two different locations within the study area along the creek and then averaged to form one width measurement.

Simulation Channel Slope:
In order to calculate the simulation channel slope we used:

- Google Earth

Field Channel Slope:
In order to calculate the field channel slope we used:

- An Automatic Level to conduct a levels survey from within the channel foresighting and backsighting parallel to the flow. The change in elevation determined the gradient/slope of the stream (stream length divided by the change in elevation)

4.3 Size of Sediment That Can Be Eroded

Simulation Sediment Size That Can Be Eroded:
In order to calculate the simulation sediment size that can be eroded we used:

- Simulated channel depth and slope to calculate shear stress.
- An equation to calculate simulated median grain size
- An equation to calculate simulated maximum mobile particle size

Field Sediment Size That Can Be Eroded:
In order to calculate the field sediment size that can be eroded we used:

- A Wolman Pebble Count and gravelometer to measure 100 particles at random sections along the stream. Medium grain size and largest particle observed were measured.

4.4 Possibility Of Flooding

In order to calculate the possibility of flooding we used:

- The previous values of the 100-year flood calculation, field flow depth and size of sediment that can be eroded.
- An Automatic Level to collect the average bank height by collecting multiple heights of both sides of the stream channel. When flow depth > bank height then a flood will occur.

Therefore, the bank height in relation to the channel bed will determine the maximum depth prior to flooding.

5| Results

5.1 Flood Frequency Analysis

Simulation Calculations:

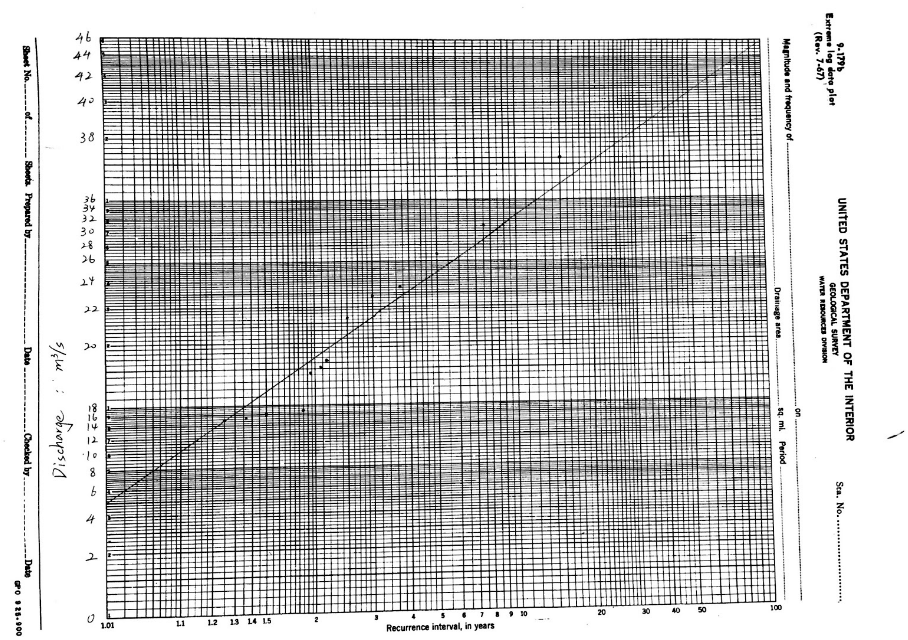

Figure 2. A flood frequency analysis (above figure) of this Fitzsimmons River

If a 100-year flood were to occur at Fitzsimmons Creek the total discharge would be around 46 m^3/s. Using the formula below we can convert this discharge to Britannia Creek:

$Q_{Britannia,100}=Q_{fitzsimmons,100}*(Area_{Britannia}/Area_{fitz})^{0.75}$

$Q^{(fitz,100)}$ is 46, and $A^{(brit)=23.8km2,}$ $A^{(fitz)=89.7km2,}$ then $Q^{(brit,100)=}$ 17m^3/s.

5.2 Flow Depth, Channel Width and Slope

Simulation Calculations:

To calculate the flow depth, we need to use $d=\{Qn/ws^{0.50}\}^{0.6}$

Q: discharge of Brit 100 years = 17m^3/s

n: Manning's roughness coefficient =0.1

W: channel width of Brit= 20.8m

S: channel gradient of Brit= stream length (424m)/ change in elevation (19-0=19m)= 4.48%

d= 0.56m

Field Observations:
Observations that were made in the field are below:

Bank Height: 3.17m River Depth: 3.73m d: 0.56m W: channel width of Brit= 22.04m S: channel gradient of Brit= 4.100-2.148/60x100=3.25%

5.3 Size Of Sediment That Can Be Eroded

Simulation Calculations:
Then to determine the shear stress, we need to use = pgds
p=1000kg/m^3
g=9.8m/s^2
d: from above, the flow depth=0.56m
s: is channel gradient of Brit =4.5%=0.045m/s

$_T$o=246.96 N

Then we can use this to determine D_{50}
Oc= 0.045
g= 9.8m/s^2
ps= 2650kg/m^3
p= 1000kg/m^3

D_{50}=0.34m= 340mm

Then we can use this to find D_{max}

D_{max}=0.68m= 680mm

Field Observations:
Observations that were made in the field are below:

D_{50}= 30.59mm D_{max}=74.75mm

5.4 Possibility of Flooding

Field Observations:
Based on the calculated simulated flow depth which was 0.56m compared to the measured value in the field of 0.56m, Britannia Creek was engineered large enough to handle a 100-year flooding event.

Comparing the D_{50} (340mm) and D_{max} (680mm) grain size values calculated to the field measurements of D_{50} (30.59mm) and D_{max}(74.75), during a hundred year flooding event the bed course would not be able to resist full mobility. The calculated value would be able to support a 100-year flooding event. It should be noted that during field measurements the gravelometer approach was bias. Viewing the stream, it was seen that there are larger boulders in the stream that relate to the calculated values but the gravelometer did not produce the same results.

6| Summary And Recommendations

6.1 Project Objectives and Findings

The project objects were to compare both simulated calculations of a 100-year flooding event at Britannia Creek, to field measurements obtained at Britannia Creek. With this information it is possible to determine the accuracy of Hazard Assessment simulations. Finally, using the field data collected recommendations will be provided for Britannia Beach Infrastructure, wildlife, and human safety components. The main findings are seen below:

	Calculated	Observed
Flow Depth (m)	0.56	0.56
D_{50} (mm)	340	30.59
D_{Max} (mm)	680	74.75

Figure 3. Summary of data calculated and observed.

6.2 Recommendations for The Britannia Creek Watershed

Based on findings through research and calculation, it is evident that potential development throughout the Britannia Creek area is safe. We recommend that any future structures on or near the river take serious precautions, though as our calculations suggest Britannia Creek will not flood during a 100-year flooding event, but will be filled to the absolute maximum depth it can hold.

7| Bibliography

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