



**GEOLOGICAL SURVEY OF CANADA**

**OPEN FILE 5741**

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**Historical accounts of landslides and flooding events along  
the Sea to Sky corridor, British Columbia, from 1855-2007**

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A. Blais-Stevens, D. Septer

2008



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Photo of The Barrier taken by A. Blais-Stevens; head scarp of the first historical landslide ever recorded in the Sea to Sky Corridor. It took place sometime in the fall-winter of 1855-56. It is described as a complex rock avalanche-debris flow (also known as the Rubble Creek landslide; Moore and Mathews, 1978).

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## 1. Introduction

The Sea to Sky transportation corridor, which includes Highway 99 and BC Rail line, runs through some of the most challenging terrain in British Columbia in terms of physiography, geology, hydrology, and climate. Some of the historical landslide and flooding events have had devastating effects on property and have resulted in the loss of life. Throughout the report the Sea to Sky Highway is also referred to as Squamish Highway, Seaview Highway, and Highway 99. The Sea to Sky transportation corridor is often in the news because of frequent motor vehicle accidents, road closures, train derailments, washouts, and rock slides. Hence, the term “Sea-to-Slide” corridor has also been used (Fig. 1).

Landslides and flooding events in the southern Coast Mountains have received much coverage in the media and various reports. Such events, on steep slopes of the east shore of Howe Sound have resulted in costly damage to Highway 99, the BC Rail line, and many settlements mainly located between Horseshoe Bay and Squamish.

In 1956, the North Vancouver to Squamish extension of the Pacific Great Eastern Railway (PGE), in 1972 renamed BC Rail, was completed along Howe Sound. In 1958, the two-lane Highway 99 between North Vancouver and Squamish was opened. Soon after, settlement and associated development occurred in the area. Pemberton was not easily accessible by road until 1975 when Highway 99 was completed north of Whistler. The Sea to Sky Highway officially ends at the T-junction just east of downtown Pemberton; Highway 99 continues east towards Lillooet and is known as the Duffey Lake Road.

During construction of the highway, and immediately thereafter, many rock slides affected the PGE rail line. For the greater part of the 45 km stretch between Horseshoe Bay and Squamish, the highway parallels the rail line and is located a short distance above the track. The construction of the Squamish Highway was delayed considerably since all blasted rock had to be hauled away by truck rather than pushed downslope onto the existing PGE track.

The main objective of this compilation is to produce a chronological list of reported historical landslide and flooding events along the Sea to Sky Corridor from Horseshoe Bay to Pemberton, British Columbia. This listing forms a database that will provide a better understanding about the occurrence and magnitude of such devastating events in this energy lifeline. Thus, a better understanding may help in infrastructure development planning, emergency planning, and hazard and risk assessments. The historical information was compiled from many different sources, including newspapers, scientific and technical reports, climate stations, and streamflow records.

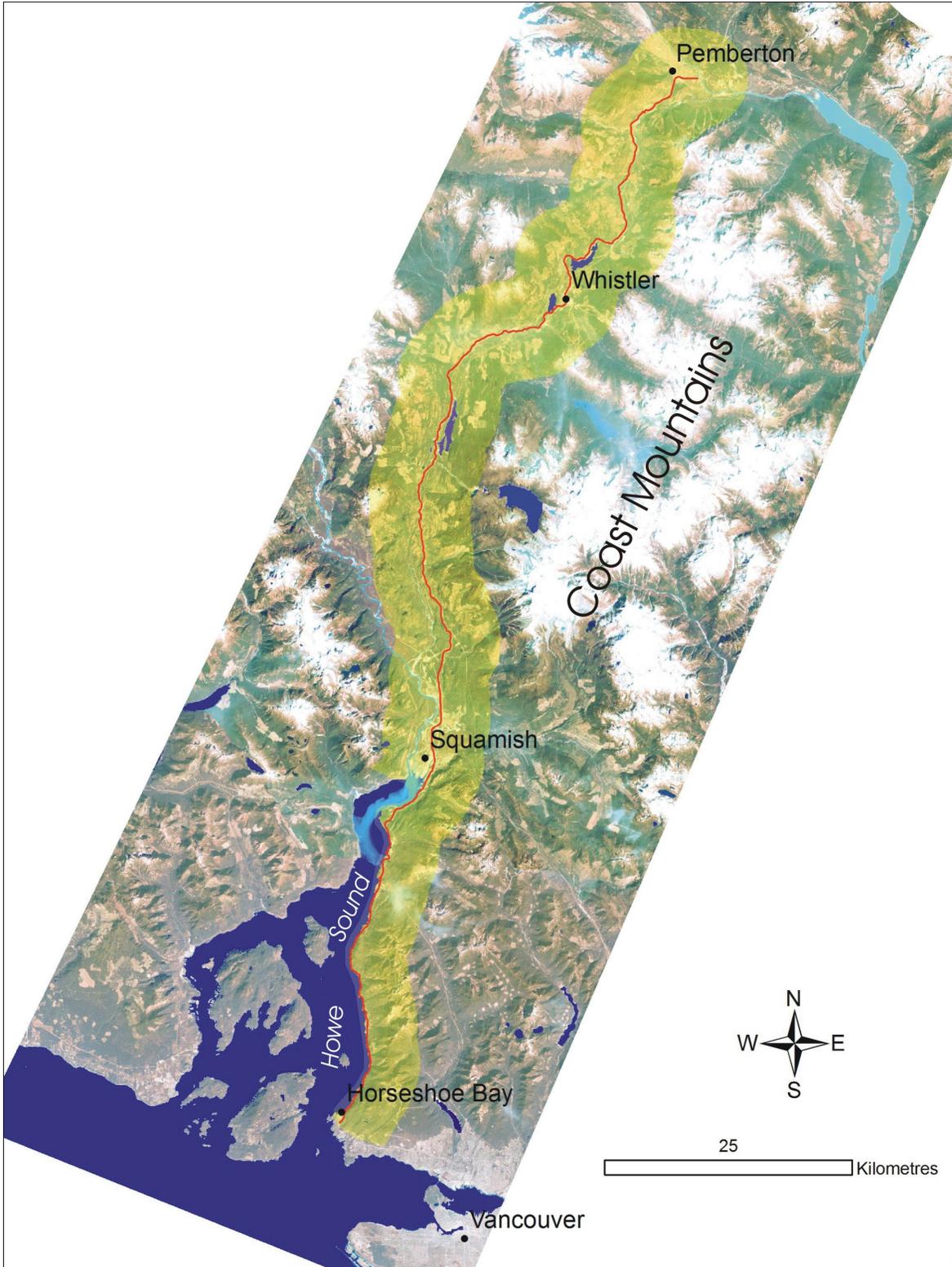


Figure 1. Location of the Sea to Sky Highway (Hwy 99) from Horseshoe Bay to Pemberton (red line) and Sea to Sky Corridor (area outlined in yellow). BC Rail line runs roughly parallel to the highway.

## **2. Information reliability**

Weather is a common topic of conversation and media interest. Extreme events, such as heavy rainstorms and subsequent damage, can generate news coverage, which varies considerably in detail and accuracy. Terminology used to describe flooding and landslide events often also varies widely in newspaper accounts. It is important to note that in many cases, the events were described using non-technical terms. Thus, no effort has been made to confirm the accuracy of terms used in the original reports. Eyewitness accounts and many reported cases of “worst flooding on record” are all in quotation marks by the authors. Such information must be taken at face value. However, for the landslide events table listed in Appendix 1, some interpretation had to be made in order to classify landslides according to type. Thus, we used the classification by Cruden and Varnes (1996).

An effort was made to be as accurate and complete as possible, but the chronological list of landslide and flooding events is undoubtedly incomplete. Smaller events may have only been reported in the local media. Early news coverage for Squamish, the only community along Howe Sound publishing a newspaper, is sparse. Prior to June 1938, between January 1944-August 1948, August 1949-July 1950, and March 1956-January 1976, no newspaper was published in Squamish. A retrospective newspaper index in the British Columbia Legislative Library has a major gap for the years 1914-1943. Consequently, many landslide and flooding events likely have been missed.

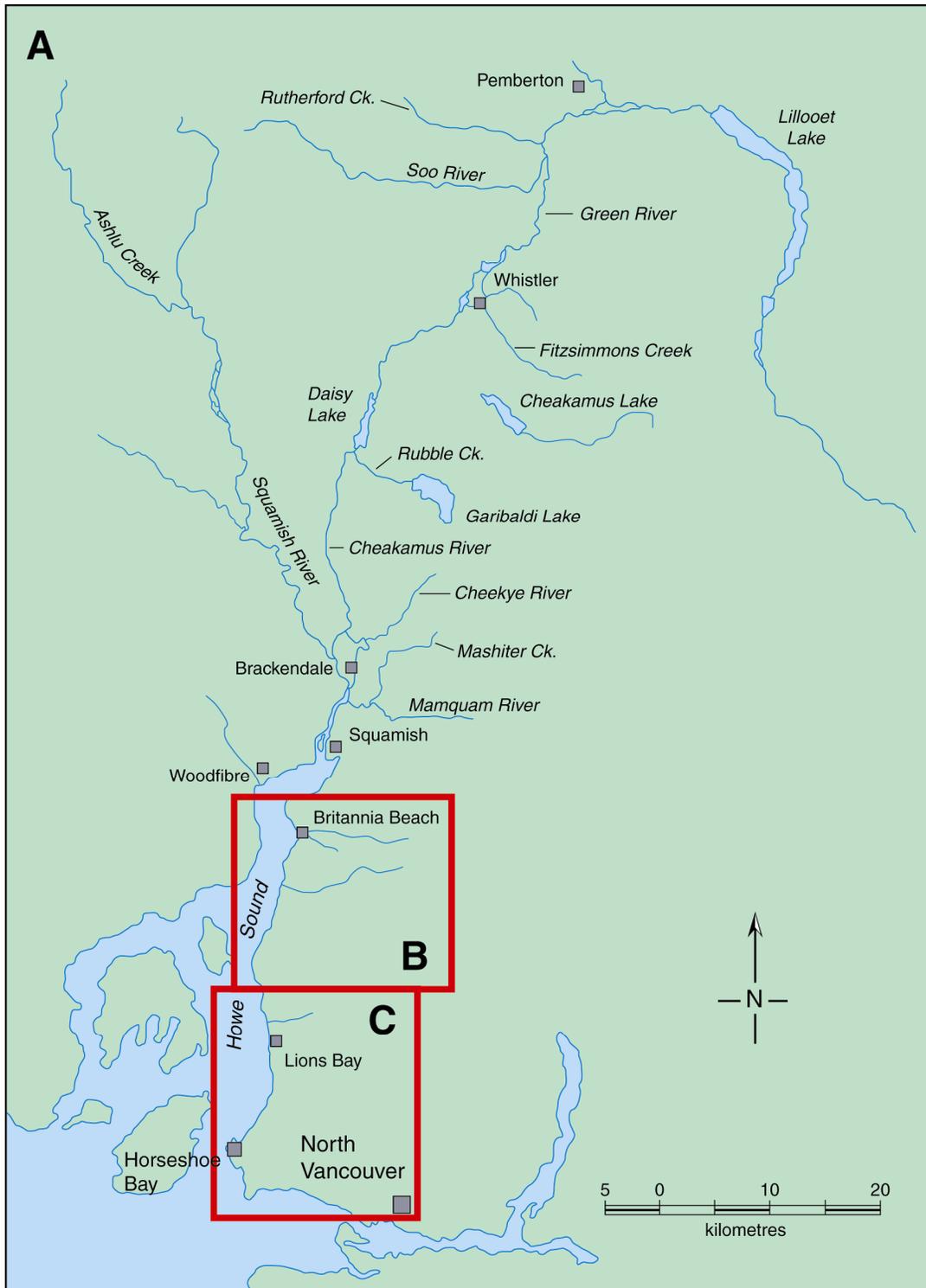
Of the frequent rock falls recorded by the BC Ministry of Transportation and Highways (MoTH), only those larger than 5 m<sup>3</sup> were reported and thus, included in this historical data compilation. Since approximately mid-2005, the section of Highway 99 from Horseshoe Bay to Whistler is no longer under direct MoTH control, but operated by a private Design-Build-Finance-Operate Concessionaire.

## **3. Organization of the chronological list of events**

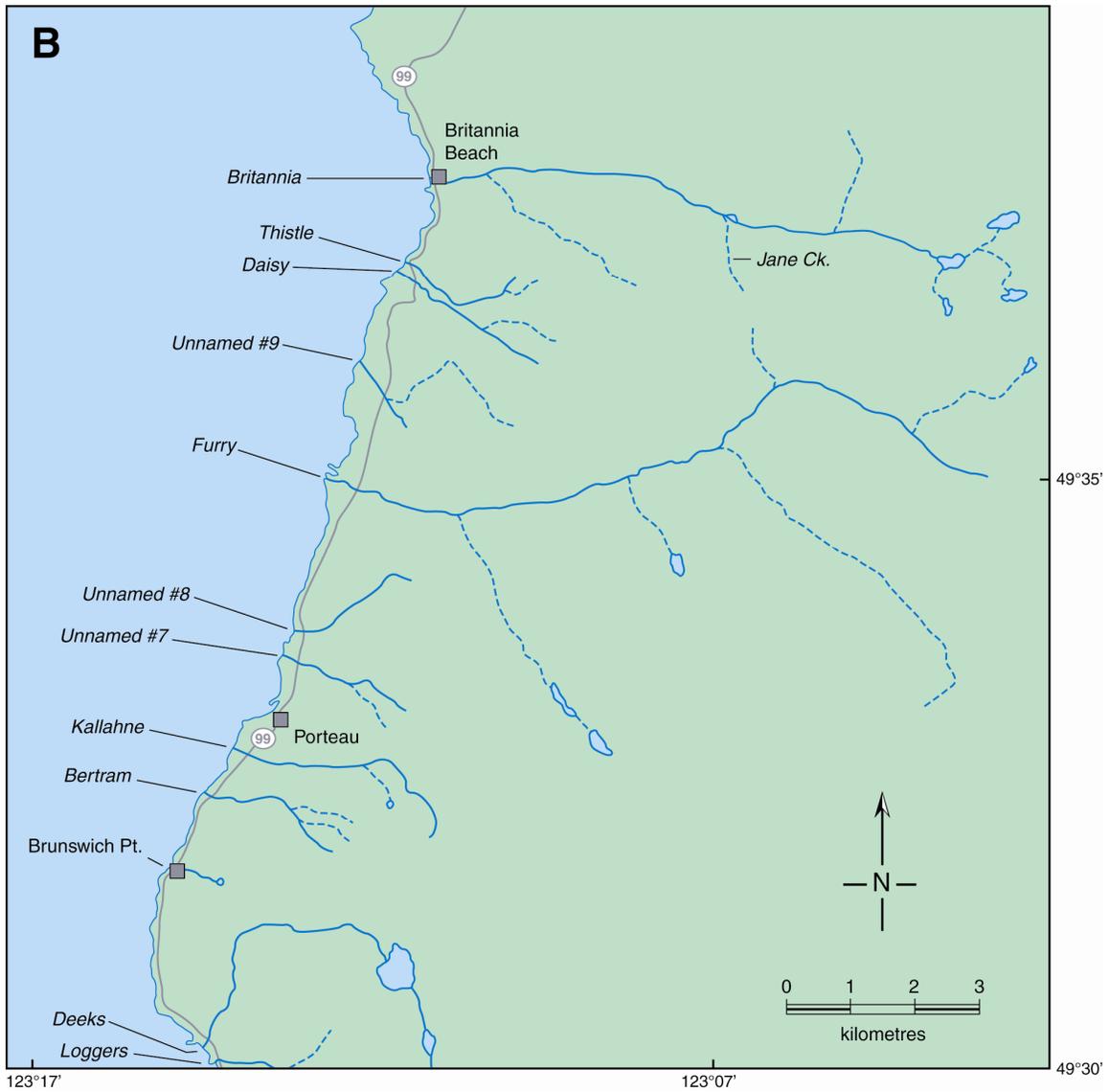
The chronological list of flood and landslide events for the Sea to Sky Corridor forms the main content of this report. This chronology of events covering the period from June 1900 to July 2007 consists of a wide variety of event types, including several types of landslides (e.g., rock fall, rock slides, debris flows, etc.), tidal flooding, flooding due to extreme runoff or dam burst.

Appendix 1 is a compilation of the landslide events with location coordinates. The authors made some interpretation of events based on the description and setting in which the events took place. Furthermore, from this historical landslide dataset, three reports were published (Blais-Stevens and Septer, 2006; Blais-Stevens and Hungr, 2007; Blais-Stevens, 2007).

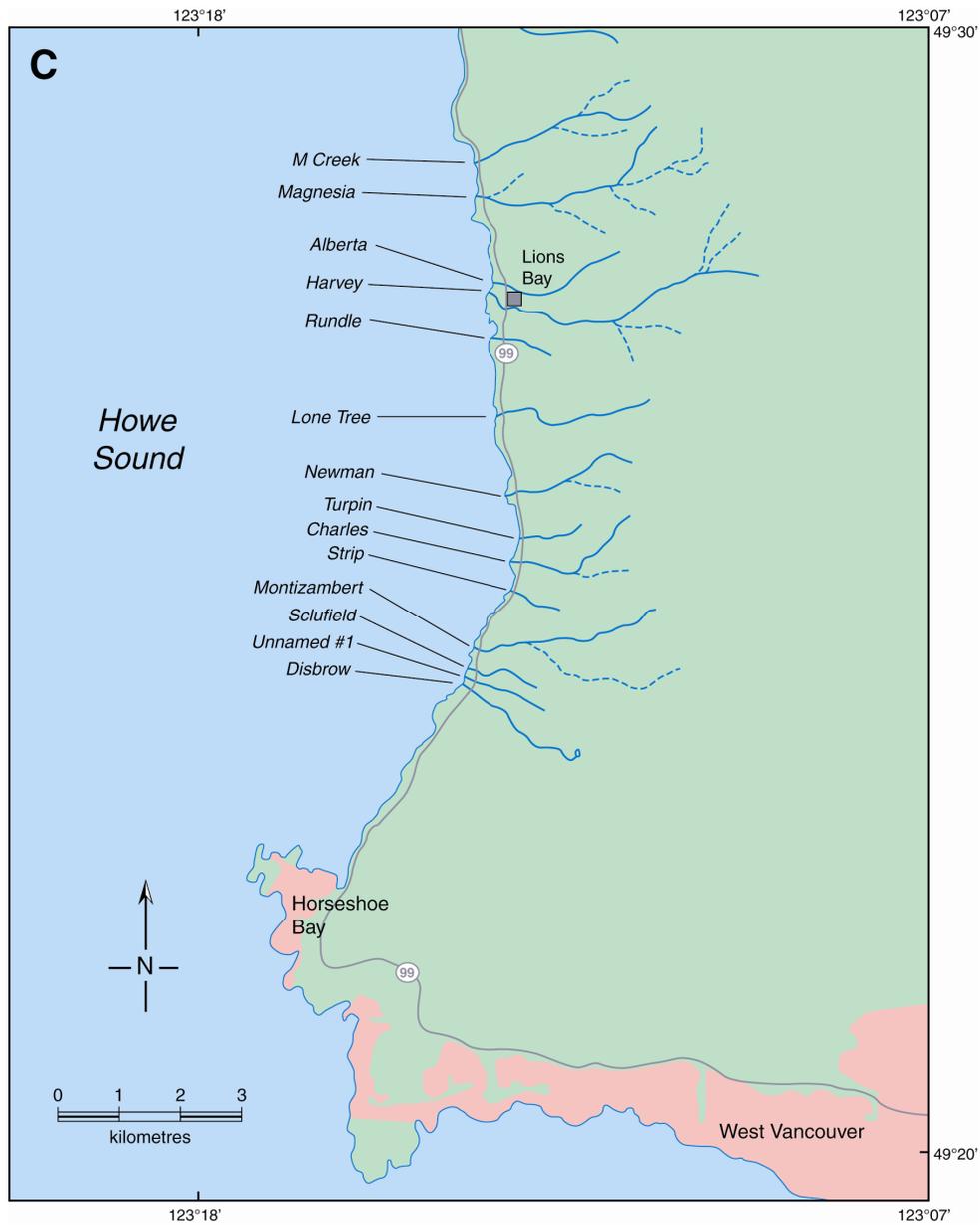
Appendix 2 gives a list of flooding events in creeks and rivers. Appendix 3 lists the MoTH bridges and other creek crossings, segments 1-44 km from Horseshoe Bay to Squamish. Appendix 4 gives a chronological list of some of the reported flood and landslide-related fatalities. Finally, Appendix 5 provides a list of climate stations mentioned in the text. For reference to place names, refer to detailed location maps in Figures 2A, B, C.



**Figure 2A.** Detailed location maps. Insets B and C show locations of streams, creeks, and rivers along the eastern shore of Howe Sound.



**Figure 2B.** Inset map from Figure 2A; detailed map showing locations of streams, creeks, and rivers along the northern part of Howe Sound.



**Figure 2C.** Inset map from Figure 2A; detailed map showing locations of streams, creeks, and rivers along the southern part of Howe Sound.

#### 4. Chronological list of recorded flood and landslide events

##### **The Barrier**

##### **Fall-Winter 1855-56**

**Event type:** Rock avalanche-debris flow

**Precipitation:** Unavailable

**Source:** Moore and Mathews, 1978.

**Details:** An estimated  $25 \times 10^6 \text{ m}^3$  of rock devastated Rubble Creek Valley. The bedrock was composed of late glacial dacitic lava. The slide travelled as much as 4.6 km with a maximum drop of 1060 m, thus moving on an average slope of  $8.5^\circ$ . Velocities were estimated to exceed 20 m/s (72 km/h) and sliding was probably completed within 10 min. Tree-ring data indicate that the slide occurred in the fall or winter of 1855–1856. The trigger mechanism has not been identified, but the presence of an exceedingly steep original slope of the lava front, attributed to ponding against latest Pleistocene ice occupying the valley below, was clearly a contributing factor. Both the precipitous headwall and a second ice-dammed lava front are considered to be potential sources for new slides. Some evidence suggests that previous slides have occurred here since the last glaciation, about 11,000 years ago. A court ruling barring residential development in the area devastated in 1855–1856 on the grounds of future hazard to life was legislated in 1981.

##### **June 25-27, 1900**

**Event type:** Flooding.

**Precipitation:** Vancouver PMO, 38.4 mm/1 day, June 20, 1900. (Between June 25-27, the maximum daily temperatures at Agassiz CDA were between  $27\text{-}29^\circ \text{C}$ .)

**Source:** *Victoria Daily Colonist*, June 26, 28 and 29; July 7, 1900; *The Province*, June 26, 27, 28 and 29; July 2, 1900; *The Vancouver World*, July 11, 1916.

**Details:** Sudden warm weather and recent rain melting snow caused rivers and their tributaries to rise. This rise followed two weeks of heavy rain in the lower country.

The warm weather caused the Squamish Valley to flood with 5-6 ft. (1.5-1.8 m) of water. Several small buildings were washed away and some settlers were forced to live almost entirely in the upper parts of their homes. Damage was estimated at \$40-50,000 in 1900 dollars.

##### **September 5-10, 1906**

**Event type:** Flooding.

**Precipitation:** Vancouver PMO, 164.4 mm/5 days, September 5-9, 1906; Coquitlam, 218.7mm /5 days, September 5-9, 1906; Vancouver PMO, 79.5 mm/1 day, September 6, 1906; Coquitlam, 87.6 mm/1 day, September 7, 1906.

**Source:** *The Daily Columbian*, September 7, 8, 10, 11, 12 and 13, 1906; *The Vancouver Daily Province*, September 6 and 10, 1906; Jackson et al., 1985 (pp. 4-11); B.C. Ministry of Environment 1975; Ward et al., 1992 (p. 356).

**Details:** On September 6, one of the earliest documented floods in Vancouver's history was described as "the worst in 10 years" with "the city road under 3 ft. (90 cm) of water for hundreds of feet." Precipitation records for Vancouver PMO station showed a peak rainfall of 79.5 mm for the 24-hour period preceding the flood (Ward et al., 1992).

On September 8, the Squamish road was flooded with 12 ft. (3.6 m) of water. Communications with the ranching section of the Squamish and Britannia valleys were cut off by high water. The greatest damage may have occurred to the hop ranches 5-7 mi. (8-11.2 km) up the Squamish Valley from the wharf on Howe Sound. High waters washed away a small bridge crossing the east mouth of the Squamish River near Madill's Ranch. The bridge about 2 mi. (3.2 km) from the mouth of the stream was torn from its anchorage and swept down into the sound. On September 8, it was seen floating in the vicinity of Britannia. In order to carry this bridge away, the water had to rise at least 10 ft. (3 m) above its normal level. The relatively new bridge had been recently built. The upper bridge was slightly damaged at one end. The bridge over the Cheakamus River was washed away and the road was cut in many places. On September 10, the river went down considerably. As the water had come in very quietly, very few hop poles were washed away.

On September 10, a flood on Britannia Creek caused extensive damage in the new mining settlement. Due to a logjam in its channel, the creek shifted its course at the apex of its fan. The pile-up of stumps and trees may have been a consequence of the development of the extensive mine property (Jackson et al., 1985).

At Britannia Beach, the water roared down the valley. At the upper end of the flat near the Chinese bunkhouses, the creek was blocked by debris and changed its course striking down the centre of the flat. In order that the creek might be returned to its usual course, the Britannia Company had a gang of men at work on September 9, blasting the obstruction in the creek, causing it to turn over the flat when the rush of water came.

At Britannia Beach, floodwaters tore down the assayer's house and power plant (BC Ministry of Environment, 1975). The water tore right through the house. Its resident escaped uninjured, but lost all possessions. Boulders were left piled 6 ft. (1.8 m) high in front of the house. Some of the rocks were reported to weigh at least 1.5 tons. At the time the creek broke its bank, an accident happened at the camp's electrical plant. On the morning of September 9, the hotel at Britannia was surrounded by 4 ft. (1.2 m) of water. One employee of the mining camp was swept away by the torrent, only saved by a picket fence near the beach.

### **December 12, 1908**

**Event type:** Storm surge/tidal flooding.

**Precipitation:** Vancouver PMO, 49.5 mm/1 day; Coquitlam, 54.1mm.

**Source:** *The Vancouver Daily Province*, December 14, 1908.

**Details:** On the morning of December 12, southern gales up to the velocity of a hurricane drove the sea over the dykes lining the Squamish River for about 1 mi. (1.6 km). According to residents of the lower Squamish Valley, the flooding tide was a full 4 ft. (1.2 m) higher than the highest recorded since the settlement of the valley. The dykes were reported broken in several spots. As in most places, the water simply poured over the tops of the embankments. No great amount of damage was done other than many drift logs were deposited in the farmers' fields.

## March 22, 1915

**Event type:** Debris slide.

**Precipitation:** None; rapid snowmelt in previous 48 hours.

**Source:** *Victoria Daily Times*, October 30, 1921; *The British Columbian*, March 22, 23, 24, and 25, 1915; Ramsey, 1967 (p. 39-46); Eisbacher, 1983; BC Ministry of Energy, Mines and Petroleum Resources, 1993.

**Details:** On March 22 at 12:05 a.m., a “snow and landslide” or rock avalanche came down striking several bunkhouses at the Jane Mining Camp, part of the Britannia Mine complex more than a 2 mi. (3.2 km) distance from the beach.<sup>1</sup> Without warning hundreds of thousands of tons of earth and water-saturated snow, rocks, and trees slid from the upper mine high up near the top of the mountain. The volume of the debris was estimated at more than 100,000 m<sup>3</sup>, but the BC Ministry of Energy, Mines and Petroleum Resources (1993) estimated the amount of rock displaced by the Jane Camp failure at 200,000 m<sup>3</sup>.

The slide cut a swath through the camp carrying buildings and trees with it and burying them in a mass of debris. The huge solid mass completely destroyed the bunkhouse, cookhouse, rockhouse, mine office, store, tool houses, candle house at the tunnel mouth, tramway terminal, and other dwellings. All electric light wires and tramway terminals were demolished. Part of the aerial tramway from the mine to the beach was also carried away.

A total of 54 people were killed, including four women and six children. Several families were entirely wiped out (*The British Columbian*, March 25, 1915). Nine people were severely injured and 12 others, slightly injured. Although Ramsey (1967) and all other sources put the number of fatalities at 56, the death toll was later reduced to 54. One man was not in the camp during the disaster and later showed up while another had a miraculous escape. The principal loss of life occurred in the bunkhouses, which were entirely buried under the debris. Iron beds in the bunkhouses were attributed to saving some lives. Having been asleep in the lower bunk of an iron bed when the slide struck, one man was taken out alive from beneath 15 ft. (4.5 m) of earth.

According to survivors, the slide made an “almost indescribable sound, chiefly resembling the noise made by a colossal explosion.” It was estimated it would take at least three months to remove debris and restore the destroyed equipment. Another witness said the slide “smashed the (rock) crusher like it crushed ore from the mine.” She thought it was a hurricane. “You’ve heard a big wind when it tears down trees and it thunders and lightning crashes” (Ramsey, 1967; *The British Columbian*, March 25, 1915).

BC Police Constable M.T. Spence said, “I found the mine office, store, rock crusher, tram terminus, a big bunkhouse, and a half dozen homes had been blotted out by the millions of tons of rock, which in some places was piled 50 feet deep over what had been the level of the camp.” The slide also destroyed Chas. Dainton’s schoolhouse near the mouth of the mine. Dainton himself was amongst the missing (Ramsey, 1967).

The slide was possibly caused by rapidly melting snow during the above normal warm weather of the preceding 48 hours. The average daily temperature on March 22, 1915 was almost double the expected normal for March of 5.8°C. On both days prior to the landslide, maximum daily temperatures reached 18.3°C.<sup>2</sup>

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<sup>1</sup> The camp was situated along the south side of Britannia Creek, 37 km north of Vancouver. A new Tunnel Camp was established as “headquarters” to replace the original Jane Camp by the Boscowitz’ at the 1,050

ft. level (Camp 1050). The Britannia Mine operated from 1905 till 1974. It is presently the site of the BC Mining Museum (Eisbacher, 1983).

2 Tunnelling in fractured Mesozoic volcanoclastic rocks above Jane Camp in 1914 may have contributed to a progressive deterioration of an unstable bedrock ridge approximately 300 m above the camp. A near-vertical crack on the ridge crest above Jane Camp was observed and photographed before the disaster struck (Eisbacher, 1983; Evans and Gardner, 1989).

### **October 24-29, 1921**

**Event type:** Flooding; Submarine landslide.

**Precipitation:** Britannia Beach, 228.4 mm/6 days, October 24-29, 1921; Vancouver PMO, 134.9 mm/6 days, October 24-29, 1921; Britannia Beach, 121.9 mm/1 day, October 28, 1921; Vancouver PMO, 59.4 mm/1 day, October 28, 1921.

**Source:** *Vancouver Daily Province*, October 29 and 31, 1921; November 29, 1921; *The Daily Colonist*, December 13, 1921; January 1, 1922; *The British Columbian*, October 28, 29 and 31; November 1, 2, 3, 4, 5 and 8, 1921; *Victoria Daily Times*, October 28, 29 and 30, 1921; May 20, 1922; *The Squamish Times*, September 10, 1991; Eisbacher and Clague, 1981; Eisbacher, 1983; Ramsay, 1967 (p. 59-67); Skermer, 1988.

**Details:** During the last week of October, heavy rains occurred on Vancouver Island and the Lower Mainland. During the 24-hour period ending 5 a.m. on October 28, Victoria and Vancouver recorded 0.84 and 2.24 in. (21.3 and 56.9 mm) of rain, respectively. Between October 28 at 5 a.m. and October 29 at 10 p.m., Victoria received an additional 1.35 in. (34.3 mm) and Vancouver 1.78 in. (45.2). The rain, remained unabated for three days, ceased on October 29. The *Victoria Daily Times* reported “never in the history of this section of the Pacific coast, have flood conditions been so serious.”

On October 28, heavy rainfall caused flooding conditions on Britannia Creek, (gradient 17%), 40 km north of Vancouver. During the 24 hours previous to the flood, 5.74 in. (145.8 mm) of rain fell in the district. Warm Chinook winds melted the snow, which added water to the already swollen streams. Then, according to Japanese eyewitnesses that were in the mountains at the time, at 8 p.m. a cloudburst took place. An enormous cloud that hovered over Goat Mountain literally changed into a “flash of solid sheet of water.” (*The Vancouver Daily Province*).

Halfway between the dams and Britannia Beach is a wide valley, ending in a considerable gulch and canyon. A few miles above the town, where the mine railway crossed a narrow gorge, a culvert had plugged. The railway embankment acted as a dam, ponding an estimated 14 million Gal. (63.7 million L) of water (Skermer, 1988). One of the creek’s unstable banks collapsed, temporarily blocking its flow. When the barrier broke, a devastating deluge of logging debris, sediment, and water hit the village of Britannia Beach at 9:30 p.m.<sup>1</sup> A watchman at the “railway fill” above the village first saw a solid wall of water coming towards him. Britannia Mines manager S.J. Donahue, at the mine 3 mi. (4.8 km) back from the beach, sent an urgent message over the mine telephone. It was received by Ms. Elaine Patterson, who was on duty at the compressor plant in the village. She instantly rang everybody connected by telephone, simply carrying the manager’s message, “For God’s sake get out of your houses, flood coming down the creek.” Before the warning could be understood and passed on to all residents, the waters crashed down, sweeping away the transmission lines and plunged the village into darkness. In its 3 mi. (4.8 km) journey, the water had descended 2,000 ft. (600 m) and left the course of Britannia Creek, running through the village itself. Dynamite later had to be used to

divert it back to its former course. The flood came upon a community confused by the sudden darkness. Falling timbers injured many people. Most of the survivors who lived in the centre of the town were left with nothing “but the clothing they stood in.”

Later reports put the height of the flood wave that struck the town, between 3-70 ft. (0.9-21 m) (Skermer, 1988). Eyewitnesses described the torrent, which swept the residential part of the mining village as a “wall of water 70 ft. (21 m) high.” (*The Vancouver Daily Province*). Homes were sheared off their foundations, crushed, or buried. More than 50 of the 110 homes in the settlement were destroyed. A number of buildings were seen drifting out to sea. Howe Sound in the immediate vicinity was covered with floating debris. Thirty-seven people lost their lives and 15 others were seriously injured (Ramsey, 1967; Eisbacher and Clague, 1981; Eisbacher, 1983).<sup>2</sup> Some of the bodies were washed into the muddy waters of Howe Sound and were never recovered. The body of a miner killed in a mine accident, just before the flood, was carried out to sea. Six gangs of men each under a foreman, all of whom were sworn in as constables, carried out rescue and recovery operations under the senior police officer Constable North. The assay office was turned into a temporary morgue. Much of the centre of the town was under a 10 ft. (3 m) deep mass of matted and tangled cables, poles and parts of damaged or destroyed buildings, as well as mud, rocks, logs and trees up to 5 ft. (1.5 m) in diameter (Skermer, 1988). Telephone and telegraph communications to Squamish and Britannia Beach were cut off.

A survivor who was asleep in Bunkhouse No. 3 woke up “by a shock of such force” that he thought the powerhouse at the 800-foot level had been blown up. The floodwaters took out the original “high level” bridge over the creek. It was later replaced by a steel span (Ramsey, 1967)

It is possible that during this event a small failure along the delta front caused retreat of the shore face near the mouth of Britannia Creek. Several large blocks deposited during the disaster are still scattered about in the vicinity of the highway bridge crossing Britannia Creek (Eisbacher, 1983).

The coroner’s jury found that the accident was caused by the collapse of a culverted railway fill that had become blocked thus damming the rain-swollen Britannia Creek. The jury noted that “it was criminal neglect on the part of Britannia Mining and Smelting Co. Ltd. ...for deliberately allowing the blocking of...Britannia Creek causing a menace to persons living at Britannia Beach (*Vancouver Daily Province*, November 29, 1921).

On December 12, the Attorney General’s Department announced it would immediately undertake a criminal prosecution of the responsible managers of Britannia Mines. The action charged negligence on the part of the managers in protecting human life. The *Victoria Daily Times* referred to the outcome of the loss of some 14 lives, three weeks prior. Later, the coroner’s jury found that the company had been criminally negligent in constructing a crossing with an opening so small that it could be blocked by debris (Skermer, 1988).

Bob Philip, manager of the Britannia Mines store until his retirement in 1958, said the construction of houses then contributed to their demise. “They had built the houses on the worst footings I had ever seen. They rested on cedar blocks with a little cement around them” (*The Squamish Times*, September 10, 1991).

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<sup>1</sup> Britannia Beach was a closed town where Britannia Mines Co. controlled everything. This company looked after all the relief work and did not ask for government assistance (*Victoria Daily Times*).

<sup>2</sup> Based on contemporary photographs (see Ramsay, 1967), a large proportion of Britannia Creek basin had lost its forest cover during initial exploration and development activities related to mineral exploration (Eisbacher, 1983).

### **September 20-23, 1924**

**Event type:** Flood.

**Precipitation:** Britannia Beach, 211.9 mm/4 days, September 20-23, 1924; Garibaldi, 183.7 mm/4 days, September 20-23, 1924; Vancouver PMO, 114.3 mm/4 days, September 20-23, 1924; Britannia Beach, 94.5 mm/1 day, September 21, 1924; Garibaldi, 123.2 mm/1 day, September 22, 1924; Vancouver PMO, 62.7 mm/1 day, September 22, 1924.

**Source:** *The British Columbian*, September 22 and 23, 1924.

**Details:** On September 22-23, torrential rains and a strong southeast gale caused severe damage in the Lower mainland.

On September 22, the Squamish railway bridge was damaged by high water along Mamquam River. Traffic on the PGE rail line was re-routed by stage to Ashcroft. The government bridge at Squamish was also destroyed. As conditions in the river were too dangerous due to high water, it was decided that it would be too dangerous to transfer the passengers. Damage was estimated in the thousands of dollars with repairs expected to last two to three days.

### **December 17-18, 1931**

**Event type:** Debris flow.

**Precipitation:** Hollyburn, 173.9 mm/3 days, December 16-18, 1931; Vancouver PMO, 120.7 mm/3 days, December 16-18, 1931; Vancouver Harbour CS, 145.6 mm/3 days, December 16-18, 1931; Britannia Beach, 162.1 mm/3 days, December 16-18, 1931; Buntzen Lake, 253.7 mm/3 days, December 16-18, 1931; Capilano Intake, 341.3 mm/3 days, December 16-18, 1931; Hollyburn, 59.9 mm/1 day, December 17, 1931; Vancouver PMO, 63.5 mm/1 day, December 17, 1931; Britannia Beach, 81.3 mm/1 day, December 17, 1931; Vancouver Harbour CS, 81.8 mm/1 day, December 17, 1931; Buntzen Lake, 109.7 mm/1 day, December 17, 1931; Capilano Intake, 154.9 mm/1 day, December 17, 1931.

**Source:** *The Daily News*, December 16-17, 1931; *The Vancouver Sun*, December 19, 1931; *The Vancouver Daily Province*, December 19, 1931; *The British Columbian*, December 17 and 19, 1931; January 11, 1932; BC Ministry of Environment, 1975.

**Details:** Between December 16-18, Vancouver recorded 5.12 in. (130.0 mm) of rain. While precipitation values for those three days did not constitute a record, they were “unusually heavy” (*The Vancouver Daily Province*, December 19, 1931).<sup>1</sup>

Early on December 18 at Clay’s Landing in the Howe Sound area, a major flood or debris flow occurred on Disbrow Creek. The debris flow destroyed a small house and a cottage at Sunset Beach, 3 mi. (4.8 km) northwest of Horseshoe Bay. The roof of one house was swept far out on Howe Sound. According to BC Ministry of Environment records, a small dam in the headwaters of the creek burst, triggering the event. The stream arising on Black Mountain swept the entire house away, except a 7-ft. (2.1 m) length of water pipe. Damage was estimated at \$5,000 (1931 dollars). The house later washed ashore on Gambier Island. The cottage was completely destroyed and the underlying ground eroded away. Two launches moored at the beach on Howe Sound were badly damaged and three

rowboats, practically destroyed (*The British Columbian*; BC Ministry of Environment, 1975).

Two motor launches hauled up on shore for winter storage were broken in two and “buried beneath the trunks of trees torn from the mountainside.” According to Clay, nothing was left of the land upon which the two buildings stood. In its place, was a rushing stream of muddy water. Sunset Beach, a resort adjoining Clay’s Landing was not damaged (*The Vancouver Sun*, December 19, 1931).

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1 Between December 1-19, Vancouver recorded 8.56 in. (217.4 mm) of rain (*The Vancouver Daily Province*, December 19, 1931).

### **December 16-22, 1933**

**Event type:** Storm surge/tidal flooding.

**Precipitation:** Vancouver PMO, 101.8 mm/5 days, December 16-21, 1933; Britannia Beach, 118.8 mm/5 days, December 16-21, 1933.

**Source:** *The Vancouver Daily Province*, December 20, 21 and 22, 1933; *The Daily Colonist*, December 29, 30 and 31, 1933; *The British Columbian*, January 2 and 3, 1934; *The Review*, January 4, 1934; *The Daily Colonist*, December 31, 1972 ; British Columbia Ministry of Environment, 1975.

**Details:** On December 20, the latest of a series of winter storms “worst storm in 30 years” battered the Pacific Northwest for the fourth successive day. On December 19, a storm centre off Vancouver Island had moved towards the Mississippi Valley. The storm of even greater intensity had taken its place and beyond it a series of depressions stretched across the entire Pacific Ocean moving swiftly eastward. The storm was also described as “the worst in the memory of some old-timers.” Almost unprecedented high tides were driven ashore by gales caused much damage

The business and residential sections of Squamish were flooded to a depth of 4 ft. (1.2 m). Considerable damage was done when seawater swept in the town. The post office was surrounded by deep water. Part of the PGE right-of-way was carried away and the telephone and telegraph services were cut. At some points, there was 18 in. (45 cm) of water across the railroad tracks. The Union Steamship Co.’s *S.S. Chelohsin*, was storm-bound at Squamish with 195 passengers stranded at the end of steel (Squamish). Due to the storm, on December 20, the *S.S. Capilano* was unable to make landings at Squamish and Woodfibre. Water reached the bottom of the train cars parked on the Squamish pier. Passengers reached Vancouver after spending the night in the train cars sleeping on the seats or the floor.

### **Circa 1935**

**Event type:** Debris flows.

**Precipitation:** Britannia Beach, 263.9 mm/6 days, December 31, 1934-January 5, 1935; Britannia Beach, 196.9 mm/5 days, January 21-25, 1935.

**Source:** Thurber Consultants, 1983; VanDine, 1985 (p. 67); Jackson et al., 1985 (p. 4-19).

**Details:** Sometime in the early to mid-1930s, debris flows [torrents] or flooding events may have occurred in the Howe Sound area on Alberta, Newman, and Unnamed #1 creeks. Interpretation of 1936 vertical air photographs indicates that these events had taken place prior to the date of photography (Thurber Consultants, 1983; BC Ministry of Environment, air photographs 1936). VanDine (1985) determined that for the Alberta Creek, the event took place at *ca.* 1935.

Between 1932 (Government of Canada air photos A4441: 74-77) and 1939 (Government of British Columbia air photos BC143: 80-81), a debris slide into Alberta Creek near 1,060 m elevation, triggered a debris flow that ran all the way to Howe Sound. The debris slide occurred in an area burned early in this century.<sup>1</sup>

Apparently, at the same time, debris flows occurred in a small unnamed water course between Alberta and Harvey creeks, stopping at 550 m elevation, and in Harvey Creek, stopping near 500 m on a gradient of about 12°, above the 33° plunge into the lower basin (Jackson et al., 1985).

These Howe Sound debris flows or flooding events may have occurred during the ice storm/rain-on-snow event of January 20-27, 1935. During this ice storm, described as “the worst storm of the century,” torrential rain, following a week of heavy snowfall, caused the formation of “Campus Canyon” at the campus of the University of British Columbia. Elsewhere in the Lower Mainland and southern British Columbia, a total of 15 people were killed in seven separate mud and snow slide accidents. Between December 31, 1934 and January 5 1935, Britannia Beach recorded 263.9 mm of rain in six days.

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<sup>1</sup> By 1968, slide scars had healed and torrent debris was revegetated (Jackson et al., 1985).

### **October 27-29, 1937**

**Event type:** Flooding.

**Precipitation:** Britannia Beach, 138.2 mm/3 days, October 26-28, 1937; Tunnel Camp, 174.2 mm/3 days, October 26-28, 1937; Capilano Intake, 236.5 mm/3 days, October 26-28, 1937; Britannia Beach, 102.9 mm/1 day, October 27, 1937; Tunnel Camp, 101.6 mm/1 day, October 27, 1937; Capilano Intake, 146.6 mm/1 day, October 27, 1937; Vancouver International Airport, 25.4 mm/1 day, October 27, 1937; Garibaldi, 38.9 mm/1 day, October 27, 1937. (Temperatures were above normal at Britannia Beach.)

**Source:** *The Daily Colonist*, October 28, 29 and 30, 1937; *The Vancouver Daily Province*, October 28 and 29, 1937; October 20, 1940; Environment Canada, 1991.

**Details:** Early on October 28, the raging Mamquam River tore out a railway bridge 4 mi. (6.4 km) east of Squamish. The bridge was not expected to be repaired before early November. The river changed channel, rushing down its old bed near the Squamish school.

A few miles further east, the Cheekye River flooded the railway tracks to a depth of 4 ft. (1.2 m) for some distance and forced the railway bridge over Cheekye River out of alignment. Between these two breaks, Brackendale (population of 200) was isolated.

On the afternoon of October 28, floodwaters began entering Squamish. The incoming tides forced the water over the banks. Sandbags were used to keep water from the main street. A sick woman was brought out from her home in the PGE shop area by canoe and taken into Squamish by speeder. Several families north of Squamish were “marooned by unprecedented flood conditions.” As far as provincial police could learn, the families were in no immediate danger.

BC Electric Railway Co.’s high-tension wire to Britannia Mine was washed out on a steep mountainside along Howe Sound, leaving the mine without power. Service was expected to be restored late on October 29.

In addition, Lillooet River near Pemberton recorded an estimated maximum daily discharge of 510 m<sup>3</sup>/s (Environment Canada, 1991).

By October 29, Squamish River had dropped 8-9 ft. (2.4-2.7 m). Around the PGE

railway shops, there was still considerable water. The small settlement of Brackendale was still cut off by road and rail.

### **October 19, 1939**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport, 34.8 mm/3 days, October 17-19, 1939; Britannia Beach, 220.7 mm/5 days, October 18-22, 1939.

**Source:** Smith and Vallieres, 1986 (p. 4).

**Details:** According to an unpublished report, at 5:30 on October 19, the maximum instantaneous discharge (of the Lillooet River) at Pemberton was estimated to be 1,640 m<sup>3</sup>/s. This flood consisted of the main channel flow of 1,120 m<sup>3</sup>/s and a tributary channel flow of 250 m<sup>3</sup>/s. The dykes, which closed off the old flood channels and also the then PGE railway trestles spanning these channels, were damaged (Smith and Vallieres, 1986).

### **October 17-20, 1940**

**Event type:** Flooding.

**Precipitation:** Britannia Beach, 86.4 mm/1 day, October 17, 1940; Tunnel Camp, 103.6 mm/1 day, October 17, 1940; Pemberton Meadows, 120.7 mm/4 days, October 17-20, 1940; Tunnel Camp, 274.5 mm/4 days, October 17-20, 1940; Garibaldi, 158.5 mm/4 days, October 17-20, 1940; Britannia Beach, 213.6 mm/4 days, October 17-20, 1940; Capilano Intake, 283.8 mm/4 days, October 17-20, 1940; Vancouver International Airport, 85.9 mm/4 days, October 17-20, 1940; Garibaldi, 68.6 mm/1 day, October 18, 1940; Capilano Intake, 221.0 mm/1 day, October 18, 1940; Vancouver International Airport, 35.8 mm/1 day, October 18, 1940; Pemberton Meadows, 57.2 mm/1 day, October 19, 1940. (Heavy rains had also occurred earlier this month with some values greater than 60 mm in 24 hours.)

**Source:** *The Vancouver Daily Province*, October 18, 19, 21 and 30, 1940; *The Daily News*, October 22 and 26, 1940; *Evening Empire*, October 22, 1940; *Victoria Daily Times*, October 21, April 4, 1941; Smith and Vallieres, 1986 (p. 4).

**Details:** On October 18, for a period of 12 hours ending 8 am, Vancouver recorded 2.47 in. (62.7 mm) of rain or for a 24-hour period 3.13 in. (79.5 mm), both being near-records. The heavy rain caused flooding conditions on Vancouver Island and the southern mainland.

Heavy flooding occurred in the Squamish area and along the PGE rail line between Squamish-Quesnel. On October 18, Squamish recorded 5 in. (125 mm) of rain and an almost equal amount fell on October 19. Mamquam River flooded Squamish streets with 5 ft. (1.5 m) of water. The current, described as “a 5-foot wall of water,” was so strong that a number of cars were overturned. Old-timers agreed it was the “worst river rampage they could remember.”<sup>1</sup>

Communication in Squamish was temporarily cut when the floor of the telephone exchange was covered with 3 ft. (90 cm) of water. Late on October 19, twenty families had to move to higher ground.<sup>2</sup> Evacuees were taken to Vancouver on board the *Lady Cynthia*. According to BC Police, almost all livestock in the lower Squamish Valley north of town was drowned. According to Const. John R. White, waters rose 20 ft. (6 m) in the upper valley. Dynamite was used to blast the main sea dykes and some small dykes behind, which the water was trapped.

The PGE railway sustained heavy damage. Floodwaters weakened the PGE rail bridge at Mamquam River, 4 mi. (6.4 km) north of Squamish. Traffic was halted until repairs could be made. Powder was used to blow a channel through litter that endangered the PGE bridge. Part of the bridge had to be dynamited to save the rest of the bridge. Several other smaller railway bridges also washed away. It took considerable time before traffic was fully restored. Traffic on the rail line resumed on October 28, after having been interrupted for 10 days. The October 18-19 floods at Squamish were troublesome and costly for the PGE.

Debris from Squamish River extended from Squamish to the Strait of Georgia and made navigation impossible for small craft and very dangerous for larger vessels. On the morning of October 21, the Union Steamship Co. waited until daylight before she came out through the floating debris. The flood at Squamish was more serious than the last one in 1937, which struck first at Brackendale, 7 mi. (11.2 km) up the valley.

At Pemberton, 57 mi. (91.2 km) north of Squamish further up the narrow river bottom, a small bridge washed out. Rev. F.L. Rimmer, Anglican clergyman wrote on October 25 in a letter to Ven. Archdeacon Sir Francis Heatcote: "The (Lillooet?) river situation is more serious than ever. Gradual silting up has moved the river channel farther and farther east. The last flood was only three years ago, when the flood was several hundred yards from the crossing. Now it is 20 yards from the crossing south of the PGE shops. It will take only a mild spell and a few days' rain combined to permanently inundate the town. The next flood brings the river permanently through the main section of the town. The strength of one small dyke prevented this from happening last Saturday (October 19). Up the valley, the situation is pathetic. Several houses were washed away, and the farmers lost all their livestock. Many people in the valley and village are planning to remove from here in the next few days. The rest will journey to Vancouver in their own houses in the next flood. There has been much government neglect of precautions."

The unpublished maximum instantaneous discharge at the Lillooet River near Pemberton was estimated at 1,640 m<sup>3</sup>/s at 5:30 PST on October 19. This flood consisted of the main channel flow of 1,120 m<sup>3</sup>/s and flood channel flow of 250 m<sup>3</sup>/s. The dykes, which closed off the old flood channels and also the then Pacific Eastern Railway trestles spanning these channels, were damaged (Smith and Vallieres, 1986). The flow would appear too high an estimate, as it is likely that the flow in the flood channel was due to a storage effect and should not be entirely attributed to the instantaneous flow of the main channel (Smith and Vallieres, 1986).

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1 In 1941, Public Works Department used an aircraft in a flood control survey of the Squamish region. The flood control plans included a diversion of the course of one river mouth, alternation of roads and other changes, which could be best plotted on aerial photos (*Victoria Daily Times*).

2 There were about 600 people living in Squamish at the time.

### **November 26-December 3, 1949**

**Event type:** Flooding.

**Precipitation:** Britannia Beach, 49.0 mm/1 day, November 26, 1949; Tunnel Camp, 126.7 mm/1 day, November 26, 1949; Garibaldi, 70.1 mm/1 day, November 26, 1949; Hollyburn, 172.7 mm/8 days, November 26-December 3, 1949; Buntzen Lake, 266.8 mm/8 days, November 26-December 3, 1949; Britannia Beach, 178.3 mm/8 days, November 26-December 3, 1949; Tunnel Camp, 309.6 mm/8 days, November 26-

December 3, 1949; Garibaldi, 116.8 mm/8 days, November 26-December 3, 1949; Seymour Falls, 618.7 mm/8 days, November 26-December 3, 1949; Capilano Intake, 594.4 mm/8 days, November 26-December 3, 1949; Buntzen Lake, 74.9 mm/1 day, November 28, 1949; Capilano Intake, 256.5 mm/1 day, November 30, 1949; Hollyburn, 91.9 mm/1 day, November 30, 1949; Seymour Falls, 228.1 mm/1 day, December 1, 1949. **Source:** *The Daily News*, November 28, 1949; *The British Columbian*, November 26, 28, 29 and 30; December 1, 2 and 3, 1949; January 30, 1950; *The Vancouver Sun*, November 28 and 29, 1949; *Kamloops Sentinel*, November 28, 1949; *Nanaimo Daily Free Press*, December 1, 2 and 3, 1949; *The Victoria Daily Times*, March 13, 1951; Rogers, 1992 (pp. 178-179).

**Details:** The year 1949 saw a whole series of violent winter storms that took a heavy toll of property and lives on the British Columbia coast. One of the worst storms to lash the North Pacific began on November 26. On the North Shore where 9.2 in. (233.7 mm) of rain fell, shattered a 20-year old rain record.

On November 26, a storm with heavy rains struck the North Pacific seaboard. It left millions of dollars of destruction in its wake (Rogers, 1992). The storm also left at least 24 dead in British Columbia. Twenty people died from drowning and four were killed in storm-caused traffic accidents. The worst flooding occurred at Squamish, at the time the terminus of the PGE. In the vicinity of the PGE railway shops 2 mi. (3.2 km) north of the main community, 10-12 families had to be evacuated. At one stage the water was within 2 in. (5 cm) of the top of the dykes ringing the settlement. In Squamish itself, lower level homes were surrounded by water and basements flooded in the school area.

The overflowing log-jammed Squamish and Mamquam rivers wiped out three bridges, including a highway bridge and a 500-ft. (150 m) PGE railway bridge. Mamquam River took out the centre span of the 70 ft. (21 m) long highway bridge. About 500 yd. (450 m) downstream, the river took out about 80 ft. (24 m) of the PGE bridge. The heavy tracks across the PGE Mamquam River bridge 3.5 mi. (5.6 km) north of Squamish wrecked on November 26 were twisted at right angles by the torrent. Some 300 homes were temporarily isolated by 7 ft. (2.1 m) of water, which flooded the valley. With bridges out on the PGE railway, temporary ferry service was in effect. PGE operations to the north were expected to be on schedule by November 30.

### **October 7-8, 1950**

**Event type:** Flooding and debris flow.

**Precipitation:** Garibaldi, 190.4 mm/8 days, October 3-10, 1950; Britannia Beach, 283.3 mm/8 days, October 3-10, 1950; Tunnel Camp, 326.4 mm/8 days, October 3-10, 1950; Britannia Beach, 87.9 mm/1 day, October 7, 1950; Tunnel Camp, 102.6 mm/1 day, October 7, 1950; Garibaldi, 47.8 mm/1 day, October 8, 1950.

**Source:** *The daily News*, October 10, 1950; *The Vancouver Sun*, October 11, 1950; *Bridge River-Lillooet News*, October 24, 1957; *The Squamish Advance*, October 12, 1950.

**Details:** Late on October 7, flash floods hit the Shop area of the Squamish Valley. Road and railway crews worked all night clearing logs and debris away from the bridges. Earlier that day, heavy rain raised the Squamish River level by 1 ft. (30 cm) per hour. By 5:30 pm, the gauge at Nunley's read 31 ft. By 8:30 p.m. the river had risen to 33.2 ft. and was starting to flood the road above Meehan's and rising steadily. By 10:30 p.m., floodwaters were pouring into Carl Leski's and Squamish River was "well over its banks." At flood peak, the water

reached 35.7 ft., almost a foot higher than the previous year's 34.8 ft. The Leski's evacuated as the water rose to over the fence posts in front of their place. Approximately 50 ft. (15 m) of bank at the J.P. Meehan's place fell into the river, including the barn.

On October 8, by 8 a.m., Mamquam River crested and started to recede. At that time, Squamish River was still rising and areas around the PGE shop were covered with about 10 ft. (3 m) of water. Although both bridges were still holding, the Mamquam bridge had a "decided curve" where floating logs had torn the decking and railings. Near the little bridge at Meehan's, an approximately 1-ft. deep had been cut in the side of the road. The approach to the bridge at Meehan's washed out.

Early on October 8, water came in around Dentville, forcing residents of several houses to be evacuated. Only one house in the area was flooded with a few inches of water. A tree falling across the wires cut power and phone service to Brackendale. The high tide at 3:30 p.m. backed up the water from the swollen river of several of the outlying areas, but did not affect the town itself. As the tide receded, the rivers gradually went down and by early next day, they were well inside their banks.

Torrential rains caused two slides onto the PGE line. On October 8, a slide blocked the rail tracks at Mile 18 in the Cheakamus Canyon. After "tunnelling" through the 25-ft. (7.5 m) deep slide, new slides came down at Mile 19. The first slide was 100 ft. (30 m) long and 25 ft. (7.5 m) high, with huge boulders that had to be blasted during removal. At least 1,200-1,500 yd.<sup>3</sup> (900-1,150 m<sup>3</sup>) of rock alone were reported to have been removed during the operation. As the slides occurred at the mouth of a tunnel, this made clearing operations more difficult as the crews could only work from one side.

Though rail service was scheduled to resume on the afternoon of October 10, the rail line was still blocked by additional slides in the Cheakamus Canyon. Rail service was resumed on the morning of October 12. The four-day tie-up emphasized the importance of rail line to communities such as Pemberton, Creekside, Shalath, Lillooet and points north. Three hundred sacks of mail alone were reported to have been tied up during the suspension of service.

### **November 27-December 4, 1951**

**Event type:** Storm surge/tidal flooding.

**Precipitation:** Britannia Beach, 261.3 mm/10 days, November 25-December 4, 1951; Britannia Beach, 58.7 mm/1 day, November 27, 1951.

**Source:** *Vancouver Daily Province*, December 1 and 4, 1951; *The Vancouver Sun*, December 3 and 5, 1951; November 21, 1972; *The Squamish Advance*, December 6, 1951.

**Details:** Overnight December 1, high tides, lashed by wind and rain, caused flooding in some low-lying areas of Squamish. On the morning of December 1, the dyke behind the PGE tracks near the Western Plywoods dump was breached in two places by the wind-backed tides. Water poured into the area on the east side of Cleveland Avenue. Within a short time, water was running over the sidewalks and the main street of Squamish was flooded with 2 ft. (60 cm) of water. All the basements in the centre of town were inundated. Work crews sandbagged the dyke and low spot on the Pemberton Road dyke. Part of River Road near the Red Bridge was washed out and several houses in that area were completely surrounded with some of them, several inches of water on the floors.

In Squamish, there was water in the Shell garage and some of the buildings on Cleveland Avenue had water on the floors. Tide water also poured over the low-lying

portions of the dyke in the lower part of town. Houses at the lower end of Victoria Street were surrounded by water. The washed out floodgate at the end of Victoria Street would have to be replaced. Just outside Squamish, the Squamish-Britannia highway (i.e., Sea to Sky) was also washed out.

On the morning of December 3, high tides again sent water over River Road near the Red Bridge, washing out a portion of the road. Water also covered the road almost 1 ft. (30 cm) deep above Cowdell's corner and was spilling over a 60-ft. (18 m) length of low dyke behind Henry Smith's, completely surrounding the houses in that area.

### **Early January, 1953**

**Event type:** Storm surge/tidal flooding.

**Precipitation:** Not applicable.

**Source:** *The Squamish Advance*, January 8, 1953.

**Details:** Early in January, high tides backed by a strong south wind drove water over River Road near the Red Bridge and flooded low-lying areas near Squamish. On the morning of January 6, the road was washed out and badly rutted for 100 yd. (90 m). One residence was flooded and water came within inches of coming into several others. In the lower end of Squamish, the water was almost level with the dyke.

### **November 4-5, 1954**

**Event type:** Flooding

**Precipitation:** Britannia Beach, 91.7 mm/2 days, November 4-5, 1954.

**Source:** *The Squamish Advance*, November 11, 1954.

**Details:** On November 4, heavy warm rain melted snow on the mountains along Howe Sound and brought the river levels up. The Squamish River came over the road in several places and Mamquam River was "running bank full." Section crews dynamited logs, which jammed against the railway bridge while Public Works crews kept close watch on the road bridge.

On November 5 at 5:30 p.m., a derailment occurred on the PGE rail line at Mile 91 along Anderson Lake. Six cars of a freight train went off the tracks. It caused a 24-hour delay in passenger service to Prince George.

### **November 13-21, 1954**

**Event type:** Flooding.

**Precipitation:** Britannia Beach, 276.8 mm/8 days, November 13-21, 1954.

**Source:** *The Squamish Advance*, November 18 and 25; December 2, 1954.

**Details:** In the middle of November, heavy rains and subsequent flooding caused considerable damage to the road and bridge system in the Squamish Valley. It was the second time in 10 days that heavy rains brought rivers in the area to a dangerous level. Between November 1-late November 21, 18.9 in. (480 mm) of rain were recorded.<sup>1</sup>

On the night of November 17, a culvert north of Shannon Creek was washed out for some time, cutting traffic on the road between Squamish and Britannia Beach. Repairs were made and the road reopened a few days later. Muddy conditions later forced traffic to a standstill. High water also undermined a small bridge south of Shannon Creek, which required repairs. Floodwaters also took out the culvert just north of Shannon Creek.

Logs and debris coming down the Mamquam River damaged bridge. Between the morning of November 19 till the evening of November 22, the structure was closed to all heavy traffic. Loaded log trucks were stranded on the north bank of the river.

From early morning till 10 p.m. on November 18, Squamish lost its municipal water supply. Heavy rains caused the Stawamus River to rise and wash out a bend between the intake and the forebay. On November 21, water was off in some sections of the town due to two breaks in the pipe; one at the Castle's crossing and the other in front of the PGE houses. Because of low water pressure, the hospital was without water between 3 p.m. on November 21 till the next afternoon. Gravel and debris washed in front of the intake at the dam reduced the amount of water coming through the pipe. The lack of water closed Squamish schools on the afternoon of November 22.

On November 18, Wraymar Mills were forced to close their operations when part of their road washed out. After repairs were made the men returned to work on November 22.

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<sup>1</sup> In November, Squamish recorded a total precipitation of 23.4 in. (594.3 mm), 3 in. (75 mm) more than the total for November 1953 (*The Squamish Advance*, December 2, 1954).

### **June 9-12, 1955**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport, 0.0 mm/4 days, June 12-15, 1955; Britannia Beach, 0.0 mm/4 days, June 12-15, 1955.

**Source:** *The Squamish Advance*, June 16, 1955.

**Details:** A sudden hotspell, in which temperatures climbed to 95.5°F (35.3°C) on June 9, caused the Squamish and Cheakamus rivers to rise. On June 10-11, Squamish River crested when it was 2 ft. (60 cm) below the road at Alvie Andrews'. Cool nights and lower daytime temperatures caused the river to drop almost 3 ft. (90 cm).

On the same dates, Cheakamus River was also high, threatening B.C. Electric's bridge across the Cheakamus. Rock fills were placed around the bents but further work was required as soon as the river dropped.

On June 9, the southern approach to Mamquam River collapsed when a logging truck passed over it. The approach was filled as well as a breakwater built alongside it. The bridge, which since the previous fall's high water had been anchored by cables, required extensive repairs or replacement.

### **August 22, 1955**

**Event type:** Subaqueous slope failure.

**Precipitation:** Not applicable.

**Source:** *The Vancouver Sun*, August 23, 1955; *The Squamish Advance*, August 25, 1955; Eisbacher, 1983 (p. 24); Evans, unpublished data.

**Details:** On the afternoon of August 22, a major slump at the shore face at Woodfibre, along the west side of Howe Sound, dislodged a warehouse and dock about 30 m seaward.<sup>1</sup> At 4 p.m. the wharf began to sag with a crunching sound and within half an hour a large section had slid into the deep water of Howe Sound. John Guthry, plant manager, stated "Apparently a section of sand and gravel shore had collapsed under it." A warehouse and office area collapsed next. At the head of the slump, water depths increased by about 10 m and the disturbed part of the delta front apparently extended to about 150 m below sea level

(Eisbacher, 1983). The event was thought to have been triggered by an extreme low tide (Evans, unpublished data).

The collapse of the wharf and three warehouses into Howe Sound forced the closure of Alaska Pine's rayon pulp mill, putting approximately 200 men temporarily out of work. Many tons of pulp stored in the warehouses were lost. The damage was estimated between \$500,000-750,000 (1955 dollars). The main plant, which was not involved in the cave-in, was expected to reopen a few days later (*The Vancouver Sun*).

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<sup>1</sup> Woodfibre is a major pulp mill located on the fan delta of Mill Creek. The plant and related warehouse-wharf complex were constructed in the early 1910s (Eisbacher, 1983).

### **October 23-25, 1955**

**Event type:** Flash flooding.

**Precipitation:** Britannia Beach, 126.0 mm/3 days, October 23-25, 1955; Vancouver International Airport, 40.4 mm/3 days, October 23-25, 1955; Britannia Beach, 72.1 mm/1 day, October 24, 1955; Vancouver International Airport, 24.6 mm/1 day, October 24, 1955.

**Source:** *The Squamish Advance*, October 27; November 3, 1955; February 2, 1956; *The British Columbian*, October 24, 25 and 26, 1955. (Other stations throughout the area reported peak precipitation values in excess of 70 mm on October 24).

**Details:** Squamish reported more than 6 in. (150 mm) of rain in 38 hours with 4 in. (100 mm) falling in the 24-hour period ending 8 a.m. on October 25.<sup>1</sup> The fringe of a major storm passed over northern British Columbia. Overnight October 24-25, Sea Island airport recorded 1 in. (25 mm) of rain while Hope reported just under 3 in. (75 mm). Winds in the Lower Mainland reached up to 30 mph (48.3 km/h).

The heaviest property damage occurred at Squamish where the Squamish and Mamquam rivers rose 8 ft. (2.4 m) in 24 hours. On October 25, many acres of the north end of Squamish were flooded. Property damage ran in "the thousands of dollars." Floodwaters took out the Mamquam River main highway bridge. After debris piled against it, both ends gave way and hurled against the railroad bridge. Steel cables were fixed to the remaining centre portion to prevent it from going out and knocking the railway bridge out. On the morning of October 25, the bridge was a "twisted mass of wreckage" with a portion of the bridge draped over a huge logjam in the middle of the river. Both the north and south sections of the bridge were washed out, cutting road communication between Squamish and the Valley.<sup>2</sup> PGE crews managed to save their bridge by blasting away the logs and debris which had lodged against it. Until the completion of a new road bridge, the railway bridge across Mamquam River was planked and a temporary road built to the highway. It was expected ready for use on November 3.

Many families in the area between the Mamquam bridge and the PGE shops moved out with four of them taking refuge in the school. Between the shops and the Brackendale store, water covered the road in most places. At Leski's crossing, water was reported to be up to the tops of the fence posts. On October 25, water also came over the road in several spots between the shops and Buckley's Crossing, but soon drained off when the tide went down. Twelve families had to be evacuated from homes in the low-lying north end of Squamish. Clogged drains caused flooding in front of the taxi office and many streets had up to 1ft. (30 cm) of water. Homes on Britannia Avenue and other streets in the area north of Government Road had flooded basements. North of Government Road, floodwaters coming down the old Mamquam River channel behind the school inundated the streets

there. On October 25, both schools in Squamish were closed. As a temporary measure the PGE was transporting 65 pupils from Brackendale to the Shops each day.

A washed-out bridge closed the highway between Squamish-Britannia Mines. As the bridge near the old telephone camp below Shannon was in a “shaky condition,” traffic on the Britannia Highway was halted. Washouts on the PGE line interrupted rail traffic for more than 24 hours. Several PGE trains were cancelled due to washouts and slides. Several small slides came down between Squamish and Lillooet. The two main “trouble spots” were between Rainbow and Parkhurst where there was a washout 80 ft. (24 m) long and 2 ft. (60 cm) deep. Above Parkhurst, a 300-ft. (90 m) section was washed out to a depth of 8 ft. (2.4 m).

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1 Forty percent of the total rainfall of 15.9 in. (403.9 mm) recorded in October fell in less than 48 hours between the afternoon of October 23 to 8 a.m. on October 25. (*The Squamish Advance*, October 27; November 3, 1955).

2 This was about the tenth time in 28 years that logs and debris coming down the Mamquam took this bridge out. Each time, it was rebuilt with the same type, a wooden bridge on pilings. An editorial in *The Squamish Advance* suggested it was time to construct a modern steel bridge across the river. A steel span would permit the logs to pass underneath it (*The Squamish Advance*, October 27, 1955). On January 26, 1956, the new Mamquam road bridge, replacing the old one was opened for traffic. Eight feet (2.4 m) above the level of the road and just east of the former one, the bridge angled to conform to the river current. The piers were also set in at an angle to permit logs and debris to flow under it and prevent jamming. The latter was one of the causes of the old bridge’s washout. The new structure had four short bends at the south end and two at the north approach with two centre steel spans each 60 ft. (18 m) long (*The Squamish Advance*, February 2, 1956).

## **November 1-4, 1955**

**Event type:** Flooding.

**Precipitation:** Chilliwack, 159.0 mm/3 days, November 1-3, 1955; Hollyburn Ridge, 283.2 mm/3 days, November 1-3, 1955; North Vancouver Capilano, 195.5 mm/3 days, November 1-3, 1955; North Vancouver Mosquito Creek, 228.7 mm/3 days, November 1-3, 1955; West Vancouver Macbeth, 174.2 mm/3 days, November 1-3, 1955; New Westminster, 124.0 mm/3 days, November 1-3, 1955; Buntzen Lake, 309.4 mm/3 days, November 1-3, 1955; Chilliwack, 115.8 mm/1 day, November 2, 1955; Hollyburn Ridge, 146.1 mm + 5.1 cm snow/1 day, November 2, 1955; Vancouver International Airport, 61.0 mm/1 day, November 2, 1955; North Vancouver Capilano, 122.4 mm/1 day, November 2, 1955; North Vancouver Mosquito Creek, 122.2 mm/1 day, November 2, 1955; West Vancouver Macbeth, 113.3 mm/1 day, November 2, 1955; New Westminster, 89.7 mm/1 day, November 2, 1955; Buntzen Lake 188.2 mm/1 day, November 2, 1955; Agassiz CDA, 161.3 mm/2 days, November 2-3, 1955; Britannia Beach, 165.3 mm/3 days, November 2-4, 1955; Tunnel Camp, 179.5 mm/3 days, November 2-4, 1955; Vancouver International Airport, 91.8 mm/3 days, November 2-4, 1955; Britannia Beach, 118.1 mm/1 day, November 3, 1955; Tunnel Camp, 129.8 mm/1 day, November 3, 1955; Agassiz CDA, 81.3 mm/1 day, November 3, 1955.

**Source:** *The Vancouver Province*, November 4, 5, 7, 8, 9 and 10, 1955; *Victoria Daily Times*, November 15, 1955; *The Vancouver Herald*, November 23, 1955; *The Squamish Advance*, November 10; December 1, 1955.

**Details:** Between November 1-4, the “worst rainstorm ever to hit the west coast” caused widespread flooding. In a 72-hour period, North Vancouver recorded 18.58 in. (471.9

mm) of rain. The rains melted over 14 in. (35 cm) of snow from Hollyburn (*The Vancouver Sun*).

It was the second storm in as many weeks to hit the Lower Mainland. Vancouver Airport recorded 2.40 in. (61.0 mm) in 24 hours, while North Vancouver registered a record 4.82 in. (122.4 mm) during the same period. Between the night of November 2 and November 4, weather forecaster Ralph V. Tyner recorded 7.71 in. (195.8 mm) in his rain gauge at Sunnycrest, North Vancouver. The bulk of this, 4.55 in. (115.6 mm), fell between 7 p.m. on November 2 and 9 a.m. on November 3.

Floodwaters in the Squamish River valley caused heavy losses to pink salmon stocks. According to Chief Fisheries Supervisor A.J. Whitmore, the salmon “verges on disaster.” Loss of salmon due to flood damage to Lower Mainland streams could run as high as 90% in some varieties.

For a second time in two weeks, high water threatened the Squamish Valley. Light snow falling on November 2 turned into heavy rain later that day. The rain, which continued all of next day, brought local rivers over their banks. Early on November 3, the bridge across Stoney Creek was “in a precarious condition.” School buses transportation to Britannia Beach was cancelled. By early afternoon, the Mamquam and Squamish were rising and Brackendale and Shops (owned by PGE); stpupils were sent home. On November 4, school was cancelled.

The Mamquam and Squamish rivers flooded the valley from the former Joyce ranch to below the Shops. About 100 people were evacuated from the area between the Shops and Brackendale. In the lower portion of the valley, some residents in the area between the Shops and the Mamquam River were also moved out. Several families along Britannia Avenue and Newport Avenue temporarily left their homes, most of which had flooded basements. Cleveland Avenue flooded for almost half a block as well as the sidewalk of the street. Water lapped over the sidewalk in front of the taxi office. The lower end of town below Vancouver Street was also inundated. On Cleveland Avenue the drains were plugged in the lower end of town. As there was not long enough runoff between tides to permit the water to drain away, the floodgates could not be opened. Early on November 5, all the water had drained in that part of the village, but Cleveland Avenue was still flooded the following week.

On November 4, Squamish lost power for several hours and also their water supply. Stawamus River waters took out part of the pipeline, a section of which had to be rebuilt. Stawamus River also flooded the road to the Anderson camp and the First Nations Reserve. Near Cheekye, Cheakamus River washed out a small portion of the road to Paradise Valley. Evans Creek washed holes in the upper valley road, portions of which were still under water on November 6.

Heavy rains also washed out the Empire Mills road near the foot of the hill east of Curly Lewis (Squamish area). A bridge was reported being built over the washout and portions of the washed out area were being filled (*The Squamish Advance*, December 1, 1955). On the morning of November 5, a high tide brought water close to the top of the dykes.<sup>1</sup>

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<sup>1</sup> The cut-off on Squamish River, constructed by the federal government several years earlier, carried off a large amount of floodwater as well as prevented the flood from affecting the village (*The Squamish Advance*, November 10, 1955).

### **December 1-3, 1955**

**Event type:** Storm surge/tidal flooding.

**Precipitation:** Vancouver International Airport, 11.2 mm/1 day, December 1, 1955; Britannia Beach, 2.3 mm/3 days, December 1-3, 1955.

**Source:** *The Squamish Advance*, December 1 and 6, 1955.

**Details:** On the morning of December 1, high tides backed by a strong wind sent water across the main street in Squamish. The Shell garage and some of the buildings on Cleveland Avenue had water on the floors. Norman Barr's machine shop was reported to have several inches of water on his shop floor. The tide water also poured over the low-lying portions of the dyke in the lower part of town. Water surrounded the houses at the lower end of Victoria Street.

The dyke behind the PGE tracks near the Western Plywood's dump was breached in two places. Water poured through into the area on the east side of Cleveland Avenue. A foot (30 cm) of water covered Cleveland Avenue and its sidewalks. Crews sandbagged the dyke and low spot on the Pemberton Road dyke near Cowdell's corner. The latter was raised with almost a foot of dirt and gravel. Part of River Road, near the Red Bridge, was washed out with water completely surrounding several houses in that area. Some of them had several inches of water on the floors.

On the morning of December 3, high tides again sent water over River Road near the Red Bridge. Residents near the bridge had either water in their houses or could not get out for hours as water surrounded their houses. A "miniature Niagara" was pouring over the washed out portion of that road and the area behind it was flooded again. Above Cowdell's corner, water covered the road almost a foot deep. It was also spilling over a 60-ft. (18 m) length of low dyke behind Henry Smith's. Water completely surrounded all houses in that area.

Officials who inspected the dykes, the site of the washed out floodgate and the waterlogged area around Cowdell's corner, told residents that they would ask Public Works Department for funds to carry out work necessary to prevent further flood damage. This would involve repairs to the dyke, replacing floodgate at the end of Victoria Street and some dyking behind the houses.<sup>1</sup>

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<sup>1</sup> An editorial in *The Squamish Advance* called the local dykes inadequate. Dykes around the entire town had been deteriorating for years. The newspaper pointed out the district's need for adequate dyking and flood protection. For several years, the Board of Trade had requested the provincial government to improve the dyke system. The low section of the Pemberton Road dyke near Cowdell's corner had always been a danger spot, but this could easily be raised. A dyke built along the rear of the houses between this corner and Castle's crossing would safeguard the residents of this area. Raising Red River Road between the Red Bridge and Lonny Wray's by adding 1.5 ft. (45 cm) of gravel would protect the residents near this bridge. (*The Squamish Advance*, December 6, 1955).

### **June 6-9, 1956**

**Event type:** Rock slides; Flooding.

**Precipitation:** Hollyburn Ridge, 69.8 mm/4 days, June 6-9, 1956; Britannia Beach, 110.3 mm/4 days, June 6-9, 1956; Tunnel Camp, 171.2 mm/4 days, June 6-9, 1956; Britannia Beach, 63.8 mm/1 day, June 8, 1956; Tunnel Camp, 98.0 mm/1 day, June 8, 1956; Hollyburn Ridge, 24.6 mm/1 day, June 9, 1956.

**Source:** *The Vancouver Province*, June 7, 9, 11 and 12, 1956; *The Vancouver Sun*, June 9, 1956; *The Vancouver Herald*, June 9, 1956.

**Details:** On June 8 and 9, rock slides came down at Mile 22, 10 mi. (16 km) north of Horseshoe Bay on the nearly completed 40-mi. (64 km) PGE railway extension. A slide blocked the track 2 mi. (3.2 km) from where work had finished. Rush to get the project completed by June 11 was stalled when the more than 200-ton rock slide covered the rails. On the morning of June 9, a 3-ton boulder fell across the line, again at Mile 88, requiring the replacement of the rail. Between Squamish and Britannia, a bridge was washed out.

A special train carrying Railway Minister W.R.T. Chetwynd and other government officials was scheduled to travel from Horseshoe Bay to Porteau on June 10. That day, the last spike was driven at Mile 26.2 on the PGE south extension.<sup>1</sup> Although the line was officially completed, there still had to be a lot of work done before it would be reasonably safe for trains to run the 30-mi. (48 km) stretch from Squamish to Horseshoe Bay. Tons of loose rock had yet to be scaled off cuts and tons of ballast had to be dropped and tamped into place. In some places, only every second tie had been put down and not all spikes had been driven (*The Vancouver Province*, June 11, 1956).

Heavy rains in the Vancouver area forced up the levels of all North Shore streams. Mamquam, Squamish, and Cheakamus rivers, which went on brief rampages, were reported rising 1 ft. (30 cm) per hour. Near Squamish, the Squamish and Mamquam rivers threatened three bridges. On June 7, at 5 p.m., a sudden rise sent logs and debris into a PGE bridge and two highway spans about 3 mi. (4.8 km) north of Squamish. Mamquam River flooded a road about 2 mi. (3.2 km) from Squamish and washed away the approaches of a vehicular bridge. Logging companies in the area were blasting logs and debris away from all bridges and moving logging equipment to higher ground. By 9 p.m., the rivers had subsided.

On June 10, creeks in North Vancouver dropped considerably and at Squamish, the Squamish and Mamquam rivers receded by 1.5 ft. (45 cm).

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<sup>1</sup> PGE south extension, had taken a 40 year wait, a total of \$10,500,000 of taxpayers' money, the lives of five men, "considered low for a job of this magnitude," and the removal of 1,500 million tons of rock (*The Vancouver Province*, June 11, 1956).

## **August 27, 1956**

**Event type:** Debris slide.

**Precipitation:** Hollyburn Ridge, 29.2 mm/1 day, August 25, 1956.

**Source:** *Victoria Daily Times*, August 27, 1956; *The Province*, August 30, 1956; *The Vancouver Sun*, September 7, 1956; Ramsey, 1962 (pp. 247-248).

**Details:** On the forenoon of August 27, a rock and mudslide came down near Horseshoe Bay at Mile 18 at a place called "Socred Cut" on the recently completed PGE railway extension.<sup>1</sup> The slide estimated to be 40 ft. (12 m) wide and consisting 200 tons halted the inaugural trains. Within a few minutes, a section of cliff 50 ft. (15 m) wide and 120 ft. (36 m) high tumbled down across the tracks, covering the new track for about 100 ft. (30 m) to a depth of 30 ft. (9 m). According to Ramsey (1962), the slide was 200 ft. (60 m) long.<sup>2</sup>

Though Minister Chetwynd suspected the slide to be caused by sabotage, his deputy Joe S. Broadbent noted it was probably due to natural causes. It occurred in a basalt rock formation sloping toward the ocean. Heavy rains were believed to have undercut the columnar rock layers making the underlying clay so greasy that the rock slid. This was about the 80<sup>th</sup> slide since the previous October when construction was begun on the Sunset Beach rockcut, amongst construction crews known as "Social Credit Cut."

The slide was reported only a few minutes after Premier W.A.C Bennett had addressed a crowd of 3,000 at North Vancouver who had come to watch three inaugural specials pull out. Earlier that day, C.R. Crysedale, consulting engineer with PGE since it was begun in 1912, had driven a copper “last” spike marking the completion of the last link of the Vancouver-Squamish section. Immediately afterwards, heavy rain started falling. The slide at Sunset Beach on Howe Sound stalled the premier and his 350 guests for 16 hours.

Early on August 28, 50 workmen and two bulldozers managed to clear the tracks and inaugural trains began moving at 3: 50 a.m. that day. “Whistle stop” receptions scheduled by the Premier and his cabinet at stations along the PGE line were cancelled. The inaugural trains due at Prince George, were 19 hours behind schedule.

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1 British Columbia Liberal leader Arthur Laing claimed the construction of the extension had been a “hurried job” and predicted more slides on the PGE right-of-way (*The Province*, August 30, 1956). Liberal candidate Frank Millerd claimed construction of the highway to Squamish in the vicinity of Horseshoe Bay was stalled “because they are afraid to blast rocks down on the PGE. Instead, every pound of rock has to be lifted over the PGE and dumped into the water.” (*The Vancouver Sun*, September 7, 1956).

2 It certainly was an embarrassment to the premier and his party of officials. It was recalled that on one of Premier John Oliver’s official trips up the line, a locomotive had gone off the track near Lac La Hache just ahead of the premier’s train. So as not to embarrass the premier, the train crew covered the engine with hay to make it look like a haystack (Ramsey 1962).

### **September 24-26, 1956**

**Event type:** Debris slide, rock slide, and flooding.

**Precipitation:** Hollyburn Ridge, 131.3 mm/4 days, September 23-26, 1956; Vancouver Harbour CS, 33.8 mm/4 days, September 23-26, 1956; Britannia Beach, 62.5 mm/4 days, September 23-26, 1956; Tunnel Camp, 88.9 mm/4 days, September 23-26, 1956; Buntzen Lake, 168.5 mm/4 days, September 23-26, 1956; Hollyburn Ridge, 48.3 mm/1 day, September 25, 1956; Vancouver Harbour CS, 23.1 mm/1 day, September 25, 1956; Britannia Beach, 27.4 mm/1 day, September 25, 1956; Tunnel Camp, 35.1 mm/1 day, September 25, 1956; Buntzen Lake, 71.4 mm/1 day, September 25, 1956. (Heavy rains of similar values also occurred days prior to this period).

**Source:** *The Vancouver Sun*, September 27 and 28, 1956.

**Details:** On September 26, a mud and rock slide wreaked havoc on the new PGE Squamish line. On the night of September 25-26, rain caused Mamquam River to rise 6 ft. (1.8 m) at its mouth at Squamish. The floodwater roaring down the 40-mi. (64 km) Mamquam Valley piled up debris against a railway bridge. At 2:30 p.m., the rain-swollen Mamquam River knocked out a 60-ft. (18 m) section of the PGE main line 2 mi. (3.2 km) north of Squamish. Two workmen on the bridge scrambled off with only seconds to spare. A 35-ton railway crane, they were manning, toppled upside down into the 12-ft. (3.6 m) deep river. Only half an hour earlier, an eight-coach train with some 140 passengers had crossed the bridge.

Five hours later at 7:30 p.m., a work train bound from Squamish to Vancouver was derailed by a small rock slide at Mile 22 about 5 mi. (8 km) north of Horseshoe Bay. The engine, three cars, and a caboose were derailed. The rock slide that came down about 100 ft. (30 m) from the highway above was believed to have been caused by construction work on the Upper Levels Highway. The diesel engine swung off to the left, ramming into a cliff. Had it swung to the right, it would have crashed 50 ft. (15 m) into Howe Sound.

The track was cleared before dawn. About 60 passengers aboard the train delayed by the slide were forced to remain at North Vancouver overnight. The two accidents

temporarily halted all traffic on the rail lines between Vancouver-Squamish and Squamish-Lillooet. Five trains were cancelled.

### **October 19, 1956**

**Event type:** Mud (debris) slides.

**Precipitation:** Hollyburn Ridge, 242.1 mm/10 days, October 10-19, 1956; Vancouver Harbour CS, 179.5 mm/10 days, October 10-19, 1956; Tunnel Camp, 251.2 mm/10 days, October 10-19, 1956; Britannia Beach, 157.8 mm/10 days, October 10-19, 1956; Buntzen Lake, 301.4 mm/10 days, October 10-19, 1956; West Vancouver Macbeth, 217.2 mm/10 days, October 10-19, 1956; Hollyburn Ridge, 104.1 mm/1 day, October 19, 1956; Vancouver Harbour CS, 103.6 mm/1 day, October 19, 1956; Tunnel Camp, 92.7 mm/1 day, October 19, 1956; Britannia Beach, 39.1 mm/1 day, October 19, 1956; Buntzen Lake, 131.1 mm/1 day, October 19, 1956; West Vancouver Macbeth, 120.4 mm/1 day, October 19, 1956.

**Source:** *The Vancouver Sun*, October 20, 1956.

**Details:** In a 17-hour period starting 7 a.m. on October 19, the Vancouver International Airport recorded 2.34 in. (59.4 mm) of rain. During the same period, downtown Vancouver and the North Shore recorded 3.76 in. (95.5 mm) and 6 in. (150 mm), respectively. By 7 p.m., North Vancouver's three main highway routes to the Second Narrows bridge were severed.

On the night of October 19, a dozen mudslides blocked the PGE tracks.<sup>1</sup> More than 200 train passengers were ferried by road and sea from Squamish to Horseshoe Bay. About 140 passengers were stranded when mudslides held the southbound PGE train at Squamish. They were ferried to Horseshoe Bay by the 99-ft. (29.7 m) vessel *Hollyburn*. A fleet of busses carried them to Vancouver. The northbound train was held up by slides at Porteau Beach, 29 mi. (46.4 km) from North Vancouver at 11:40 a.m. and did not arrive at Britannia until 11 p.m.

A bridge was also undermined and it would be days before full service from Howe Sound points into the North Vancouver depot could be resumed. Though the slides were reported all cleared on October 20, train service was still suspended.

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<sup>1</sup> This hold-up was the sixth on the new line since it opened on August 27. (*The Vancouver Sun*, October 20, 1956).

### **November 20-24, 1956**

**Event type:** Rock slide.

**Precipitation:** Britannia Beach, 33.0 mm/2 days, November 15-16, 1956; Vancouver International Airport, 16.5 mm/1 day, November 16, 1956.

**Source:** *The Province*, November 21 and 26, 1956.

**Details:** On November 24, a rock slide came down at Mile 23.5 on the PGE line. The tons of rock held up the regular morning train with a North Vancouver Board of Trade delegation bound for Squamish for four hours. For the second time in a week and a third time in just over a month, all rail traffic between North Vancouver and Squamish was suspended for one day.

### **April 13-17, 1957**

**Event type:** Debris slides.

**Precipitation:** West Vancouver, 29.5 mm/3 days, April 13-15, 1957; Anvil Island, 36.8 mm/3 days, April 13-15, 1957; Hollyburn Ridge, 61.7 mm/3 days, April 13-15, 1957; Britannia Beach, 73.4 mm/3 days, April 13-15, 1957; Tunnel Camp, 91.7 mm/3 days, April 13-15, 1957.

**Source:** *The Vancouver Sun*, April 18, 1957; *The Province*, April 18, 1957.

**Details:** On April 16, a slide 22 mi. (35.2 km) north of Vancouver came down on the PGE rail line, blocking rail traffic to Squamish. It was 400 ft. (120 m) in length and varied in depth from 8-35 ft. (2.4-10.5 m). Blasting on the Upper Level Highway caused the slide. According to PGE General Manager J.S. Broadbent, such slides were “inevitable” because the highway is above the rail line.

It was expected to have the line cleared by 5 p.m. on April 18. The track blockage was the longest since the line to Prince George opened. The delay in clearing the slide was caused by the potential danger of further slides in the area. Clearing operations were too dangerous until overhanging rock was blasted away.

During the night of April 17, a second slide came down 18 mi. (28.8 km) north of Squamish, which derailed a self propelled Bud car of a PGE Cariboo Dayliner passenger train.

### **April 24, 1957**

**Event type:** Debris slide.

**Precipitation:** Not applicable.

**Source:** *The Vancouver Sun*, April 25, 1957.

**Details:** On April 24, an “earth slide” caused by blasting operations on the Upper Levels Highway 25 mi. (40 km) north of Vancouver (Sunset Beach area) blocked the PGE tracks with “tons of earth.” It was hoped to have the line clear on April 25. A northbound train from Vancouver was hemmed in by two slides blocking the line 6 mi. (9.6 km) north of Horseshoe Bay for a day and a half.

### **May 15, 1957**

**Event type:** Debris slide.

**Precipitation:** Not applicable.

**Source:** *The Province*, May 17, 1957.

**Details:** On May 15, a slide on the PGE line attributed to highway construction delayed a PGE passenger train. According to PGE Vice President Einar Gunderson, “road contractors have strict orders not to work while trains are operating below.”<sup>1</sup>

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<sup>1</sup> For the greater part of the 45-km stretch between Horseshoe Bay and Squamish, the highway parallels the rail line approximately 50 m above the track.

### **June 27, 1957**

**Event type:** Subaqueous slope failure.

**Precipitation:** Hollyburn Ridge, 43.9 mm/3 days, June 25-27, 1957; Britannia Beach, 20.1 mm/3 days, June 25-27, 1957; Tunnel Camp, 26.9 mm/3 days, June 25-27, 1957; Anvil Island, 20.0 mm/3 days, June 25-27, 1957.

**Source:** *The British Columbian*, June 28 and 29, 1957; *Prince Rupert Daily News*, June 28, 1957; *The Vancouver Sun*, June 28, 1957; *The Province*, June 28; July 30, 1957.

**Details:** On June 27, a subaqueous slope failure occurred just south of the station at Britannia Beach. Waves generated by a submarine slump washed out a section of the PGE rail line shortly after the grade was constructed.<sup>1</sup> The giant failure left 50 yd. (45 m) of PGE rail line dangling over the water of Howe Sound after one train passed and 35 minutes before a passenger train was due in from Vancouver. An eyewitness said a section of gravel fill about 50 yd. (45 m) long and 50 yd. (45 m) wide slowly broke away and slid into Howe Sound. According to Bob Alexander of Britannia Mining Company, who watched the slide happen, it left the rails hanging about 20 ft. (6 m) above the low-water mark.

Angry residents of Britannia Beach criticized the government for rushing through the PGE before completing Squamish Highway. Immediately following the slide, Robert Strachan, provincial leader of the Co-operative Commonwealth Federation (CCF) demanded a complete and independent engineering inspection of the PGE roadbed from North Vancouver to Squamish. He demanded that all traffic be stopped on the PGE until such a survey would be completed. Strachan noted that the PGE was becoming “once more the laughing stock of the country, only this time it has tragic implications.”

Premier W.A.C. Bennett dismissed Strachan’s demand as a “political move.” He added, “It just shows that the CCF is opposed to the PGE. They have way worse slides on the CPR and CNR.” Premier Bennett clearly indicated that there would be no survey. PGE Manager Joe S. Broadbent said that in his opinion, the railway was quite safe. “If it wasn’t safe, we wouldn’t be running trains on it.” One PGE spokesman said the railroad runs a track patrol 1,000 ft. (300 m) in front of every passenger train between Squamish and North Vancouver.

On July 29, Premier Bennett stated that tests carried out by Thurber Engineering firm showed that the fill that had collapsed into Howe Sound had been put there 16 years previous by the Britannia Mine Company and thus “wasn’t our fault.” (*The Province*, July 30, 1957).

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<sup>1</sup> Though there had been numerous rock slides, this was the first time such a failure occurred since the section of line between North Vancouver and Squamish opened (*The Province*, June 28, 1957).

## **September 5-6, 1957**

**Event type:** Flash flooding.

**Precipitation:** Alta Lake, 52.6 mm/1 day, September 5, 1957; Pemberton Meadows, 50.8 mm/1 day, September 5, 1957; Clowhom Falls, 53.8 mm/1 day, September 5, 1957; Alta Lake, 70.4 mm/3 days, September 5-7, 1957; Tunnel Camp, 96.3 mm/3 days, September 5-7, 1957; Britannia Beach, 95.4 mm/3 days, September 5-7, 1957; Clowhom Falls, 63.5 mm/3 days, September 5-7, 1957; Tunnel Camp, 61.2 mm/1 day, September 6, 1957; Britannia Beach, 63.2 mm/1 day, September 6, 1957.

**Source:** *The Sunday Sun*, September 7, 1957; *The Daily Colonist*, September 8, 1957.

**Details:** On September 5, torrential rains caused flooding in the Squamish Valley. The swollen Squamish River burst its banks, flooding to a depth of 14 ft. (4.2 m) in places and blocking the only road. Dozens of cars and trucks were trapped. A BC Electric powerhouse under construction at Cheakamus was flooded. The river poured over a dam built above the new powerhouse. It cut off 40 construction workers for two nights. Twenty of them were at the powerhouse and 20 more were marooned on a hillside further up the valley. The flash

flood trapped residents in attics of their homes. The river crept 10 ft. (3 m) up a hillside to swamp a \$35,000 helicopter before it could be moved from its landing site 4 mi. (6.4 km) from the powerhouse. At flood height on September 6, the water had reached about 4 ft. (1.2 m) up the site. The pilot was unable to reach the machine due to the deep water. Residents of a flooded house had to take refuge in a barn loft.

### **October 6, 1957**

**Event type:** Rock slide.

**Precipitation:** Vancouver International Airport, 6.9 mm/1 day, October 1, 1957; Britannia Beach, 58.2 mm/3 days, October 2-4, 1957.

**Source:** *Victoria Daily Times*, October 7, 1957.

**Details:** On the afternoon of October 6, rocks on the track derailed five freight cars of a PGE train 21 mi. (33.6 km) north of Brunswick Beach. The derailment occurred at 2:45 p.m. and a slide of rocks later crashed into the derailed train. PGE officials hoped to have the line open again on October 7.

### **October 22, 1957**

**Event type:** Flooding.

**Precipitation:** Hollyburn Ridge, 163.1 mm/8 days, October 22-29, 1957; Tunnel Camp, 102.8 mm/8 days, October 22-29, 1957; Britannia Beach, 69.8 mm/8 days, October 22-29, 1957; Hollyburn Ridge, 64.8 mm/1 day, October 23, 1957; Tunnel Camp, 41.1 mm/1 day, October 23, 1957; Britannia Beach, 30.7 mm/1 day, October 23, 1957.

**Source:** *Victoria Daily Times*, October 23, 1957; *Bridge River-Lillooet News*, October 24, 1957.

**Details:** On October 22, a small bridge, 16 mi. (25.6 km) south of Squamish was washed out, halting traffic on the PGE line. Although the crossing was expected to be restored on October 23, on that day, passengers on the Cariboo Dayliner were transported to Squamish by boat.

### **January 23-25, 1958**

**Event type:** Flooding and debris slide.

**Precipitation:** Hollyburn Ridge, 72.9 mm/1 day, January 22, 1958; Vancouver International Airport, 84.9 mm/4 days, January 22-25, 1958; Anvil Island, 150.4 mm/4 days, January 22-25, 1958; Britannia Beach, 112.6 mm/4 days, January 22-25, 1958; Tunnel Camp, 132.8 mm/4 days, January 22-25, 1958; Hollyburn Ridge, 186.9 mm/4 days, January 22-25, 1958; West Vancouver Cypress Park, 121.5 mm/4 days, January 22-25, 1958; Vancouver International Airport, 57.7 mm/1 day, January 23, 1958; Anvil Island, 66.3 mm/1 day, January 23, 1958; Britannia Beach, 59.2 mm/1 day, January 23, 1958; Tunnel Camp, 72.4 mm/1 day, January 23, 1958; West Vancouver Cypress Park, 57.2 mm/1 day, January 23, 1958. (Temperatures at Vancouver International Airport were approximately 6° C above normal.)

**Source:** *The Daily Free Press*, January 23 and 24, 1958; *The Vancouver Sun*, January 24, 1958; *Victoria Daily Times*, January 24, 1958; *The Lake Leader/Cowichan Leader*, January 30, 1958; *The Province*, January 24; December 2, 1958.

**Details:** On January 23, heavy continuous rain occurred over the Lower Mainland and Vancouver Island. In the 24-hour period ending 10 p.m., Vancouver set a January record of 2.56 in. (65.0 mm)<sup>1</sup>.

A section of PGE rail line 27 mi. (43.2 km) north of Vancouver was washed out. On January 23 at 5:15 p.m., a slide blocked the PGE line at Brunswick Beach. Passengers were moved by boat from Squamish to North Vancouver on the midnight run and again on the morning run northbound. The slide was expected to be cleared and track repaired by noon on January 24.

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<sup>1</sup> The previous January rain record was 1.38 in. (35.1 mm) set on January 6, 1946 (*Victoria Daily Times*, January 24, 1958).

## **August 1958**

**Event type:** Debris flow.

**Precipitation:** Lois River Dam, 37.6 mm/1 day, August 28, 1958; Hollyburn Ridge, 42.9 mm/1 day, August 28, 1958; Vancouver Harbour CS, 30.5 mm/1 day, August 28, 1958; Mount Seymour, 58.2 mm/1 day, August 28, 1958; West Vancouver, 32.0 mm/1 day, August 28, 1958; West Vancouver Cypress Park, 30.0 mm/1 day, August 28, 1958; West Vancouver Macbeth, 33.5 mm/1 day, August 28, 1958; North Vancouver Mosquito Creek, 36.8 mm/1 day, August 28, 1958; Vancouver International Airport, 16.0 mm/1 day, August 28, 1958; Burnaby Mountain Terminal, 62.0 mm/2 days, August 28-29, 1958; Britannia Beach, 24.4 mm/1 day, August 29, 1958; Buntzen Lake, 31.5 mm/1 day, August 29, 1958.

**Source:** Eisbacher, 1983; Jones, 1959; Evans, 1992 (p. 75); Ward et al., 1992 (p. 356); Clague and Evans, 1994 (p. 8); Egginton, unpublished data, 2004.

**Details:** Following a sudden rainstorm, thousands of yards of tuff breccia debris and logs rushed down the Cheekye River, 5 km north of Squamish.<sup>1</sup> The debris flow built a 15-ft. (4.5 m) high temporary dam across the mouth of the Cheakamus River. According to eyewitnesses, the mudflow moved at 5 mph (8 km/h) near the mouth of the Cheekye. It flowed for several minutes, and appeared to be 10 ft. (3 m) high (Jones, 1959).<sup>2</sup> In discussion mudflows, Jones concluded, “the magnitude and frequency is unpredictable, as their occurrence appears to depend upon sudden abnormal rainstorms rather than upon normal autumn rainfall peaks.” (Ward et al., 1992).

From these scant data, it is estimated that the debris lobe had a total volume of 50,000-100,000 m<sup>3</sup> (Eisbacher, 1983). The source material consisted of Quaternary volcanic rocks (Clague and Evans, 1994). Debris floods buried tracts of forest on the floor of Cheakamus Valley up to 3.5 km below Rubble Creek. Numerous rooted stumps of trees killed by these floods are still visible in the banks of the river (Evans, 1992).

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<sup>1</sup> Somewhat significant precipitation occurred between August 3-6. However, heavier rainfall was recorded between August 28-31, with August 28 having the highest total daily rainfall overall (Egginton, unpublished data, 2004).

<sup>2</sup> According to accounts by local residents, an even larger flow occurred about 30 years prior to 1958 (Jones, 1959). Both flows were of the order of 100,000 m<sup>3</sup>.

### **October 11-12, 1958**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport, 65.6 mm/3 days, October 9-11, 1958; Britannia Beach, 118.6 mm/3 days, October 10-12, 1958; Squamish, not available.

**Source:** *The Province*, October 14, 1958.

**Details:** Around October 11-12, heavy rainfall was experienced on the North Shore.

Squamish River spilled over its banks, flooding the road into the Squamish Valley up to 5 ft. (1.5 m) high. As a precaution, two families in the valley were evacuated. The rain gouged out huge potholes in the Squamish Highway, north of Britannia Beach and the southern section around Horseshoe Bay.

### **November 30-December 1, 1958**

**Event type:** Debris slide.

**Precipitation:** Vancouver International Airport, 39.9 mm/1 day, November 30, 1958; Britannia Beach, 128.2 mm/2 days, November 30-December 1, 1958; Squamish, not available.

**Source:** *Victoria Daily Times*, December 1, 1958; *The Province*, December 2, 1958.

**Details:** Around November 30-December 1, heavy rain brought 15 ft. (4.5 m) of mud, rocks and gravel down on a section of the Seaview Highway, 10.5 mi. (16.8 km) north of Horseshoe Bay. The slide was about 100 ft. (30 m) wide and 10 ft. (3 m) deep. Public Works crews built a temporary road over the slide. A second slide nearby, which came down on December 1 at 3 p.m., was cleared without difficulty. A PGE bridge over a creek at Mile 18, 6 mi. (9.6 km) north of Horseshoe Bay, was damaged. Logs and debris piled up and some of the road bank was torn out. As a safety measure, passengers were bussed to Vancouver; the bridge was repaired with traffic resuming late on December 1.

### **April 29, 1959**

**Event type:** Debris slide.

**Precipitation:** Alta Lake, 118.0 mm/3 days, April 27-29, 1959; Garibaldi, 93.7 mm/3 days, April 27-29, 1959; Britannia Beach, 180.1 mm/3 days, April 27-29, 1959; Tunnel Camp, 174.8 mm/3 days, April 27-29, 1959; Pemberton Meadows, 42.9 mm/3 days, April 27-29, 1959; Clowhom Falls, 136.8 mm/3 days, April 27-29, 1959; Alta Lake, 53.8 mm/1 day, April 28, 1958; Garibaldi, 41.9 mm/1 day, April 28, 1958; Britannia Beach, 86.6 mm/1 day, April 28, 1958; Tunnel Camp, 93.5 mm/1 day, April 28, 1958; Clowhom Falls, 88.1 mm/1 day, April 28, 1958.

**Source:** *The Sun*, April 30, 1959.

**Details:** A rock and mudslide struck a moving PGE combined passenger and freight train near Pemberton. The slide hit the train behind the engine, derailing six freight cars. The two passenger coaches at the rear of the train stayed on the tracks. No injuries were reported.

### **Early 1960s**

**Event type:** Flooding.

**Precipitation:** Not available.

**Source:** Thurber Consultants, 1983 (p. 3, Table 2.1).

**Details:** In the early 1960s, flood events occurred on Kallahne and Daisy creeks.

### **January 24-27, 1960**

**Event type:** Flooding and rock slide.

**Precipitation:** Hollyburn Ridge, 104.4 mm/6 days, January 22-27, 1960; Hollyburn Ridge, 53.3 mm/1 day, January 24, 1960; Britannia Beach, 20.6 mm/1 day, January 26, 1960; Tunnel Camp, 17.0 mm/1 day, January 26, 1960; Squamish, 5.8 mm/1 day, January 26, 1960.

**Source:** *The Province*, April 25 and 28, 1960.

**Details:** On January 24, heavy rain and melting snow caused flooding and washouts. On that date, a broken waterline at Britannia weakened 300 ft. (90 m) of PGE roadbed. Then southbound passengers were bussed to North Vancouver.

On January 27, a 100-ft. (30 m) section of cliff came down onto the Squamish Highway and the PGE rail line near Porteau. The slide, 15 ft. (4.5 m) deep and 150 ft. (45 m) wide, was in the same area as the slide that delayed the inaugural train in 1956. The operator of a loading machine working on the highway had to run for his life as the “truck-size” boulders hurtled down, pushing the machine near the road edge. Officials estimated it would be till late the next day before road and rail traffic would be able to resume. Engineers blamed the slide on frost penetrating the rock.

### **March 24, 1960**

**Event type:** Rock slide.

**Precipitation:** Britannia Beach, 0.0 mm/1 day, March 24, 1960; Squamish, 0.0 mm/1 day, March 24, 1960; Vancouver International Airport, 0.0 mm/1 day, March 24, 1960.

**Source:** *The Vancouver Sun*, March 24, 1960.

**Details:** Early on March 24, a rock slide blocked both the Seaview Highway and the PGE line near Porteau, 15 mi. (24 km) north of Horseshoe Bay. Public Works officials estimated it would take 24 hours to blast the 8,000 tons of boulders.

### **Fall 1960**

**Event type:** Flooding.

**Precipitation:** Not available.

**Source:** Thurber Consultants, 1983 (p. 3, Table 2.1).

**Details:** In the fall of 1960, a flood event occurred on Magnesia Creek.

### **January 8-17, 1961**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport, 126.0 mm/10 days, January 8-17, 1961; Vancouver Harbour CS, 280.7 mm/10 days, January 8-17, 1961; Hollyburn Ridge, 497.5 mm/10 days, January 8-17, 1961; Squamish, 331.4 mm/10 days, January 8-17, 1961; Buntzen Lake, 482.1 mm/10 days, January 8-17, 1961; Seymour Falls, 797.6 mm/10 days, January 8-17, 1961; Hope A 241.3 mm/10 days, January 8-17, 1961; Britannia Beach, 278.5 mm/10 days, January 8-17, 1961; Tunnel Camp, 330.8 mm/10 days, January 8-17, 1961; Woodfibre, 557.4 mm/10 days, January 8-17, 1961; Haney East, 238.2 mm/10 days, January 8-17, 1961; Cheekye, 422.4 mm/10 days, January 8-17, 1961; Tunnel Camp, 60.5 mm/1 day, January 9, 1961; Britannia Beach, 69.6 mm/1 day, January 10, 1961; Haney East, 79.5 mm/1 day, January 10, 1961; Vancouver International

Airport, 42.9 mm/1 day, January 10, 1961; Vancouver Harbour CS, 101.3 mm/1 day, January 10, 1961; Hollyburn Ridge, 162.1 mm/1 day, January 14, 1961; Seymour Falls, 314.2 mm/1 day, January 14, 1961; Squamish, 85.9 mm/1 day, January 14, 1961; Woodfibre, 197.1 mm/1 day, January 14, 1961; Cheekye, 137.4 mm/1 day, January 14, 1961; Buntzen Lake, 225.8 mm/1 day, January 15, 1961; Hope A, 91.7 mm/1 day, January 15, 1961.

**Source:** *The Vancouver Sun*, January 10, 11, 13, 16 and 17, 1961; April 22, 1961; *The Province*, January 16 and 17, 1961; *The Nanaimo Daily Free Press*, January 16, 1961; February 2, 1961; *The Daily Colonist*, January 18, 1961; *Victoria Daily Times*, January 18, 1961; *Prince Rupert Daily News*, January 11, 16, 18 and 19, 1961; *Ocean Falls Advertiser*, January 23, 1961; *West Coast Advocate*, January 19 and 26, 1961; *Times Colonist*, January 25, 1982; Pollock 1975; Egginton, unpublished data, 2004.

**Details:** Between January 8-10, the Lower Mainland was hit by three days of torrential rains. Very heavy rains were recorded and daily temperatures were several degrees above normal.

There were two peak precipitation periods, the first around January 10 and the second around January 14.<sup>1</sup> The heavy rain, which started at 10 p.m. on January 9, caused widespread flooding. Unseasonably mild weather with temperatures reaching as high as 54°F (12.2°C) and nearly a week of heavy rains cut road and rail links. On January 10, hardest hit was the North Vancouver district.

On January 17, still 7 ft. (2.1 m) of water was passing over the Cleveland Dam. Cheekye Bridge, 8 mi. (12.8 km) north of Squamish was expected to reopen allowing eight evacuated families to return to Brackendale First Nations Reserve.

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<sup>1</sup> January 1961 was one of the wettest and warmest January's on some station's records. It was the wettest January at Seymour Falls in its 1927-2002 record, the second wettest in Woodfibre's 1960-2003 record and Squamish's 1959-1996 record, the fourth wettest in Hollyburn Ridge's 1954-1995 record and Vancouver Harbour CS's 1925-2002 record, and the fifth wettest at Britannia Beach in its 1913-2000 record. Squamish and Britannia Beach both recorded their second warmest January's in 1961 (Egginton, unpublished data, 2004).

## **October 11-13, 1962**

**Event type:** Flooding; Debris flow.

**Precipitation:** Buntzen Lake, 125.7 mm/1 day, October 8, 1962; Seymour Falls, 183.9 mm/3 days, October 11-13, 1962; Woodfibre, 83.3 mm/3 days, October 11-13, 1962; Britannia Beach, 90.0 mm/3 days, October 11-13, 1962; Vancouver International Airport, 15.0 mm/1 day, October 12, 1962; Squamish, 53.6 mm/1 day, October 12, 1962; Seymour Falls, 119.1 mm/1 day, October 12, 1962; Woodfibre, 83.3 mm/1 day, October 12, 1962; West Vancouver Copper Cove, 29.2 mm/1 day, October 12, 1962; Britannia Beach, 49.8 mm/1 day, October 12, 1962.

**Source:** *The Vancouver Province*, October 15, 1962; *The Daily Colonist*, October 13 and 14, 1962; *The Vancouver Sun*, December 31, 1996; *Times Colonist*, July 17, 2000; Lewis and Moran, 1985 (p. 5.50); Thurber Consultants, 1983 (Appendix B); Egginton, unpublished data, 2004.

**Details:** In October, the Pacific Coast from northern California to British Columbia was hit by the worst storm in recorded history. Between October 11-13, two very severe storms struck the coast from California to southern British Columbia in rapid succession. The first

storm caused severe damage in the Vancouver-Victoria area with power blackouts and uprooted trees (Lewis and Moran, 1985). The second storm, nicknamed “Columbus Day Windstorm,” was one of the most destructive ever recorded in the Pacific Northwest. The storm, an extra tropical continuation of typhoon “Freda” left 48 people dead and caused \$110 million in 2000-dollars (*Times Colonist*, July 17, 2000). The storm struck southwestern British Columbia just after midnight on October 13, after a day in which gale-force winds had already battered the region.

The majority of the storm damage was most likely caused by severe winds. However, heavy rains were also apparent in the climate data. At the Vancouver International Airport, the precipitation on October 12 was only 15.0 mm, but wind gusts were very significant at 89-126 km/h from the east to southeast direction for the period of October 11-13. (Egginton, unpublished data, 2004).

On October 12, the remnant caused high runoff and high-level snowmelt. In the Howe Sound area, a flood on Magnesia Creek generated a small debris torrent [debris flow] in the lower course.<sup>1</sup> A logjam swept down the rain swollen creek caused a flood at Brunswick Beach, 7 mi. (11.2 km) north of Horseshoe Bay. Trees swept into the creek joined with timber from a logging camp had formed the logjam. The storm only lasted four hours, from 11 a.m. to 3 p.m. The creek went up and down very quickly before and after. According to local resident Merna Gates, it was the “worst event since she had come to the area in 1938.” (Gates interview, 1982 In: Thurber Consultants, 1983). The PGE railway bridge and wooden trestles for the highway and a logging road were all washed out. The torrent piled up tons of debris in front of some houses and pushed one house off its foundation (Thurber Consultants, 1983). Cottages on the south side of the creek flooded.

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<sup>1</sup> A BC Rail drawing of Magnesia Creek (drawing R1-12519) indicates that the creek is subject to flash floods and that the original bridge was washed out in 1962 (Thurber Consultants, 1983).

## **November 19-20, 1962**

**Event type:** Rock slides.

**Precipitation:** Hollyburn Ridge, 140.5 mm/2 days, November 18-19, 1962; Squamish, 106.4 mm/2 days, November 18-19, 1962; Tunnel Camp, 94.2 mm/2 days, November 18-19, 1962; Woodfibre, 137.7 mm/2 days, November 18-19, 1962; Buntzen Lake, 197.6 mm/2 days, November 18-19, 1962; Britannia Beach, 96.8 mm/2 days, November 18-19, 1962; Anvil Island, 93.3 mm/2 days, November 18-19, 1962; Seymour Falls, 158.5 mm/2 days, November 18-19, 1962.

**Source:** *The Vancouver Sun*, November 20, 1962; *The Province*, November 20 and 21, 1962; *The Daily Free Press*, November 20 and 21, 1962; Egginton, unpublished data, 2004.

**Details:** On November 19, heavy wind and runoff from rain and melting snow cut several British Columbia road links.<sup>1</sup> “Tons of rock and mud cascaded down” on the Seaview Highway between Vancouver-Squamish and also blocked the PGE line. At Porteau, the highway had 30,000-40,000 yd.<sup>3</sup> (23,000-30,500 m<sup>3</sup>) of fill washed away. Repair crews worked through the night to get one traffic lane in service.

Overnight November 19-20, the PGE rail line, which follows the road several hundred feet below it, was closed. Crews working all day cleared the rail line by 2 a.m. on November 20. Numerous mud and rock slides blocked the line. On November 19, the PGE had a minor washout and debris on the track near Brunswick Beach. That night, southbound

passengers were transferred at Brunswick to a bus for North Vancouver. PGE officials hoped to the line repaired early on November 20.

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1 Heavy wind and rain were thought to contribute to melting snow and various landslides. The Vancouver International Airport did not record significant rainfall; however, maximum wind gusts were 68 km/h from the south on November 19 and 43 km/h from the west on November 20. Daily temperatures were a few degrees above normal as well. Daily temperatures at Hollyburn Ridge, Squamish, and Britannia Beach were a couple to several degrees above normal. Tunnel Camp and Britannia Beach experienced the second wettest November on their 1924-1974 and 1913-2000 respective records. (Egginton, unpublished data, 2004).

### **October 21, 1963**

**Event type:** Rock slide.

**Precipitation:** Britannia Beach, 101.4 mm/2 days, October 20-21, 1963; Tunnel Camp, 169.5 mm/2 days, October 20-21, 1963; Hollyburn Ridge, 142.7 mm/2 days, October 20-21, 1963; Vancouver International Airport, 54.6 mm/2 days, October 20-21, 1963.

**Source:** *The Vancouver Sun*, October 21 and 25, 1963.

**Details:** On October 21, heavy rain and high winds battered the Howe Sound area. At about 1:20 a.m., a rock slide near Mile 20 about 3 mi. (4.8 km) south of Britannia Beach caused a PGE train to derail. Six diesel-electric units and the first eight car of the 109-car northbound freight train left the track. They crashed down a steep slope but stopped short of toppling into Howe Sound. Several other boxcars also fell over on their sides. The track was badly damaged in the derailment. The train's 43-year old conductor died three days later of injuries received in the accident. The train engineer and fireman escaped with minor injuries (*The Vancouver Sun*, October 25, 1963).

### **December 23, 1963**

**Event type:** Flooding.

**Precipitation:** Squamish, 221.5 mm/4 days, December 21-24, 1963; Squamish, 111.8 mm/1 day, December 22, 1963; Britannia Beach, 104.6 mm/1 day, December 22, 1963; Vancouver International Airport, 76.7 mm/2 days, December 22-23, 1963; Britannia Beach, 213.9 mm/3 days, December 22-24, 1963.

**Source:** *The Vancouver Sun*, December 23 and 24, 1963; *The Province*, December 24, 1963; British Columbia Ministry of Environment, 1975.

**Details:** On December 22-23, torrential rains and melting snow caused flooding in Britannia Beach. Streets and lawns were inundated with water up to 6 ft. (1.8 m) deep. On December 22, seven families were evacuated and the highway at Britannia Beach was washed out. This was the fourth flood in three years (British Columbia Ministry of Environment 1975). Homes and a medical centre were flooded. Twelve families were forced to leave their homes. All services, including flooded water mains and severed roads were restored for Christmas.

Around 4 a.m. on December 23, floodwaters began spilling their banks. By 10 a.m., the water had risen so high to make evacuations necessary. Seven families were evacuated from homes "clustered in a small hollow" near the medical building alongside the Squamish highway. Twenty people were rescued in rowboats. One woman said that when she was taken from her house, the Christmas tree and presents were floating in her

living room. The male population of the community was called out to fight the rising waters of Britannia Creek.

By early afternoon, the highway north of Britannia Beach was flooded closing all traffic. Five of the houses sustained serious water damage. Four floods had hit this area in just over one year. Local resident Gus Manson, who in an earlier flood lost his car, claimed that the culverts under the highway were too small.

### **March 1964**

**Event type:** Rock slide.

**Precipitation:** Not available.

**Source:** *The Vancouver Sun*, October 26, 1990.

**Details:** In March, tons of rock came down onto Highway 99, narrowly missing six motorists.

### **November 26, 1964**

**Event type:** Rock slide

**Precipitation:** Hollyburn Ridge, 91.9 mm/2 days, November 22-23, 1964; Port Mellon, 79.0 mm/1 day, November 23, 1964; Squamish, 67.1 mm/1 day, November 23, 1964; Woodfibre, 72.4 mm/1 day, November 23, 1964; Hollyburn Ridge, 19.1 cm snow/1 day, November 25, 1964; Gambier Harbour, 14.2 mm/1 day, November 25, 1964; Port Mellon, 23.1 mm/1 day, November 25, 1964; Squamish, 13.5 mm/1 day, November 25, 1964; Woodfibre, 12.7 mm/1 day, November 25, 1964.

**Source:** *The Vancouver Sun*, November 26, 1964; *The New Westminster Columbian*, November 26, 1964; *The Province*, November 27, 1964; Nasmith, 1972 (pp. 6-7); Eisbacher, 1983 (p. 22); Egginton, unpublished data, 2004; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 26 at 3 a.m., a rock slide with rocks 16 ft. (4.8 m) in diameter came down near Porteau Cove covering 350 ft. (105 m) of highway and railway tracks. Several thousand cubic metres of rock slid from the Porteau Cove cut, 10 km north of Lions Bay, onto Highway 99 (Eisbacher, 1983). However, according to the rock fall notification summary, 1,000 m<sup>3</sup> of rock came down at 25.3 km. The rock slide closed the West Vancouver-Squamish Highway and the PGE rail line for 18 hours.

At the location of the slide, both the road and rail line follow the shoreline contour of Howe Sound. Thawing immediately preceded by heavy rains along Howe Sound were blamed for the slide. The slide occurred along pre-existing joint surfaces with no fresh breaks in the rock (Nasmith, 1972)<sup>1</sup>.

There had been some significant rainfall prior to the event on November 23 with amounts of 91.9 mm at Hollyburn Ridge (including November 22), 79.0 mm at Port Mellon, 67.1 mm at Squamish, and 72.4 mm at Woodfibre (Egginton, unpublished data, 2004).

At 2:45 a.m., a loaded northbound freight train preceded by a patrol speeder had passed the area. According to a highways department official, the highway was expected to reopen to one-lane traffic on the afternoon on November 26. PGE hoped to clear its tracks by the evening of the same day.

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<sup>1</sup> Slides in the same area closed the highway for four days in February-March 1969. At Porteau, well-developed joints in a near vertical cliff of quartz diorite strike parallel with the highway and dip westerly toward

the road at approximately 50 degrees. The main joints are spaced 3-25 ft. (0.9-7.5 m) apart and a secondary widely spaced set trends east west, dipping vertically. Road construction undercut the toe of the steeply dipping joints causing slides (Nasmith, 1972).

### **November 20, 1966**

**Event type:** Rock slide.

**Precipitation:** Alta Lake, 11.7 mm/1 day, November 19, 1966; Tunnel Camp, 56.3 mm/2 days, November 19-20, 1966; Port Mellon, 12.7 mm/1 day, November 20, 1966; Hollyburn Ridge, 18.5 mm/1 day, November 20, 1966; Hollyburn Ridge, 9.7 cm snow/1 day, November 22, 1966; Port Mellon, 54.4 mm/1 day, November 24, 1966; Squamish, 44.5 mm/1 day, November 24, 1966; Hollyburn Ridge, 78.7 mm/1 day, November 24, 1966; Tunnel Camp, 44.2 mm/1 day, November 24, 1966; Alta Lake, 30.5 mm/1 day, November 24, 1966; Britannia Beach, 50.5 mm/1 day, November 24, 1966. (Between November 20-25, Hollyburn Ridge, Squamish and Britannia Beach all had daily temperatures a few degrees above normal.)

**Source:** *Victoria Daily Times*, November 25, 1966; *The Vancouver Sun*, November 21 and 26, 1966.

**Details:** On November 20, a self-propelled PGE passenger car derailed about 4 mi. (6.4 km) south of Pemberton after hitting rock fallen on the tracks. The train was delayed for two hours between 7-9 p.m.

### **November 25, 1966**

**Event type:** Rock slides.

**Precipitation:** Alta Lake, 11.7 mm/1 day, November 19, 1966; Tunnel Camp, 56.3 mm/2 days, November 19-20, 1966; Port Mellon, 12.7 mm/1 day, November 20, 1966; Hollyburn Ridge, 18.5 mm/1 day, November 20, 1966; Hollyburn Ridge, 9.7 cm snow/1 day, November 22, 1966; Port Mellon, 54.4 mm/1 day, November 24, 1966; Squamish, 44.5 mm/1 day, November 24, 1966; Hollyburn Ridge, 78.7 mm/1 day, November 24, 1966; Tunnel Camp, 44.2 mm/1 day, November 24, 1966; Alta Lake, 30.5 mm/1 day, November 24, 1966; Britannia Beach, 50.5 mm/1 day, November 24, 1966. (Between November 20-25, Hollyburn Ridge, Squamish and Britannia Beach all had daily temperatures a few degrees above normal.)

**Source:** *Victoria Daily Times*, November 25, 1966; *The Vancouver Sun*, November 21 and 26, 1966.

**Details:** Early on November 25, rock slides blocked the PGE line between Horseshoe Bay and Squamish. Heavy rain caused an earth and rock slide onto the rail line near Porteau. A short time later, it was followed by a second slide at the same spot. About 300 ft. (90 m) of track was reported covered. Passengers were taken around the slide by bus. Railway authorities hoped to have the line restored at 6 p.m. that same day.

### **October 30-November 1, 1967**

**Event type:** Flooding

**Precipitation:** Britannia Beach, 91.2 mm/2 days, October 29-30, 1967; Alta Lake, 38.1 mm/1 day, October 30, 1967; Garibaldi, 40.4 mm/1 day, October 30, 1967; Lytton, 22.1 mm/1 day, October 31, 1967.

**Source:** *The Vancouver Sun*, October 31; November 1, 4 and 6, 1967; *The Province*, November 1, 1967.

**Details:** On October 31, record rainfalls and abnormally warm weather caused widespread flooding. The freezing level was between 8,000-10,000 ft. (2,400-3,000 m) and none of the precipitation fell as snow at higher levels. The downpour followed days of heavy rain, which undermined already sodden hillsides.<sup>1</sup> Rail and highway links were severed by washouts.

At Britannia Beach, floodwaters swept away the water main supplying the town when Britannia Creek spilled over its banks, cut a new channel down the mountain, and poured through the village. The flood all but destroyed the home of the Brazeau family. Floors were covered with 3 ft. (90 cm) of mud and all the furniture ruined. One other house (belonging to Ulrich Buthghe) was damaged and the townsite was covered with 6 in. (15 cm) of mud. At flood height, the six-room elementary school and more than 30 homes were evacuated. The school's six teachers and 172 pupils were evacuated when floodwaters began to undermine a 36-in. (90 cm) pipeline that carries water to a power generator. At one time, it was feared that a high-pressure water pipeline above the six-room Britannia Beach elementary school would burst. Basements were flooded up to 5 ft. (1.5 m). At one point, 2 ft. (60 cm) of water covered the Squamish Highway. Operations at the Anaconda Company (Canada) Ltd. plant were suspended. Employees were put to work shoring up the creek banks. By noon, floodwaters were receding.<sup>2</sup>

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<sup>1</sup> Rainfall at the Vancouver airport in October totalled 11.26 in. (286.0 mm), 0.16 in. (4.1 mm) above the record set in November 1954 (*The Vancouver Sun*).

<sup>2</sup> The flooding came three days after the 46<sup>th</sup> anniversary of the disastrous 1921 flood that took 37 lives and destroyed half the homes in the village of Britannia Beach.

## **January 12-20, 1968**

**Event type:** Flooding.

**Precipitation:** Alta Lake, 61.0 cm snow/1 day, January 12, 1968; Vancouver International Airport, 184.2 mm/9 days, January 12-20, 1968; Britannia Beach, 382.1 mm/9 days, January 12-20, 1968; Squamish, 362.6 mm/9 days, January 12-20, 1968; Alta Lake, 233.8 mm/9 days, January 12-20, 1968; Garibaldi, 341.3 mm/9 days, January 12-20, 1968; Chilliwack, 256.5 mm/9 days, January 12-20, 1968; Garibaldi, 74.2 mm/1 day, January 13, 1968; Britannia Beach, 104.6 mm + 3.8 cm snow/1 day, January 18, 1968; Squamish, 100.3 mm/1 day, January 18, 1968; Chilliwack, 93.2 mm/1 day, January 18, 1968.

**Source:** *The Province*, January 15, 1968; *The Vancouver Sun*, January 15, 1968; *The Daily News*, January 22, 23 and 24, 1968; Egginton, unpublished data, 2004.

**Details:** On January 13, a moist southwest flow caused temperatures in Vancouver to soar to 56°F (13.3°C). At the Vancouver International Airport and Alta Lake, daily mean temperatures were up to 8°C above normal. At Britannia Beach and Squamish, temperatures were up to 6°C and approximately 4°C above normal, respectively (Egginton, unpublished data, 2004).

On January 14, the sudden thaw in nearly all parts of British Columbia caused flooding and snowslides. A band of moisture brought more than 48 hours of continuous rain. Freezing levels went as high as 4,000 ft. (1,200 m) causing snow to melt at lower elevations. On January 12-13, Chilliwack had recorded 2.97 in. (75.4 mm) of rain, including 1 in. (2.5 cm) of snow.

On the afternoon of January 14, a section of Highway 99 between Whistler Mountain and Pemberton closed after 3.5 ft. (1.05 m) of water flooded the road near Tisdall. The Pemberton Highway was closed at the junction with Highway 99 where a quarter mile (400 m) was under 4 ft. (1.2 m) of water. On the outskirts of Pemberton, floodwaters caused the evacuation of the residents of two houses.

### **September 16-17, 1968**

**Event type:** Flooding.

**Precipitation:** Seymour Falls, 119.9 mm/1 day, September 16, 1968; Hollyburn Ridge, 137.2 mm/1 day, September 16, 1968; Tunnel Camp, 67.8 mm/1 day, September 16, 1968; North Vancouver Cleveland, 128.5 mm/1 day, September 16, 1968; Squamish, 61.7 mm/1 day, September 16, 1968; Vancouver International Airport, 38.6 mm/2 days, September 16-17, 1968; Britannia Beach, 70.9 mm/2 days, September 16-17, 1968.

**Source:** *The Province*, September 17, 1968; *The Vancouver Sun*, September 17, 1968.

**Details:** Overnight September 16-17, heavy rain occurred in the Lower Mainland. Worst hit was the North Shore, where a gauge at Cleveland Dam recorded 4.09 in. (103.9 mm) of rain in 24 hours. During the same period, 3.09 in. (78.5 mm) was reported from Mount Seymour. The Vancouver International Airport recorded 1.52 in. (38.6 mm).<sup>1</sup>

The Squamish Highway was washed out 2.5 mi. (4 km) south of Squamish. The area was still under construction. On September 16, the rains washed out a temporary road and culvert built around the bridge. Traffic was delayed for up to two hours. Shortly after 9 p.m., the road was open again.

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<sup>1</sup> The September record is 2.2 in. (55.9 mm), set in 1959 with 2.45 in. (62.2 mm) recorded in New Westminster (*The Vancouver Sun*).

### **October 23, 1968**

**Event type:** Flooding.

**Precipitation:** Britannia Beach, 71.6 mm/1 day, October 23, 1968; Squamish, 78.0 mm/1 day, October 23, 1968; Tunnel Camp, 67.6 mm/1 day, October 23, 1968.<sup>1</sup>

**Source:** *The Province*, October 24, 1968; *The Vancouver Sun*, October 24, 1968; Egginton, unpublished data, 2004.

**Details:** On October 23 at about 5:30 p.m., Stoney Creek spilled its banks, flooding and washing out a section of the Squamish Highway and PGE track 2.5 mi. (4 km) south of Squamish. About 30 ft. (9 m) of rail track was washed out. The highway and rail line were closed. While train traffic was temporarily halted, passengers were transferred around the washout. By noon next day, the rail line was back in service. The highway was expected to reopen around noon on October 24, more than 17 hours after it was washed out.

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<sup>1</sup> Britannia Beach and Squamish had their fourth wettest October on their 1913-2000 and 1959-1996 respective records. It was the fifth wettest October on the 1924-1974 record for Tunnel Camp (Egginton, unpublished data, 2004).

### **October 29, 1968**

**Event type:** Flooding.

**Precipitation:**

**Source:** *The Vancouver Sun*, October 30, 1968.

**Details:** On October 29, a washout 7 mi. (11.2 km) south of Pemberton closed Highway 99. Repairs were expected to be completed later that day.

### **December 30, 1968-January 1, 1969**

**Event type:** Snow avalanches.

**Precipitation:** Garibaldi, 55.4 cm snow/3 days, December 30, 1968-January 1, 1969; Squamish, 50.3 cm snow/3 days, December 30, 1968-January 1, 1969; Alta Lake, 56.2 cm snow/2 days, December 31, 1968-January 1, 1969; Daisy Lake Dam, 50.8 cm snow/2 days, December 31, 1968-January 1, 1969; Vancouver International Airport, 31.2 cm snow/1 day, December 31, 1968; Vancouver International Airport, 9.4 mm/1 day, January 1, 1969.

**Source:** *The Sun*, January 2, 1969.

**Details:** Between December 31-January 1, snowfall was reported in the Sea to Sky Corridor. On January 1, snow at the Vancouver International Airport turned into rain. Following the snowfall in the morning of December 31, the hourly observations reported freezing rain and drizzle, which continued into the morning of January 1.

On January 1, four persons were rescued unharmed after their car was buried under 10 ft. (3 m) of snow of one of three snowslides that came down onto Highway 99 in Cheakamus Canyon. A highways department grader operator and drivers of other cars that were missed by the snow rescued them in a matter of minutes. At 9 p.m., the Pemberton-Squamish highway was closed after snow slides blocked more than 400 ft. (120 m) of highway. Crews worked throughout the night in gale-force winds in a clearing operation. On January 2 at 10 a.m., the highway reopened to one-lane traffic.

### **February 7-9, 1969**

**Event type:** Rock slides.

**Precipitation:** Squamish, 54.9 mm/2 days, February 7-8, 1969; Britannia Beach, 69.1 mm/3 days, February 7-9, 1969; Tunnel Camp, 139.5 mm/3 days, February 7-9, 1969; Hollyburn Ridge, 69.3 mm/3 days, February 7-9, 1969; Port Mellon, 81.6 mm/3 days, February 7-9, 1969; Garibaldi, 96.7 mm/3 days, February 7-9, 1969. (All amounts are mixed rain and snow water equivalent.)

**Source:** *The Vancouver Sun*, February 8 and 10, 1969; March 5, 1969; *The Daily News*, February 10, 1969; *Citizen Shopper*, January 22, 1981; Nasmith, 1972 (pp. 6-7); Eisbacher, 1983 (p. 22); Egginton, unpublished data, 2004.

**Details:** On February 9, freeze-thaw conditions caused a rock fall along Highway 99 near Porteau Cove, 10 km north of Lions Bay. A slab of rock landed on a moving car. The 1-ton boulder, measuring 4.5 ft. (1.35 m) tumbled 80 ft. (24 m) down killing three people.<sup>1</sup> The highway from Lions Bay to Britannia Beach, which was partially blocked, was closed.

The heavy precipitation in the Porteau Cove area included significant amounts of both rain and snow. Similar conditions seem to have continued for the next several days with daily temperatures fluctuating between several degrees above and below zero with periods of rain and snow. This would cause the snowpack to be very heavy and thus creating conditions vulnerable to slope failure (Egginton, unpublished data, 2004).<sup>2</sup>

Snowslides also closed the Cheakamus Canyon on the Squamish-Pemberton highway north of Alice Lake. Several cars were trapped in the canyon slides. According to

Mount Whistler Lodge manager Harry Wiese, on February 7 and 8, snowslides prevented skiers getting to the mountain.<sup>3</sup>

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<sup>1</sup> This was the first fatal rock fall in eight years.

<sup>2</sup> Due to repeated freeze-thaw cycles other slides occurred at the same location on February 17 and March 4 (Eisbacher, 1983). Thawing immediately preceded by heavy rain were blamed for the slides. They occurred along pre-existing joint surfaces and no fresh breaks in the rock occurred (Nasmith, 1972).

<sup>3</sup> In January 1981, after years of pressure from municipal governments, Chambers of Commerce, and private citizens of Pemberton, Squamish and Whistler, Highways Minister Alex Fraser and MLA Allan Williams announced a \$5.5 million plan for the reconstruction of 2.45 km of Highway 99 through Cheakamus Canyon. The plan involved the removal of an estimated 311,000 yd.<sup>3</sup> (237,790 m<sup>3</sup>) of rock, some river diversion as well as the usual upgrading, paving, shouldering, and draining (*Citizen Shopper*, January 22, 1981).

### **February 13-17, 1969**

**Event type:** Rock slides.

**Precipitation:** Squamish, 54.9 mm/2 days, February 7-8, 1969; Britannia Beach, 69.1 mm/3 days, February 7-9, 1969; Tunnel Camp, 139.5 mm/3 days, February 7-9, 1969; Hollyburn Ridge, 69.3 mm/3 days, February 7-9, 1969; Port Mellon, 81.6 mm/3 days, February 7-9, 1969; Garibaldi, 96.7 mm/3 days, February 7-9, 1969. (All amounts are mixed rain and snow water equivalent.)

**Source:** *The Vancouver Sun*, February 8 and 10, 1969; March 5, 1969; *The Daily News*, February 10, 1969; *Citizen Shopper*, January 22, 1981; Nasmith, 1972 (pp. 6-7); Eisbacher, 1983 (p. 22); Egginton, unpublished data, 2004.

**Details:** On February 13, a slide near Brunswick Point, 5 km north of Lions Bay, closed Highway 99. The rock slide had a volume of 6,000 m<sup>3</sup> (Eisbacher, 1983). The massive slide blocked the highway till February 17. Shortly before it was scheduled to be reopened, another rock slide closed the road for two more days (*The Vancouver Sun*, March 5, 1969).

### **March 3-4, 1969**

**Event type:** Rock slide;

**Precipitation:** Britannia Beach, 7.6 mm/2 days, March 3-4, 1969; Tunnel Camp, 25.4 cm snow/1 day, March 4, 1969; Hollyburn Ridge, 38.1 cm snow/1 day, March 4, 1969; Point Atkinson, 25.7 mm/1 day, March 4, 1969; Gambier Harbour, 32.8 mm/1 day, March 4, 1969; Port Mellon, 44.2 mm/1 day, March 4, 1969.

**Source:** *The Vancouver Sun*, March 5, 1969; *The Province*, March 6, 1969.

**Details:** On March 4, heavy rain in the Porteau Cove area caused another rock slide on the Squamish highway. It came down at 8:30 p.m., 1.5 mi. (2.4 km) north of Horseshoe Bay. Some boulders measured up to 10 ft. (3 m) high. As the rocks, mud and trees blocked the highway, a detour had to be built at Porteau Cove.

On March 5, Highways Minister Black said that despite the latest blockage of the road by a rock slide late on March 3, Squamish Highway was safe for traffic. He made the comment on a claim by Squamish Mayor Pat Brennan that the road was unsafe because of the recent slides. The rock fall near Horseshoe Bay had been cleared and the highway would stay open.

## September 16-18, 1969

**Event type:** Debris flow; Flooding.

**Precipitation:** Britannia Beach, 98.8 mm/3 days, September 16-18, 1969; Tunnel Camp, 162.9 mm/3 days, September 16-18, 1969; Hollyburn Ridge, 134.3 mm/3 days, September 16-18, 1969; Gambier Harbour, 86.2 mm/3 days, September 16-18, 1969; Point Atkinson, 55.9 mm/3 days, September 16-18, 1969; Britannia Beach, 64.5 mm/1 day, September 17, 1969; Tunnel Camp, 105.7 mm/1 day, September 17, 1969; Hollyburn Ridge, 58.9 mm/1 day, September 18, 1969.

**Source:** *The Daily News*, September 19, 1969; *The Province*, September 19, 20 and 23, 1969; *The Sunday Sun*, September 20, 1969; *The Burnaby Columbian*, September 18, 19 and 22, 1969; Russell, 1972; Eisbacher, 1983 (p. 19); Jackson et al., 1985 (p. 4-18); Reid, Collins and Associates Limited, 1969; Egginton, unpublished data, 2004.

**Details:** On September 16 and 17, heavy rain caused severe floods on some of the very steep creeks in the Lions Bay area.<sup>1</sup> During the abnormal localized rainstorm, the Squamish highway washed out in two places. In the early morning of September 18, floodwaters cut the Squamish highway in two places and PGE tracks after two bridges were knocked out. Luxury homes in the area were flooded.<sup>2</sup>

On September 18 at 1:45 a.m., a boulder [debris] flow of several thousand cubic metres came down Charles [Strachan-2] Creek, a high-gradient (52%) torrent 4 km north of Horseshoe Bay.<sup>3</sup> The first debris torrent destroyed all four bridges between the highway and the Howe Sound shore. A major debris jam developed behind the highway bridge, causing it to collapse (Jackson et al., 1985). The wooden highway trestle of the bridge over Charles Creek was completely carried away. About 400 yd. (360 m) upstream from the highway, there is a 50-ft. (15 m) waterfall. Downstream of the waterfall, there was evidence of temporary damming due to piling up of debris and riverbed material. The dam, which formed about 200-ft. (60 m) upstream of the waterfall, had been about 20-ft. (6 m) high before bursting.

The other dam, situated just downstream of the waterfall, had been about 10 ft. (3 m) high. The apparent peakflow at the outfall was estimated at 3,000-4,000 cfs (85-113 m<sup>3</sup>/s). Near flood peak, these dams burst and caused washing out the road and railway bridges below (Reid, Collins and Associates Limited, 1969). The torrent also dislodged the 30-ft. (9 m) PGE railroad bridge after sections of the highway bridge above it crashed down the raging creek. The PGE line was expected to reopen on September 19.

Two cars plunged into the gaping hole, but the four occupants survived. One other car and its driver disappeared along this stretch of road, and were presumably carried to sea by the debris flow (Eisbacher, 1983). By September 20, Squamish RCMP had found no trace of the 25-year old West Vancouver man missing since early on September 18, around the time the Charles Creek bridge collapsed.

During the storm of September 18, several other torrents in the area spilled debris into the sea. On September 17, a surge of debris and water on Harvey Creek washed out the water supply intake, and threatened five houses along the creek bed. The creek overtopped its banks in several places below the highway and extensively eroded its banks. The debris flow in Harvey Creek (gradient 23%), near Lions Bay damaged several homes on the delta cone. The debris consisted of trees and boulders derived from a high-level point source in unconsolidated deposits. Some residents of Lions Bay were forced to leave their homes as swollen Harvey Creek threatened to flood them. Early on September

18, Harvey Creek running wild tore 12 ft. (3.6 m) of land from Mrs. Pat Dickson's property and threatened the foundations of her \$50,000 home. A few feet below in an exposed bend directly in the path of the creek, the house of Edward Kurvits was threatened.

Russell (1972) estimated the peak of the debris flow at more than 100 m<sup>3</sup>/s. Very rough estimates from high water marks indicated a peak discharge of about 115 m<sup>3</sup>/s (4,000 cfs) on Harvey Creek and flows of about the same size (110 m<sup>3</sup>/s) on Newman and Charles creeks. However, there was no evidence of unusually high flows in Lone Tree Creek nor the creeks north of Harvey Creek or south of Charles Creek.

According to an editorial, logging seemed directly responsible for the floods [debris flows]. A large clearcut, stretching across most of the catchment area, may have intensified runoff that mobilized the main pulse of debris (Eisbacher, 1983). Before 1968, Lions Bay residents asserted that Harvey Creek rose slowly after heavy rains and the water was mostly clear. However, after logging, the stream rose rapidly after rain and was muddied with debris. Also, creek levels were discernibly lower in mid-summer than they were before (*The Province*, September 23, 1969). Reid, Collins Associated Ltd. (1969) agreed that logging disturbance, bridge construction in the development area and the stream obstruction and deflection were attributed to land slippage in the upper reaches of the drainage. The slippage in the upper reaches and obstruction and deflection in the lower reaches were significant secondary causes (Reid, Collins and Associates Ltd., 1969).

Furthermore, a debris flow at Newman Creek blocked the highway with tons of debris. The highway bridge was buried under 3 m of mud, rock and stumps. Approximately 5,000 yd.<sup>3</sup> (3,825 m<sup>3</sup>) of material was deposited against the bridge. Water gnawed at the lower part of a house and tore away 12-ft. (3.6 m) of land. Above the houses, a new subdivision property, which was to be sold as lots, was partly buried in debris and a water intake pool was wrecked (*The Province*, September 19, 1969). The peakflow at the outfall was estimated at 3,000 cfs (84.9 m<sup>3</sup>/s).

Crews worked 24 hours a day on the bridge replacement at Strachan [Charles]<sup>3</sup> Creek and clearing rubble from Newman Creek bridge. Components for a Bailey bridge at Strachan Creek had to come from all over the province. The Newman Creek bridge was reopened to traffic early on September 19. Highway department officials were hopeful to have the bridge at Strachan Creek replaced and the Squamish highway reopened by September 23.

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1 Record monthly precipitation occurred for September 1969 in the area. Point Atkinson, Gambier Harbour, and Hollyburn Ridge had their wettest September on their 1968-1998, 1962-2002, and 1954-1995, respective records. It was the second wettest September in the 1924-1974 record for Tunnel Camp and the third wettest for Britannia Beach in its 1913-2000 record. (Eginton, unpublished data, 2004).

2 The community of Lions Bay began to be developed in 1957 during construction of Highway 99. Following completion of the railway and highway in 1958, a number of residential subdivisions were built, the principal being the now incorporated Village of Lions Bay (Jackson et al., 1985).

3 Charles Creek is also referred to as Strachan-2 Creek or by local residents as Strachan Creek.

## **January 20-24, 1972**

**Event type:** Snow avalanches.

**Precipitation:** Agassiz CDA, 20.3 cm snow/1 day, January 18, 1972; Squamish FMC Chemicals, 21.6 cm snow/2 days, January 18-19, 1972; Garibaldi, 68.4 cm snow/2 days, January 18-19, 1972; Pemberton BCFS, 61.0 cm snow/2 days, January 18-19, 1972;

Agassiz CDA, 25.7 mm/1 day, January 19, 1972; Alta Lake, 64.3 cm snow/1 day, January 20, 1972; Daisy Lake Dam, 38.1 cm snow + 3.0 mm/1 day, January 20, 1972; Squamish FMC Chemicals, 38.6 mm/2 days, January 20-21, 1972; Daisy Lake Dam, 8.9 mm/1 day, January 23, 1972; Garibaldi, 38.6 cm snow/2 days, January 20-21, 1972; Pemberton BCFS, 83.8 cm snow/2 days, January 20-21, 1972; Alta Lake, 118.1 cm snow/5 days, January 20-24, 1972; Agassiz CDA, 67.9 mm/5 days, January 20-24, 1972; Chilliwack, 95.8 mm/5 days, January 20-24, 1972; Hope A, 39.4 cm snow/1 day, January 20, 1972; Hope A, 58.2 mm/2 days, January 21-22, 1972; Garibaldi, 3.8 mm/1 day, January 22, 1972; Hope A, 24.7 cm snow/2 days, January 23-24, 1972.

**Source:** *The Vancouver Sun*, January 21 and 22, 1972; *The Chilliwack Progress*, January 26, 1972; *Victoria Times*, January 21 and 24, 1972; *The Daily Colonist* January 23, 1972; *The Daily News*, January 25, 1972; *Times Colonist*, October 1, 1986; February 12, 1987; Wilson and Wilson, 1998 (pp. 182-184).

**Details:** On January 20, British Columbia was hit by “one of the worst winter storms in history.” Observational reports state that there was freezing rain the morning of January 21 and heavy snow on January 23. At the Vancouver International Airport, maximum wind gusts were recorded between 32-82 km/h between January 20-24.

The “silver thaw” of 1972 almost hit the same date as the great ice storm of 1935 (January 21 in 1935). Weather conditions created a combined total of 2.5 in. (6.25 cm) of ice during most of January 20. On January 21, *The Vancouver Sun*’s headline read, “Snow storm isolates southern B.C.” It was probably the greatest weather disaster BC Hydro had ever faced. The storm cut off the main power supply to the Lower Mainland and Vancouver Island, causing a critical shortage of electricity. Both the 500,000-V transmission lines from the Peace River power station and the two 360,000-V lines from the Bridge River generating station were knocked out. (Wilson and Wilson, 1998).

The Upper Fraser Valley and Squamish-Pemberton areas were hit by the worst ice storm in at least 20 years. The severe icing, snowslides and fallen trees also closed the Squamish to Pemberton highway. Near Squamish, the 500,000-V Peace River transmission line was damaged.

## **February 19, 1972**

**Event type:** Rock slide.

**Precipitation:** Hollyburn Ridge, 1.3 cm snow + 2.8 mm/1 day, February 19, 1972; Tunnel Camp, 0.5 cm snow + 22.9 mm/1 day, February 19, 1972; Tunnel Camp, 2.5 cm snow + 8.4 mm/1 day, February 21, 1972; Point Atkinson, 6.1 mm/1 day, February 22, 1972; West Vancouver Copper Cove, 11.2 mm/1 day, February 22, 1972; Tunnel Camp, 7.4 mm/1 day, February 22, 1972; Hollyburn Ridge, 5.6 mm + 11.4 cm snow/1 day, February 22, 1972; Gambier Harbour, 5.3 mm/1 day, February 22, 1972.

**Source:** *The Province*, February 24, 1972.

**Details:** On February 19, a freight train derailed at Fisherman’s Cove. Following the derailment the line was cleared. During the night of February 22 at about 11 p.m., a two self-powered unit PGE passenger train were derailed 6 mi. (9.6 km) north of the derailment of February 19. The front wheels of the first unit jumped the tracks after nosing into a slide that had fallen a few minutes previously. A patrol unit, a few minutes ahead of the southbound train, running about two hours late, had passed the spot before

the slide came down. According to a PGE spokesman, it was raining in the area at the time and weather conditions caused the slide.

Following the second derailment in a week, PGE defended its record. The PGE spokesman said that despite its rugged terrain, the railroad still had less frequent derailments than many others did in North America. He reiterated that the PGE had a good track record borne out by the fact that it is insured for only \$100,000 deductible compared to \$1 million for most railroads.

### **July 11-12, 1972**

**Event type:** Debris flow.

**Precipitation:** Britannia Beach, 112.7 mm/2 days, July 11-12, 1972; Vancouver International Airport, 65.0 mm/2 days, July 11-12, 1972.

**Source:** *The Chilliwack Progress*, July 12 and 19, 1972; *The Vancouver Sun*, July 12; October 18, 1972; *The Province*, July 13, 1972; Schaefer and Nikleva, 1973; Eisbacher and Clague, 1981; Eisbacher, 1983 (p. 17).

**Details:** On July 11-12, a freak summer rainstorm dumped more than 95 mm of rain on the slopes of West Vancouver.<sup>1</sup> The storm continued for 30 hours and produced two to three times the average July allotment.

At most stations, rainfall on July 12 exceeded the normal value for the entire month.<sup>2</sup> Storm totals ranged from under 2 in. (50 mm) at Delta Tsawwassen Beach, southwest of Vancouver, to over 10 in. (250 mm) on Hollyburn Ridge. Hollyburn Ridge received the greatest accumulation reported and established a new all-time one-day record of 6.09 in. (154.7 mm). The two-day total of 10.29 in. (261.4 mm) was just short of the record 10.80 in. (274.3 mm) set in November 1955.

The rainstorm caused landslides in the Vancouver region (Eisbacher and Clague, 1981). Early on July 12, a small slide came down 0.5 mi. (800 m) north of Horseshoe Bay on the Squamish Highway, covering part of the road. While it was being cleared, traffic was reduced to one-lane.

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<sup>1</sup> The frontal storm occurred under a strong southwesterly flow of warm moist air. It was associated with a stalled low-pressure zone over the Pacific. A high-altitude zonal flow of westerly winds is quite unusual for this time of the year, often happening in spring and fall. The flow carries weather systems clear across the Pacific from southern Japan.

<sup>2</sup> July 12 was not only the wettest July day on record for many locations, July was the wettest ever (*The Province*, July 13, 1972).

### **November 3 and 7, 1972**

**Event type:** Debris flow; Flooding.

**Precipitation:** Hollyburn Ridge, 51.8 mm/1 day, November 3, 1972; Bowen Island Millers Landing, 26.9 mm/1 day, November 3, 1972; Point Atkinson, 21.3 mm/1 day, November 3, 1972; Gambier Harbour, 22.4 mm/1 day, November 3, 1972; Hollyburn Ridge, 160.3 mm/5 days, November 3-7, 1972; Bowen Island Millers Landing, 94.0 mm/5 days, November 3-7, 1972; Point Atkinson, 58.9 mm/5 days, November 3-7, 1972; Gambier Harbour, 99.1 mm/5 days, November 3-7, 1972. (During this period, the temperatures at Hollyburn Ridge were “a couple” of degrees above normal).

**Source:** *The Vancouver Sun*, November 7 and 8, 1972; *The Province*, November 9, 1972; *Victoria Times*, December 4, 1972; Thurber Consultants, 1983 (Appendix B).

**Details:** On November 3 at 4 a.m., 27 residents in the Charles Creek area were awakened by what was described as a rumble in the creek. It had been raining, but not excessively heavy for the time of year. It was reported that a “slurry mixture of rocks, small boulders, gravel and some logs” collapsed one of the private local bridges across Charles Creek. It was swept downstream to form a blockage against the railway bridge. With the channel blocked, the slurry mixture poured over the railway to a depth of 8 ft. (2.4 m) and partially buried the James residence on the southern part of the fan at the creek mouth in “tons of relatively small material.” The flow was reported to have continued for three or four hours. Above the railway bridge, the creek filled in with bedload material consisting of heavy boulders and gravel (Thurber Consultants, 1983).<sup>1</sup> The creek changed course by flowing over the railway bridge to the left and right of the creek. The James residence had the creek flowing right through the house, piling up gravel and boulders up to the windows. The slide caused about \$8,000 damage to this home, destroying the garage and wrecking two cars.

Flooding also occurred through several properties north of the fan due to blockage. Water flowed mainly into Lot 10, two lots away on the left side of the creek. Water also flowed along the road into Lots 1, 2, 3, 4, 11, 12, 13 and 14.<sup>2</sup> Work crews had the rail line cleared of debris by 2 p.m. on November 4.

On November 7, heavy rains sent Charles Creek on the rampage for a second time in four days. The BC Rail was blocked and homes below the Squamish highway were endangered. Flooding occurred when rocks were wedged under the railway bridge across Charles Creek. The bridge was pushed out 3 or 4 ft. (0.9 or 1.2 m) and rocks were tumbling over the top (*The Sun*; Thurber Consultants, 1983). An access road was washed out and two houses were damaged. The event followed 75 mm of rain in the preceding 48 hours (VanDine, 1985).

Rocks wedging under the railway bridge caused renewed flooding. The railway was cleared on November 8. According to a BC Rail spokesman, the blockage under the railway bridge was compounded by the fact that a private bridge serving the homes was washed down the creek with “tons of mud and debris.” The debris was washed down the creek to the homes below. The spokesman noted that the railway acknowledged responsibility for keeping drainage culverts clear.

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<sup>1</sup> Residents of Strachan (Charles) Creek estimated their property damage up to \$20,000 (*Victoria Times*).

<sup>2</sup> The area was hit by a similar flooding in September 1969, when the Strachan [Charles] Creek bridge, a section of rail track and a rail bridge were washed out.

## **December 15-22, 1972**

**Event type:** Debris flows; Flooding.

**Precipitation:** Bowen Island Millers Landing, 62.7 mm/1 day, December 15, 1972; Pemberton BCFS, 30.5 cm snow/2 days, December 15-16, 1972; Vancouver International Airport, 140.0 mm/8 days, December 15-22, 1972; Point Atkinson, 176.9 mm/8 days, December 15-22, 1972; Hollyburn Ridge, 423.5 mm/8 days, December 15-22, 1972; Bowen Island Millers Landing, 235.4 mm/8 days, December 15-22, 1972; Gambier Harbour, 216.1 mm/8 days, December 15-22, 1972; Squamish FMC Chemicals, 241.4 mm/8 days, December 15-22, 1972; Alta Lake, 120.5 mm/8 days, December 15-22, 1972; Pemberton BCFS, 100.6 mm/8 days, December 15-22, 1972; Vancouver International Airport, 45.5 mm/1 day, December 16, 1972; Point Atkinson, 41.4 mm/1 day, December 16, 1972; Hollyburn Ridge, 97.8 mm/1 day, December 16, 1972; Gambier Harbour, 60.5

mm/1 day, December 16, 1972; Alta Lake, 36.8 cm snow + 5.6 mm/1 day, December 16, 1972; Squamish FMC Chemicals, 83.1 mm/1 day, December 18, 1972. (Temperatures were 4-6°C above normal for the majority of the period beginning December 16.

Temperatures at Pemberton BCFS were 6°C below normal at the start of the event but rose to near 6°C above normal for the majority of the period.)

**Source:** *The Province*, February 13, 1970; *The Vancouver Sun*, December 16 and 18, 1972; *Victoria Times*, December 18, 19 and 22, 1972; Thurber Consultants, 1983 (Appendix B); Church and Miles, 1987 (p. 73).

**Details:** A rainstorm occurred across southern British Columbia towards the end of a two-week warm and very wet period. The heavy precipitation, some of it in snow, caused landslides and extensive flooding of basements in greater Vancouver (Eddy, 1979). Between 4 p.m. on December 15 and 4 a.m. on December 18, Vancouver recorded 2.39 in. (60.7 mm) of rain. Overnight December 15-16 in Vancouver, 1.26 in. (32.0 mm) of rain melted about 6 in. (15 cm) of snow accumulated during the previous 10 days.

On December 15, flooding and debris flows occurred on Harvey Creek in Howe Sound. Debris flows occurred on Harvey and Lawson creeks. The highway was blocked and a house was damaged in Lions Bay (Thurber Consultants, 1983). For this event, the 24-hour precipitation recorded at Hollyburn Ridge was 56 mm, accompanied by a significant snowmelt (Church and Miles, 1987).

### **December 25-26, 1972**

**Event type:** Debris flows and flooding

**Precipitation:** Hollyburn Ridge, 104.1 mm + 11.4 cm snow/1 day, December 25, 1972; Vancouver International Airport, 95.2 mm/2 days, December 25-26, 1972; Bowen Island Millers Landing, 112.8 mm/2 days, December 25-26, 1972; Coquitlam Lake, 115.8 mm/2 days, December 25-26, 1972; Vancouver Harbour CS, 203.2 mm/2 days, December 25-26, 1972; Squamish, 121.9 mm/2 days, December 25-26, 1972; Hollyburn Ridge, 11.4 cm snow + 2.5 mm/1 day, December 26, 1972.

**Source:** *The Vancouver Sun*, December 26, 27 and 28, 1972; *Nanaimo Free Press*, December 27, 1972; *Cowichan Leader*, December 28, 1972; *The Daily News*, December 27, 1972; Jackson et al., 1985 (p. 4-19); Melone, 1985 (p. 57); Thurber Consultants, 1983 (Appendix B).

**Details:** The rainstorm of Christmas Day began in the early morning hours on December 25 and lasted from 23 to 26 hours. The renewed heavy rains shattered records in Victoria and on the Lower Mainland. It broke the 34-year record at the Vancouver International Airport and the 70-year record at Vancouver PMO for the greatest rainfall in a 24 hour floating period, i.e. as measured during any period of 24 consecutive hours.

At Lions Bay, residents and firemen sandbagged a massive slide [debris flow] that sent boulders running down the hillside into the subdivision. Basements of six homes were inundated with mud and rock. A small slide [debris flow] was caused by Daon Development Limited diverting a small section of a former tributary to Harvey Creek (Lions Brook) into Alberta Creek.<sup>1</sup> Some plugging of culverts and localized flooding occurred (Thurber Consultants, 1983).

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<sup>1</sup> There is a prior history of debris torrents [debris flows] in Alberta Creek. Sometime between 1932 and 1939, a debris torrent in the creek ran all the way to Howe Sound (Jackson et al., 1985).

### **May 23-25, 1973**

**Event type:** Flooding and debris flows.

**Precipitation:** Hollyburn Ridge, 71.1 mm/1 day, May 23, 1973; Point Atkinson, 23.4 mm/1 day, May 23, 1973; Tunnel Camp, 89.2 mm/1 day, May 23, 1973; Britannia Beach, 45.0 mm/1 day, May 23, 1973; Gambier Harbour, 26.2 mm/1 day, May 23, 1973.

**Source:** Thurber Consultants, 1983 (Appendix B).

**Details:** On May 23, a heavy rainfall combined with snowmelt resulted in high flows in Harvey Creek. This resulted in erosion of banks and around bridge footings. Near the Korol residence, Lot 33 Cloudview Place, local overtopping occurred. Opposite the Anderson residence, Lot 17 Seaview Place, it also caused a landslide. This slide undermined a house, necessitating its owner to relocate the house and protect the slope (Thurber Consultants 1983).<sup>1</sup>

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<sup>1</sup> Shortly before the slide, an effort had been made to anchor a neighbouring house. The owner had undertaken some grouting in an attempt to stabilize the high bank (Thurber Consultants, 1983).

### **October 27, 1973**

**Event type:** Flash flooding.

**Precipitation:** Garibaldi, 37.4 mm/2 days, October 27-28, 1973; Daisy Lake Dam, 38.3 mm/2 days, October 27-28, 1973; Alta Lake, 41.9 mm/2 days, October 27-28, 1973; Pemberton BCFS, 52.8 mm/2 days, October 27-28, 1973; Squamish FMC Chemicals, 47.5 mm/1 day, October 28, 1973.

**Source:** *The Province*, October 29, 1973; *The Colonist*, November 6, 1973.

**Details:** Heavy rain overnight October 27-28 caused flash floods between 2-3 a.m. on October 28. At Alta Lake, weather observations for October 27 show continuous precipitation continuing until 11 a.m. the next day when thunderstorms and moderate rain occurred.

The torrential rains washed out a 40-ft. (12 m) section of Highway 99 near Brandywine Falls, 30 mi. (48 km) north of Squamish. The break occurred at a washed out culvert and bridge on a new stretch of highway about 1 mi. (1.6 km) north of Brandywine Falls. Scores of people were left stranded at Alta Lake and beyond. Late on October 27, a washout cut the rail line, interrupting service. During the night of October 28, construction of a temporary Bailey bridge commenced. The highway was not expected to reopen till October 31.

### **April 19-20, 1974**

**Event type:** Rock slide.

**Precipitation:** Britannia Beach, 14.0 mm/1 day, April 19, 1974; Gambier Harbour, 17.0 mm/1 day, April 19, 1974; Hollyburn Ridge, 21.1 mm/2 days, April 19-20, 1974.

**Source:** *The Vancouver Sun*, April 20 and 22, 1974.

**Details:** On April 20 at 8:30 a.m., a rock slide blocked the BC Rail line 2 mi. (3.2 km) south of Porteau Station, between Britannia Beach and Horseshoe Bay. After a 10-hour delay, traffic on the line resumed. The slide did not affect highway traffic.

### **February 12, 1975**

**Event type:** Debris slides.

**Precipitation:** Woodfibre, 54.3 mm/2 days, February 11-12, 1975.

**Source:** *The Vancouver Sun*, February 13, 1975.

**Details:** Early on February 12, three slides in the Cheakamus Canyon closed Highway 99 between Squamish and Whistler. At about 8 p.m., the highway opened to single-lane alternating traffic.

### **October 23, 1975**

**Event type:** Flooding.

**Precipitation:** Squamish FMC Chemicals, 202.9 mm/8 days, October 16-23, 1975; Gambier Harbour, 174.0 mm/8 days, October 16-23, 1975; Squamish FMC Chemicals, 93.5 mm/1 day, October 16, 1975; Gambier Harbour, 120.9 mm/1 day, October 16, 1975.

**Source:** *The Vancouver Sun*, October 24; November 18, 1975; December 17, 1988; *The Province*, October 21 and 22, 1975.

**Details:** On October 23, rain-swollen Stoney Creek washed out a section of the Squamish highway and 30 ft. (9 m) of track on the BC Rail line 2 mi. (3.2 km) south of Squamish. The highway was closed at 5:30 p.m. At 5:45, the rail line closed but was back in service by noon the next day. Freight movement slowed down but passengers were transferred around the damaged area.

### **October 29-November-6, 1975**

**Event type:** Flooding.

**Precipitation:** Alta Lake, 29.5 cm snow/1 day, October 29, 1975; Pemberton BCFS, 14.2 cm snow/1 day, October 29, 1975; Squamish FMC Chemicals, 307.9 mm/9 days, October 29-November 6, 1975; Daisy Lake Dam, 265.2 mm/9 days, October 29-November 6, 1975; Garibaldi, 242.0 mm/9 days, October 29-November 6, 1975; Alta Lake, 183.4 mm/9 days, October 29-November 6, 1975; Pemberton BCFS, 191.7 mm/9 days, October 29-November 6, 1975; Gates Station, 119.0 mm/9 days, October 29-November 6, 1975; Squamish FMC Chemicals, 77.0 mm/1 day, November 2, 1975; Garibaldi, 42.9 mm/1 day, November 2, 1975; Gates Station, 48.0 mm/1 day, November 3, 1975. (At the beginning of November, temperatures were up to 10°C above normal for both Alta Lake and Pemberton BCFS.)

**Source:** *The Vancouver Sun*, October 30, 1975; *The Province*, October 30, November 5 and 6, 1975; *Victoria Times*, November 5, 1975; *The Daily Colonist*, November 6 and 7, 1975.

**Details:** During the first week of November, steady to intermittent rain caused flooding in a number of areas. Tides driven by strong southeast winds added to the problem. A surge of warm Pacific air caused the snow to melt. During the earlier part of November, the elevation of melting was around 8,000 ft. (2,400 m).

On November 4, runoff from continuous rain combined with a sudden rise in the freezing level to 7,000 ft. (2,100 m) caused the Cheakamus, Squamish and Upper Squamish rivers to flood.<sup>1</sup> Due to high water along the Cheakamus River in the upper Squamish area, dozens of residents were evacuated or commuted by rowboat. Many backroads were impassable and homes were surrounded by 3 ft. (90 cm) of water.

The Daisy Lake reservoir on the Cheakamus River quickly threatened to overflow the impounding dam. BC Hydro was forced to open the dam's gates to spill water, thus increasing the river levels above its banks at some locations downstream. About 25-30 people were believed to have left the Cheakamus area north of Cheekye when minor flooding hit their homes. Worst hit were about 12 families at Tantalus Acres, a development

about 11 mi. (17.6 km) north of Squamish with water reported lapping at trailer windows and car roofs. In Squamish, areas where the Squamish River follows the highway were flooded with 3 ft. (90 cm) of water. Residents of Harris Road, Eagle Run Village and Brackendale used rowboats to get to their homes.

The Squamish highway also closed after heavy rain washed out a temporary bridge at Stoney Creek, 3 mi. (4.8 km) south of Squamish.

About 20 km (32 km) north of Pemberton, a flooding Birkenhead River washed out about 2 mi. (3.2 km) of track. A second washout occurred 8 mi. (12.8 km) south of Pemberton at Green River. A washout 7 mi. (11.2 km) south of Pemberton forced a closure of Highway 99. Repairs were expected to be completed on October 31.

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<sup>1</sup> The northern end of the Squamish River bank was dyked during the previous winter at a cost of \$550,000. Previously, Squamish requested the provincial government to finance the construction of a dyke to bolster the central areas along the Squamish and Mamquam rivers, estimated to cost about \$1.5 million (*The Province*, November 6, 1975).

### **August 25-September 1, 1976**

**Event type:** Rock slides and rock fall.

**Precipitation:** Hollyburn Ridge, 29.7 mm/1 day, August 25, 1976; Squamish FMC Chemicals, 12.4 mm/1 day, August 25, 1976; Hollyburn Ridge, 261.5 mm/12 days, August 25-September 5, 1976; Gambier Harbour, 43.9 mm/1 day, August 27, 1976; Gambier Harbour, 40.6 mm/1 day, September 4, 1976; Hollyburn Ridge, 79.0 mm/1 day, September 4, 1976; Squamish FMC Chemicals, 101.6 mm/1 day, September 6, 1976; Woodfibre, 99.6 mm/1 day, September 6, 1976.

**Source:** *The Vancouver Sun*, August 25 and 30, 1976; *Nanaimo Daily Free Press*, August 26, 1976; *The Province*, August 26, 1976; *The Daily Colonist*, August 26, 1976; *Squamish Citizen*, September 6, 1976; Eisbacher, 1983.

**Details:** On August 25 at 1 a.m., the collapse of a small cliff near Brunswick Point closed Highway 99. The fall, which consisted of some 1,500 m<sup>3</sup> of rock, also blocked the rail line for 300 ft. (90 m) below and caused a train derailment (Eisbacher, 1983), about 4 mi. (6.4 km) north of Lions Bay. The rock, mud and debris slide, blamed on recent rain and wet conditions, knocked an engine of a four-unit BC Rail freight train off its tracks. The four-man train crew escaped injury, but the line would not be cleared until later that day.

The slide, which was reported about 2 a.m., covered about 100 ft. (30 m) of the highway with rocks and debris 20 ft. (6 m) deep and stretched about 300 ft. (90 m) from the cliff to the rail line below. The highway department expected to have the slide cleared late on August 25 or early next day.

The slide left a number of motorists stranded in Squamish. BC Rail passengers were bussed and the railway's Royal Hudson steam train trip from North Vancouver to Squamish was cancelled. Rayonier Canada Ltd., operating a pulp mill at Woodfibre, chartered a boat to pick up its employees stuck at the south side of the slide at Horseshoe Bay (*The Vancouver Sun*, August 25, 1976).

On September 1, a rock slide north of Lions Bay closed down Highway 99. A slight earthquake or the vibration of a passing train below may have set off the slide. According to B. Vetch of the Highway Department, it was caused by weather eroding away at a U-shaped fault in the rock bluff above the road. Rocks, including one several tons in weight, broke out of the bluff and knocked out a section of reinforced concrete. The rock fall blocked BC

Rail line causing a passing train to partially derail. The railway tracks were cleared late on September 1. By 11 p.m. Highway 99 re-opened one lane to traffic.

### **September 9-10, 1978**

**Event type:** Debris flow.

**Precipitation:** Woodfibre Henrietta Lake, 76.0 mm/1 day, September 9, 1978; Squamish FMC Chemicals, 63.4 mm/2 days, September 9-10, 1978; Gambier Harbour, 50.0 mm/2 days, September 9-10, 1978; Woodfibre Henrietta Lake, 109.8 mm/2 days, September 9-10, 1978; Hollyburn Ridge, 48.5 mm/2 days, September 9-10, 1978.

**Source:** *The Squamish Times*, September 13 and 20, 1978; Thurber Consultants, 1983 (Appendix B).

**Details:** On September 9, runoff from a rainfall of 14.3 mm caused more than 90 ft. (27 m) of boulders and concrete riprap to be swept away from the bed of Harvey Creek. An estimated 5 ft. (1.5 m) of erosion took place over a 50 ft. (15 m) length of the creek (Thurber Consultants, 1983). In addition, heavy rain caused a number of traffic accidents around Squamish.

### **December 12-18, 1979**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport 170.9 mm/7 days, December 12-18, 1979; Hollyburn Ridge, 316.6 mm/7 days, December 12-18, 1979; Gambier Harbour, 272.6 mm/7 days, December 12-18, 1979; Point Atkinson, 178.4 mm/7 days, December 12-18, 1979; Vancouver Harbour CS, 268.1 mm/7 days, December 12-18, 1979; Point Atkinson, 56.8 mm/1 day, December 13, 1979; Hollyburn Ridge, 107.0 mm/1 day, December 16, 1979; Gambier Harbour, 88.9 mm/1 day, December 16, 1979; Vancouver International Airport, 87.5 mm/1 day, December 17, 1979; Vancouver Harbour CS, 76.8 mm/1 day, December 17, 1979. (Temperatures at the Vancouver International Airport were up to 5° C above normal.)

**Source:** Thurber Consultants, 1983 (Appendix B).

**Details:** From the evening of December 12 to the evening of December 14, a southwesterly flow of mild, moist Pacific air brought heavy rain to the Vancouver area. Between December 12-18, two periods of intense rainfall triggered widespread flooding and slope failures throughout coastal southwestern British Columbia. Between the morning of December 15 and December 17 at 4:15 p.m., Vancouver reported 110 mm of rain.

In December, flooding occurred on Disbrow Creek in the Howe Sound area (Church and Miles, 1987). The culvert under the subdivision road blocked, forcing the creek to flow over the road. Sandbagging prevented flooding the residence just north of the creek (Thurber Consultants, 1983).

### **September 1, 1980**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 45.5 mm/1 day, September 1, 1980; Britannia Beach, not available.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On September 1, 10 m<sup>3</sup> of rock came down onto Highway 99 (at 3.7 km) near Horseshoe Bay.

## **December 23-27, 1980**

**Event type:** Flooding; Debris flows.

**Precipitation:** Hope A, 207.2 mm/5 days, December 23-27, 1980; Vancouver International Airport, 79.0 mm/5 days, December 23-27, 1980; Chilliwack, 150.8 mm/5 days, December 23-27, 1980; Squamish Upper, 212.6 mm/5 days, December 23-27, 1980; Seymour Falls, 416.5 mm/5 days, December 23-27, 1980; Daisy Lake Dam, 149.5 mm/5 days, December 23-27, 1980; Pemberton BCFS, 95.8 mm/5 days, December 23-27, 1980; Whistler Roundhouse, 153.0 mm/5 days, December 23-27, 1980; Chilliwack, 105.8 mm/1 day, December 25, 1980; Seymour Falls, 149.5 mm/1 day, December 25, 1980; Daisy Lake Dam, 95.6 mm/1 day, December 25, 1980; Hope A, 82.3 mm/1 day, December 26, 1980; Vancouver International Airport, 39.0 mm/1 day, December 26, 1980; Squamish Upper, 77.7 mm/1 day, December 26, 1980; Pemberton BCFS, 76.2 mm/1 day, December 26, 1980; Whistler Roundhouse, 64.0 mm + 5.0 cm snow/1 day, December 26, 1980.

**Source:** *The Province*, December 28, 1980; January 4 and 7, 1981; *The Vancouver Sun*, December 27, 29 and 30, 1980; January 3, 6 and 13, 1981; April 7, *Citizen Shopper*, January 8, 15 and 22, 1981; January 14 and 22, 1982; *Cowichan News*, February 4, 1981; *Times Colonist*, November 5, 1982; January 3, 4, 9, 14 and 27, 1983; May 7, 1983; October 15, 1983; VanDine, 1985 (p. 65); Church, 1991 (pp. 216-217); Church and Miles, 1987 (pp. 64-67); Eisbacher, 1983 (p. 31, 38, 42); Melady, 1997 (pp. 87-97); Ministry of Environment, Lands and Parks files.

**Details:** On December 23-24, a storm struck southwestern British Columbia. Freezing level records from two upper air stations in southern British Columbia indicate the possibility for snowmelt during the storm. The 1980 Christmas storm was the culmination of a series of cyclonic disturbances that moved into the area from the southwest after December 20. Between December 25-27, southwestern British Columbia experienced heavy precipitation and unusually high temperatures.

On December 26, a two-day rainstorm and a rise in temperature caused extensive debris floods in the southern Coast Mountains. Though the rainfall was not unusual for the time of the year, a combination of rain and melting of snow packs caused flooding in such areas as Hope and Squamish. During the event, there was a substantial snowpack. The event produced a maximum streamflow well in excess of that expected from the amount of rainfall from the storm, to judge from return period criteria for the rainfall (Church, 1988).

Storm runoff and snowmelt at higher levels brought about unusually high flows in most streams on Vancouver Island. Extensive erosion and overtopping of riverbanks ensued, causing inundation and subsequent loss or damage for many residents in southwestern British Columbia. In the Hope and Lower Fraser Valley areas, streamflows were uncommonly large and in many cases record flows. Record peak instantaneous flows were recorded on the Coquihalla River, Chilliwack River, Cheakamus River, Lillooet River, Mamquam River, Squamish River, Stawamus River and Silverdale Creek. Preliminary estimates of the frequency for these occurrences were in the 1:30 to 1:90-year return intervals.

Water levels in the area lakes, Cheakamus, Daisy, and Garibaldi were much higher than usual. Overflow from Daisy Lake caused back up of Squamish River, closing

Highway 99 between Squamish and Garibaldi. About 2 km of old Highway 99, known as Government Road, was under water. Cheakamus River threatened several cottages between it and Highway 99. Angry residents of the Upper Squamish Valley had accused Hydro of causing a good portion of the flooding problems, which destroyed or damaged 200 homes by untimely releases of water from the dam.

Rescue co-ordinator for the Provincial Emergency Program, Al Bird, was satisfied that BC Hydro did everything it could do to control the flow and that the public was “warned in reasonable time.” Dave McDonald, a production superintendent at BC Hydro, said: “Daisy Lake is a fairly small lake and we had absolutely massive amounts of water coming in. We made the decisions on holding it or releasing it in the interest of everybody’s safety.” BC Hydro defied provincial government regulations by holding back more water than permitted in the Daisy Lake Dam reservoir above Squamish. According to Bill McNeney, Hydro production manager in the area, the inflow into the reservoir on December 26 was ten times the normal amount for this time of the year.

Squamish was the hardest hit area in the province. The flooding of the night of December 26 was caused by logjams, which suddenly swept down the Squamish, Cheakamus and Mamquam rivers. A partial jam in Mamquam River suddenly gave way, sending a wall of water down the river. Squamish River overtopped dykes flooding an area where the dyke was never completed because funding ran out. The riprap put in place was wiped out. According to an emergency measures spokesman, he had “never seen this much water come down the river in 30 years.”

A Comox-based Labrador Search and Rescue helicopter rescued two families trapped by rising floodwaters near Squamish. In a daring mission, the crew plucked two and four people, respectively to safety. Weather conditions during the operation were bad (Melady, 1997).

Dykes prevented flooding in Squamish itself and the new highway but the unprotected area on the north shore of the Mamquam River and from the confluence of the Mamquam and the Squamish rivers up to the Lions Easter seal camp suffered heavy flooding.

According to John Jellis, flooding on his property on Meadow Avenue near Brackendale was caused by an obstruction across Dryden Creek where a bridge had been built creating a culvert. Jellis said the log bridge filled with earth, which acted as a dam, backed up the water. When during high water a series of small culverts further down the creek broke the water went down. (*Citizen Shopper*, January 22, 1981).

On December 26, a flood or debris flow event occurred on Culliton Creek, north of Cheekye. It was caused by high rainfall causing debris and logs to block a culvert and wash out Highway 99 (VanDine, 1985). Judging from the stream gauge records of other torrents of similar size in this region, maximum flood discharge of Culliton Creek during this storm amounted to about 30 times the mean rate of discharge for the month of December (Eisbacher, 1983). The dam at Culliton Creek held back only by a man-made dyke (*The Province*, December 28, 1980). The gorge at Culliton Creek had been bridged for the highway by construction of a 25-m high earth-fill dam. Though the two large culverts allowed the water to flow through, the immense runoff built a head of water estimated by the RCMP at 20 m.

South of Pemberton, one abutment of the railroad bridge across Rutherford Creek was washed out necessitating replacement of the whole structure. In Pemberton, the

Ferguson home was hardest hit by flooding. During the rainstorm, there was a major shift of the braided Rutherford Creek channel between the bridge and Green River (Eisbacher, 1983).

The only way to travel north of Alpine Meadows on Highway 99 was by a stepladder across the rushing waters of 19 Mile Creek. Whistler volunteers dug out this section of the highway in order to save the surrounding residences from being washed away by the floods. On December 26, floods damaged Miller Creek bridge in Pemberton Meadows. The Squamish highway reopened on December 28.

Traffic on the 130-km stretch of track on the BC Rail line between Squamish and Lillooet was halted due to more than 20 washouts of roadbeds and bridges. BC Rail lost a railway bridge due to the washout at Rutherford Creek. As service was expected to be halted for about a month, 300 hundreds BC Rail employees were laid off until service would resume. Repair cost was estimated at between \$850,000-1 million. By January 3, 1981, 13 of the 25 washouts were repaired and all slides cleared. Traffic along the BC Rail line was restored on January 15, nine days ahead of schedule.

The forest industry also suffered losses to damaged road links. MacMillan-Bloedel reported a cost of \$160,000 to repair damage in its Squamish division.

Summary of expenditures December 27, 1980 flood: Pemberton area: Miller Creek; Ryan River; Wolverine Creek; Speech (Spetch?) Creek; Eight Mile Creek; No Name Creek; Pemberton Creek; Lilted River; Grandmothers Slough; Green River (\$242,670). Upper Cheakamus area: Culliton Creek; Cheakamus River; Swift Creek (\$109,056). Squamish area: Squamish River; Mashiter Creek; Mamquam River; Stawamus River (\$313,670) (File P80-21, June 9, 1981).

Final flood repair costs for flood of December 28, 1980 were: D'Arcy area: \$15,538.61; Pemberton area: \$242,670.72; Upper Cheakamus area: \$109,056.45; Squamish area: \$313,670.71 (MacFayden, 1981).

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<sup>1</sup> Following the Boxing Day flooding, some 400 residents petitioned the three levels of government to construct a well-designed dyke system for the whole district of Squamish. According to Attorney-General Allan Williams, MLA West Vancouver-Howe Sound a major hydrology study was required as the current dyking arrangement was clearly not sufficient. The provincial government compensated flood victims of the floods that damaged hundreds of homes in the Squamish and Hope areas. The federal government confirmed to pay about \$6.5 million. This federal contribution was based on the provincial government's estimate of \$13 million damage to homes and roads (*The Vancouver Sun*, January 3, 1981). The provincial government paid \$6.2 million for flood compensation during 1980. An additional \$500,000 for flood damage that occurred in southwestern British Columbia in December 1979 and \$2 million for damage in Bella Coala in December 1980 (*The Province*, July 22, 1981). On January 8, 1982, Stephen Rogers announced the approval of a \$750,000 grant for dyking in the Squamish municipality. The District of Squamish had already committed \$250,000 towards dyking. According to Mayor Jim Elliott, the first priority would be dyking on the right bank of Mamquam River between the old and new highways. One million yd.<sup>3</sup> (764,600 m<sup>3</sup>) gravel was to come out of Mamquam River. Internal drainage in Squamish River was required and dredging of both rivers scheduled to be done in July and August and the material stockpiled for later in the fall (*Citizen Shopper*, January 14, 1982). Early January 1983, the federal government made its first payment of \$1.5 million towards the damage cost of an estimated 2,000 homes and several bridges the floods throughout southwestern British Columbia (Greater Vancouver, Squamish, Whistler, Hope and Chilliwack) in December 1980 (*Times Colonist*, January 9, 1983). Due to road and bridge washouts, delays were experienced in assessing homes and contents in the Upper Squamish and Upper Cheakamus areas (*Citizen Shopper*, January 22, 1981).

In the political aftermath, both provincial and federal politicians called for long-term flood planning. Sen. Ray Perrault said that it would be wise to improve flood-control programs now to avoid worse disasters in

the future. Rogers noted that the provincial government would have to devise a long-term policy to deal with future floods and claimants who were asking for assistance for the second and third times. He warned people who continued to build in areas prone to flooding could find compensation cut off in the future (*The Vancouver Sun*, December 30, 1980). P.M. Brady, Director of the provincial environment ministry's inventory and engineering branch, expected worse flooding of Squamish River in the future. He said requests by the ministry for better flood protection of Squamish River had been ignored for the last four years. Instead of requiring that homes be set back from waterways and raised above a safe level, the district appeared to have caved in to developers and sought money for dykes. Squamish mayor Jim Elliott, in office less than a month, noted that his council could not stop people from building on flood plains until it had a bylaw in place, which could take up to a year (*The Province*, January 4, 1981).

### **January 21, 1981**

**Event type:** Flooding.

**Precipitation:** Squamish Upper, 101.6 mm/5 days, January 17-21, 1981; Daisy Lake Dam, 98.0 mm/4 days, January 18-21, 1981; Whistler Roundhouse, 48.0 mm/1 day, January 21, 1981; Squamish Upper, 35.8 mm/1 day, January 21, 1981; Daisy Lake Dam, 34.8 mm/1 day, January 21, 1981.

**Source:** *Citizen Shopper*, January 22, 1981; *The Vancouver Sun*, January 22, 1981; Egginton, unpublished data, 2004.

**Details:** Early on January 21, a temporary log bridge on the main Whistler-Squamish highway was washed out. The structure at Culliton Creek, 19 km north of Squamish, had been installed only weeks prior as a replacement for the permanent bridge that had been washed out during the 1980 Boxing Day floods. According to Department of Highways spokesman Bob Veitch, the washout was caused by heavy rain developing a dam, which broke and released the floodwaters. As the water was running too fast, crews were prevented from constructing a walkway.

That day, the mean temperature was 9°C above normal at the Upper Squamish weather station and this was the warmest January in its 1979-2003 record. Thus snowmelt may have been a contributing factor to the flooding. Daisy Lake Dam saw its warmest January on the 1968-1983 record as well as Whistler Roundhouse.

Since the floods also washed out an old logging road bridge into the area, children going to school in Squamish and residents going to work, walked a 47-m long railway bridge across Culliton Creek. Because of its length and a curve in the rail line making it extremely dangerous, BC Rail security posted a temporary “no trespassing” sign on the bridge, the only lifeline for 25 Upper Cheakamus Valley families. Poor visibility for the rail crew and a steep grade on the entire line, trains could not be stopped on time.

Whistler Mayor Pat Carleton said the highway bridge was expected to be reopened by early January 23.

### **April 24, 1981**

**Event type:** Rock slides.

**Precipitation:** Not applicable.

**Source:** Memorandum June 30, 1981. Michael F. Oliver to R. Winbow. Tunnel Point Bluffs Remedial Rockwork Program.

**Details:** On April 24 around 8:30 p.m., a rock slide occurred on Highway 99 approximately 3 km north of Lions Bay. The slide occurred in an area of highway that had recently been widened to three lanes. The volume of slide material was estimated at 1,000 m<sup>3</sup>. The scarp area, approximately 20 m above the road, contained overhanging blocks of

rock and zones of fractured rock. The remedial rockwork involved the removal of loose and fractured material.

On April 28, a small slide containing 400 m<sup>3</sup> occurred in the lower zone of the bluff. On April 30, a blast and subsequent scaling removed 500 m<sup>3</sup> from the scarp area. Additional scaling in this zone was completed on May 1. A zone of unstable material was noted approximately 15 m to the south of the slide area. Excavation of this material was scheduled for the week of May 4-8.

However, on May 4, a slide occurred in this zone and tension cracks, approximately 30 cm in width, were noted 10 m upslope from the original slide zone. A blast and subsequent scaling on May 12 removed an estimated 1,500 m<sup>3</sup>. After small blasts were made on May 15, 28, June 3, and 11, scaling was completed on June 15. The estimated total quantity of material removed from the site was 4,500 m<sup>3</sup>.

### **October 4, 1981**

**Event type:** Rock slides.

**Precipitation:** Hollyburn Ridge, 139.8 mm/1 day, October 1, 1981; Point Atkinson, 24.4 mm/3 days, October 1-3, 1981; Gambier Harbour, 56.6 mm/4 days, October 1-4, 1981.

**Source:** *Citizen Shopper*, October 4, 1981; *The Vancouver Sun*, October 5, 1981.

**Details:** On October 4 at 7:30 a.m. following heavy rain, an estimated 300 m<sup>3</sup> of rock came down onto the Squamish Highway, 2 km north of Sunset Beach. The rock slide knocked out a power line and blocked traffic for nearly four hours. Shortly after 11 a.m., enough rock was cleared away to allow a single lane of traffic. The disruption led to long line-ups in both directions most of the day. A concrete guard-rail on the highway prevented the rocks from tumbling further downhill and possibly knocking out the BC Rail tracks below. On October 8, the work on clearing the highway continued.

Some residents in the area north of Sunset Beach and south of Lions Bay were without electricity as well as 300 Lions Bay residents had no telephone service for most of the day. One kilometre of telephone cable had to be replaced. Both utilities were back in service late on October 4.

### **October 27-Nov. 1, 1981**

**Event type:** Flooding; Debris flows; Rock slides.

**Precipitation:** Gambier Harbour, 150.8 mm/5 days, October 27-31, 1981; Hollyburn Ridge, 258.0 mm/5 days, October 27-31, 1981; Squamish Upper, 303.2 mm/5 days, October 27-31, 1981; Squamish FMC Chemicals, 258.2 mm/5 days, October 27-31, 1981; Hollyburn Ridge, 136.4 mm + 2.2 cm snow/1 day, October 30, 1981; Squamish FMC Chemicals, 186.0 mm/1 day, October 30, 1981; Gambier Harbour, 98.0 mm/1 day, October 31, 1981; Squamish Upper, 114.6 mm/1 day, October 31, 1981.

**Source:** *The Vancouver Sun*, October 28, 29 and 30, November 17 and 25, 1981; December 12, 1981; January 28, 1982; *The Globe and Mail*, October 29, 1981; *Times Colonist*, October 28 and 29, 1981; *The Province*, December 16, 1981; *Citizen Shopper*, December 21, 1981; January 14, 1982; *The Squamish Times (Times Today)*, April 6, 1982; MacFayden, 1981; Eisbacher, 1983 (pp. 17-22); VanDine, 1985 (p. 68); Skermer, 1988 (pp. 21-23); Thurber Consultants, 1982; Thurber Consultants, 1983 (Appendix B); Hungr et al., 1984; Jackson et al., 1985 (p. 4-21); Church and Miles, 1987 (pp. 69-70); B.C. Ministry of Energy, Mines and Petroleum Resources, 1993; Ministry of

Environment, Lands and Parks files; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** After October 24, a sequence of Pacific storms moved onshore. A weak, double-centred low that dissipated over the coast was followed by a major cyclonic storm that formed in the southern Gulf of Alaska on October 27. Warm-front rain on October 27 from that storm produced the M-Creek debris torrent [flow] and minor debris movements on two other creeks. Late on October 28, an occluded front moved inland and a new storm approached the coast. On October 30-31, this storm delivered far heavier rain to the region. Local flooding occurred in Howe Sound, including at Furry Creek, and debris torrents were triggered in the mountains east of Howe Sound (Church and Miles, 1987).

During the 48-hour period ending November 1 at 8 a.m., Squamish and Pemberton recorded 177 mm and 96 mm, respectively. Prior to this date, this area had experienced mild temperatures with above normal rainfall, and below normal snow pack at higher elevations. The most common damage resulted from scouring, bank and dyke erosion, channel changes, wood debris, bedload deposition, landslides and inundation. The degree of damage to transportation, private dwellings and utilities, prompted the provincial government to extend aid under the Provincial Emergency Program. In addition to providing compensation for damage to personal property, this program provided for restoration of river channels, repairs to dykes and bank protection.

Around midnight on October 27, a small avalanche came down M-Creek, a high-gradient (48%) creek, 2 km north of Lions Bay. Initiation appears to have occurred in a small gully on the south side of the main channel at the 900 m elevation. It marked the first occurrence of a debris flow in the region in nine years. The event, caused by temporary damming of water or by debris surcharge, triggered a major debris flow that cleared out the rockbound gully to its base near sea level (Church and Miles, 1987). The mudline on the walls of the rock canyon near the bridge reached up to 25 ft. (7.5 m) and 15 ft. (4.5 m) on the north and south sides, respectively (Thurber Consultants, 1983).

The avalanche (which evolved into a debris flow) consisted of surficial debris and fractured bedrock, failed along a steep tributary draw along the margin of an old clear-cut at an elevation of 1,500 m. The destruction of an old logging bridge 650 m upstream of the M-Creek bridge on Brunswick Mountain caused debris to pile up. The debris grew to a volume of approximately 15,000 m<sup>3</sup>. Thurber Consultants (1983) put the volume at approximately 20,000 m<sup>3</sup>. The rock debris brought down onto the fan was estimated to have covered 0.7 ac. (0.3 ha.) or approximately 25% of the total fan area and the after-flow of liquefied organic mulch covered 1.5 ac (0.6 ha) (Thurber Consultants, 1983). It is believed that within about 5 minutes, the pulses of debris subsided. Most of the debris came from the accumulated load in the creek channel (Skermer, 1988).

Hungr et al. (1984) estimated the velocity of the 1981 M-Creek debris flow at 4.2-4.7 m/s. *The Vancouver Sun* reported a speed of 80 km/h. (22.2 m/s). At sometime between 12:20-12:30 a.m., the slide, which piled 6 m high in the narrow creek gully, flattened out to a 1.5-m wall before reaching the bridge. It ricocheted in the gully and smashed against concrete foundations, knocking it over before speeding down the final slope to the sea. Sometime between 12:30 a.m.-1:13 a.m., the torrent knocked out the central wooden support columns and the 18-m long and 8-m wide centre span of the old two-lane wooden trestle highway bridge and cut an 18-m gap across the roadbed.<sup>1</sup> Another column fell, and two more spans of the bridge collapsed. The wall of the slide

roared by, sweeping away 70 m of BC Rail track and a small house built on the beach near the creek's mouth. The bridge, a timber trestle structure built in 1957, was demolished in less than 30 seconds (*The Vancouver Sun*, November 25, 1981).

Five cars approaching the bridge in the darkness plunged into the hole and disappeared in the debris streaming to the sea. It was raining hard at the time. The fatal spot is about 70 m north of a curve, and for northbound drivers the gap would have been difficult to spot immediately on a bad night. Five of the victims were recovered immediately. Around November 16, Squamish RCMP recovered in about 80 m of water in Howe Sound another body and located in the same area a vehicle containing two other people. A ninth body was recovered on December 11, one-an-a-half months after the disaster. Police divers discovered the victim's car in 75 m of water in Howe Sound. On November 18, the search had been called off because of equipment failures and mounting costs, but the victim's family asked that it be resumed. Although according to most sources the accidents claimed nine lives (*The Vancouver Sun*, December 12, 1981; Eisbacher, 1983), VanDine (1985) and the Ministry of Energy, Mines and Petroleum Resources (1993) state the M-Creek debris torrent [flow] caused 10 deaths.<sup>2</sup>

BC Rail line was inundated and a portion of the rail was also taken out. Seventy metres of line were destroyed and the bridge covered in debris (*Times Colonist*, October 28 and 29, 1981). The rail bridge over the creek, to the railway known as Yahoo Creek, was covered in rubble and mud. On October 28, the first freight train went over the rail line; the first passenger train the next day.

On October 28, Magnesia Creek experienced a very small debris torrent [flow] or flood (Jackson et al., 1985). Rock and boulders rolling down the creek blocked the BC Rail bridge over Magnesia Creek. Water flowed over the bridge and washed out a portion of the left bank of the creek. This temporarily diverted the creek through the property at the mouth on the north side of the creek and buried a truck and garage with rock (Thurber Consultants, 1983).

At Kallahne Creek, the highway culvert was blocked. After the culvert and road were washed out, a large amount of material was deposited downstream of the highway. On October 31, at Furry Creek the bridge abutment fill was washed out. The washout was attributed to high creek flows and debris jamming (Thurber Consultants, 1983).

Squamish River overflowed its left bank from the downstream end of the dyke completed in 1975 to the BC Rail crossing at Government Road. This dyke runs along the BC Rail right-of-way, through the Spiral Mobile Park and then into the area of the confluence of Mamquam and Squamish rivers. The total cost of all equipment and materials was \$32,620. Horse Ranch Creek inundated the Easter Seal Camp area. Cost of building a temporary dyke was \$3,050.

On November 1, 500 m<sup>3</sup> of rock came down onto Highway 99 (at 6.0 km) at Sunset Beach Slide.

Summary of expenditures October 30, 1981 flood: Pemberton area: Miller Creek; Pemberton Creek; Birkenhead River; Green and Soo rivers and Rutherford Creek areas; Ryan River; Wolverine Creek; Spetch Creek; Pemberton Creek; Salmon Slough; Grandmothers Slough; Green River (\$323,319); Lillooet River. Whistler area: 19-Mile Creek; Fitzsimmons Creek; Cheakamus River; Alpha Creek (\$7,827). Upper Cheakamus area: Culliton Creek; Cheakamus River; Swift Creek (\$81,261; Cheekye. Squamish area: Squamish River; Mashiter Creek; Mamquam River; Stawamus River; Horse Ranch

Creek; Shannon Creek; Kallahne Creek (\$289,460). Howe Sound area: Cypress Creek; Magnesia Creek; Strachan Creek (\$14,443). For detailed damage information see: MacFayden.

Total damage costs October 31, 1981 flood for Pemberton area: \$323,410.95; Whistler area: \$7,827.00; Upper Cheakamus: \$90,268.04; Squamish area: \$403,834.13; Howe Sound-North Shore area: \$41,862.56, for a grand total of \$1,548,961.52 (MacFayden n.d.). Restoration costs by watershed: Gates River (\$2,000); Wolverine Creek (\$7,000); Lillooet River: (\$69,000); Ryan River (\$20,000); Miller Creek (\$104,200); Pemberton Creek (\$54,400); Birkenhead River (cost alternate access road \$37,000); Stawamus River (\$100,000); Horse Ranch Creek (\$25,000); Judd Slough (I.R.) (\$25,000); Outdoor School (\$10,000); Upper Cheakamus (\$40,000); Culliton Creek (\$20,000); Swift Creek (\$6,000); Cheekye River (\$12,000). (Memo November 6, 1981-File P81-10).

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1 Eight of the 18 bridges on the Squamish highway were of similar construction as the collapsed 25-year old M-Creek bridge (*The Province*, September 28, 1982). Since the 1981 debris torrent, blasting rock from the mouth of the steep, narrow, rock gorge to the east has relocated the highway at M-Creek. A new free-span steel-concrete bridge was completed across the torrent in 1982-83 (Eisbacher, 1983; Jackson et al., 1985). The new structure rests on a skewed abutment on spread footings partially on rock and partially on gage steel H-pile. The 41.48-m long single-span steel girder structure has a 10.8-m roadway and two concrete parapets (*The Squamish Times*, April 6, 1982).

2 In April 1982, during the M-Creek inquest in the coroner's court, it was found that the accident occurred "because of an Act of God" and that the old wooden bridge was not at fault.

As a result of the accident, safety measures were introduced including a tape-recorded highway status system, a series of roadside emergency telephones and 24-hour road patrols at a cost of almost \$5 million (*The Vancouver Sun*, February 11, 1983). At the end of December 1981, Highways Minister Alex Fraser announced that up-to-date road conditions on Highway 99 would be broadcast on Radio 1490. Two small transmitters were installed – one 1.5 km south of Squamish, the other 1.5 km east of the Eagle Ridge overpass near Horseshoe Bay – that would broadcast endless loop tapes containing reports on highway conditions. (*Citizen Shopper*, December 24, 1981). In August 1983, the provincial government announced it would spend \$138 million to improve and widen the Squamish Highway to four lanes from two. The program was to be carried out over a 12-year period (*The Vancouver Sun*, November 16, 1983).

## **November 11, 1981**

**Event type:** Flooding.

**Precipitation:** Squamish FMC Chemicals, 68.0 mm/2 days, November 10-11, 1981; Squamish Upper, 82.8 mm/2 days, November 10-11, 1981; Daisy Lake Dam, 91.4 mm/2 days, November 10-11, 1981. (On November 11, the mean daily temperature at Squamish Upper was 6° C above normal.)

**Source:** *Richmond Review*, November 18, 1981; *The Vancouver Sun*, November 12 and 17, 1981; *The Daily News*, November 16, 1981.

**Details:** On November 11, Cheakamus River overflowed its banks, breaking dykes and washing out a 300-m stretch of road at Paradise Valley, 12 km north of Squamish.

Eighteen pupils and three teachers from Brackendale elementary school were left stranded in the Cheakamus subdivision. The remainder of the school's 350 pupils was not affected. Squamish RCMP reported no other flooding in the area. Squamish mayor Jim Elliott said that work crews hoped to have the road repaired later on November 12.

### **November 19, 1981**

**Event type:** Rock fall.

**Precipitation:** North Vancouver Capilano, 20.4 mm/1day, November 19, 1981; Vancouver International Airport, 11.7 mm/1day, November 19, 1981; Britannia Beach, not available.

**Source:** *The Squamish Times*, November 24, 1981; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On the night of November 19, 500 m<sup>3</sup> of rock came down onto Highway 99 at “Thursday Nite Slide,” at 2.5 km just north of Horseshoe Bay.

### **December 3-4, 1981**

**Event type:** Debris flows; Flooding.

**Precipitation:** Hollyburn Ridge, 24.2 cm snow/3 days, December 1-3, 1981; Gambier Harbour, 77.2 mm/4 days, December 1-4, 1981; Port Mellon, 112.7 mm/4 days, December 1-4, 1981; Hopkins Landing, 86.6 mm/4 days, December 1-4, 1981; Hollyburn Ridge, 18.2 mm/1 day, December 4, 1981.

**Source:** *Citizen Shopper*, December 10, 1981; *The Vancouver Province*, December 6, 7 and 17, 1981; November 17, 1983; Eisbacher, 1982 (p. 132); Eisbacher, 1983 (p. 19); Thurber Consultants, 1983 (Appendix B); Lister et al., 1984; Hungr et al., 1987 (pp. 212-213); Church and Miles, 1987 (p. 73).

**Details:** On December 3-4, debris torrents [flows] occurred at Charles and Newman creeks and flooding at Alberta Creek in the Howe Sound area (Church and Miles, 1987). On December 4, at Charles [Strachan-2] Creek, a high-gradient torrent [flow] (52%), 4 km north of Horseshoe Bay, some 30,000-40,000 m<sup>3</sup> of debris mobilized from the rubble-filled upland ravine.

The event was composed of many small surges, with an estimated maximum discharge of less than 100 m<sup>3</sup>/s. The initial surges were deposited behind a low subdivision road bridge located below the highway, quickly filling the available channel freeboard. This likely caused further progressive deposition upstream of the small bridge, until the 6-m clearance of the large highway bridge was also infilled. Debris flow material, amounting to at least 20,000 m<sup>3</sup>, was then deposited on and above the highway bridge, covering the highway to a depth of 6 m. The post-event flood flow was diverted along the highway ditch and caused severe damage to residential properties 500 m distant from the creek (Hungr et al. 1987).<sup>1</sup>

Residents living on the Charles Creek fan heard an approaching noise “not unlike a train but much louder.” There was a slow moving churning mass of rock pieces, water and silt. Eyewitnesses described the flow as similar to slow moving lava. The movement was so slow that one ton boulders came to rest against bridges without cracking or chipping the concrete. On the north side of the creek, water and gravel sized rock inundated two houses, though no structural damage occurred (Thurber Consultants, 1983). The flow contained blocks with diameters of more than 2 m. According to Lister et al. (1984), between 10,000-15,000 m<sup>3</sup> of debris were deposited in a 1,800 m<sup>2</sup> triangular area upstream of the highway. Boulders up to 3 m in diameter were present although most were in the 0.5-1.0 m range. An afterflow of clean uniform sand was also present. The torrents originated in the talus material that fills the main channel at the 950-1,000 m elevation (Lister et al., 1984).

Thus, more than 40 people were evacuated from the 14 houses located below Charles Creek Bridge. During the hasty evacuation, a woman was caught in the floodwater and swept away. On December 16, Squamish RCMP permanently called off the search for the missing woman. They had searched an area in Howe Sound 180 m in each direction from Charles [Strachan] Creek up to a depth of 150 m (*The Province*, December 16, 1981).

Highway 99 was closed for about 48 hours. Unlike M-Creek, Charles Creek bridge was not washed out. It withstood the pressure of the slow-moving boulder lobe and blocked its further advance onto the debris cone where several homes were built in the 1970s. Logs jammed underneath forced the creek to flow over top of the debris and alongside it. Until the Highway Department was able to clear the mud and debris from the road, the highway was initially only open 10 minutes every hour. Following an around-the-clock clearing, the highway reopened on December 6.

The private bridge upstream was also buried. Under the rail bridge, the creek bed filled in leaving only 5 ft. (1.5 m) of clearance under the structure. As north of the highway debris blocked the bridge, water flowed over the north abutment following a rock cut along the highway for about 150 ft. (45 m) before descending onto the railway tracks below. Material picked up from a small slump in a cutbank was deposited against two homes. Water flowed between the rails depositing a layer of silt. A second flow of debris was deposited on the BC Rail line just north of the end of the rail bridge. Water from this flow also ran northward down the road and southward across the lower private bridge. The creek bed below the lower private bridge scoured down 6-8 ft. (1.8-2.4 m). Gabions along both banks at the lower end of the creek were undercut, but remained in relatively good condition (Thurber Consultants, 1983).

During the same night, on December 4, Harvey Creek came close to avulsing below the subdivision bridge, which is below the highway bridge. The creek water got to within 1 ft. (30 cm) of the top of the creek bank before a downstream constriction broke and the water level was lowered. The Newman Creek debris flow was reported that 4,000 yd.<sup>3</sup> (3,058 m<sup>3</sup>) of material was involved in this debris torrent [flow]. A large amount of debris blocked the marina bridges and the BC Rail bridge. Water and debris came over the lower marina bridge and flowed to the left. It deposited large material just below the marina road, while mud and small boulders were directed towards the warehouse. Some mud was also deposited inside the warehouse (Thurber Consultants, 1983).<sup>2</sup>

In view of the M-Creek disaster and the recent problems at Charles Creek, in the inaugural meeting of the council for the District of Squamish on December 7, the feeling was expressed that a positive position must be taken with the provincial government on the construction of dykes and drainage systems in Squamish in the near future. The government's commitment of building four "catchment basements" to contain slide debris at Alberta and Harvey creeks in Lions Bay and at the Charles and Magnesia creeks, Vancouver geologist Lou Bayrock was doubtful whether they would even help. Nigel Skermer called Alberta Creek a "loaded gun." (*The Province*, November 17, 1983).

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<sup>1</sup> The bridge consisted of two steel I-beam stringers approximately 0.75m high, covered by timber planking. It had a maximum clearance of only 1.5 m and was located 20 m downstream from a concrete highway bridge with a 6-m clearance. Both were located a short distance downstream of a fan apex where the channel slope was approximately 14° (Hung et al., 1987).

2 At the time, four bridges crossed the apex of the cone, providing some protection to the houses located below (Eisbacher, 1983).

### **December 20, 1981**

**Event type:** Debris flow.

**Precipitation:** Hollyburn Ridge, 34.0 mm/2 days, December 18-19, 1981; Gambier Harbour, 37.8 mm/2 days, December 18-19, 1981; Port Mellon, 68.5 mm/2 days, December 18-19, 1981; Squamish FMC Chemicals, 37.0 mm/2 days, December 18-19, 1981; Squamish Upper, 59.4 mm/2 days, December 18-19, 1981.

**Source:** *The Vancouver Sun*, December 21, 1981.

**Details:** On December 20 at about 8 a.m., a rock- and mudslide came down and partially covered the Squamish highway. On December 21, crews were still working the slide and hoped to restore the road to two-lane traffic later that day.

### **January 16-18, 1982**

**Event type:** Rock fall.

**Precipitation:** Gambier Harbour, 32.2 mm + 5.0 cm snow/1 day, January 15, 1982; Port Mellon, 27.8 mm + 6.6 cm snow/1 day, January 15, 1982; Squamish Upper, 5.4 mm + 14.5 cm snow/1 day, January 15, 1982; Hollyburn Ridge, 81.4 cm/2 days, January 15-16, 1982; Point Atkinson, 53.6 mm/2 days, January 15-16, 1982; Gambier Harbour, 24.2 mm/1 day, January 16, 1982; Port Mellon, 49.0 mm/1 day, January 16, 1982; Squamish Upper, 1.5 mm + 20.6 cm snow/1 day, January 16, 1982.

**Source:** *Citizen Shopper*, January 21, 1982; *The Daily News*, January 18, 1982; *The Citizen*, September 19, 1991; *The Squamish Times*, May 4, 1982; Eisbacher, 1983 (p. 22); Cory and Sopinka, 1989); Bunce et al., 1997 (p. 344); Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** Early on January 16, heavy snowfall brought traffic on Highway 99 to a standstill at Brunswick Point, 5 km north of Lions Bay. At approximately 8:45 a.m., a single boulder fell from Argillite Cut, a badly sheared rock face above the highway at 21.6 to 22.1 km between Horseshoe Bay and Squamish. It landed on top of a car, killing a 28-year old woman from Toronto. The rock landed in the middle of the car, crushing the vehicle. The victim's father, also a passenger in the car, was seriously injured (*Citizen Shopper*, January 21, 1982; Eisbacher, 1983). The survivor later sued the provincial government for \$1 million (*The Citizen*, September 19, 1991).<sup>1</sup>

It is thought that a tree, a 10-m long Douglas fir, toppled by the weight of heavy snow, set off the rock fall onto Highway 99. The tree became dislodged after a series of heavy winter storms hit the area in January 1982. Experts believe that the heavy snow coupled with weakened rock caused by the swelling of the tree's frozen roots caused the tree to fall.

On January 18, 5 m<sup>3</sup> of rock came down onto Highway 99 (at 6.6 km) south of Strachan No. 1 Creek. On the same day, 100 m<sup>3</sup> came down onto the highway at 14.4 km at the Tunnel Point slide.

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<sup>1</sup> The father (Mr. Just) successfully sued the provincial Ministry of Transportation and Highways (MoTH) for damages (known as the Just Case). The Supreme Court of Canada (Cory and Sopinka, 1989) found that the Ministry could readily foresee the harm might befall users of the highway if it were not reasonably maintained and that maintenance could be found to extend to the prevention of injury from fallen rock

(Bunce et al., 1997). Prior to the Just accident, MoTH was specifying locations for rock scaling when resources and manpower were available. Subsequently, the Ministry developed a comparative method of ranking areas by hazard. They then employed their limited resources to reduce the risks posed by the areas presenting the greatest hazards. Since 1993, MoTH has adopted the Rock fall Hazard Rating System (Bunce et al., 1997).

At the coroner's inquest on April 28, 1982, some of the recommendations made by the jury included more frequent highway patrols, upgrading of highway standards, and better warning systems for motorists using Highway 99 (*The Squamish Times*, May 4, 1982).

### **April 13, 1982**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 26.1 mm/3 days, April 11-13, 1982.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On April 13, 50 m<sup>3</sup> of rock came down onto Highway 99 (at 14.9 km) at Loggers Creek.

### **October 6, 1982**

**Event type:** Flooding.

**Precipitation:** Hollyburn Ridge, 50.4 mm/2 days, October 5-6, 1982; Gambier Harbour, 35.4 mm/2 days, October 5-6, 1982; Port Mellon, 65.6 mm/2 days, October 5-6, 1982; Squamish Upper, 73.0 mm/2 days, October 5-6, 1982.

**Source:** Thurber Consultants, 1983 (Appendix B).

**Details:** On October 6, 60 mm of rain fell within a 24-hour period in the Lions Bay area and caused heavy flows along Harvey, Newman, and Magnesia creeks. At Newman Creek, a minor amount of material was washed from above the lower marina access road. The material washed over the road and down towards the warehouse (Thurber Consultants, 1983).

### **December 2-3, 1982**

**Event type:** Debris flow; Rock fall.

**Precipitation:** Vancouver International Airport, 121.7 mm/8 days, November 26–December 3, 1982; Hollyburn Ridge, 221.1 mm/8 days, November 26–December 3, 1982; Gambier Harbour, 208.6 mm/8 days, November 26–December 3, 1982; Port Mellon, 354.1 mm/8 days, November 26–December 3, 1982; Squamish A, 185.6 mm/8 days, November 26–December 3, 1982; Hollyburn Ridge, 77.0 mm/1 day, December 2, 1982; Gambier Harbour, 71.4 mm/1 day, December 2, 1982; Port Mellon, 91.0 mm/1 day, December 2, 1982; Squamish A, 72.0 mm/1 day, December 2, 1982; Vancouver International Airport, 31.6 mm/1 day, December 3, 1982. (At Vancouver International Airport and at Squamish A, the daily mean temperatures were 2–5 °C and up to 6 °C above normal, respectively.)

**Source:** *The Vancouver Sun*, December 3, 1982; *Times Colonist*, December 4, 1982; Thurber Consultants, 1983 (Appendix B); Jackson et al., 1985 (p. 4-18 and 4-20); Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** Between December 2 at 10 p.m. and December 3 at 4 a.m., the Vancouver International Airport recorded 19.1 mm of rain. On December 1 and 2, Vancouver reported 10.0 mm and 8.3 mm of rain, respectively. The freezing level at the south coastal mountains was up to 9,000 ft. (2,700 m), melting snow and causing avalanches.

On December 3, at 8:10 a.m., a landslide occurred on the Squamish Highway, north of M-Creek bridge. It happened following a week of heavy rain and warm temperatures that melted snow on south coastal mountains. It blocked the highway for about 20 minutes. The highway was opened briefly to one-lane traffic when another slide occurred further north. Northbound traffic was blocked off at Lions Bay and southbound traffic was halted indefinitely at Britannia Beach.

On the same day, 1,000 m<sup>3</sup> of rock came down onto Highway 99 (at 13.0 km) near Tunnel Point.

Moreover, a small debris torrent [flow], or series of torrents [debris flows] occurred in the upper watershed of Alberta Creek. The event occurred after approximately 62 mm of rain were recorded at the Lions Bay works yard during a 24-hour period (Thurber Consultants, 1983). Debris was deposited on the logging road at the creek crossing. There was also a logjam just upstream from the Lions Bay municipal water intake at 280 m elevation (Jackson et al., 1985). There was evidence that this minor debris was accompanied by a large flow of water in the creek (Thurber Consultants, 1983). Behind the forestry road bridge/fill structure across Alberta Creek at an approximate elevation of 660 m, an estimated 350-450 m<sup>3</sup> of rock and log debris accumulated and partially removed the bridge/fill structure. An approximate 2-3 m levee formed on the left (south) side of the creek. On the right side, a 0.5-1m levee formed. The bridge/fill structure formed a log crib and debris “dam” approximately 4 m high (Thurber Consultants, 1983).

### **January 7-10, 1983**

**Event type:** Rock slides

**Precipitation:** Vancouver International Airport, 42.4 mm/4 days, January 7-10, 1983; Hollyburn Ridge, 72.2 mm/4 days, January 7-10, 1983; Gambier Harbour, 87.8 mm/4 days, January 7-10, 1983; Port Mellon, 164.4 mm/4days, January 7-10, 1983; Squamish A, 172.8 mm/4 days, January 7-10, 1983; Daisy Lake Dam, 92.0 mm/4 days, January 7-10, 1983; Whistler, 115.0 mm/4 days, January 7-10, 1983; Hollyburn Ridge, 45.8 mm/1 day, January 8, 1983; Whistler, 18.0 cm snow/2 days, January 8-9, 1983; Gambier Harbour, 51.2 mm/1 day, January 9, 1983; Port Mellon, 78.1 mm/1 day, January 9, 1983; Squamish A, 80.6 mm/1 day, January 9, 1983; Daisy Lake Dam, 75.0 mm + 7.0 cm snow/1 day, January 9, 1983.

**Source:** *The Daily News*, January 10 and 11, 1983; *Citizen Shopper*, January 13, 1983; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** Heavy rain and snowstorms hit southern British Columbia, forcing closure of many transportation routes. Unseasonably high temperatures reaching the 1,828-m level caused major problems in the mountain passes. Highway crews worked round the clock at two sections of the Squamish Highway north of Vancouver. On the night of January 9, a massive traffic jam on Five Mile Hill just south of Whistler resulted in a minimum two-hour wait for skiers heading back to Vancouver. Several vehicles equipped with summer tires were caught in the blizzard conditions and blocked traffic in both directions for several hours.

On January 7 at 7:30 p.m., a rock slide came down in the salt shed area of Cheakamus Canyon. It blocked the northbound lane and a portion of the southbound lane

of the highway. Some 1,500 m<sup>3</sup> of rock came down onto Highway 99 (at 30.4 km) in Cheakamus Canyon causing delays in traffic.

Early on January 10, two rock slides on either side of M-Creek closed Highway 99 for seven hours. The slides, coming down at 7:15 a.m. on the south side and at 8:30 a.m. on the north side, were caused by heavy rain.

### **February 8-11, 1983**

**Event type:** Debris flows; Flooding.

**Precipitation:** Vancouver International Airport, 67.3 mm/4 days, February 8-11, 1983; Hollyburn Ridge, 240.4 mm/4 days, February 8-11, 1983; Gambier Harbour, 159.4 mm/4 days, February 8-11, 1983; Port Mellon, 343.0 mm/4 days, February 8-11, 1983; Squamish A, 155.6 mm/4 days, February 8-11, 1983; Hollyburn Ridge, 104.0 mm/1 day, February 10, 1983; Gambier Harbour, 67.4 mm/1 day, February 10, 1983; Port Mellon, 129.4 mm/1 day, February 11, 1983; Squamish A, 80.9 mm/1 day, February 11, 1983.

(At the end of the period, at the Vancouver International Airport and Squamish airports, daily mean temperatures were up to 5°C and up to 4°C above normal, respectively.)

**Source:** *Times Colonist*, February 12; July 9, 1983; April 18, 1984; *The Vancouver Sun*, February 11, 12 and 17, 1983; February 22, 1984; January 29, 1987; *The Daily News*, February 14 and 15, 1983; VanDine, 1985 (pp. 67-68); Church and Miles, 1987 (p. 70 and 73); VanDine and Lister, 1983 (pp. 9-11); Bayrock, 1983; Thurber Consultants, 1983 (Appendix B); Hungr et al., 1984; Lister et al., 1984. Jackson et al., 1985 (p. 4-11, pp. 4-18-4-20); B.C. Ministry of Energy, Mines and Petroleum Resources, 1993.

**Details:** On February 8-10, an intense Pacific cyclonic storm approached the British Columbia coast from the west-southwest, drawing a strong southwesterly airflow onto the coast. There was substantial precipitation ahead of the low-pressure centre, which fell as snow at higher elevations. Precipitation was heaviest on February 10 when the freezing level rose abruptly to near 2,000 m, causing significant snowmelt. The 24-hour precipitation for the area recorded at Hollyburn Ridge was 80 mm. In the seven days prior to this, 175 mm of rain had been recorded (Church and Miles, 1987).

Between February 8-10, almost all meteorological stations in the Howe Sound region reported heavy rain and snow at high elevations. Warm moist air flowed into the area on the night of February 10-11, raising the freezing level to about 3,000 m and bringing fresh rain. Temperatures in the area reached 11°C and remained high for the next couple of days (*Times Colonist*, February 12, 1983). Snow melted causing flooding in the Squamish area. In the Howe Sound area, debris flows occurred on Alberta, Newman, Charles, Harvey, and Turpin creeks.

On February 11, a large debris torrent [flow], more than 12,000 m<sup>3</sup>, occurred on Alberta Creek severing all bridges except the railway overpass right at the bottom of the creek course. It severely damaged six houses and took the lives of 18- and 19-year old brothers.<sup>1</sup> Five access road crossings and four houses were destroyed (VanDine, 1985). Earlier that day, a woman was rescued from another trailer that was hit by a mud and debris slide. About 275 residents on the north side of the creek were cut off from the rest of Lions Bay. At 4 a.m., the highway bridge across Alberta Creek closed. A temporary Bailey bridge replaced the bridge. Highway 99 was scheduled to reopen late on February 14.<sup>2</sup>

An earlier debris flow blocked Charles [Strachan] Creek bridge, 8 km north of Horseshoe Bay. At least 0.5 m of water covered some sections of the Squamish Highway. Furthermore, a saturated snow avalanche appeared to have occurred in the very steep, rockbound upper gully of the creek. Launched over a 6-m waterfall, it set in motion abundant earth and rock debris in the channel below (Church and Miles, 1987). Hungr et al. (1984) estimated the velocity of Charles Creek debris flow at 4.6-8.1 m/s. Const. Doherty observed the last surge at the subdivision road crossing downstream of the highway and estimated its speed to approximate 2 m/s (Thurber Consultants, 1983). Flow velocities have been estimated to be near 9 m/s at the highway. Alberta Creek, which is normally a trickle during the dry season, turned into a “river of rock and mud.” According to Frank Smith, Works Manager for the Village, Alberta Creek seemed to be damming up from time to time, which caused further slides.

The debris torrent [flow] was initiated at the forestry road, which crosses the creek at an elevation of approximately 2,000 ft. (665 m) above sea level (Bayrock, 1983). A snow deposit with admixed soil was found on the logging road crossing. Above and below the crossing, saplings were broken and stripped of bark, probably as a result of sliding snow. Immediately below the road, on a 30° gradient, there was evidence of major erosion of channel debris. Two hundred metres below the crossing, both banks of the channel were scoured to heights of 8 m. Thus, part of the snow avalanche flowed below the crossing and loaded the debris sporadically in the channel, initiating the major debris torrent [flow] (Jackson et al., 1985).

Some 65 families were evacuated from Lions Bay and nearby Harvey Creek and returned by February 13. At the Lions Bay, the debris torrent [flow] was contained within the stream gully to below the highway bridge. At this stretch, the torrent [flow] damaged only roads and bridges. At a point below the highway bridge, the debris torrent [flow] spread to the surrounding terrain from the gully. All damage done to houses and property was from the initial point of spreading downward (Bayrock, 1983). An eyewitness described the event as “like thunder coming close.” The crashing of rocks on each other could be heard. Another local resident described it as, “the sound of a jet plane overhead or strong winds,” which lasted about 30 seconds. Houses would shake “as if a train would go by the house” (*The Vancouver Sun*, February 12, 1983). A total of five culverts, two above the bridge and three below, were washed out. Further downstream, an unoccupied residential building on the fan delta near the BC Rail line was knocked off its foundations and pushed into Howe Sound.

Alberta and Harvey creeks, which run through Lions Bay, also supply the community of 1,000 with water. Consequently, besides losing power and telephone, residents also temporarily had to go without water. Though the telephone cable was damaged, only about 10-15 subscribers out of 460 were affected. One resident, who lost a large part of his backyard carved out by the debris flow, was left with a 20-m deep trench where the small creek was previously.

The Alberta Creek debris torrent displaced some 15,000 m<sup>3</sup> of debris (Ministry of Energy, Mines and Petroleum Resources, 1993). About 10,000 m<sup>3</sup> of debris were deposited at the mouth of the fan commencing 75 m from the shoreline and out about 30 m into the sea. As some of the sediment flowed into Howe Sound, estimates of the total volume of the debris torrent could range as high as 20,000 m<sup>3</sup>, though the actual value is probably much nearer 12,000 m<sup>3</sup>. Many logs were floating in Alberta Bay on the

following morning. Furthermore, BC Rail line was closed after two sections of track were buried by mud and debris. On a 100-m section, the debris was 2-3 m deep. BC Rail restored both freight and passenger service on February 11.

At Newman Creek, the debris torrent [flow] deposited an estimated 7,500 m<sup>3</sup> of debris between the highway bridge and a waterfall 120 m upstream, and at the mouth of the creek. There was little evidence of forest debris, except towards the edge of the deposit upstream of the bridge. However, there was evidence of an older logjam at this location. The deposit at the mouth of the creek covered an area of approximately 700 m<sup>2</sup>. The torrent partially blocked the highway bridge. A small amount of material ended up on the deck of a private wooden bridge immediately downstream, blocking access to the boat yard. Some of the debris came to rest against a mobile home and a combination house and office on the south side of the creek. The torrent blocked and overtopped two access roads and covered a parking area with debris (VanDine, 1985). A helicopter reconnaissance showed a fresh scar on the side slopes of the creek at about an elevation of 1,000 m. It was thought that that elevation was where the torrent was initiated. The marina owner stated that during the event, large blocks of snow were observed mixed with the debris in the lower deposit. This suggests that a snow avalanche may also have played a role in initiating the torrent (Thurber Consultants, 1983).

At Turpin Creek, a debris torrent deposited an estimated 1,500 m<sup>3</sup> of fine rock interspersed with logs. The debris filled up the depression of the upstream side of the highway to the top of the concrete barrier. The deposit diverted the creek to flow 100 m to the south, eroding a section of the road embankment on the downhill side approximately 15 m long. The debris from this washout terminated at the railway below (Thurber Consultants, 1983).

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<sup>1</sup> In July, the government authorised \$364,000 in aid to residents of the four properties damaged or destroyed in the February 11 mudslide at Lions Bay (*Times Colonist*, July 9, 1983). Almost four years later, claims arising out of the torrent which claimed two lives on February 11, 1983 were settled out of court. Lawyers for all parties involved in the civil actions refused comment on the terms (*The Vancouver Sun*, January 29, 1987).

<sup>2</sup> As the old wooden bridges with footings in creek beds could easily be downed by floods, they would eventually all be replaced by concrete or concrete and steel bridges, which would be able to span creeks without footings (*The Vancouver Sun*, February 12, 1983).

### **April 25, 1983**

**Event type:** Rock fall.

**Precipitation:** Squamish, 19.1 mm/2 days, April 23-24, 1983; Vancouver International Airport, 9.1 mm/1 day, April 25, 1983.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On April 25, 10 m<sup>3</sup> of rock came down onto Highway 99 (at 24.0 km) near Porteau Bluffs.

### **November 15, 1983**

**Event type:** Debris flows.

**Precipitation:** Lions Bay, 256.6 mm/6 days, November 10-15, 1983; Squamish A, 258.8 mm/6 days, November 10-15, 1983; Port Mellon, 557.0 mm/4 days, November 12-15, 1983; Hollyburn Ridge, 295.2 mm/3 days, November 13-15, 1983; Lions Bay, 56.0 mm/1

day, November 15, 1983; Hollyburn Ridge, 129.2 mm/1 day, November 15, 1983; Squamish A, 97.8 mm/1 day, November 15, 1983; Port Mellon, 327.6 mm/1 day, November 15, 1983.

**Source:** *The Province*, November 15, 1983; *The Daily News*, November 17, 1983; *The Vancouver Sun*, November 15, 16 and 17, 1983; *The Times*, November 22, 1983; Thurber Consultants, 1983; VanDine, 1985 (pp. 51-52); Church and Miles, 1987 (pp. 70-72); Hungr et al., 1987 (p. 209; pp. 213-214); Egginton, unpublished data, 2004.

**Details:** On November 15, heavy rains caused debris slides on the Squamish Highway, which was closed between Horseshoe Bay and Squamish at 2:30 p.m. Debris flows occurred in Charles, Newman, and Montizambert creeks, all within 2.5 km of each other. Twenty families were evacuated, including 14 from Strachan Creek, a tiny community at the mouth of Charles Creek. This damage marked the fourth time in two years, since October 1981, that residents had to be evacuated or lost their lives on this stretch of highway.<sup>1</sup>

The debris flow, down Charles Creek, demolished three bridges leading to local subdivisions. It damaged a fourth bridge and the bridge on the Squamish Highway, closing Highway 99. Two girders under the highway bridge's northbound lane had to be replaced. The highway bridges over Montizambert and Newman creeks also suffered damage but remained intact. On November 16, although the Charles Creek bridge was open to one-lane traffic, no busses or trucks were allowed. A Bailey bridge was put into place while the bridge was under repairs (*The Daily News*, November 17, 1983).

In Charles Creek, the main source of debris, is rocky material derived from rapidly weathering quartz diorite cliffs above 500 m in elevation where the creek follows a fracture zone. The site probably represents the nearest approach to a purely meteorological controlled torrent in the region (Church and Miles 1987). The velocity of this debris was estimated to be 7 m/s (VanDine, 1985). The channel carried a maximum debris flow discharge estimated to be 295 m<sup>3</sup>/sec. (Hungr et al., 1987). The BC Rail bridge below the highway was swept away. The bridge deck then twisted out of the other abutment. The flowing debris lifted it and carried the structure into Howe Sound some 100 m downstream. Charles Creek, which normally runs 4.6 m below bridge level, pushed the 15-m long, 70-ton steel box girder span off its concrete foundations. According to BC Rail engineers, it must have taken a wall of debris and water 25 ft. (7.5 m) high to knock out this bridge.<sup>1</sup> The BC Rail line was expected to be closed for at least two weeks but after a by-pass was built, trains were expected to running the following week. BC Rail freight traffic, mostly southbound lumber, was diverted on CNR tracks through the Fraser Valley. Passengers were bussed to catch trains to Squamish or Prince George.

At Charles Creek, six such events have occurred in 16 years. Between 1956-86, 35 "natural" events occurred in 15 of the 26 creeks in the Howe Sound area between Britannia Beach and Horseshoe Bay. Twelve people lost their lives, including nine at M-Creek on October 28, 1981. Debris flows destroyed 17 structures (bridges, houses, and culverts) and blocked or damaged 24 more. Flooding destroyed seven structures and damaged five more (Thurber Consultants, 1983; updated to December 1986 In: Church and Miles, 1987 p. 73, Table 5).

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<sup>1</sup> In comparison, when in 1981 the M-Creek highway bridge crashed down on BC Rail's bridge, identical to the one over Charles Creek, this steel span moved less than 1 cm (*The Vancouver Sun*). In the natural

deposition zone of a debris flow stream, bridges should be designed after eventually buried by a debris flow to withstand its impact, so as to be serviceable immediately upon re-excavation. The low-massive bridges constructed by BC Rail on its line along Howe Sound are a good example of such structures. They consist of short, massive box girder reinforced concrete spans about 80 tons in weight, keyed into heavy concrete abutments. The keys are of reinforced concrete, 15 cm wide. They have resisted the impact of an approximately 300 m<sup>3</sup> discharge on M-Creek in 1981 and Alberta Creek in 1983, although in the latter event, the concrete of the abutment keys cracked (Hungt et al., 1987).

### **October 6-12, 1984**

**Event type:** Flooding; Debris flow; Rock fall

**Precipitation:** Hollyburn Ridge, 250.6 mm/7 days, October 6-12, 1984; Lions Bay, 185.6 mm/7 days, October 6-12, 1984; Port Mellon, 326.5 mm/7 days, October 6-12, 1984; Squamish A, 352.3 mm/7 days, October 6-12, 1984; Whistler, 181.7 mm/7 days, October 6-12, 1984; Pemberton BCFS, 167.4 mm/7 days, October 6-12, 1984; Hollyburn Ridge, 58.0 mm/1 day, October 7, 1984; Port Mellon, 132.2 mm/1 day, October 7, 1984; Squamish A, 101.0 mm/1 day, October 7, 1984; Whistler, 60.7 mm/1 day, October 7, 1984; Lions Bay, 77.0 mm/1 day, October 7, 1984; Pemberton BCFS, 68.4 mm/1 day, October 7, 1984.

**Source:** *The Coast Mountain Courier*, November 7, 1984; *Times Colonist*, October 9, 10, 11, 1984; *The Province*, October 9, 10, 11, 1984; *The Daily News*, October 9, 10, 11 and 12, 1984; *The Sun*, October 9, 11, 12 and 13, 1984; (Squamish) *Times Today*, October 23, 1984; *The Times*, October 22, 1985; Clague and Souther, 1982; Jackson et al., 1985 (p. 4-9); Evans, 1986; Smith and Vallieres, 1986; Talbot, 1986; Jordan, 1987; Lu, 1988; Hickin and Sickingabula, 1988; 1989 (p. 337); Cruden and Lu., 1989 (p. 336); Environment Canada, 1991; Ministry of Environment, Lands and Parks files; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** The flood of October 8 was caused by heavy rainfall, which covered the entire Lillooet River basin above Pemberton. Moreover, Squamish River near Brackendale recorded a maximum instantaneous discharge of 2,610 m<sup>3</sup>/s and a maximum daily discharge of 2,150 m<sup>3</sup>/s (Environment Canada, 1991).<sup>1</sup> On that date, a 30-year return period flood changed the channel of the Squamish River. At least 10 homes near Squamish had to be evacuated because of heavy flooding. The channel changes caused by this flood were quite dramatic in comparison with the geomorphic activity of the preceding four decades. There are indications that changes before the October flood may have taken place as a result of the June 28, 1984 debris flow into the Squamish River (Hickin and Sickingabula, 1988).

The flood destroyed roads and bridges and inundated many homes in the Squamish Valley, causing millions of dollars in damage. Considerable damage occurred to existing dykes and bank protection and a number of creeks and rivers were filled with an accumulation of logs and coarse sediment. Despite its large size, the flood accomplished little more floodplain modification in the meandering and wandering reaches of the river than had previous smaller floods of similar duration. In contrast, in the braided reach the flood caused floodplain erosion and major reorganisation of the channel to an extent previously unrecorded, apparently here exceeding a threshold for channel stability.

A section of dyke along Cheekye River to Cheakamus River, which crested approximately 4 p.m. on Thanksgiving Day, caused a major problem. The dyke started to give way behind the Black Bear Restaurant by Alice Lake. Temporary repairs were

made. Had the structure given way, floodwaters would have run the BCR track to Axen Road and Brackendale.<sup>2</sup> Cheakamus River washed out the bridge across it, which was expected to cost \$300,000 to be replaced with a concrete one. Temporarily, a 120-ft. (36 m) Bailey bridge replaced the lost structure.

In the Eagle Run Drive area, water was starting to collect behind the Petro Can station and in the nearby trailer court. A ditch was dug from the court to the nearby pump house, which relieved the problem. It was recommended to install a permanent pump in the sump on Eagle Run.

Also, on October 8, a debris torrent [flow] occurred at Sculfield Creek in the Howe Sound area. Flooding also occurred on Harvey Creek (Jackson et al., 1985). The “wall of water” on Harvey Creek washed away six weeks of work on the flood control dam under construction. Project supervisor Rick Boudreau said a “torrent of water came tearing down, like a huge wave” in the afternoon causing damage estimated at \$300,000. The wave shot through a partially constructed dam, buckling metre-thick reinforced concrete slabs and undermining the whole project. On October 10, the 40-man crew at the site, started to rebuild the dam about 60 m above Squamish Highway. The purpose of the dam is to slow floodwaters and remove debris.

On October 9, a large rock came down onto Highway 99 (14.4 km) at the Tunnel Point slide.

The estimated cost of repairs amounted to \$1,738,700. The Thanksgiving weekend flooding in Squamish and to the north also added to the problems of an already depressed logging industry in the area. According to Weldwood general manager Carl Rathburn, damage to washed away logging roads and bridges was estimated at \$750,000. The repairs would delay the company’s spring start-up by about two months, keeping about 140 employees out of work longer than expected. The immediate affect of the flooding was minimal, as Weldwood had closed down its Squamish logging operation just a week earlier because of poor market conditions.

Summary of watercourses impacted by the October 8 flooding and estimated cost: Squamish River (\$205,000); Mamquam River (\$6,700); Stawamus River (\$115,000); Cheekye River (\$160,000); Cheakamus River-Squamish area (\$136,200); Culliton Creek (\$149,800); Cheakamus River-Whistler area (\$85,000); Fitzsimmons Creek (\$18,000). (Storm damage assessment October 8, 1984 flooding Pemberton, Whistler, Squamish areas. (Talbot, 1986). Overall total (allotted) \$1,946,700 and (expended) \$1,632,493.36 (as per January 10, 1986).

Description of some of the most costly repair costs of the flood damage:  
Squamish River: Cost to replace washed out bank protection along a 250-m length of overbank about 200 m upstream from Judd Slough floodbox was \$120,000. Stawamus River: cost to replace toe rock along 450 m of riverbank upstream from Valleyview Elementary School was \$115,000. Cheekye River: Cost of gravel removal from streambed about 300 m upstream of BC Rail bridge was \$80,000. Culliton Creek: right bank downstream from Jack Webster bridge, cost to replace toe rock, reconstruct dyke in section where dyke washed out was \$110,000.

Flood damage at Whistler: Cheakamus River: severe erosion occurred over a reach of some 250 m above the municipal sewage treatment facilities, resulting in migration of Cheakamus River channel and loss of about 1 ha of land. Permanent protection would require construction of a riprapped training dyke over the affected reach

at an estimated cost of \$150,000. Large logjams completely blocked Cheakamus River in its canyon section downstream of the treatment facility. Cost to remove and dispose of the blockages could range up to \$75,000. Fitzsimmons Creek: between Blackcomb Way bridge and the Blackcomb Creek confluence, two footbridges were washed out. Minor local accumulations of logs and debris were scattered over the reach from the Blackcomb Way bridge to the Nancy Green Drive bridge on Fitzsimmons Creek. Creek overflows were reported to have entered the day parking area (Talbot, 1986).

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1 The highest previous levels were an instantaneous flow of 2,270 m<sup>3</sup>/s on September 6, 1958. In comparison, the disastrous floods of December 27, 1980 had only peak flows of 2,180 (instantaneous) and 2,110 m<sup>3</sup>/s (*The Times*, October 22, 1985).

2 Contributing to the problem is the fact that these dykes are built in 1974 to a 1:50-year standard. All the other dykes built in 1981 were built one in 200-year standard (*Times Today*, October 23, 1984).

### **December 10-17, 1984**

**Event type:** Debris flow.

**Precipitation:** Lions Bay, 54.4 mm/8 days, December 10-17, 1984; Hollyburn Ridge, 75.4 cm snow/8 days, December 10-17, 1984; Bowen Island Millers Landing, 97.8 mm/8 days, December 10-17, 1984; Port Mellon, 136.3 mm/8 days, December 10-17, 1984; Hollyburn Ridge, 38.0 cm snow/1 day, December 11, 1984; Bowen Island Millers Landing, 58.1 mm/1 day, December 13, 1984; Port Mellon, 87.2 mm/1 day, December 13, 1984. (Daily mean temperatures at Hollyburn Ridge were up to 10° C below normal.)

**Source:** *The Vancouver Sun*, December 15 and 17, 1984; Jackson et al. 1985; Hungr et al. 1987 (pp. 205-206; p. 211).

**Details:** On December 13, a Pacific storm caused debris/snow avalanches, road closures, and power failures. Heavy rains melted the snowpack in the south coastal mountains; the freezing level was at 3,000 m. The storm dropped 26 mm of rain on the Lower Mainland and 32 cm of snow in parts of the Interior.

On December 14, a debris torrent [flow] occurred in Sculfield Creek in the Howe Sound area. It came down during light rain following a week of cold weather with substantial snow accumulation. Snowmelt provided the runoff that generated the debris torrent, which started at a relatively low elevation. The torrent [flow] was composed of about 5,000 m<sup>3</sup> of debris. About 60% of the large material was timber, and 55% by volume of the less than 50 mm-sized material was organic (15% by weight). The torrent [flow] filled the natural basin upstream from the highway and spilled across the road to deposit some material on the slope to the railway (O. Hungr, pers. comm., 1985 In: Jackson et al., 1985).

The lower part of the indirect impact zone was saved by the presence of several cross ditches, which contained much of the debris, diverting the flow to the right (Hungr et al. 1987). The torrent [flow] was unusual among other Howe Sound events in the very high proportion of organic debris. It is probable that the torrent began at the logjam in the channel above the cliff (Jackson et al., 1985).

Peak discharge estimates made from super elevation observations after the event on Sculfield Creek ranged from 390 m<sup>3</sup>/s. at the base of a steep reach to 280 m<sup>3</sup>/s. on a flatter reach, 100 m downstream, to 180 m<sup>3</sup>/s. at the crest of a waterfall 100 m further downstream. It appears that the surge thickened through a reach of reduced slope angle,

producing a higher peak, then spread out again at a convex channel reach (Hungry et al., 1987).

On December 15 at 10:15 a.m., a mud and rock slide blocked a culvert at Sculfield Creek, 5 km north of Horseshoe Bay and closed the Squamish highway. The slide, about 100 m wide and with an average depth of 1.5 m, also covered the BC Rail tracks. The highway was reopened by 4 p.m. BC Rail had to wait for the highway department to contain the flow of water before the railway company could start to repair the damage caused by the slide. After the highway culvert blocked, the railway one also blocked. Though the track was left intact, about 50 m were covered by water, mud, and logs. The line reopened at 3 p.m.

### **January 1985**

**Event type:** Rock fall

**Precipitation:** Not available.

**Source:** *The Sun*, January 16, 1986.

**Details:** In January, a slide at Charles Creek closed down Squamish Highway for about 90 minutes.

### **September 6, 1985**

**Event type:** Rock fall

**Precipitation:** Squamish, 40.6 mm/2 days, September 5-6, 1985; Vancouver International Airport, 24.2 mm/1 day, September 6, 1985.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On September 6, 4-6 m<sup>3</sup> of rock came down onto Highway 99 (at 22.2 km) near the Deeks Lake Trail parking lot.

### **October 1, 1985**

**Event type:** Rock fall

**Precipitation:** Squamish, 1.4 mm/1 day, October 1, 1985; Vancouver International Airport, 2.0 mm/1 day, October 1, 1985.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On October 1, 15 m<sup>3</sup> of rock came down onto Highway 99 (at 7.1 km) at Charles Creek.

### **October 31, 1985**

**Event type:** Rock slide.

**Precipitation:** Vancouver International Airport, 43.7 mm/1 day, October 31-November 1, 1985; Squamish, 61.9 mm/3 days, October 31-November 2, 1985; Whistler Roundhouse, 12.0 cm snow/3 days, November 1-3, 1985; Squamish Upper, 38.3 mm/4 days, November 1-4, 1985; Whistler, 19.7 mm/4 days, November 1-4, 1985.

**Source:** *The Sun*, November 4 and 5, 1985; *The Times Today*, November 5, 1985; *The Province*, December 17, 1985; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On October 31 at 5:56 p.m., a rock slide came down between Tunnel Point and Loggers Creek. Approximately 2,000 m<sup>3</sup> of rock came down onto Highway 99 (at 15.7

km) at the Loggers Creek slide. The slide caused a motor vehicle accident. Traffic was reduced to single-lane alternating till 9:12 a.m. when two-way traffic resumed.

### **November 4, 1985**

**Event type:** Rock slide

**Precipitation:** Vancouver International Airport, 43.7 mm/1 day, October 31-November 1, 1985; Squamish, 61.9 mm/3 days, October 31-November 2, 1985; Whistler Roundhouse, 12.0 cm snow/3 days, November 1-3, 1985; Squamish Upper, 38.3 mm/4 days, November 1-4, 1985; Whistler, 19.7 mm/4 days, November 1-4, 1985.

**Source:** *The Sun*, November 4 and 5, 1985; *The Times Today*, November 5, 1985; *The Province*, December 17, 1985; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 4 at 1:10 a.m., a northbound BC Rail freight train hit a small rock and debris slide in Cheakamus Canyon, 4 km north of the Daisy Lake dam, and derailed. The head engine slid about 30 m down the embankment, landing on its side. The second engine slid about 18 m, and the third engine came down on top of it. Two cars also went down the embankment and a third one was derailed. About 60 m of track were torn up in the incident. The crew who rode the engine down during the slide escaped injury. BC Rail recovered the three locomotives valued at \$4.5 million during the first half of December.

### **January 15-18, 1986**

**Event type:** Debris flow; Rock slide; Flooding.

**Precipitation:** Lions Bay, 101.4 mm/4 days, January 15-18, 1986; Hollyburn Ridge, 131.0 mm/4 days, January 15-18, 1986; Bowen Island Millers Landing, 101.8 mm/4 days, January 15-18, 1986; Squamish A, 204.9 mm/4 days, January 15-18, 1986; Squamish STP, 152.2 mm/4 days, January 15-18, 1986; Lions Bay, 38.2 mm/1 day, January 17, 1986; Hollyburn Ridge, 75.0 mm/1 day, January 17, 1986; Bowen Island Millers Landing, 82.2 mm/1 day, January 18, 1986; Squamish A, 117.0 mm/1 day, January 18, 1986; Squamish STP, 64.4 mm/1 day, January 18, 1986. (At Hollyburn Ridge and Squamish A, the daily mean temperatures were up to 3° C.

**Source:** *The Sun*, January 16, 1986; *The Citizen*, January 16 and 23, 1986; *The Times*, February 25, 1986; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On January 15 at 8 p.m., a slide at Charles Creek, estimated at 1,000-1,500 m<sup>3</sup> of rock poured onto the Squamish Highway. Described as “about 100 to 150 truckloads,” it covered about 50 m of the highway. It was not until midnight that clearing of tons of debris began. The Highway department district manager, Ron Winbow, hoped to clear the last of the slide during the regular daily closing hours of 10 a.m. to 2 p.m. and have both lanes open subsequently.<sup>1</sup>

On January 15, 150 m<sup>3</sup> of rock came down onto Highway 99 (at 7.1 km) between Strip and Charles creeks.

On January 18, heavy rains combined with frost in the ground resulted in minor flooding in a number of areas in the Squamish Valley. Problems were reported in Brackendale, some in Garibaldi Estates, and minor ones in Valleycliffe.

<sup>1</sup> The regular four-hour closure was to allow work on a new bridge at nearby Newman Creek.

### **February 1-3, 1986**

**Event type:** Rock slide.

**Precipitation:** Whistler, 6.3 mm/1 day, February 1, 1986; Whistler Roundhouse, 13.0 cm snow/1 day, February 1, 1986.

**Source:** *The Sun*, February 3, 1986.

**Details:** On February 3 at 1:50 a.m., a rock slide, 16 km north of Whistler, derailed a northbound BC Rail train. Four locomotives were derailed, but remained upright, blocking the line. Passengers were bussed between Mons near Whistler and Pemberton.

### **October 4, 1986**

**Event type:** Rock fall

**Precipitation:** Squamish, 0.0 mm/1 day, October 4, 1986; Vancouver International Airport, 0.0 mm/1 day, October 4, 1986.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On October 4, about 10 m<sup>3</sup> of rocks came down onto Highway 99 (at 0.9 km) at Horseshoe Bay Bluff.

### **April 29, 1987**

**Event type:** Rock slides

**Precipitation:** Lions Bay, 8.8 mm/1 day, April 29, 1987; Port Mellon, 4.8 mm/1 day, April 29, 1987; Squamish STP Central, 9.2 mm/1 day, April 29, 1987. (On April 29 and a few days prior to the rock slide, temperatures at Squamish STP Central were 3-6°C above normal).

**Source:** *The Vancouver Sun*, April 30, 1987.

**Details:** On April 29, rock slides, possibly attributed to an earthquake on April 8, came down onto Squamish Highway. Boulders from the first slide, which came down at 8:30 a.m., hit a northbound car with two passengers. The second one, which came down an hour later, punctured the tires of a truck that ran over fallen rocks. It was speculated that the 3.7 Richter scale earthquake might have destabilized the high bluff area between Lions Bay and Britannia Beach, where the slides occurred.

### **July 8, 1987**

**Event type:** Rock fall.

**Precipitation:** Squamish, 70.1 mm/2 days, July 4-5, 1987; Vancouver International Airport, 23.8 mm/1 day, July 5, 1987.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On July 8, 15-20 yd.<sup>3</sup> (11.4-15.2 m<sup>3</sup>) of rock came down onto Highway 99 (at 2 km) at the Snake Hill Bluff.

### **December 8, 1987**

**Event type:** Rock slide.

**Precipitation:** Squamish, 181.6 mm/5 days, December 5-9, 1985; Vancouver International Airport, 27.4 mm/2 days, December 5-6, 1987.

**Source:** *The Times*, December 15, 1987; Ministry of Transportation and Highways, Rock fall notification summary; Mike Dowlde, pers. comm. December 11, 2006.

**Details:** On December 8, 80 m<sup>3</sup> of rock came down onto Highway 99 (at 24.6 km) near the Porteau Bluffs.

### **March 22-23, 1988**

**Event type:** Rock slide.

**Precipitation:** Squamish, 81.8 mm/4 days, March 19-22, 1988; Cypress Bowl, 10.0 cm snow + 11.0 mm/1 day, March 22, 1988; Lions Bay, 14.6 mm/2 days, March 22-23, 1988; Bowen Island Cates Bay, 12.6 mm/2 days, March 22-23, 1988; Hollyburn Ridge, 19.6 cm snow/2 days, March 22-23, 1988; Cypress Bowl, 4.0 cm snow + 5.0 mm/1 day, March 23, 1988.

**Source:** *The Vancouver Sun*, March 23, 1988; *The Times*, March 29, 1988.

**Details:** On March 22 at 11:30 p.m., a massive rock slide came down just south of Strip Creek, blocking Squamish Highway. The slab of rockface came down as a result of heavy rains. An estimated 2,500 m<sup>3</sup> blocked both lanes of the highway, which reopened to traffic at 7 a.m. the next day. No damage or injuries were reported. Some of the debris also fell onto the railway line.

According to the Ministry of Highways and Transportation spokesperson, Tucker Forsyth, the slide occurred in a construction zone, where construction at Strip Creek had just commenced. Forsyth also stated that a recent slide in the same vicinity had been the result of ongoing blasting operation.

### **July 7, 1988**

**Event type:** Rock fall.

**Precipitation:** Squamish, 13.8 mm/1 day, July 5, 1988.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On July 7, 50 m<sup>3</sup> of rock came down onto Highway 99 (at 1.6 km) at the Snake Hill Bluff.

### **February 25, 1989**

**Event type:** Rock fall.

**Precipitation:** Squamish, 65.6 mm/3 days, February 21-23, 1989.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On February 25, between 10-15 m<sup>3</sup> of rock came down onto Highway 99 (at 14.2 km) at M-Creek Bluff.

### **May 25, 1989**

**Event type:** Flash flooding.

**Precipitation:** Lions Bay, 40.4 mm/4 days, May 22-25, 1989; Squamish STP Central, 8.2 mm/4 days, May 22-25, 1989.

**Source:** *The Province*, May 28, 1989.

**Details:** On May 25, the Park Lane dam above the community of Britannia Beach collapsed and caused flooding in Britannia Beach. The accident happened when contractors mistakenly blew a hole into the dam three times bigger than they had intended. The environment ministry had ordered Copper Beach Estates, the owners of

the 74-year old dam, to knock a hole in it as a precaution against an earthquake rupturing it. When the charge blew a hole 10 m wide, instead of 3 m, the creek rose almost 4 m instead of the expected 0.5 m. As a precaution, the community's 120 homes, 8 km downstream, had been evacuated and Highway 99 closed.

As the dam collapsed, the creek rose very rapidly, ripping out trees and spewing debris as the water rushed toward Howe Sound. An eyewitness noted, "We heard it coming before we could see it. It rumbled like a train, we could see trees swaying and feel the ground shaking." The flood wave was estimated at 255 m<sup>3</sup>/s at peak flow. The lower creek was partly infilled with gravel. The dam break flood deposited an estimated 10,000 m<sup>3</sup> of bed material in the creek downstream of bridge B5. The flood lasted about an hour. It washed away two footbridges and cut off water supply to most of the town. The Red Door Art Gallery was the only building to suffer major damage. According to the owner, sculptor Edward Beaulieu, he was actually lucky. "Two more feet (60 cm) of water and half the building would have been gone."

### **October 21-25, 1989**

**Event type:** Debris slide.

**Precipitation:** Squamish A, 228.2 mm/8 days, October 17-24, 1989; Squamish STP, 180.6 mm/8 days, October 17-24, 1989; Squamish A, 29.2 mm/1 day, October 25, 1989; Squamish STP, 25.4 mm/1 day, October 25, 1989.

**Source:** *The Vancouver Sun*, October 25, 1989; *The Squamish Times*, October 31, 1989; Bland, 1992 (pp. 4-6).

**Details:** On October 25 at 4:30 p.m., a rock and mudslide covered the BC Rail track in Cheakamus Canyon. The slide was 45 m long, 12 m high, and 9 m deep. The line was expected to reopen on October 26 at 3 p.m.

### **November 8-10, 1989**

**Event type:** Flooding.

**Precipitation:** Vancouver International Airport, 50.0 mm/3 days, November 8-10, 1989; Squamish A, 170.0 mm/3 days, November 8-10, 1989; Squamish Upper, 136.4 mm/3 days, November 8-10, 1989; Whistler, 79.9 mm/3 days, November 8-10, 1989; Squamish A, 108.7 mm/1 day, November 9, 1989; Squamish Upper, 70.4 mm/1 day, November 9, 1989; Whistler, 43.7 mm/1 day, November 9, 1989. (Between November 8-10, all of the stations saw daily mean temperatures up to 6-7° C above normal.)

**Source:** *The Vancouver Sun*, November 10, 13 and 22; December 15, 1989; *Times Colonist*, November 10 and 21, 1989; November 10, 1990; *The Province*, November 12, and 14, 1989; McMullen, 1990.

**Details:** On November 9-10, torrential rains and gale-force winds occurred throughout British Columbia. The rainfall broke many records throughout much of southwestern British Columbia. In some areas falling onto melting snow, it caused localized flooding or near-flooding situations and washouts.

As water levels in the Upper Squamish and Cheakamus rivers rose rapidly, RCMP warned about 75 Squamish residents to prepare to flee their homes.

Some of the watercourses Squamish-Pemberton area impacted included Cheakamus River; Cheekye River; Fitzsimmons Creek; Mamquam River; Mashiter

Creek; Pemberton Creek; Squamish River; Stawamus River; and Whistler Creek (McMullen, 1990).

### **January 8-12, 1990**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 86.8 mm/7 days, January 3-9, 1990; Squamish, 84.2 mm/2 days, January 9-10, 1990.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On January 8, between 20-30 m<sup>3</sup> of rock came down onto Highway 99 (at 6.0 km) at Strip Creek.

### **January 12, 1990**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 86.8 mm/7 days, January 3-9, 1990; Squamish, 84.2 mm/2 days, January 9-10, 1990.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

On January 12, between 20-30 m<sup>3</sup> of rock came down onto Highway 99 (at 25.5 km) at Porteau Bluffs.

### **May 13, 1990**

**Event type:** Rock fall.

**Precipitation:** Squamish, 3.0 mm/2 days, May 12-13, 1990; Vancouver International Airport, 4.4 mm/1 day, May 13, 1990.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On May 13, 15 m<sup>3</sup> of rock came down onto Highway 99 (at 16.1 km) at the Loggers Creek Slide.

### **October 20-25, 1990**

**Event type:** Debris slide.

**Precipitation:** Bowen Island Cates Bay, 22.8 mm/1 day, October 20, 1990; Gambier Harbour, 28.2 mm/1 day, October 20, 1990; Hollyburn Ridge, 40.0 mm + 1.0 cm snow/1 day, October 20, 1990; Lions Bay, 44.0 mm/5 days, October 21-25, 1990; Bowen Island Cates Bay, 39.8 mm/5 days, October 21-25, 1990; Hollyburn Ridge, 74.0 mm/5 days, October 21-25, 1990.

**Source:** *Prince Rupert Daily News*, October 23, 1990; *The Vancouver Sun*, October 22; November 3 and 7, 1990; *The Squamish Times*, October 24 and 30; November 6, 1990; *PEP Talk*, December 1990; *The Squamish Chief*, May 21, 1996.

**Details:** On October 21 at 12:49 a.m., a debris slide came down onto Highway 99 approximately 4 mi. (6.4 km) north of Lions Bay. The volume of rock and debris was estimated at 10,000 m<sup>3</sup>. Other sources put the volume of debris that covered 100 m of the highway 9 m deep between 5,000-7,000 m<sup>3</sup> (*The Squamish Times*, October 24, 1990). The highway was closed at about 11 p.m. after a few boulders fell in the Tunnel Point area. An hour later, the main slide, which was attributed to recent rainfall in the area, buried the highway. BC Rail main line beneath the road was also put out of service when debris fell on 30 m of track.

Thousands of Lower Mainland residents attending the weekend Oktober Fest at Whistler were trapped. Because the only other passable road to the area was the site of a blockade by protesting Mount Currie First Nations, the slide effectively cut off Squamish, Whistler, and Pemberton.

The Squamish PEP set up an emergency operations centre. The Ministry of Forests brought in mobile kitchen and toilet facilities from Kamloops. During a single day, meals to as many as 1,600 people were served. Harbour Ferries sent their chartered 495-passenger cruise ship *Britannia* to take stranded people back to Vancouver. Vancouver Helicopters Ltd. had six of their helicopters making 64 trips to Vancouver from Squamish and Whistler on October 21. On October 23, three vessels belonging to BC Ferries were pressed into service to run between Darrell Bay and Vancouver. BC Ferries established a free ferry service to Horseshoe Bay. Their *MV Nicola* and *MV Vesuvius Queen* carried a total of only 46 vehicles making round trips about every five hours.

On October 25 around 1 p.m., five men working in a gully at the slide area on clearing the slide were hit by another rock slide. The slide struck shortly after six scalers had climbed the slope face to clear loose rocks following a dynamite blast. A huge slab of rock broke free above them, shattering as it fell and dislodging other debris. The slide area began near the base of a sheer rock face about half way up the mountain. Falling rock and debris had created a steep smooth chute that reached its narrowest point just above the highway. The road was covered in a rubble swath about 30 m wide.

One of the scalers found unconscious, with his head wedged between two boulders, was flown by helicopter to the Vancouver General Hospital. Some rock fell from 800 ft. (240 m) above the workers. The highway, which had been scheduled to reopen at 6 p.m. that same day, was closed again.

By midday on November 2, the Squamish highway reopened after a 13-day closure (*The Vancouver Sun*, November 3, 1990).<sup>1</sup> The rail line had been closed for 12 days. Over the next two weeks work continued to stabilize the slope and put a new permanent road surface.

The slide cost \$7 million in repairs and subsequent preventative structures. According to Ministry of Highways and Transportation spokesperson, Tucker Forsyth, it was probably the largest landslide in Highway 99's history and was likely the result of years of deterioration of the rock face (*The Squamish Chief*, May 21, 1996).

On November 6 at 11:30 p.m., the highway closed again only four days after reopening. At the same site 16 km north of Horseshoe Bay, another slide consisting of all small rock came down (*The Vancouver Sun*, November 7, 1990).

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<sup>1</sup> As a result of the highway closure, there were renewed calls for an alternate highway route along Howe Sound. For approximately 15 years, the Ministry of Highways had been looking at a variety of options. Routes proposed were through the Capilano and Seymour watersheds and up either side of Indian Arm. In 1983, the ministry's cost estimates were \$137 million for a Squamish route; \$151 million for the Capilano, \$239 million for the Seymour and \$200 million for the Indian Arm route.

Critics of the Squamish route contended that the cost of enhancing the existing route and bringing it up to four lanes had been seriously underestimated. They pointed out that since the M-Creek slide in 1981, the government had spent some \$50 million on straightening, widening, and bridging the existing route without appreciably changing the highway.

The Seymour route was considered too far out of the way. The Indian Arm route was not only further out of the way, but also susceptible to 12 ft. (3.6 m) of snow and avalanches in the winter. The Indian River valley is

also very narrow and has been actively logged, something tourists obviously would not appreciate. The option of putting more lanes through the existing route using tunnels and avalanche shelters would also destroy the highway's famous scenic value (*The Squamish Times*, October 30, 1990).

Although two sources (Innovation 8 (3), April 2004, (p. 13); Ministry of Energy, Mines and Petroleum Resources, 1993) mention a rock slide having occurred in 1991 near Loggers Creek that closed the Sea to Sky Highway for 12 days and cost \$7 million for repairs and preventative structures, they obviously refer to the debris slide of October 21, 1990.

### **November 8-12, 1990**

**Event type:** Flooding.

**Precipitation:** Pemberton A, 219.7 mm/16 days, November 1-16, 1990; Vancouver International Airport, 105.8 mm/6 days, November 8-12, 1990; Seymour Falls, 654.7 mm/6 days, November 8-13, 1990; Squamish A, 389.0 mm/6 days, November 8-13, 1990; Whistler, 207.2 mm/6 days, November 8-13, 1990; Pemberton A, 172.2 mm/6 days, November 8-13, 1990; Abbotsford A, 168.0 mm/6 days, November 8-13, 1990; Chilliwack, 249.9 mm/6 days, November 8-13, 1990; Agassiz CDA, 269.6 mm/6 days, November 8-13, 1990; Hope A, 441.9 mm/6 days, November 8-13, 1990; Abbotsford A, 79.6 mm/1 day, November 9, 1990; Chilliwack, 99.4 mm/1 day, November 9, 1990; Agassiz CDA, 98.2 mm/1 day, November 9, 1990; Hope A, 173.1 mm/1 day, November 9, 1990; Seymour Falls, 300.0 mm/1 day, November 10, 1990; Squamish A, 164.4 mm/1 day, November 10, 1990; Whistler, 72.0 mm/1 day, November 10, 1990; Pemberton A, 67.1 mm/1 day, November 10, 1990.

**Source:** *The Squamish Times*, November 14, 20 and 27, 1990; Ministry of Environment, Lands and Parks, files 55.4803(02)/P90-10 and 280-20/ADM.

**Details:** Torrential rains on November 8 caused flooding in large areas in southern British Columbia and northwest Washington. The storm was a high-intensity, long-duration storm. It exceeded the 25-year records at Whistler. Since the beginning of the month, Climate station Pemberton A had seen rain almost every day for 16 days totalling 219.7 mm. The Squamish area was hit by 164.6 mm of rain on the morning of November 10 and 68.8 mm on the evening of November 11. An additional 71 mm were recorded the next morning. Daily mean temperatures at all of the climate stations throughout the area were up to 7-8°C above normal for the period.

The Pemberton airport was flooded out. Britannia Creek was running so fast that boulders could be heard rumbling and crashing along the creek bed. Parts of Mamquam were flooded, as was the upper valley. Floodwaters temporarily closed the Squamish Highway.

Internal drainage behind dykes caused problems and the Squamish water intake washed out. (MELP file 280-20/ADM). All forestry access roads in the Soo Timber Supply Area were closed due to the damage arising from the heavy rains. Early cost estimates for repairing forestry roads were over \$300,000. (*The Squamish Times*, November 20, 1990). On Cheakamus River, the rock riprap at the toe of the dyke was washed out. Following the October 1984 flood, this site was repaired at a cost of \$17,365.

Late on the afternoon of November 10, high water caused the Mashiter Creek rock dam to break. Adjacent to the new intake structure, a 50-ft. (15m) rock dam was ripped out. The hole in the dam allowed water to divert away from the intake and reopen the original creek bed. When the dam broke, a "tremendous pulse" of water, gravel and logs was sent down the creek. Damage was extensive and the (BC) Fisheries intake on the diversion structure was completely buried in gravel. Cost to repair the damage to the

water intake was estimated at \$15,000. Although a section of the diversion weir was washed out and sediment was deposited, there was no apparent damage to the gates, screens or concrete of the diversion structure. It was rumoured that the dam had been designed to fail under such flooding conditions in order to reduce damage to the main intake (*The Squamish Times*, November 14 and 27, 1990).

On November 10, high water on the Green River damaged BC Hydro's 500-KV powerline south of Pemberton. The river took out three transmission towers, one of which had the foundations washed from underneath. When it brought down 3,300 ft. (990 m) of line down a second tower was buckled and a third one was damaged. On November 12, BC Hydro warned Vancouver Island pulp mills their power could be endangered after flooding caused two towers carrying four 500-KV power lines to collapse into Green River between Pemberton and Rainbow on the mainland.

### **November 16-24, 1990**

**Event type:** Debris flow; Flooding.

**Precipitation:** Hope A, 269.2 mm/8 days, November 17-24, 1990; Squamish A, 289.4 mm/8 days, November 17-24, 1990; Pemberton A, 106.2 mm/8 days, November 17-24, 1990; Hope A, 116.1 mm/1 day, November 23, 1990; Squamish A, 123.8 mm/1 day, November 23, 1990. (Squamish A reported temperatures up to 4° C above normal. Daily mean temperatures were up to 6° C at Hope A.)

**Source:** *Alberni Valley Times*, November 15 and 26, 1990; *Times Colonist*, November 21, 26; December 28, 1990; *The Squamish Times*, November 27, 1990; *Chilliwack Times*, November 27, 1990; *The Vancouver Sun*, December 1, 1990; *The Globe and Mail*, December 6, 1990; *PEP Talk*. Vol. 2, No. 1, Spring, 1991.

**Details:** On November 16, slides and high water closed Highway 99 at the Tunnel Point slide site, Function Junction, and near Paradise Valley. At the old slide site north of Lions Bay, mud came down, closing the highway at 12:02 p.m. The highway opened to single-lane traffic only at 4:45 p.m. At Function Junction, the highway closed between 4 p.m.-9 p.m. A washout at Paradise Valley, 23 km north of Squamish closed the highway from 3:45 p.m.-9 p.m. In Brackendale, basements flooded again.

On November 17, high water on Green River south of Pemberton washed out one tower on a major powerline between the mainland and Vancouver Island and buckled another one, bringing down about 550 m of the 500-KV transmission line. Repairs were expected to cost more than \$500,000. The downed line also affected customers on the Sechelt Peninsula and Powell River. BC Hydro hoped to have the line back in service on November 18. Repairs at the confluence of Rutherford Creek and Green River were just being completed when the second storm struck (*The Squamish Times*, November 27, 1990).

### **April 11, 1991**

**Event type:** Rock fall.

**Precipitation:** Squamish, 133.2 mm/6 days, April 3-8, 1991; Vancouver International Airport, 77.6 mm/6 days, April 3-8, 1991.

**Source:** Bunce et al., 1991 (p. 348).

**Details:** On April 11, a rock fall from the Argillite Cut (Porteau Cove) caused minor vehicle damage.

### **August 27-31, 1991**

**Event type:** Flooding; debris slides; debris flows.

**Precipitation:** Lions Bay, 189.0 mm/6 days, August 26-31, 1991; Squamish STP Central, 214.2 mm/6 days, August 26-31, 1991; Squamish Upper, 259.2 mm/6 days, August 26-31, 1991; Whistler, 157.5 mm/6 days, August 26-31, 1991; Gates Station, 114.8 mm/6 days, August 26-31, 1991; Lions Bay, 76.4 mm/1 day, August 29, 1991; Squamish STP Central, 81.2 mm/1 day, August 29, 1991; Squamish Upper, 128.6 mm/1 day, August 29, 1991; Whistler, 64.4 mm/1 day, August 29, 1991; Gates Station, 65.0 mm/1 day, August 29, 1991.

**Source:** *The Squamish Chief*, April 16, 1991; *Coquitlam Port Moody Port Coquitlam Now*, September 1, 1991; *The Squamish Times*, September 3, 10, 17 and 24, 1991; February 4, 1992; *The Citizen*, September 5, 12 and 26; October 3, 1991; Ward et al., 1992 (pp. 355-363); Bland, 1992 (p. 1 and 5); Egginton, unpublished data, 2004; Ministry of Environment, Lands and Parks files.

**Details:** During the last week of August, torrential rains caused devastating flooding in the Howe Sound communities of Britannia Beach and Cheekye. Dozens of people were evacuated from their houses after rivers burst their banks and flooded at least 50 homes. A low-pressure area stalled for a long period off the west coast. This caused weather patterns similar to those typically expected in the late fall. Winds associated with the front carried moist air into the western Cordillera and caused heavy rain between August 27-31.

All the climate stations in the Sea to Sky Corridor experienced their wettest August on record: Lions Bay, 1983-1999; Squamish STP Central, 1986-2002; Squamish Upper, 1979-2002; Whistler 1976-2002 and Gates Station 1974-1994 (Egginton, unpublished data, 2004).

At Britannia Beach, gravel build up in Britannia Creek caused the creek to overflow its banks, temporarily cutting off Highway 99. The creek deposited considerable amounts, sand, gravel, and debris flooding the lower townsite with 5 ft. (1.5 m) of water in and around homes and businesses on Copper Beach Estates. The evacuation of about 30 residences on the north and south sides had just started half an hour earlier.

During the night of August 29 and all day August 30, floodwaters inundated an 800-m wide area along the highway from the Britannia Creek bridge to the 99er Restaurant. BC Rail line acted as a dyke and prevented the floodwaters from flowing into Howe Sound. According to some eye witness accounts, BC Rail made the disaster worse by actively shoring up rail lines along the Britannia foreshore thus preventing the flood waters to drain. As BC Rail gradually completed its operations, floodwaters visibly rose 1-2 ft. (30-60 cm) along flooded area. Floodwaters eventually flowed out over the bridge and into Howe Sound through the 2 m hole washed out of the rail embankment.

Poor maintenance of old Jane Basin mining roads resulted in debris slides which contributed sediment to Britannia Creek. According to John Crook, Squamish Forest District media relations officer, some of the slides that carried down debris to Britannia

Creek originated from the old mining roads. He noted that most of the recent slide activity had taken place on the south side of the creek.

Peter Jordan, geomorphologist with the Vancouver Forest Region, said that at least six fresh debris slides and debris flows had been observed along the old mining road that switchbacks into Jane Basin. Some of these slides originated from the road itself, others originated further upslope. He said the reason that there was so much flood damage was because of aggradation of the creek bed, which made the creek jump its banks. The source of the high quantity of gravel in the creek was identified as originating from the previous year's floods, by the gravel in the creek as a result of Copper Beach Estates blowing the Park Lake Dam the previous year and from the most recent fresh debris (*The Squamish Times*, September 10, 1991). Early estimates of damage inflicted over the three days starting the night of August 29 amounted to \$4 million.

In addition, extremely heavy rainfall between August 27-31 resulted in flooding or near-flooding situations in the Squamish area. On August 30, Squamish recorded its greatest one-day rainfall with 103 mm. In Squamish, high flows in the Squamish, Cheakamus, Cheekye, Mamquam and Stawamus rivers and in Culliton and Mashiter creeks caused limited flooding and considerable damage to rock riprap bank protection, roads, and the water intake of Mashiter Creek. The dyke and revetment on the right bank of Stawamus River in Valleycliffe suffered damage to bank protection at several locations. Damage also occurred at Mamquam River opposite the golf course and at Squamish River at Judd Slough, Culliton Creek, Cheakamus River, Fitzsimmons Creek, Miller Creek, and Ryan River.

The Mashiter Creek dam was taken out after a debris jam formed in the water intake on August 31. On August 30, rocks and debris had infilled the dam reservoir and rendered it inoperable. An estimated 20,000-50,000 tons of debris clogged the dam. The overall damage seemed worse than previous years.<sup>1</sup> Squamish-based engineer Frank Baumann first expressed geotechnical concerns about Mashiter Creek in a letter to the Ministry of Municipal Affairs in December 1987: "Mashiter Creek drains a basin that has been heavily logged. Its upper reaches are underlain by unstable volcanic debris from Mount Garibaldi that has produced numerous mud flows in the past and is likely to produce more slides in the future." In a submission to council just over two months before this event, Baumann stated, "The unstable soils together with the clear-cut logging and poor road building of the past, mean that the Mashiter watershed is much more susceptible to landslides than the Stawamus River basin." On the morning of August 30, the original creek bed was riprapped but it was not until 5 p.m. that day that the creek was redirected.

The widespread flooding forced the evacuation of many Upper Cheakamus residents. The First Nations community of Cheekye was completely flooded in several feet of water. Starting on August 29 at 10 p.m., waters quickly rose and flooded an area encompassing 15 homes. Residents were evacuated by helicopter. The First Nations graveyard was also washed out. Floodwaters washed away the majority of the grave markers. Sandbagging was unsuccessful, as the water was moving too quickly. At one point, Cheekye River was monitored flowing at 28 km/h. The community has no proper dyking system. On one side, the dyke was not high enough and the water just ran over it.

On August 29-30, a flood of unprecedented timing and size occurred on Fitzsimmons Creek near Whistler.<sup>2</sup> Gravel deposits and log debris infilled the creek in its

lower reaches within the town site. Existing bank protection was damaged or destroyed. In the steep upper reaches of the creek, considerable log debris had accumulated and a large slide was reported. The peak instantaneous flood was estimated at 120 m<sup>3</sup>/s, which was about twice the channel capacity of Fitzsimmons Creek. The most spectacular changes to the channel bed and floodplain occurred in the canyon reach. During the flood, the creek incision lowered the channel bed about 4.5 m lower than the level in June 1991.

Concerns existed about the stability of a logjam that existed about 100 m upstream of the Blackcomb Mountain pump station intake. The logjam was completely carried away and/or smothered by new bed material and debris. At the pump station immediately downstream of this reach, the creek bed had risen about 2.5 m during the flood. Within eight days of the flood, it fell to the same level that existed before the flood. Significant amounts of damage were done to bridges and other facilities near the creek channel. About \$4 million have been spent since the event on remedial measures, including removal of sand, gravel, boulders and organic debris brought down by the unusually high flows.

According to fire chief and co-ordinator of the Whistler Emergency Program Tony Evans, the damage in Whistler was substantial. The biggest problem was to get things back to normal before the winter would strike. Fitzsimmons Creek needed re-channeling and the banks would have to be fortified. The bridges would have to be repaired and the water had to get back to White Gold. By September 3, the bridge to the KOA (camp site) had been repaired for emergency access to White Gold. The flood had demolished the White Gold bridge. Fitzsimmons Creek Park was completely washed out and the Blackcomb Skier bridge had to be repaired.

In Pemberton, significant flooding of agricultural land occurred when the dyke on Ryan River was overtopped. In addition, damage was caused to bank protection and dykes on the Lillooet and Ryan rivers, and Miller Creek. The Pemberton Valley reported 60 mm of rain in 24 hours. Furthermore, Miller Creek spilled its banks. Paul Froese of Agriculture Canada estimated at least 50% of the valley's potato crop was lost. Many farmers lost two to three years worth of future potato seed.<sup>3</sup> On the first day after PEP opened a claim centre for the Squamish-Whistler area, between 75-100 calls for aid were received. It would take months to repair the estimated \$4 million of damage in the Sea to Sky Corridor. Train operations were expected to be back in service around September 7.

The washouts and damage caused by the heavy rains to bridges in the Squamish Forest District resulted in cutting of approximately 75% of the district logging roads. Damage to forestry logging roads could reach as high as \$2 million. By September 26, the majority of the damage caused to Forest Service logging roads on August 30 was repaired. Remaining closed while under repair, included Indian River, Chance Creek, Meager Creek, west side of Lillooet Lake (from Billygoat Creek south to Fire Creek) and Upper Lillooet (access to Salal Creek only).

Flood damage to Meager Creek Hot Springs resulted in an early closure. The M-Creek access road was also closed due to flood damage.

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<sup>1</sup> The Mashiter Creek dam had earlier been the centre of controversy because of accusation about flawed engineering and disagreement over its cost effectiveness. In November 1990, only three days after its completion, the dam collapsed in a series of disasters that had plagued the \$1.6 million project intending to supply Squamish with an additional water source (*Squamish Times*).

2 The infrastructure development, including bridges, roads and buildings, was built on the alluvial fan reach of Fitzsimmons Creek (Ward et al., 1992).

3 For some valley growers the potato crop amounted to 90% of their annual income. Agriculture Canada had chosen the valley because of its location and low insect populations. In 1979, four greenhouses were built in Pemberton and local farmers began producing their own cuttings. By 1991, growers in the Pemberton Valley annually harvested about 500 ac. (200 ha), producing 4,000-5,000 tons of potatoes with an estimated value of \$1 million (*The Citizen*, September 5 and 12, 1991).

### **August 26-September 3, 1991**

**Event type:** Rock fall.

**Precipitation:** Squamish, 184.0 mm/5 days, August 26-30, 1991; Vancouver International Airport, 127.2 mm/5 days, August 26-30, 1991. (Temperatures were near normal to 2° C above.)

**Source:** *The Squamish Times*, September 10, 1991; Smith, 1994; Bunce et al., 1997 (p. 345).

**Details:** On September 3, a rock fall on the Squamish Highway near Porteau Cove Provincial Park claimed the life of a 43-year old Squamish man. The 12-in. (30 cm) diameter falling rock fell through the windshield of his vehicle. The accident happened 3.5 km north of the Just fatality on January 16, 1982.

The Just case had set a legal precedent when Just was awarded compensation by the B.C. Supreme Court for losses resulting from a rock fall in the Argillite Cut. Subsequently, Lewis (Smith, 1994) was awarded compensation for the death of her husband (Bunce et al., 1997). Since 1993, the Ministry of Highways and Transportation has adopted the Rock fall Hazard Rating System.

### **September 18, 1991**

**Event type:** Rock fall.

**Precipitation:** Squamish, 0.0 mm/1 day, September 18, 1991; Vancouver International Airport, 0.0 mm/1 day, September 18, 1991.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On September 18, 5 m<sup>3</sup> of rock came down onto Highway 99 (at 9.0 km) near Newman Creek.

### **November 6-17, 1991**

**Event type:** Rock fall.

**Precipitation:** Squamish, 40.8 mm/2 days, November 3-4, 1991; Squamish, 78.0 mm/3 days, November 10-12, 1991; Squamish, 80.8 mm/3 days, November 15-17, 1991.

**Source:** *The Squamish Times*, November 12 and 26, 1994; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 6, 30 m<sup>3</sup> of rock came down onto Highway 99 (at 27.8 km) in Cheakamus Canyon. On November 8 at 5:41 a.m., the Squamish RCMP reported a rock slide on Highway 99, 6 km north of Lions Bay. Falling debris struck a vehicle but no injuries were reported. The slide blocked one lane for one hour before the fallen material was removed.

On November 13, 30 m<sup>3</sup> of rock came down onto Highway 99 (at 27.8 km) in Cheakamus Canyon.

On November 17, 100 m<sup>3</sup> of rock came down onto Highway 99 (at 33.5 km) along Howe Sound. On November 17 at 1:30 a.m., an RCMP vehicle coming around a corner at North Britannia Beach, collided with several rocks on the road from the small slide. Damage to the car was in excess of \$2,500., but only minor head injuries resulted from the collision.

### **January 22-February 2, 1992**

**Event type:** Rock slide; Flooding.

**Precipitation:** Vancouver International Airport, 39.8 mm/1 day, January 23, 1992; Squamish, 332.2 mm/12 days, January 22-February 2, 1992.

**Source:** *The Squamish Times*, January 28; February 4, 1992; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On January 26 at 3:45 a.m., 150 m<sup>3</sup> of rock came down onto Highway 99 (at 34.3 km) near Britannia Creek. The rock slide, 1 km south of Murrin Lake, blocked two lanes of Highway 99. No vehicles were involved. Later that morning, highway crews were able to open one lane of traffic. Two boulders, “comparable in size to tandem dump trucks,” were drilled and blasted. A long line of ski-traffic was held back until the road opened to two-lane traffic at 10:15 p.m.

Early on the morning of January 28, flooding occurred near the confluence of Cheekye and Cheakamus rivers. Debris left over from the massive flooding in August 1991 contributed to the minor flooding of the Cheakamus. According to Squamish public works assistant superintendent Mike Darbyshire, damage could have been more widespread were it not for the high grade of Paradise Valley Road, which held back much of the rising water. “The debris on the road acted like a dam and caused the water to flow into the right area, away from the houses and the highway. The damage was minimal compared to what would have happened if the road was lower.” The water bypassed Squamish First Nations reserve subdivision and followed an old riverbed. As a safety precaution, the subdivision was evacuated for one night.

### **March 23, 1992**

**Event type:** Rock fall.

**Precipitation:** Squamish, 0.0 mm/1 day, March 23, 1992; Vancouver International Airport, 0.0 mm/1 day, March 23, 1992.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On March 23, 10 m<sup>3</sup> of rock came down onto Highway 99 (at 2.3 km) at Snake Hill.

### **April 22, 1992**

**Event type:** Rock fall.

**Precipitation:** Squamish, 17.4 mm/3 days, April 19-21, 1992; Vancouver International Airport, 8.4 mm/1 day, April 22, 1992.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On April 22, 5 m<sup>3</sup> of rock came down onto Highway 99 (at 25.6 km) at Porteau Bluffs.

**May 3, 1992**

**Event type:** Rock fall.

**Precipitation:** Squamish, 74.8 mm/2 days, April 28-29, 1992; Vancouver International Airport, 39.6 mm/1 day, April 29, 1992.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On May 3, 40 m<sup>3</sup> of rock came down onto Highway 99 (at 24.0 km) near the Porteau Bluffs.

**June 12-15, 1992**

**Event type:** Rock falls.

**Precipitation:** Squamish, 45.0 mm/2 days, June 12-13, 1992; Vancouver International Airport, 30.4 mm/2 days, June 12-13, 1992.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On June 12, 10 m<sup>3</sup> of rock came down onto Highway 99 (at 7.0 km) at Strip Creek.

On June 15, 71 m<sup>3</sup> of rock came down onto Highway 99 (at 14.2 km) between M-Creek and Loggers Creek.

**October 23-26, 1992**

**Event type:** Flooding; Rock fall.

**Precipitation:** Pemberton A, 52.8 mm/2 days, October 23-24, 1992; Squamish, 216.6 mm/7 days, October 17-23, 1992; Whistler, 69.8 mm/2 days, October 23-24, 1992. (Daily mean temperatures at Whistler were up to 5°C degrees above normal.)

**Source:** Ministry of Environment, Lands and Parks files; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On October 23, residents at Tantalus Acres subdivision, north of Brackendale near the Squamish River, experienced flooding problems. Water was flowing along the Squamish Valley Road and onto the road to the subdivision. The water, 6-12 in. (15-30 cm) deep, collected in some low-lying areas including front and back yards. Subdivision residents noted they had been experiencing flooding more frequently in the past few years. They attributed the cause to an increase in riverbed elevation in Squamish River. Apparently at high water in Squamish River, water backs up a creek channel that crosses Squamish Valley Road, leading along a hill side and back under the road to the east and south to a wide low area, from where it flows down the road to Tantalus Acres. Some of the houses in this subdivision are low enough to suffer flooding at times of high water.

On October 23-24, flooding occurred in Pemberton after Ryan Creek breached a dyke. Fitzsimmons Creek in Whistler was also reported to be in danger of flooding.

On October 26, 30 m<sup>3</sup> of rock came down onto Highway 99 (at 28.4 km) in the Cheakamus Canyon.

**November 10, 1992**

**Event type:** Rock fall.

**Precipitation:** Squamish, 29.2 mm/1 days, November 6, 1992; Vancouver International Airport, 31.8 mm/2 days, November 6-7, 1992.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 10, 5 m<sup>3</sup> of rock came down onto Highway 99 (at 25.0 km) in the Porteau Bluffs area.

### **February 19, 1993**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, no precipitation, February 19, 1993;

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On February 19, 80 m<sup>3</sup> of rock came down onto Highway 99 north of Alice Lake Park. The soft, brown rock sloughed from the top of a 10 m bluff.

### **April 26, 1993**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 25.4 mm/2 days, April 24-25, 1993; Squamish, not available.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On April 26, 10 m<sup>3</sup> of rock came down onto Highway 99 (at 15.7 km) approximately 1 km south of Loggers Creek.

### **February 26-28, 1994**

**Event type:** Rock fall and landslide.

**Precipitation:** Vancouver International Airport, 54.6 mm/4 days, February 26-March 1, 1994; Squamish, 179.6 mm/5 days, February 27-March 1, 1994; Britannia Beach, 158.4 mm/3 days, February 27-March 1, 1994.

**Source:** *The Squamish Chief*, March 8, 1994; May 28, 1996; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On February 26, 40 m<sup>3</sup> of rock came down onto Highway 99 (at 27.9 km) at Godfrey's Lookout in Cheakamus Canyon. Prior to the slide, there was intense rainfall. Bruce Hayden, Geotechnical Engineer for Ministry of Transportation and Highways, said that two defined discontinuities in a wedge quite high up on the slope popped out and caused in the slide (*The Squamish Chief*, May 28, 1996).

On February 28 at 1 a.m., a rock slide hit the northbound lane of Highway 99 at Murrin Point near Lions Bay, closing the road for two hours. According to the Squamish RCMP, the same spot is subject to rock falls "every year or two." Two years earlier, a larger slide came down at the same location (*The Squamish Chief*, March 8, 1994).

### **November 18, 1994**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 31.2 mm/ 1 day, November 19, 1994; Squamish, 39.9 mm/2 days, November 18-19, 1994; Britannia Beach, not available.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 18, 6 m<sup>3</sup> of rock came down onto Highway 99 (at 9.4 km) 300 m south of Lone Tree Creek.

**December 8, 1994**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 30.5 mm/ 3 days, December 6-8, 1994; Britannia Beach, 71.2 mm/3 days, December 6-8, 1994; Squamish, 48.9 mm/2 days, December 7-8, 1994.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On December 8, an estimated 230 lbs. (103.5 kg) of rock came down onto Highway 99 (at 21.8 km) at Argillite Cut (Porteau Cove), with 200 lbs. (90 kg) ending up on the road and 30 lbs. (13.5 kg) in the ditch.

**December 17-20, 1994**

**Event type:** Rock fall.

**Precipitation:** Britannia Beach, 118.1mm/2 days, December 18-19, 1994; Squamish, 160.4 mm/3 days, December 18-20, 1994.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On December 17, one “large” rock came down onto Highway 99 (at 2.6 km) at the Snake Hill.

**December 26, 1994**

**Event type:** Rock slide.

**Precipitation:** Lions Bay, 50.0 mm/1 day, December 26, 1994; Cypress Bowl, 44.6 mm/1 day, December 26, 1994; Cypress Bowl, 16.0 mm + 8.0 cm snow/1 day, December 25, 1994; Howe Sound Strachan Creek, 85.0 mm/1 day, December 25, 1994.

**Source:** *The Vancouver Sun*, December 27, 1994; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On December 26, heavy rain caused a 75 m<sup>3</sup> rock slide, 30 m north of Turpin Creek, about 8 km north of Horseshoe Bay. The slide, which occurred at 7:45 a.m., covered three lanes of a four-lane section of Highway 99 (at 7.8 km) (about 8 m). It was 40 ft. (12 m) long and 3-4 ft. (0.9-1.2 m) deep at the shoulder. On the northbound lane, between 30-40 m<sup>3</sup> of rocks were reported.

**June 9-10, 1995**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 13.2 mm/ 1 day, June 10, 1995; Britannia Beach, 0.0 mm/1 day, June 10, 1995; Squamish, 0.0 mm/1 day, June 10, 1995.

**Source:** Ministry of Transportation and Highways rock fall notification summary.

**Details:** On June 9, rocks up to “baseball size” covered the northbound lane of Highway 99, 240 m south of Windy Point, 20 km north of Horseshoe Bay. During a second occurrence here in 24 hours, rocks covered both lanes of the highway.

**January 13, 1996**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 24.4 mm/ 3 days, January 6-8, 1996; Britannia Beach, 158.6 mm/5 days, January 6-10, 1996; Squamish, 156.4 mm/5 days, December 6-10, 1996.

**Source:** Ministry of Transportation and Highways rock fall notification summary.

**Details:** On January 13, heavy rain flushed small rocks off the bank 100 m south of Windy Point onto Highway 99, 20 km north of Horseshoe Bay.

### **February 23, 1996**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 12.0 mm/ 2 days, February 22-23, 1996; Britannia Beach, 105.5 mm/3 days, February 17-20, 1996.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On February 23, 5 m<sup>3</sup> of rock came down into the ditch along Highway 99 (at 1.5 km) near Pasco Road.

### **May 18-24, 1996**

**Event type:** Rock fall; Rock slide.

**Precipitation:** Vancouver International Airport, 21.1 mm/ 2 days, May 17-18, 1996; Britannia Beach, 40.2 mm/2 days, May 17-18, 1996; Squamish, 53.4 mm/2 days, May 17-18, 1996.

**Source:** *The Squamish Chief*, May 21 and 28; June 4 and 18, 1996; Ministry of Transportation and Highways, Rock fall notification summary; Ministry of Transportation and Highways rock fall records; Squamish RCMP File # 96-4598.

**Details:** On the evening of May 18, a small slide was reported to have occurred on the highway south of Whistler.

On May 19 at 8:25 a.m., 15,000 m<sup>3</sup> of rock came down onto Highway 99 (at 28.0 km) at Godfrey's Lookout in Cheakamus Canyon. It covered an estimated 100 m of the road and was about 15 m high in places with rocks "as big as houses." At noon, there was still debris coming down. One lane was opened to alternating traffic late that night. The slide just south of the Garibaldi salt shed covered all three lanes, leaving motorists in Squamish and Whistler stranded. There were no injuries reported from the slide.

The highway was closed for part of the week. When the highway reopened, it was open for limited hours with single-lane alternating traffic. On May 21, as rock-clearing work was being carried out, more rubble fell. On the morning of May 22, another slide closed the highway for the rest of the day and most of the next day. There was further rock fall activity on the evening of May 23 and the morning of May 24. Using passenger cars from the Royal Hudson sightseeing train, BC Rail transported people between Vancouver and Whistler on May 24.

Cleanup and stabilization work would take more than two weeks. By early June, crews had worked for 18 days straight. One member of the rock-scaling crew sustained minor injuries. By June 4, about 45,000 m<sup>3</sup> of rock had been removed from the cliff, while an additional 10,000 m<sup>3</sup> still would be sheared off. Commuters and weekend travellers would experience further delays well into August.

The reason for the slide was not established, but it had been raining heavily at the time. Where the slide occurred, the remaining rock was a smooth, brown plane, indicating an old discontinuity and weakness in the rock. The first smaller slides of the series of them came from lower on the slope and likely undermined rock, resulting in a bigger slide.

Jim Hegan, acting area manager for the Ministry of Transportation and Highways (MoTH) said that the area that slid was an area of "slip planes" and was isolated from the

rest of the slope. According to Bruce Hayden, MoTH geotechnical engineer, the metavolcanic in the rocks in the area resulted in a random jointing and fracturing pattern with some shear zones and very definite faults or joints. Electronic monitoring equipment was placed on the slope above the highway and the slide area was monitored and evaluated. But there is not much that could be done be done to prevent a major slide because “whenever you mountains up, they have to come down.”

On May 24, six “fist-sized” rocks came down onto the northbound lane of Highway 99 at Windy Point 20 km north of Horseshoe Bay. One car was hit. (Squamish RCMP File # 96-4598)

### **July 9, 1996**

**Event type:** Rock falls.

**Precipitation:** Vancouver International Airport, 0.0 mm/ 1 day, July 9, 1996; Britannia Beach, 0.0 mm/1 day, July 9, 1996; Squamish, 0.0 mm/1 day, July 9, 1996.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary; Ministry of Transportation and Highways rock fall records.

**Details:** On July 9, 40 m<sup>3</sup> of rock came down onto Highway 99 (at 38.0 km) at Howe Sound access Left. This rock fall occurred approximately 38 km north of Squamish.

On the same day at 11:11 a.m., the Ministry of Transportation and Highways reported approximately 55 m<sup>3</sup> on the highway 2 km south of Darrell Bay. Several “fist-sized” rocks blocked the northbound lane while two “dishwasher-sized” rocks came to rest on the shoulder.

Although the rocks that came down south of Shannon Falls on the morning of July 9 were fist-sized, several people reported that also much larger rocks came down. Some of them were as large as 2 m in diameter.

### **October 17, 1996**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 38.6 mm/1 day, October 17, 1996; Britannia Beach, 46.6 mm/1 day, October 17, 1996.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On October 17, more than 5 m<sup>3</sup> of rock came down onto Highway 99 south of Murrin Provincial Park. The rock fall included three rocks up to the size of 1 m<sup>3</sup> and some smaller rocks and trees. All the rocks that went through a cut on the west side of the highway were contained in the ditch.

### **November 10-16, 1996**

**Event type:** Rock falls.

**Precipitation:** Vancouver International Airport, 11.4 mm/1 day, November 7, 1996; Britannia Beach, 82.2 mm/2 days, November 7-8, 1996; Vancouver International Airport, 37.8 mm/1 day, November 12, 1996; Britannia Beach, 51.8 mm/2 days, November 11-12, 1996.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary; Ministry of Transportation and Highways rock fall records.

**Details:** On November 10, rocks came down onto the southbound lane, shoulder, and ditch along Highway 99, 1.5 km north of Emerald Estates. One rock measured 2.5 m<sup>3</sup>; a few 3 m<sup>3</sup> rocks ended up on the shoulder and the ditch filled with “fist-sized” rocks.

On November 13, 15 m<sup>3</sup> of rock came down onto Highway 99 (at 1.8 km) at the bottom of Snake Hill, 14 m<sup>3</sup> on the highway and 1 m<sup>3</sup> in the ditch.

On November 16, 7 m<sup>3</sup> of rock came down in the Tunnel Point rest area (at 15.8 km), 5 m<sup>3</sup> of which ending up on Highway 99 and 2 m<sup>3</sup> in the ditch.

### **February 19, 1997**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 15.6 mm/1 day, February 18, 1997;

Britannia Beach, 64.2 mm/4 days, February 16-19, 1997.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On February 19, more than 5 m<sup>3</sup> of rock came down onto Highway 99 just south of Cougar Mountain Road, 150 m north of Loggers Creek corner. The rock fall brought down a 40-ft. (12 m) fir tree and a boulder, approximately 10 m<sup>3</sup> in size.

### **April 20, 1997**

**Event type:** Rock fall.

**Precipitation:** Britannia Beach, 31.8 mm/1 day, April 19, 1997; Vancouver International Airport, 37.5 mm/2 days, April 19-20, 1997.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On April 20, 7.5 m<sup>3</sup> of rock came down onto Highway 99 at Emerald Estates 1.3 km north of Whistler. Some of the rocks measured 2-3.5 m in diameter.

### **July 20, 1997**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 0.0mm/2 days, July 19-20, 1997;

Britannia Beach, 0.0 mm/2 days, July 19-20, 1997.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On July 20, rocks came down onto Highway 99, 500 m north of Horseshoe Bay, damaging one vehicle. Between 0.06-0.08 m<sup>3</sup> gravel sized debris and one larger rock covered approximately 15 m of the north- and southbound lanes.

### **August 27, 1997**

**Event type:** Rock falls.

**Precipitation:** Vancouver International Airport, 17.4 mm/1 day, August 26, 1997;

Britannia Beach, 37.2 mm/1 day, August 26, 1997.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary; Ministry of Transportation and Highways rock fall records.

**Details:** On August 27, 112 m<sup>3</sup> of rock came down onto Highway 99 south of Culliton Creek, 20.45 km north of Squamish. The rocks, ranging up to 10 m<sup>3</sup> in size, came from a 10 m high rock face. Approximately 10 m<sup>3</sup> of rocks covered the roadway.

**November 24, 1997**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 14.0 mm/2 days, November 22-23, 1997; Britannia Beach, 30.8 mm/1 day, November 23, 1997.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On November 24, 15 m<sup>3</sup> of rock came down onto Highway 99, 1 km south of the Pemberton maintenance yard. Rocks, the largest of which was 3 m<sup>3</sup>, covered both lanes.

**January 20, 1998**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 14.2 mm/1 day, January 19, 1998; Britannia Beach, 80.8 mm/4 days, January 17-20, 1998.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary; Ministry of Transportation and Highways rock fall records.

**Details:** On January 20, 6 m<sup>3</sup> of rock came down onto the northbound lane of Highway 99 (at 24.9 km) near Porteau Bluffs, 300 m north of Porteau Cove Provincial Park, 3 m<sup>3</sup> ending up on the road and 3 m<sup>3</sup> in the ditch.

**April 5, 1998**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 1.8 mm/1 day, April 5, 1998; Britannia Beach, 4.8 mm/1 day, April 5, 1998.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On April 5, more than 5 m<sup>3</sup> of rock came down onto Highway 99, blocked it 16 km north of Horseshoe Bay. One rock measured 1.5 m<sup>3</sup>, while the weight of two rocks were estimated at 500 lbs. (225 kg); two at 150 lbs. (67.5 kg) each, and one, 1,000 lbs. (450 kg).

**October 2, 1998**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 10.4 mm/1 day, October 1, 1998; Britannia Beach, 41.6 mm/2 days, October 1-2, 1998.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On October 2, between 1-5 m<sup>3</sup> of “football-sized” rocks blocked both lanes of Highway 99, 200 m north of Cosmo Creek.

**December 6, 1998**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 25.6 mm/1 day, December 5, 1998; Britannia Beach, not available.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On December 6, 6.5 m<sup>3</sup> of rock came down onto Highway 99 north of Britannia Beach, blocking the slow-lane. The rocks included a “pickup cabin size” one.

**August 27, 1999**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 6.6 mm/1 day, August 24, 1999; Britannia Beach, 24.5 mm/1 day, August 24, 1999.

**Source:** Ministry of Transportation and Highways rock fall records; Squamish RCMP File # 99-4532.

**Details:** On August 27, a rock fall onto Highway 99, 100 m south of Windy Point, 20 km north of Horseshoe Bay, damaged one car. One lane was blocked, forcing single-lane alternating traffic.

**October 15, 1999**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 7.0 mm/1 day, October 13, 1999; Britannia Beach, 51.0 mm/1 day, October 12, 1999.

**Source:** Ministry of Transportation and Highways rock fall records.

**Details:** On October 15, more than 5 m<sup>3</sup> of rock came down onto Highway 99 on the top of Brohm Lake hill. One large rock “the size of a Volkswagen” rolled down a talus slope across three lanes into a ditch.

**January 28, 2000**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 5.6 mm/1 day, January 25, 2000; Britannia Beach, 11.2 mm/1 day, January 25, 2000.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On January 28, 8 m<sup>3</sup> of rock came down in the Snake Hill Bluff area of Highway 99 (at 2.5 km), 2 m<sup>3</sup> of which landed on the road and 6 m<sup>3</sup>, in the ditch.

**November 16, 2000**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 0.0 mm/1 day, November 16, 2000.

**Source:** *The Vancouver Sun*, November 17, 2000; Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On November 16, a woman suffered non-life-threatening injuries after she was caught in a rock fall, 9 km south of Squamish. Her vehicle was severely damaged by falling rock from a bluff above the highway. According to RCMP Sgt. Gary Brine, the slide that occurred about 5 p.m., might have been connected to a crew working on a rock face in the area. The slide closed the highway for just over an hour. Two of the three lanes then opened while crews continued working through the night to clear the debris from the road.

The 200 m<sup>3</sup> of rock that Ministry of Transportation and Highways reported to have come down the same day onto Highway 99 (at 37.0 km) in the Watts Point area, probably refers to the same event.

**January 29, 2001**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 8.8 mm/1 day, January 29, 2001.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On January 29, 15.3 m<sup>3</sup> of rock came down onto Highway 99 (at 25.5 km) at Porteau Bluffs.

**September 29, 2001**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 1.8 mm/1 day, September 28, 2001.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On September 29, 60 m<sup>3</sup> of rock came down onto Highway 99 (at 12.6 km) near the Brunswick Hill, with 45 m<sup>3</sup> ending up on the road and 15 m<sup>3</sup>, in the ditch.

**May 24, 2002**

**Event type:** Rock fall.

**Precipitation:** Vancouver International Airport, 1.2 mm/1 day, May 23, 2002.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On May 24, 30 m<sup>3</sup> of rock came down into the ditch along Highway 99 (at 11.8 km) near the Cheekye River bridge.

**May 1, 2003**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On May 1, 7 m<sup>3</sup> of rock came down into the ditch along Highway 99 (at 28.4 km) in Cheakamus Canyon, north of Cheakamus.

**October 16-22, 2003**

**Event type:** Flooding; Rock slide; Rock fall.

**Precipitation:** Vancouver International Airport, 85.0 mm/1 day, October 16, 2003; Vancouver International Airport, 181.4 mm/7 days, October 16-22, 2003; Squamish A, 480.6 mm/7 days, October 16-22, 2003; Pemberton A, 10.8 mm/7 days, October 16-22, 2003; Squamish A, 137.0 mm/1 day, October 17, 2003.

**Source:** *Times Colonist*, October 20, 2003; *The Province*, December 15, 2004; *The Vancouver Sun*, November 29, 2003 and December 15, 2004; Chapman, 2003; Ministry of Transportation and Highways, Incident # RS34772393; Ministry of Transportation and Highways, Rock fall notification summary; David Jones, meteorologist Environment Canada, Interview CBC January 18, 2005.

**Details:** On October 16, an intense front of warm Pacific origin moved into the southern coast of British Columbia. It stalled over central Vancouver Island and Howe Sound, bringing high rainfall during the four-day period of October 16-19. On October 16, the Vancouver International Airport reported maximum wind gusts of 52 km/h and temperatures up to 5°C above normal for the period of the event. In addition, the freezing elevation rose, which resulted in snowmelt at high elevation due to rain-on-snow. The system coming directly from the Tropics and thus, carrying more moisture and heavier

rain, it was dubbed a “tropical punch,” one step beyond the “Pineapple Express.” “It dumped a year’s worth of rain in four days on the Sea to Sky Corridor” (David Jones, interview CBC January 18, 2005). The storm caused widespread flooding in Squamish and Pemberton (*The Vancouver Sun*, November 29, 2003).

On October 16, a small rock slide came down on Highway 99, 19.1 km north of Horseshoe Bay, mainly blocking the northbound lane with 5-10 m<sup>3</sup> of rocks. On the same day, 13 m<sup>3</sup> of rock came down near Deeks Creek in the circular retaining wall cut area at 19.1 km on Highway 99, 3 m<sup>3</sup> of which landed on the highway and 10 m<sup>3</sup>, in the ditch. On October 17, 15 m<sup>3</sup> of rock came down into the ditch along Highway 99 (at 23.5 km) near the Porteau Boys Camp bluff (MoTH).

On October 18 around 3 a.m., floodwaters destroyed the road and rail bridges over Rutherford Creek, between Whistler and Pemberton on Highway 99. Three vehicles went off the highway into the creek, killing five occupants.<sup>1</sup> A car containing two bodies was recovered the next day. A SUV carrying two of the victims was never located. One occupant of the vehicle managed to swim to safety.<sup>2</sup>

Parts of the highway north of Whistler were also washed out. Provincial authorities set up emergency centres in Squamish and Pemberton, with 361 people signed in at the Squamish centre by the afternoon of October 22. Early damage estimates from the floods were expected to be in the \$20-30 million range.

During the flood event, nearly 800 people were forced from their homes in Squamish, Pemberton and Mount Currie. About 500 of Mount Currie’s 1,700 residents were evacuated. Though water levels had subsided substantially, on the morning of October 19, several homes in Mount Currie were still surrounded by water. Some of the 317 people evacuated from Squamish were expected to return home on October 22.

Whistler was also cut off in both directions after flooding along Cheakamus River near Cheakamus Canyon took out 200 m of pavement south of the resort community. Currents took out the south shoulder, south lane and eroded part of the north lane, leaving only one-third of the pavement remaining. Other areas were washed out with shoulder damage. The town of Pemberton, 35 km north of Whistler, was completely inaccessible by road. It took workers from the Ministry of Transportation almost a week to establish a temporary road bridge into the town.

BC Rail estimated flood damage to its rail lines “in the millions of dollars” in Cheakamus Canyon and Rutherford Creek areas.

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<sup>1</sup> In 2004, the provincial transportation ministry installed a new \$5-million bridge across Rutherford Creek designed to withstand a one-in-200 year flood (*The Vancouver Sun*, December 15, 2004).

<sup>2</sup> On December 14, more than a year later, during routine dredging work another vehicle was uncovered with one body inside. Initially it was suspected that the truck had carried two of the victims, who were swept away the night the bridge collapsed, but the vehicle turned out to be an Isuzu Trooper reported stolen at the time of the flood. The vehicle had not been reported stolen until October 2003 and nobody ever filed a missing person’s report with Pemberton RCMP in relation to the suspect’s disappearance. The RCMP later identified the victim as a 35-year old man believed to have plunged in the creek in the early hours of November 18 (*The Province*, December 15, 2004; January 13, 2005).

## **December 2, 2003**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Rock fall notification summary.

**Details:** On December 2, 6 m<sup>3</sup> of rock came down onto Highway 99 (at 9.7 km) near the Newman Creek bridge.

#### **December 12, 2004**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Maintenance Contractor's Rock fall Report Summary.

**Details:** On December 12, >5 m<sup>3</sup> of rock came down onto the south and northbound lanes of Highway 99 from a rock bluff between Whistler and the Heliport.

#### **January 21, 2005**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Maintenance Contractor's Rock fall Report Summary.

**Details:** On January 21, a side of Cheakamus slide released approximately 1,000 m<sup>3</sup> of rock material into the berm catchment along Highway 99.

#### **March 20, 2005**

**Event type:** Debris flow.

**Precipitation:** Not available.

**Source:** *The Chief*, March 25, 2005; Phillips, 2005; CBC newscasts, March 20, 2005.

**Details:** On March 20 at 5:30 a.m., heavy overnight rain caused a debris flow on Turpin Creek. The mud and debris slide tore up sections of Highway 99, forcing temporarily closure of the highway.

After the creek was blocked, it caused the highway to be flooded. An earlier report that the bridge had been washed out proved to be incorrect. A tour bus with only its driver got caught in the flooding. Equipment being used in the \$600-million upgrade project for the 2010 Olympic Winter Games, was used to clear the mud and debris almost a metre deep on the road. The slide debris reportedly originated well above the highway. According to a Ministry of Transportation, construction on the highway did not contribute to the slide.

#### **April 3-6, 2005**

**Event type:** Rock falls.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Maintenance Contractor's Rock fall Report Summary.

**Details:** On April 3, >5 m<sup>3</sup> of rock came down onto the northbound lane of Highway 99 at Pasco Road. The majority of the rock ended up in the ditch, blocking it and causing flooding.

On April 6, >5 m<sup>3</sup> of rock came down onto Highway 99 at 3.788 km approximately 1 km south of Function Junction. Five very large rocks with a number of smaller ones came down from a location 5 m above.

**September 10, 2005**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Maintenance Contractor's Rock fall Report Summary.

**Details:** On September 10, >5 m<sup>3</sup> of rock came down onto Highway 99 at 3.239 km.

**April 28, 2006**

**Event type:** Rock fall.

**Precipitation:** Not available.

**Source:** Ministry of Transportation and Highways, Maintenance Contractor's Rock fall Report Summary.

**Details:** On April 28, 60 m<sup>3</sup> of rock came down onto Highway 99 between Boat Launch and Blowdown Creek.

**November 3-6, 2006**

**Event type:** Flooding.

**Precipitation:** Not available.

**Source:** *The Vancouver Sun*, November 7, 2006.

**Details:** Late on November 6, as Squamish River was rising rapidly, evacuations were under way in Squamish. The river was expected to continue rising the next day, causing some flooding upriver from Brackendale. The town of Squamish itself was not endangered.

**February 4, 2007**

**Event type:** Rock slide.

**Precipitation:** Not applicable.

**Source:** *The Vancouver Sun*, February 5, 2007; *The Province*, February 7, 2007; CBC newscasts, February 4 and 5, 2007.

**Details:** On February 4 at 9:45 a.m., a massive mud and debris slide came down onto Highway 99 near the Ansell Place exit just south of Lions Bay. There were no injuries or damage to vehicles. At least 2 m high slide with large boulders and trees completely covered all lanes of the highway. Traffic between Eagle Ridge and Lions Bay was halted in both directions for seven hours. Dynamite was used to blow up one boulder that was too big to be moved.

The cause of the slide, which came down in an unstable area naturally prone to landslides, was unknown. Reconstruction of the highway may have played a role. Local residents blamed the slide on recent blasting in the area right where crews had been widening the road. As recently as two days earlier, rock blasting had been carried out there as part of the Sea to Sky Highway improvement project.<sup>1</sup>

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<sup>1</sup> British Columbia taxpayers could be responsible for much of the slide cleanup. The maintenance contractor's responsibility of cleaning up a slide is limited at \$43,000. The maximum amount the private corporation, which got the 35-year 3P Sea to Sky Highway maintenance contract, must pay in any single year is \$75,000. Once that threshold is passed, all cleanup costs are billed to the provincial government (*The Province*, February 7, 2007).

## Appendix 1

| List of historical landslide events. |                                      |                                   |         |          |
|--------------------------------------|--------------------------------------|-----------------------------------|---------|----------|
| Date                                 | Event interpreted                    | Location                          | Easting | Northing |
| Fall/winter 1855/1856                | rock slide                           | The Barrier, Rubble Creek         | 493300  | 5532400  |
| 15/03/1915                           | rock avalanche                       | Jane Mining Camp                  | 489800  | 5495300  |
| 28/10/1921                           | catastrophic flood/submarine failure | Britannia Beach                   | 485100  | 5497000  |
| 18/12/1931                           | debris flow                          | Disbrow Ck                        | 482350  | 5472150  |
| Ca. 1935                             | debris flows                         | Alberta Ck                        | 482850  | 5478700  |
|                                      | debris flows                         | Newman Ck                         | 483100  | 5475500  |
| 08/10/1950                           | debris flow                          | Mile 18 /Cheakamus Canyon         | 488100  | 5531350  |
| 22/08/1955                           | subaqueous slope failure/tsunami     | Woodfibre/Mill Ck                 | 482100  | 5501750  |
| 08/06/1956                           | rock slides                          | 16 km N Horseshoe bay             | 481150  | 5484800  |
| 09/06/1956                           | rock fall                            | 16 km N Horseshoe bay             | 481150  | 5484800  |
| 27/08/1956                           | debris flow                          | Mile 18 (29km N HSB)              | 483200  | 5489550  |
| 26/09/1956                           | debris flow                          | 8km N Horseshoe Bay               | 483100  | 5475500  |
| 20/11/1956                           | rock slide                           | Mile 1 (1.6km N HSB)              | 480800  | 5469900  |
| 24/11/1956                           | rock slide                           | Mile 23.5 (2.5km N Sunset Beach)  | 483150  | 5474350  |
| 13/03/1957                           | rock slide                           | Mile 15.2 (1.6km N Sunset Beach)  | 483000  | 5473700  |
| 16/04/1957                           | rock slide                           | Mile 22 (2.3km N Sunset Beach)    | 483150  | 5474150  |
| 17/04/1957                           | rock slide                           | 28.8 km N of Squamish             | 488200  | 5531300  |
| 24/04/1957                           | debris flow                          | 40km N Vancouver=Sunset Beach     | 482300  | 5472150  |
|                                      | rock slide                           | 9.6 km N Horseshoe Bay            | 482800  | 5477050  |
| 27/06/1957                           | subaqueous slope failure/tsunami     | Squamish Delta                    | 487300  | 5504200  |
| 06/10/1957                           | rock fall                            | 34km N Brunswick Beach            | 489700  | 5509700  |
| 29/10/1957                           | rock fall                            | Mile 21 (Brunswick Point)         | 481150  | 5485950  |
| 23/01/1958                           | rock slide                           | Brunswick Beach                   | 482500  | 5480000  |
| Aug. 1958                            | debris flow                          | 5 km N Squamish                   | 489600  | 5508800  |
| 30 Nov.-1 Dec. 1958                  | debris flow                          | 16.8 km N Horseshoe Bay           | 481150  | 5485600  |
| 29/04/1959                           | debris flow                          | Pemberton                         | 513900  | 5574300  |
| 27/01/1960                           | rock slide                           | Mile 18 (Porteau)                 | 483200  | 5489700  |
| 24/03/1960                           | rock slide                           | Porteau Cove                      | 483000  | 5488700  |
| 12/10/1962                           | debris flow                          | Magnesia Ck                       | 482450  | 5480250  |
| 19/11/1962                           | debris flow                          | Porteau Cove                      | 483000  | 5488700  |
| 21/10/1963                           | rock slide                           | Mile 209(4.8km S Britannia Beach) | 484100  | 5492600  |

| Date       | Event interpreted | Location                                   | Easting | Northing |
|------------|-------------------|--|---------|----------|
| 26/11/1964 | rock slide        | Porteau Cove (25.3km)                      | 483000  | 5488700  |
| 20/11/1966 | rock fall         | 6.4km S Pemberton                          | 509600  | 5568700  |
| 25/11/1966 | debris flow       | Porteau Cove                               | 483000  | 5488700  |
| 09/02/1969 | rock fall         | 10 km N Lions Bay                          | 483100  | 5489250  |
| 13/02/1969 | rock slide        | 5 km N Lions Bay                           | 482000  | 5483300  |
| 17/02/1969 | rock fall         | 10 km N Lions Bay                          | 482300  | 5487850  |
| 04/03/1969 | rock fall         | 10 km N Lions Bay                          | 482300  | 5487850  |
| 04/03/1969 | debris slide      | 2.4 km N Lions Bay                         | 482400  | 5480650  |
| 18/09/1969 | debris flow       | Charles Ck;                                | 483100  | 5474250  |
|            | debris flow       | Harvey Ck;                                 | 482850  | 5478400  |
|            | debris flow       | Newman Ck                                  | 483100  | 5475500  |
| 19/02/1972 | debris slide      | Fisherman's Cove                           | 479900  | 5467500  |
| 22/02/1972 | debris slide      | 9.6 km N Fisherman's Cove<br>=Newman Creek | 483100  | 5475500  |
| 12/07/1972 | debris slide      | 800 m N Horseshoe Bay                      | 480450  | 5469200  |
| 03/11/1972 | debris flow       | Charles Ck                                 | 483100  | 5474250  |
| 07/11/1972 | debris flow       | Charles Ck                                 | 483100  | 5474250  |
| 15/12/1972 | debris flow       | Harvey Ck                                  | 482850  | 5478400  |
| 25/12/1972 | debris flow       | Alberta Ck                                 | 482850  | 5478700  |
| 23/05/1973 | debris flow       | Harvey Ck                                  | 482850  | 5478400  |
| 20/04/1974 | rock slide        | 3.2 km S of Porteau = Brunswick Point      | 481150  | 5485950  |
| 25/08/1976 | rock fall         | 6.4 km N Lions Bay= Sunset Beach           | 482300  | 5472150  |
| 01/09/1976 | rock slide        | 200m N of Lions Bay= Alberta Creek         | 482850  | 5478700  |
| 01/09/1980 | rock fall         | 3.7 km N Horseshoe Bay                     | 481800  | 5471550  |
| 04/10/1981 | rock slide        | 2 km N Sunset Beach                        | 483100  | 5474000  |
| 27/10/1981 | debris flow       | M-Creek                                    | 482400  | 5480800  |
| 28/10/1981 | debris flow       | Magnesia Ck                                | 482450  | 5480250  |
| 01/11/1981 | rock fall         | Sunset Beach                               | 482300  | 5472150  |
| 19/11/1981 | rock fall         | 2.5 km N of Horseshoe Bay                  | 481400  | 5470650  |
| 04/12/1981 | debris flows      | Charles Ck                                 | 483100  | 5474250  |
|            | debris flow       | Newman Ck                                  | 483100  | 5475500  |
| 16/01/1982 | rock slide        | Brunswick Pt                               | 481150  | 5485950  |
| 18/01/1982 | rock fall         | 6.6 km S Charles Ck                        | 480150  | 5468650  |
|            | rock fall         | Tunnel Pt                                  | 482200  | 5482400  |
| 13/04/1982 | rock fall         | Loggers Ck                                 | 482050  | 5483100  |
| 03/12/1982 | rock slide        | N M-Creek bridge                           | 482400  | 5480800  |
|            | rock fall         | 13 km N Horseshoe Bay=<br>Magnesia Creek   | 482450  | 5480250  |
|            | debris flow       | Alberta Ck                                 | 482850  | 5478700  |
| 07/01/1983 | rock slide        | 30.4 km Cheakamus Canyon                   | 488100  | 5531350  |
| 10/01/1983 | rock slides       | M-Creek                                    | 482400  | 5480800  |

| Date              | Event interpreted      | Location                                     | Easting | Northing |
|-------------------|------------------------|--|---------|----------|
| 11/01/1983        | debris flows           | Alberta,                                     | 482850  | 5478700  |
|                   | debris flow            | Newman Ck                                    | 483100  | 5475500  |
|                   | debris flow            | Turpin                                       | 483200  | 5474700  |
|                   | debris flow            | Charles Ck                                   | 483100  | 5474250  |
| 25/04/1983        | rock fall              | Porteau Bluffs                               | 482850  | 5488550  |
| 15/11/1983        | debris flows           | Charles                                      | 483100  | 5474250  |
|                   | debris flow            | new man ck                                   | 483100  | 5475500  |
|                   | debris flow            | Montizambert Ck                              | 482450  | 5472750  |
| 08/10/1984        | debris flow            | Sclufield Ck                                 | 482400  | 5472400  |
|                   | debris flow            | Harvey Ck                                    | 482850  | 5478400  |
| 14/12/1984        | debris flow            | Sclufield Ck                                 | 482400  | 5472400  |
| 15/12/1984        | debris flow            | Sclufield Ck                                 | 482400  | 5472400  |
| 06/09/1985        | rock fall              | Deeks Lake Pkg Lot                           | 481900  | 5483300  |
| 01/10/1985        | rock fall              | Charles Ck                                   | 483100  | 5474250  |
| 31/10/1985        | rock slide             | Loggers Ck                                   | 482050  | 5483000  |
| 04/11/1985        | debris slide           | 4km N Daisy Lake                             | 492250  | 5595050  |
| 15/01/1986        | debris flow            | Charles Ck                                   | 483100  | 5474250  |
| 18/01/1986        | rock fall              | 7.1 km N Horseshoe Bay=<br>Turpin Creek      | 483200  | 5474700  |
| 03/02/1986        | rock slide             | 16 km N Whistler                             | 508400  | 5562200  |
| 8/07/1987         | rock fall              | Snake Hill Bluff                             | 481600  | 5471250  |
| 08/12/1987        | rock fall              | Porteau Bluffs                               | 482850  | 5488550  |
| 22/03/1988        | rock fall              | Strip Ck                                     | 483050  | 5473800  |
| 07/07/1988        | rock fall              | Snake Hill Bluff                             | 481600  | 5471250  |
| 25/02/1989        | rock fall              | M-Creek Bluff                                | 482400  | 5480800  |
| 08/01/1990        | rock fall              | Strip Ck                                     | 483050  | 5473800  |
| 12/01/1990        | rock fall              | Porteau Bluffs                               | 482850  | 5488550  |
| 13/05/1990        | rock fall              | Loggers Ck                                   | 482050  | 5483100  |
| 21-<br>25/10/1990 | debris flows           | 6.4 km N Lions Bay/near<br>Loggers Ck        | 481400  | 5483800  |
| 03/09/1991        | rock fall<br>(boulder) | Porteau Cove                                 | 483000  | 5488700  |
| 18/09/1991        | rock fall              | 9 km N Horseshoe Bay                         | 482800  | 5476200  |
| 06/11/1991        | rock fall              | 27.8 km N in Cheakamus<br>Canyon             | 488100  | 5531000  |
| 17/11/1991        | rock fall              | 33.5 km N Horseshoe Bay                      | 489000  | 5503400  |
| 26/01/1992        | rock fall              | 1 km S Murrin L.                             | 485000  | 5497800  |
| 23/03/1992        | rock fall              | Snake Hill Bluffs                            | 481600  | 5471250  |
| 22/04/1992        | rock fall              | Porteau Bluffs                               | 482850  | 5488550  |
| 05/03/1992        | rock fall              | 24 km N Horseshoe Bay                        | 483950  | 5482000  |
| 06/12/1992        | rock fall              | Strip Ck                                     | 483050  | 5473800  |
| 15/06/1992        | rock fall              | 14.2 km N of Horseshoe Bay=<br>Loggers Creek | 482050  | 5483100  |
| 26/10/1992        | rock fall              | 28.4 km N Horseshoe Bay                      | 484900  | 5495850  |

| <b>Date</b> | <b>Event interpreted</b> | <b>Location</b>                 | <b>Easting</b> | <b>Northing</b> |
|-------------|--------------------------|---------------------------------|----------------|-----------------|
| 11/10/1992  | rock fall                | Porteau Bluffs                  | 482850         | 5488550         |
| 26/04/1993  | rock fall                | 15.7 km N of Horseshoe Bay      | 481250         | 5484150         |
| 26/02/1994  | rock fall                | Godfrey's Lookout               | 488100         | 5531400         |
| 28/02/1994  | rock slide               | Murrin Pt                       | 485100         | 5498700         |
| 18/11/1994  | rock fall                | Lone Tree Ck                    | 482850         | 5476700         |
| 12/08/1994  | rock fall                | Argillite Cut                   | 483250         | 5488850         |
| 17/12/1994  | rock fall                | Snake Hill                      | 481600         | 5471250         |
| 27/12/1994  | rock slide               | Turpin Ck                       | 483200         | 5474700         |
| 10/06/1995  | rock fall                | 20 km N Horseshoe Bay           | 482800         | 5488350         |
| 23/02/1996  | rock fall                | 1.5 km N of Horseshoe Bay       | 480650         | 5469700         |
| 18/05/1996  | rock fall                | Garibaldi salt shed             | 488200         | 5531350         |
| 19/05/1996  | rock fall                | Garibaldi salt shed             | 488200         | 5531350         |
|             | rock fall                | Godfrey's Lookout               | 488100         | 5531400         |
| 07/09/1996  | rock fall                | 38 km N of Horseshoe Bay        | 488700         | 5502900         |
|             | rock fall                | 2 km S Darrell Bay              | 486500         | 5500050         |
| 13/11/1996  | rock fall                | Snake Hill                      | 481600         | 5471250         |
| 16/11/1996  | rock fall                | Tunnel Pt                       | 482200         | 5482400         |
| 19/02/1997  | rock fall                | Loggers Ck                      | 482050         | 5483100         |
| 20/04/1997  | rock fall                | 1.3 km N Whistler               | 503250         | 5552400         |
| 20/07/1997  | rock fall                | 0.5 km N Horseshoe bay          | 480350         | 5469900         |
| 27/08/1997  | rock fall                | 20.5 km, Culliton Ck            | 488450         | 5525200         |
| 24/11/1997  | rock fall                | Pemberton                       | 513900         | 5574300         |
| 20/01/1998  | rock fall                | Porteau Cove                    | 483000         | 5488700         |
| 05/04/1998  | rock fall                | 16 km N Horseshoe Bay           | 481200         | 5484500         |
| 02/10/1998  | rock fall                | Cosmo Ck                        | 483000         | 5475150         |
| 06/12/1998  | rock fall                | Britannia Beach                 | 485100         | 5497000         |
| 27/08/1999  | rock fall                | 20 km N Horseshoe Bay           | 482800         | 5488350         |
| 15/10/1999  | rock fall                | Brohm L. Hill                   | 490500         | 5518900         |
| 28/01/2000  | rock fall                | Snake Hill                      | 481600         | 5471250         |
| 16/11/2000  | rock fall                | Watts Pt                        | 486000         | 5500000         |
| 29/09/2001  | rock fall                | Brunswick Hill                  | 481250         | 5485750         |
| 24/05/2002  | rock fall                | Cheekye R. bridge               | 490500         | 5515600         |
| 01/05/2003  | rock fall                | 28.4 km in Cheakamus Canyon     | 488100         | 5531400         |
| 16/10/2003  | rock slide               | 19.1 km N Horseshoe Bay         | 482250         | 5487600         |
|             | rock fall                | Deeks Ck                        | 482000         | 5483300         |
| 17/10/2003  | rock fall                | 23.5 km N Horseshoe Bay         | 483500         | 5491150         |
| 02/12/2003  | rock fall                | 9.7 km N Horseshoe Bay          | 482800         | 5477250         |
| 12/12/2004  | rock fall                | Between Whistler and heliport   | no             | Location        |
| 20/03/2005  | debris flow              | Turpin Cr                       | 483200         | 5474700         |
| 03/04/2005  | rock fall                | 1 km south of Function Junction | 502800         | 5550750         |
| 10/09/2005  | rock fall                | 3.2 km N of Horseshoe Bay       | 482300         | 5472050         |
| 04/02/2007  | rock slide               | Ansell Place                    | 481000         | 5471600         |
| Jul-07      | rock slide               | 4km North Horeshoe Bay          | 481000         | 5471600         |

## Appendix 2

### Creeks/Rivers directly affected by flooding along the Sea to Sky Corridor

**Alberta Creek:** December 25-26, 1972; December 4, 1981; December 2-3, 1982; February 8-11, 1983.

**Britannia Creek (River):** September 5-10, 1906; October 24-29, 1921; December 23, 1963; October 30-November 1, 1967; May 25, 1989; August 27-31, 1991.

**Charles Creek [Strachan 2 Creek]:** September 16-18, 1969; November 3 and 7, 1972; February 8-11, 1983; November 15, 1983; January 15-18, 1986.

**Cheakamus River:** September 5-10, 1906; November 1-4, 1955; June 6-9, 1956; August 1958; October 29-November-6, 1975; December 23-27, 1980; October 27-31, 1981; November 11-14, 1981; October 6-12, 1984; November 8-10, 1989; November 8-12, 1990; August 27-31, 1991; October 16-22, 2003.

**Cheekye River:** October 27-29, 1937; October 27-31, 1981; October 6-12, 1984; November 8-12, 1990; August 27-31, 1991.

**Culliton Creek:** December 23-27, 1980; January 21, 1981; October 27-31, 1981; October 6-12, 1984; August 27-31, 1991.

**Daisy Creek:** Early 1960s.

**Daisy Lake:** October 29-November-6, 1975; December 23-27, 1980.

**Disbrow Creek:** December 17-18, 1931; December 12-18, 1979.

**Fitzsimmons Creek:** October 27-31, 1981; October 6-12, 1984; October 23-24, 1992.

**Furry Creek:** October 27-31, 1981.

**Harvey Creek:** *ca.* 1935; September 16-18, 1969; December 15-22, 1972; May 23-25, 1973; September 9-10, 1978; December 4, 1981; October 6, 1982; October 6-12, 1984.

**Kallahne Creek:** Early 1960s; October 27-31, 1981.

**Lone Tree Creek:** September 16-18, 1969.

**M-Creek:** October 27-31, 1981; August 27-31, 1991.

**Magnesia Creek:** Fall 1960; October 11-13, 1962; October 27-31, 1981; October 6, 1982.

**Mamquam River:** September 20-23, 1924; October 27-29, 1937; October 17-20, 1940; November 26-December 3, 1949; October 7-8, 1950; November 4-5, 1954; June 9-12, 1955; October 23-25, 1955; November 1-4, 1955; June 6-9, 1956; September 24-26, 1956; December 23-27, 1980; October 27-31, 1981; October 6-12, 1984; November 8-12, 1990; August 27-31, 1991.

**Mashiter Creek:** December 23-27, 1980; October 27-31, 1981; November 8-12, 1990;

**Montizambert Creek:** November 15, 1983.

**Newman Creek:** *ca.* 1935; December 4, 1981; October 6, 1982; February 8-11, 1983; November 15, 1983.

**Sculfield Creek:** October 6-12, 1984; December 10-17, 1984.

**Shannon Creek:** October 27-31, 1981.

**Stawamus River:** November 13-21, 1954; December 23-27, 1980; October 27-31, 1981; October 6-12, 1984; November 8-10, 1989; November 8-12, 1990; August 27-31, 1991.

**Stoney Creek:** November 1-4, 1955; September 16-17, 1968; October 23, 1968; October 23, 1975; October 29-November-6, 1975.

**Strachan 1 Creek:** See: Turpin Creek.

**Strachan 2 Creek:** See: Charles Creek.

**Strip Creek:** March 22-23, 1988.

**Swift Creek:** December 23-27, 1980; October 27-31, 1981.

**Unnamed Creek #1:** *ca.* 1935.

**Turpin Creek [Strachan 1 Creek]:** February 8-11, 1983; December 26, 1994; March 20, 2005.

### **Appendix 3**

#### **BC Ministry of Transportation and Highways bridges and creek crossings, Segment 1-44 km (Horseshoe Bay to Squamish)**

|       |  |
|-------|--|
| 4.74  | Disbrow Creek  |
| 5.04  | 5 km Creek   |
| 5.17  | Sculfield Creek  |
| 5.49  | Montizambert Creek bridge 1446                             |
| 6.71  | Strachan Mountain Bridge No. 1 (Strip Creek) bridge 1433   |
| 7.24  | Strachan Mountain Bridge No. 2 (Charles Creek) bridge 1457 |
| 7.66  | Turpin Creek   |
| 8.42  | Newman Creek bridge 1468                                   |
| 9.72  | Lone Tree Creek bridge 1460                                |
| 11.07 | Rundle Creek   |
| 11.51 | Harvey Creek bridge 1462                                   |
| 11.87 | Alberta Creek K bridge 1463 (Twin Baileys)                 |
| 13.55 | Magnesia Creek bridge 1452                                 |
| 14.20 | M-Creek bridge 1453  |
| 16.67 | Loggers Creek N bridge 1454                                |
| 17.19 | Deeks Creek bridge 1451                                    |
| 21.54 | Bertram Creek  |
| 22.51 | Kallahne Creek   |
| 24.18 | 24.2 km Creek  |
| 24.60 | 24.6 km Creek  |
| 27.11 | Furry South Creek bridge 1465S                             |
| 27.15 | Furry North Creek bridge 1465N                             |
| 32.82 | Britannia Creek bridge 1286                                |
| 38.29 | Stoney (Gonzales) Creek bridge 1626                        |
| 39.90 | Shannon Creek bridge 1455                                  |
| 40.42 | Oleson Creek   |
| 42.26 | Stawamus River bridge 1011                                 |
| 43.62 | Mamquam River blind channel bridge 2002                    |

## **Appendix 4**

### **Some reported flooding and landslide-related fatalities along the Sea to Sky Corridor**

**March 22, 1915:** A rock and snow avalanche near Britannia Creek hit the Jane Mining Camp, killing 54 people, including four women and six children. All other sources put the number of fatalities at 56, but the death toll was later reduced to 54. Nine people were seriously wounded and 12 others slightly.

**October 28, 1921:** The collapse of an unstable bank and damming of Britannia Creek and subsequent flooding at Britannia Beach killed 37 people and seriously wounded 15 others.

**March 13, 1957:** During the highway construction a shale and rock slide just north of Horseshoe Bay killed a rock scaler.

**October 21, 1963:** A 43-year old conductor on a PGE train was killed and the engineer and fireman were injured after their freight train hit a rock slide and derailed near Britannia Beach.

**February 7-9, 1969:** Freeze-thaw conditions caused a rock fall along Highway 99 near Porteau Cove. A slab of rock landed on a moving car and killed three people. This was the first fatal rock fall in eight years.

**September 18, 1969:** A debris avalanche on Charles Creek on the Squamish highway carried one car and its driver to sea. Neither the car nor the body were ever found.

**May 17, 1971:** A PGE employee was killed when his speeder jumped the track and plunged over an embankment north of Horseshoe Bay. The speeder was believed to have hit either a plank or a rock.

**October 27, 1981:** M-Creek, north of Lions Bay, claimed the lives of nine people whose five cars plunged into the creek, after the debris flow knocked out the highway bridge. According to VanDine (1985) and the Ministry of Energy, Mines and Petroleum Resources (1993), the M-Creek debris torrent caused 10 deaths.

**December 4, 1981:** During the hasty evacuation of about 40 people from the 14 houses located below Charles Creek a woman was killed.

**January 16, 1982:** A single boulder falling from a rock face on Highway 99 approximately 7 km north of M-Creek landing on top of a vehicle killed a 28-year old woman from Toronto, Ont. and seriously injured the father of the victim.

**February 11, 1983** A large torrent flow on Alberta Creek severely damaged six houses and took the lives of 18- and 19-year old brothers.

**September 3, 1991:** A rock falling through the windshield of a vehicle on Highway 99 near Porteau Cove Provincial Park claimed the life of a 43-year old Squamish man.

**October 18, 2003:** A washed out bridge over Rutherford Creek north of Whistler claimed the lives of five people whose three vehicles plunged into the creek. Three vehicles went off the highway into the creek, killing five occupants. The SUV carrying two of the victims was never located. One occupant of the vehicle managed to swim to safety. On December 14, 2004, more than a year later, during routine dredging work another vehicle was uncovered with one body inside.

**Appendix 5**  
**List of weather stations**

|    | <b>Name</b>              | <b>ID</b> | <b>Latitude</b> | <b>Longitude</b> | <b>Elevation (m)</b> | <b>Yrs operating</b> |
|----|--------------------------|-----------|-----------------|------------------|----------------------|----------------------|
| 1  | Alta Lake                | 1040390   | 50.150000       | -122.950000      | 668                  | 1950-1976            |
| 2  | Anvil Island             | 1040445   | 49.516667       | -123.300000      | 31                   | 1956-1963            |
| 3  | Bowen Island Cates Bay   | 1040911   | 49.416667       | -123.316667      | 27                   | 1987-2000            |
| 4  | Bowen Island Millers Ldg | 1040R09   | 49.400000       | -123.333333      | 91                   | 1972-2000            |
| 5  | Britannia Beach Furry Cr | 1041050   | 49.583333       | -123.216667      | 9                    | 1913-2000            |
| 6  | Capilano Intake          | 1041380   | 49.400000       | -123.150000      | 146                  | 1924-1955            |
| 7  | Cheekye                  | 1041490   | 49.800000       | -123.150000      | 49                   | 1960-1962            |
| 8  | Clowhom Falls            | 1041710   | 49.716667       | -123.533333      | 23                   | 1932-1990            |
| 9  | Daisy Lake Dam           | 1042255   | 49.983333       | -123.133333      | 381                  | 1968-1983            |
| 10 | Gambier Harbour          | 1043048   | 49.450000       | -123.433333      | 53                   | 1962-2000            |
| 11 | Garibaldi                | 1043060   | 49.983333       | -123.133333      | 981                  | 1921-1980            |
| 12 | Gibsons                  | 1043150   | 49.400000       | -123.516667      | 62                   | 1949-2000            |
| 13 | Hollyburn                | 1043504   | 49.316667       | -123.166667      | 46                   | 1926-1952            |
| 14 | Hopkins Landing          | 1043582   | 49.466667       | -123.483333      | 8                    | 1969-1992            |
| 15 | Howe Sound               | 10459NN   | 49.483333       | -123.300000      | 10                   | 1991-2000            |
| 16 | Lois River Dam           | 1044710   | 49.800000       | -124.316667      | 157                  | 1931-2000            |
| 17 | Port Mellon              | 1046330   | 49.516667       | -123.483333      | 8                    | 1942-1989            |
| 18 | Squamish A CS            | 10476F0   | 49.783333       | -123.166667      | 52                   | 1982-2000            |
| 19 | Squamish                 | 1047660   | 49.700000       | -123.133333      | 31                   | 1959-1996            |
| 20 | Squamish FMC Chemicals   | 1047662   | 49.683333       | -123.166667      | 3                    | 1968-1983            |
| 21 | Sqaumish Garibaldi       | 1047F6B   | 49.733333       | -123.150000      | 10                   | 1975-1996            |
| 22 | Squamish STP             | 1047670   | 49.733333       | -123.150000      | 6                    | 1981-1996            |
| 23 | Squamish STP Central     | 1047671   | 49.700000       | -123.166667      | 4                    | 1986-2000            |
| 24 | Squamish Upper           | 1047672   | 49.900000       | -123.283333      | 46                   | 1979-2000            |
| 25 | Tunnel Camp              | 1048310   | 49.616667       | -123.133333      | 671                  | 1924-1974            |
| 26 | Whistler                 | 1048898   | 50.133333       | -122.950000      | 658                  | 1976-2000            |
| 27 | Woodfibre                | 1048974   | 49.583333       | -123.883333      | 4                    | 1960-2000            |
| 28 | Woodfibre Henrietta Lk   | 1048975   | 49.683333       | -123.316667      | 869                  | 1978-1980            |
| 29 | Pemberton Airport        | 1086082   | 50.300000       | -122.733333      | 204                  | 1984-2000            |
| 30 | Pemberton BCFS           | 1086083   | 50.316667       | -122.816667      | 218                  | 1969-1984            |
| 31 | Pemberton Meadows        | 1086090   | 50.450000       | -122.933333      | 223                  | 1912-1967            |
| 32 | Abbotsford A             | 1100030   | 49.033333       | -122.366667      | 58                   | 1944-2000            |
| 33 | Agassiz CDA              | 1100120   | 49.250000       | -121.766667      | 15                   | 1889-2000            |
| 34 | Bunzten Lake             | 1101140   | 49.383333       | -122.866667      | 10                   | 1924-1983            |
| 35 | Burnaby Mtn Terminal     | 1101155   | 49.266667       | -122.933333      | 137                  | 1958-1996            |
| 36 | Chilliwack               | 1101530   | 49.166667       | -121.933333      | 11                   | 1879-2000            |
| 37 | Coquitlam                | 1101888   | 49.266667       | -122.850000      | 8                    | 1901-1933            |
| 38 | Coquitlam Lake           | 1101890   | 49.366667       | -122.800000      | 161                  | 1924-1982            |
| 39 | Cypress Bowl             | 1102253   | 49.400000       | -123.200000      | 930                  | 1984-2000            |
| 40 | Cypress Bowl Upper       | 1102254   | 49.400000       | -123.183333      | 1210                 | 1985-2000            |
| 41 | Haney East               | 1103326   | 49.200000       | -122.566667      | 31                   | 1959-2000            |

|    | <b>Name</b>              | <b>ID</b> | <b>Latitude</b> | <b>Longitude</b> | <b>Elevation(m)</b> | <b>Years</b> |
|----|--------------------------|-----------|-----------------|------------------|---------------------|--------------|
| 42 | Hollyburn Ridge          | 1103510   | 49.383333       | -123.183333      | 930                 | 1954-1995    |
| 43 | Howe Sound Strachan Crk  | 110361F   | 49.416667       | -123.233333      | 20                  | 1994-2000    |
| 44 | Lions Bay                | 1104634   | 49.450000       | -123.233333      | 52                  | 1983-2000    |
| 45 | N Vancouver Capilano     | 1105655   | 49.350000       | -123.116667      | 93                  | 1955-1990    |
| 46 | N Vancouver Cleveland    | 110EF56   | 49.366667       | -123.100000      | 157                 | 1968-2000    |
| 47 | N Vancouver Mosquito Cr  | 1105663   | 49.350000       | -123.083333      | 344                 | 1954-1960    |
| 48 | New Westminster          | 1105550   | 49.216667       | -122.933333      | 119                 | 1874-1966    |
| 49 | Point Atkinson           | 1106200   | 49.333333       | -123.266667      | 35                  | 1968-2000    |
| 50 | Seymour Falls            | 1107200   | 49.433333       | -122.966667      | 244                 | 1927-2000    |
| 51 | Vancouver Harbour CS     | 1108446   | 49.200000       | -123.116667      | 3                   | 1925-2000    |
| 52 | Vancouver Int'l A        | 1108447   | 49.266667       | -123.183333      | 4                   | 1937-2000    |
| 53 | Vancouver PMO            | 1108465   | 49.283333       | -123.116667      | 59                  | 1898-1979    |
| 54 | W Vancouver Copper Cove  | 1108826   | 49.383333       | -123.283333      | 46                  | 1959-1972    |
| 55 | W Vancouver Cypress Park | 1108828   | 49.350000       | -123.250000      | 155                 | 1957-1994    |
| 56 | W Vancouver Millstream   | 1108840   | 49.366667       | -123.133333      | 381                 | 1961-1992    |
| 57 | West Vancouver           | 1108820   | 49.333333       | -123.166667      | 29                  | 1953-1961    |
| 58 | West Vancouver Macbeth   | 1108835   | 49.333333       | -123.116667      | 55                  | 1955-1973    |
| 59 | Whistler Roundhouse      | 1108906   | 50.066667       | -122.950000      | 1835                | 1972-2000    |
| 60 | Gates Station            | 1113072   | 50.516667       | -122.516667      | 390                 | 1974-1994    |
| 61 | Hope A                   | 1113540   | 49.366667       | -121.483333      | 39                  | 1934-1995    |
| 62 | Lillooet                 | 1114620   | 50.700000       | -121.933333      | 290                 | 1878-1970    |
| 63 | Comox A                  | 1021830   | 49.716667       | -124.900000      | 26                  | 1953-2000    |

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