

## 2. Floods

### 2.1 Floods: one of many natural hazards in British Columbia

A flood is any body of water that overtops its natural or artificial boundaries and inundates land not normally under water.

Floods can result from a wide range of conditions, processes and situations associated with climate, geomorphology and human activity. For the most part, floods are natural events, however, humans are having an increasing role in their occurrence.

Only when floods affect people or property, or detrimentally affect the environment, are they considered as hazards. The effects of a flood are many and diverse, and go well beyond the area actually flooded. For example, costs directly related to the flood response and recovery are not only borne by those living in the flooded areas, but also by others in the vicinity, the region, the province and, in some cases, the country. Indirect effects can include potential economic losses for the area, for example, businesses relocating or a decrease in tourism, and psychological effects on residents due to uncertainty regarding their safety.

As one might expect in a province as large and as diverse as British Columbia, there are a wide variety of natural hazards. Some, such as major earthquakes and volcanoes, occur infrequently but can have a large effect. Others, such as landslides, snow avalanches and numerous water-related hazards, occur more frequently but have a relatively smaller effect than earthquakes and volcanoes.

#### Natural Hazards in British Columbia

earthquakes  
volcanoes  
landslides  
subsidence  
snow avalanches  
water-related hazards

*adapted from Natural Hazards in British Columbia, 1996*

### Water-Related Hazards in British Columbia

dam failures  
debris avalanches  
debris flows  
erosion and accretion  
submarine landslides  
floods  
ice jams  
landslides  
tsunamis

*adapted from BC Emergency Program Act*

Floods fall into the category of relatively frequent water-related hazards. To put floods in perspective, “within this province, over the past century, more property damage has been inflicted by various forms of flooding than by any other natural hazard” (*Natural Hazards in British Columbia, 1996*).

One reason for this is that floods are associated with most of the other types of water-related hazards and non-water-related hazards, including earthquakes, landslides, snow avalanches, dam failures and ice jams. Another reason is that British Columbians tend to live in the relatively flatter, low-lying areas of this mountainous province, and these areas are potentially prone to many different types of flooding.

## 2.2 Types of Floods in British Columbia

A number of different type of floods are common in British Columbia. Among the more common types are:

**flash floods** — are associated with intense rainfall or rain on snow events, and therefore usually occur very suddenly with little warning.

**freshet floods** — generally occur as a result of snowmelt, and therefore usually occur in the spring or during warm periods during the winter and are usually more predictable.

**ice jam-related floods** — occur when the normal flow of water in a stream or river is impeded by ice, and therefore usually occur in the spring or during warm periods during the winter, with very little warning.

**debris flow-related floods** — (also referred to as debris torrents or mudflows) involve sediment and organic material being transported with water down steep mountain streams. They can occur as a result of high runoff and therefore may occur during periods of rainfall or warm winter periods with little or no warning.

**blockage-related floods** — can occur as a result of a landslide blocking a stream or river, a landslide (or snow avalanche) changing the course of a stream or river, or a large landslide falling into a large body of water, and can occur at any time of the year, with very little warning.

**storm surge floods** — are usually the result of a combination of extreme tides and high winds, or a storm with excessive winds, and are most common during the winter, with limited warning available.

**tsunamis** — are the result of an earthquake or submarine landslides, and although this type of flood can occur at any time of the year with very little warning, special geographic conditions are usually necessary.

Flood Planning and Response Tips for each of these types of floods are summarized in PART 1, Appendix B.

Minor and major floods are not types of floods, but describe the relative severity of floods. These terms are used by the Provincial Emergency Program and other provincial government agencies, and are described more fully in PART 1, Appendix A and the *BC Flood Plan, April 1998*, which is updated annually.

Conditions that can lead to flooding are numerous. Sometimes they act alone; sometimes in combination with one another. They can be subdivided into groups on the basis of climatic conditions, geomorphic processes and human/animal-related situations.

## Conditions Conducive to Flooding

### **Climatic conditions:**

- intense rainfall event (a large amount of rainfall over a short period of time)
- moderate rainfall event over a long period of time
- snowmelt conditions
- rainfall event on snow or snowpack (accelerates snowmelt)
- ice damming (jamming) of a stream or river
- storm with excessive wind (storm surges)
- high tide combined with wind and low barometric pressure

### **Geomorphic processes:**

- landslide damming of a stream or river
- landslide or snow avalanche changing the course of a stream (avulsion)
- high stream or river discharge changing the course of the stream or river (avulsion)
- debris flow and/or log jams
- earthquake causing a tsunami
- submarine landslide causing a tsunami
- large wave generated by a landslide into a body of water

### **Human/animal-related situations:**

- activities in watersheds (e.g. logging, change of drainage patterns)
- changes in releases from upstream dams
- dike failure
- dam failure
- other human activity
- animal activity (e.g. beaver)

Geographically, most flooding occurs in four areas:

- in low lying, valley bottom areas often associated with lakes or large and/or meandering rivers;
- along streams, rivers and lakes;
- on active alluvial or colluvial fans; and
- along the coast (areas influenced by tides).

The following table summarizes the likelihood of the four different geographical areas being affected by flooding resulting from climatic conditions, geomorphic processes and human/animal-related situations.

**It should be noted that there can always be exceptions to the generalizations in this table.**

<b>Likelihood of Flooding</b>				
	Low lying, valley bottom areas	Along streams, rivers and lakes	Active alluvial or colluvial fans	Along the coast (tidal areas)
<b>Climatic conditions</b>				
intense rainfall	High	High	High	Low
moderate rainfall over a long period of time	High	High	High	Low
snowmelt	High	High	High	Low
rainfall on snow or snowpack	High	High	High	Low
ice damming (jamming) of a stream or river	Moderate	High	Low	None
storm with excessive wind	High	Low	Low	High
extreme tide combined with wind	None	None	None	High

<b>Likelihood of Flooding</b>				
<b>Geomorphic processes</b>	Low lying, valley bottom areas	Along streams, rivers and lakes	Active alluvial or colluvial fans	Along the coast (tidal areas)
landslide damming of a stream or river	Moderate	High	High	None
landslide or snow avalanche changing the course of a stream	Low	High	High	None
high stream or river discharge changing the course of a stream or river	Low	High	High	None
earthquake causing a tsunami	Low	None	None	High
submarine landslide causing a tsunami	Low	None	None	High
large wave generated by a landslide into a body of water	High	Low	None	High
<b>Human/animal-related situations</b>				
dike failure	High	High	High	High
dam failure	High	High	High	Low
human activity	Low	Moderate	High	Low
animal activity	Low	High	Moderate	Low

## 2.3 Some notable floods in British Columbia's history

### Flash Flood

Intense precipitation combined with melting snow in June 1995 caused record flood flows in the Elk River valley in Southeast BC. The storm flows resulted in flooding and a breach of the Coal Creek training berm at Fernie, the washout of several kilometres of roads, the collapse of several highway and railway bridges over Michel Creek, exposure of several sections of gas pipeline, and a near failure of the Michel Creek Mountain Mobile Home Park dike at Sparwood.

### Freshet Flood

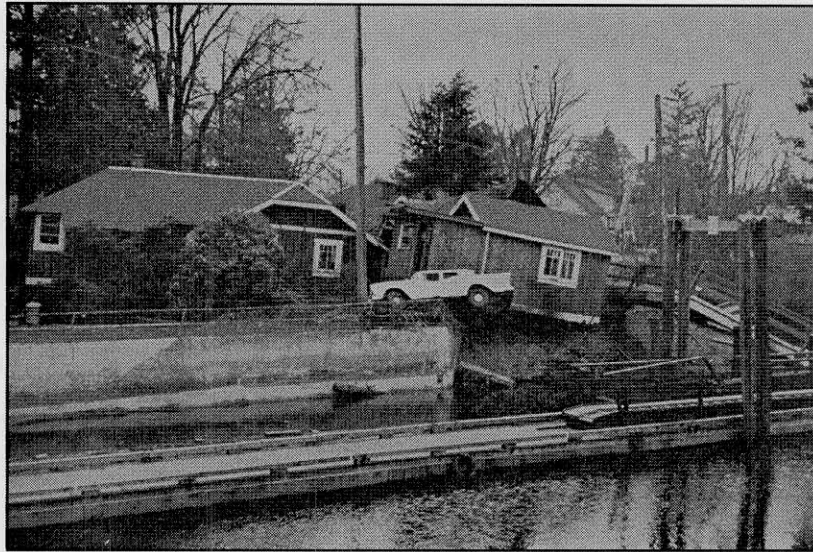
The greatest BC flood on record occurred in 1894 and affected extensive areas in the southern half of the province, including Prince George to Quesnel, Kamloops, Mission and throughout the Lower Fraser Valley. During the 1948 Fraser River Flood, several people died, 2000 houses were destroyed, 16,000 residents were evacuated, 22,000 ha of land were flooded, and both the Canadian National and CP railways, and the Trans-Canada Highway were severed. Based on the 1894 flood, an estimated \$1.8 billion in flood related damages could be expected today, if an 1894 event occurred and caused dike failure. (Adapted from *Review of the Fraser River Flood Control Program, Task Force Report to the Fraser Basin Management Board, May 1994*)

### Ice Jam-Related

In January 1984, the Nicola River and its two tributaries, near Merritt, broke up suddenly due to a sharp increase in discharge from rain-on-melting snow event while the ice cover was still thick. The resulting ice run and jam caused hundreds of thousands of dollars in damage to public and private property, including the destruction of a bridge. Damage was due to either the severe ice run within the channel, or to water forced out over the floodplain by ice jams.

## Tsunami

The Alaska earthquake of March 1964 triggered a tsunami that killed 130 people between Alaska and California. In British Columbia, Port Alberni was the hardest hit community, although Hot Springs Cove and Zeballos also suffered significant wave and flood damage. The tsunami grew as it crossed Barkley Sound and moved up the Alberni Inlet. Three waves hit Port Alberni, the largest was 7 m high, and was estimated to be moving at 50 kph. As a result 260 homes were damaged, 60 extensively, and total damage ranged between \$5 and \$10 million.



Tsunami damage in Port Alberni - 1964