

Geohazards in the South Okanagan

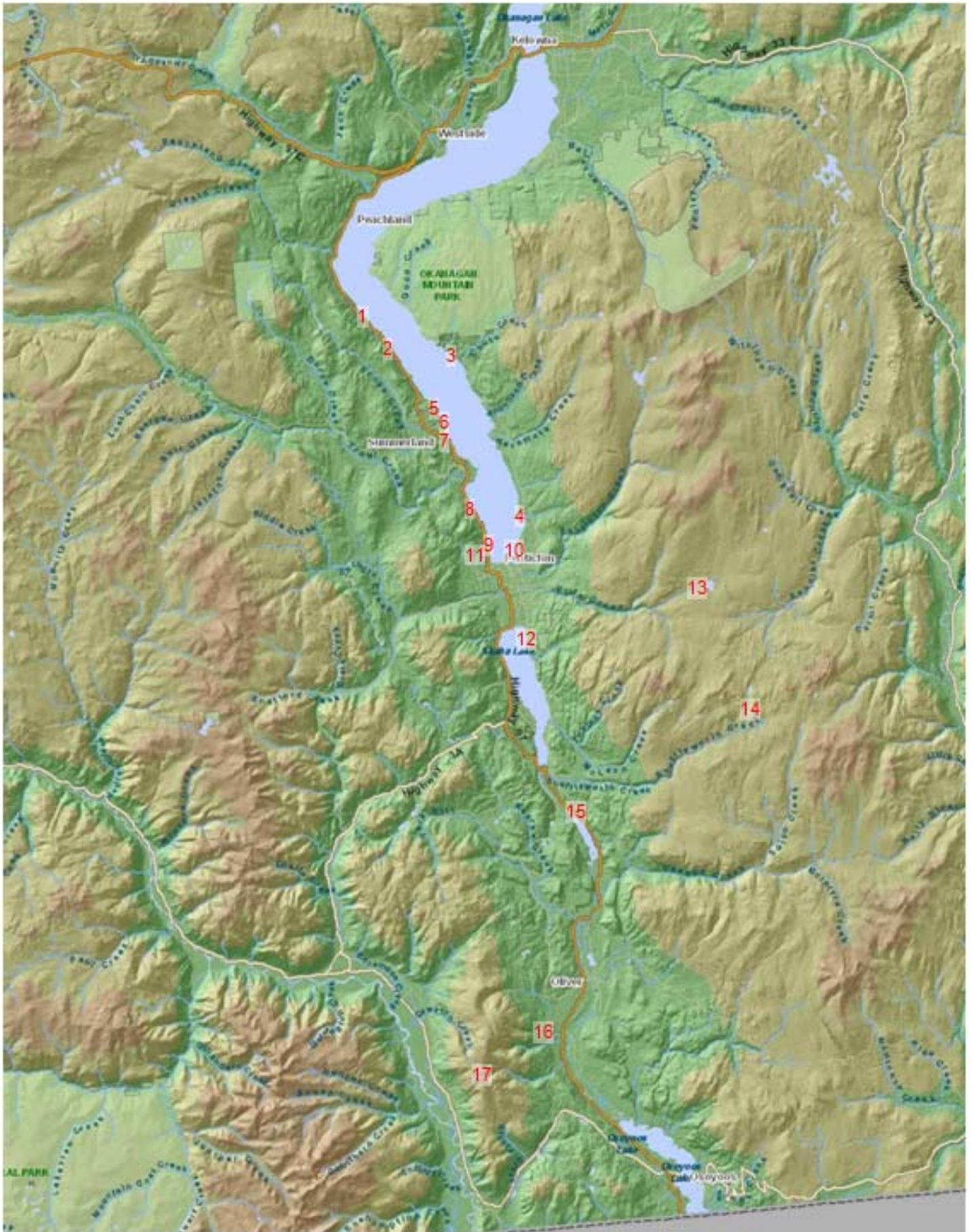
prepared By

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1. Okanagan Lake Provincial Park Landslide - March 14, 1975

The Okanagan Lake Provincial Park landslide damaged a park access road and entered the lake.

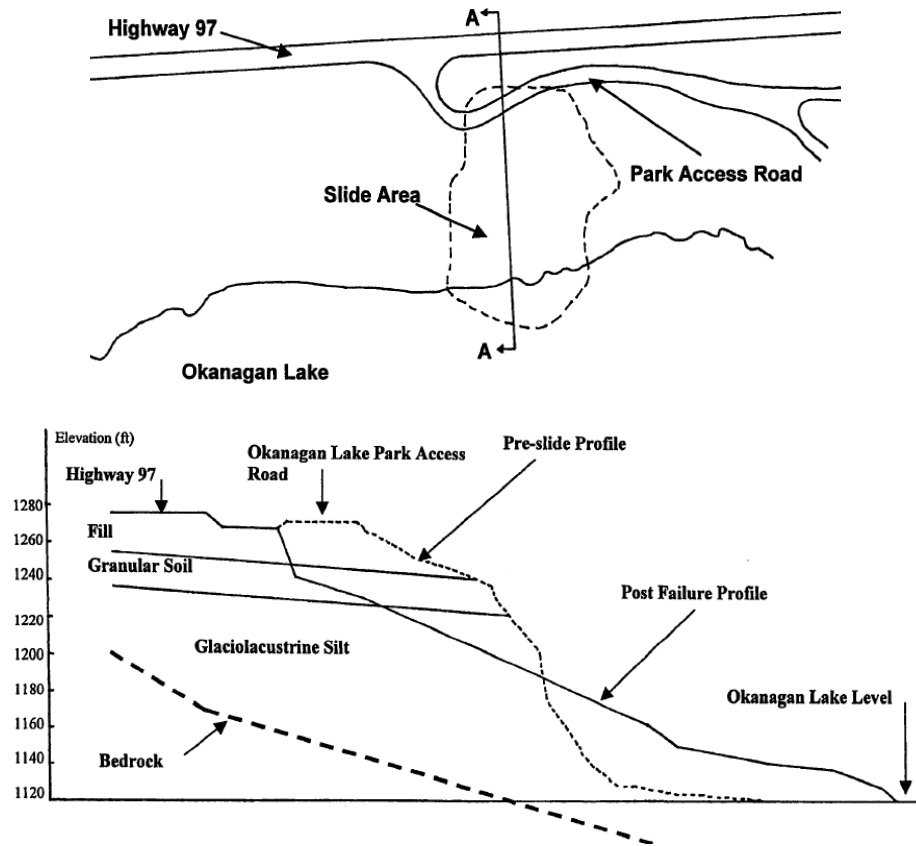


Figure 1. Plan view and vertical section of the Okanagan Lake Provincial Park landslide (Iravani 1999).

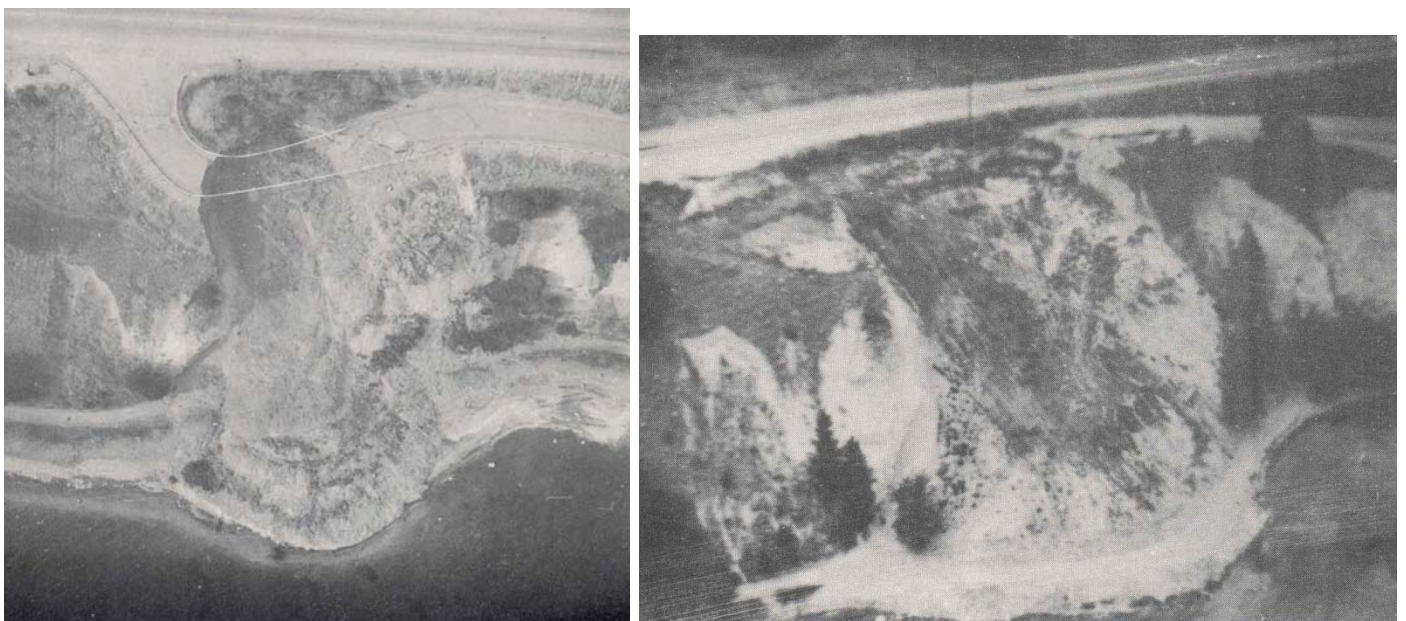


Figure 2. Okanagan Lake Provincial Park landslide (a) a few weeks after failure and (b) after slide mass was re-shaped and seeded (Nyland & Miller 1975).

2. Goat Bluff Rockslide - October 2008

Widening of a 7km stretch of Hwy. 97 between Peachland and Summerland commenced February 2008. The \$54 million four-lane project required 1.8 million m³ rock and soil excavation by Arthon Construction. Movement of a rock slope, dubbed 'Goat Bluff,' resulted in the closure of highway for 18 days and extra unexpected costs.

October 22, 2008: 10 cm fracture noted.

October 24, 2008: Highway closed after falling rocks discovered on highway.

October 25, 2008: Geotechnical engineers were flown in to inspect the wide and deep tensile fracture in the slope.

October 29, 2008: Test blast prepared however first they had to clear the area. Workers found a mountain goat trapped 6 to 10 m deep in a back-scarp fracture. The goat was tranquilized and lifted to surface. 15 homes on North Beach Ave. were evacuated as a precautionary measure, and the contractor loaded a crevice with 125 kg of explosives. The small explosive charge was used to assess stability of the slide mass.

October 30 to November 11, 2008: Rock was blasted for 12 days working downward from the top of bluff, reducing the sliding mass, and placing loose rock at a toe berm to increase movement resistance. Blasting gradually slowed the fracture creep from 10 -20 mm/day to 1 mm/day

November 12, 2008: Highway was re-opened to the public:

- Estimated total cost to taxpayers: \$6,000,000
- Labour and materials stabilizing the rock: \$3,000,000
- Upgrading detour roads, water taxi, bus, etc.: \$3,000,000 (Penticton Herald, April 21, 2009)



Figure 3. Tensile fracture and slip surface (Arthon Construction, Oct. 2008).



Figure 4. Slope movement along slip surface (day-lighted portion - left, buried under colluvium - right).

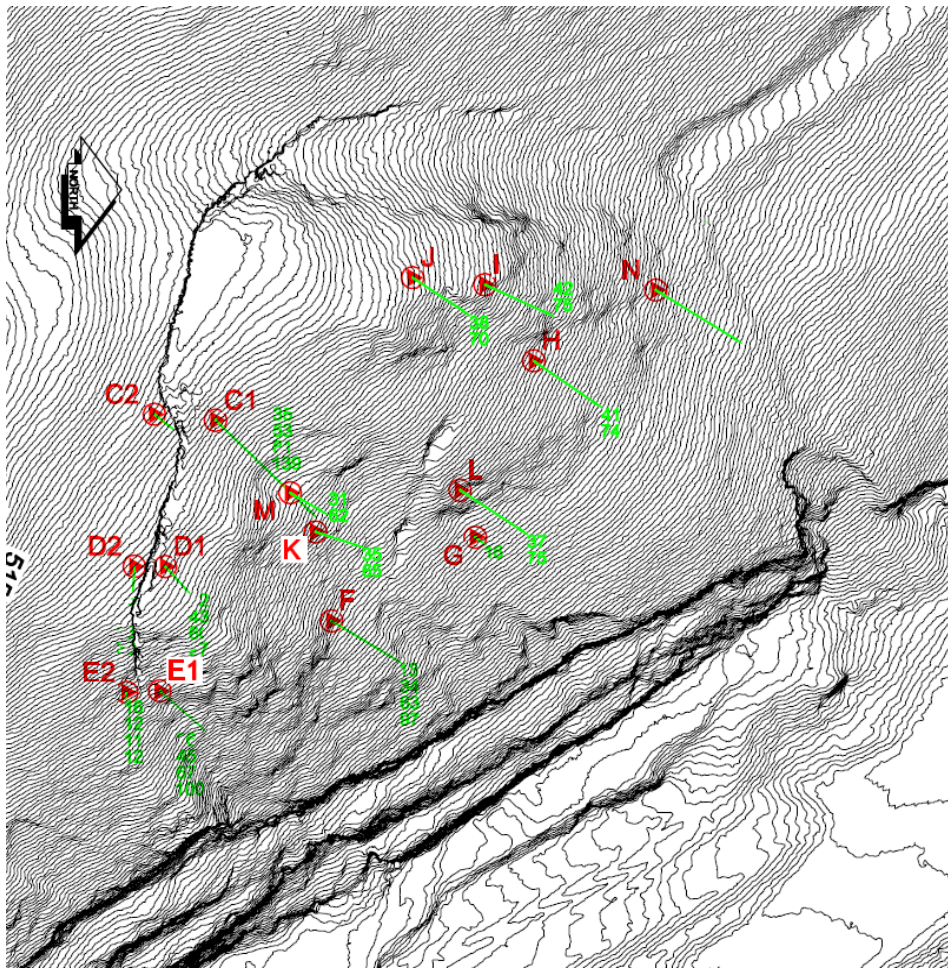


Figure 5. Contours from Lidar and survey prisms.



Figure 6. Mountain goat trapped in the fracture (Arthon Construction, Oct. 2008).



Figure 7. Preparation for removing 17,700 m³ of rock (Arthon Construction, Oct. 2008).



Figure 8. Completed construction with upper part of slope above the slip surface removed.

Glacio-Lacustrine Silt Bluff Geohazards and Incidents

The glacio-lacustrine silts deposits that flank the Okanagan Valley are a source for many landslides and subsidence features. Landslides in silt deposits occur in the form of both shallow planar slides and deep-seated rotational slides (Iravani 1999). Shallow planar slides are a common feature of the colluvial silt deposits, and can be caused by solifluction (thawing) processes or, in a larger scale, result from undercutting processes. Deep-seated rotational slides in glacio-lacustrine silt sediments create the greatest hazard to human life and property. Their size and extent of run-out are large and their occurrence is sudden. Trigger mechanisms include removal of the toe of the slope or a rise in water table from irrigation, heavy rainfall, or other infiltration. A good discussion of glacial deposits in the south Okanagan is found in the book: Okanagan Geology South – Geologic Highlights of the South Okanagan British Columbia (OGC 2011).

3. Koosi Creek Silt Bluff Slide – Aug. 3, 1942

A silt bluff slide on Aug. 3, 1942 at 9:00 am entered Okanagan Lake and created a series of 3 large waves that travelled across the lake. They were 1.5 m high when they reached Summerland. Waves cause extensive damage to docks, piers and cabins along the shore between Trout Creek point and Crescent Beach (Penticton Herald Aug. 6, 1942). Later, houses were built on the landslide deposit.



Figure 9. Location of the Koosi Creek landslide (Google Earth).

4. Plecash Slide – July 20, 1951

Silt bluff slide created a 4 m high wave that washed over house rented by Doctor Plecash and his family - they were lucky to escape.

Silt Bluff Collapses onto Highway 97

Numerous silt bluff collapses have resulted in debris covering Highway 97. To date, none of these has resulted in a fatality but there have been some close calls. For example, on Feb. 28, 2004, a silt bluff collapse caught a pickup truck in 2000 to 2500 m³ of slide debris. The road was reopened after 13 hours.

5. Schuster Silt Bluff Slide - Sept. 15, 1992

A steep silt bluff above North Lakeshore Drive in Summerland collapsed at 5:15 pm on Sept. 15, 1992. The silt debris travelled across the road and engulfed a garage and the vehicles and boats inside (Schuster house). Lakeshore Drive was blocked by up to 5 m of silt. Fortunately no people were injured in this event.



Figure 10. Schuster slide area showing toe berm built after the landslide (N. Skermer).

6. Lower Summerland Slide - Sept. 27, 1970

Sudden collapse of a silt bluff in lower Summerland in 1970 killed a man and hospitalized his wife. Three houses were destroyed.

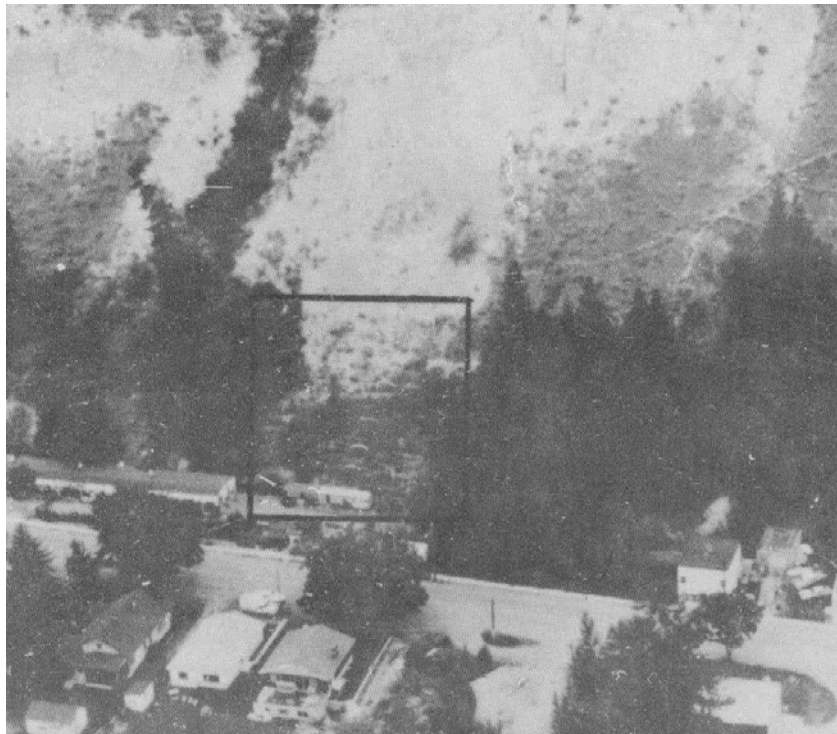


Figure 11. Lower Summerland landslide location (Nyland & Miller 1975).

7. Fletcher Slide - Nov. 13, 1993

Silt bluff collapse - 12:30 pm Nov. 13, 1993. 13,000 m³ involved, blocking all four lanes of the highway.



Figure 12. Dry silt flow triggered by block fall from a scarp in glacio-lacustrine silt (Hungre et al. 2001)

8. Old Agricultural Research Station Slides – Aug. 20, 1969; Dec. 1971 and 1974



Figure 13. Agricultural Research Station landslides (Nyland & Miller 1975).

9. Silt Bluff Collapses



Figure 14. Example of a silt bluff block failure (N. Skermer).

10. Joe Raymond Slide - November 29, 1949

Amazingly no one was killed when a Kettle Valley Railway train entered the slide depression and turned on its side. The slide is named after the conductor of the train - Joe Raymond.



Figure 15. Joe Raymond landslide on the Kettle Valley Railway just north of Penticton (N. Skermer).

11. Sink Holes and Subsidence



Figure 16. Glacio-lacustrine silt bench NW of Penticton (1950 airphoto from Nyland & Miller 1975).



Figure 17. Glacio-lacustrine silt bench NW of Penticton (1975 airphoto from Nyland & Miller 1975).

12. Lakeside Road Silt Landslides – June 1996 to 1998

Mud flows and landslide movements occurred over a 3-year period. Six property owners affected, 3 or 4 houses were condemned.



Figure 18. Aerial views of Lakeside Road landslides.



Figure 19. Google Streetview images of Lakeside Road landslides.

13. Ellis Creek Dam Failures and Debris Flow/Floods (May 19, 1921; May 12, 1941; May 23, 1942)

1921: Newly constructed dam failed and released 370,000 m³ of water after a hot day followed by heavy rain.

1941: The 10 m high, 560 m long, No. 4 Ellis Creek dam failed. The storage capacity of the reservoir had been tripled from the previous year by raising the height of the dam by 1.8 m. The dam was inspected just before the failure and no signs of seepage were noted. The failure released approximately 740,000 m³ of water.

1942: Heavy precipitation and snowmelt resulted in partial failure of the Ellis Creek dam No. 4, releasing 150,000 m³ of water, which was added to the already overflowing Ellis Creek. Extensive flood damage occurred in Penticton.



(BC Environment 1989)



Penticton Museum & Archives

Figure 20. Dam failure in 1941 and resulting debris flood in Penticton (1941).



Penticton Museum & Archives

(Faulkner 1942)



Figure 21. Dam failure at wooden spillway in 1942 and flood in Penticton.

14. Shuttleworth Creek Dam Failures (May 15, 1928; May 15, 1936; May 27, 1944)

1928: The old Allendale dam on Shuttleworth Creek failed resulting in damage to homes and bridges in Okanagan Falls. The preceding winter was reported to have been unusually wet in the Okanagan Valley.

1936: The large Campbell Meadows dam on Shuttleworth Creek failed. An earthfill dam had been built in 1935 to store 1.2 million m³ of water for late summer use. Two days of intermittent heavy rain showers had weakened the structure. The dam did not overtop as the water never rose within 1.2 m of the crest of the dam. The dam was new and it is suspected that seepage through the dam led to its failure. The dam failure released approximately 123,000 m³ of water.

1944: The Campbell Meadows dam on Shuttleworth Creek failed. Heavy rains followed by warm weather were responsible for heavy runoff. The day before the dam failed, 1200 m³ of water was released from the reservoir to keep it half full (620,000 m³) with a 3 m freeboard. The watchman at the dam witnessed the failure; the dam was not overtopped and failure was likely caused by internal seepage and piping. Approximately 370,000 m³ of water left the dam over about 3 hours causing extensive damage near Okanagan Falls. The Campbell Meadows dam was not rebuilt.

15. Vaseux Lake Debris Flow - June 30, 2004

An intense rainstorm near Vaseux Lake on June 30, 2004 created severe run-off and triggered numerous small debris flows. Debris crossed Highway 97, temporarily closing the highway, and entered the north end of Vaseux Lake. Private property was also damaged. The Vaseux Lake forest fire (3,300 ha) the year before is believed to have been a contributing factor (Forest Practices Board 2005) by changing the water infiltration and run-off characteristics in the watershed.



Figure 22. Small debris flows that blocked Highway 97.

16. Tinhorn Creek Mud Flows – May 28, 1983 & Aug. 9, 1989

On May 28, 1983, a mud flow came down Tinhorn Creek and crossed and blocked Highway 97. This event occurred after a week of increasingly hotter temperatures in the south Okanagan. It also occurred in the middle of the driest four-week period recorded at Oliver in the first six months of 1983. It is likely that late spring snowmelt was the main factor in causing the mud flow.



Figure 23. Tinhorn Creek mud flow May 28, 1983 (Osoyoos Times).



Figure 24. Tinhorn Creek mudflow triggered by rainfall on Aug. 9, 1989 (Oliver Chronicle).

17. Testalinden Lake Dam Failure and Mud Flow – June 13, 2010

A large mud flow descended Testalinden Creek on the afternoon of Sunday, June 13, 2010. It caused extensive property damage on the fan of Testalinden Creek and destroyed five houses. Fortunately there was no loss of life. A breach occurred in a small dam constructed in the 1930's for the purpose of water storage and irrigation at Testalinden Lake at the headwaters of the creek, approximately 1500 m above the fan. The dam failure coincided with the first period of sustained hot weather for the year. The hot weather accelerated the melting of the lingering late season snowpack at the top of Mount Kobau. The small reservoir had already been filled and the dam was overtopping. The last surge of snowmelt, which was occurring at the time of the breach, created enough overflow velocity and resulting erosive energy to scour through a harder, grass covered, outer surface crust on the dam, and expose a softer, more easily eroded core. The breach released approximately 20,000 m³ of water that descended the creek to the Okanagan Valley, entraining materials from the creek and growing to more than 200,000 m³ in volume by the time it reached the alluvial fan (Tannant & Skermer 2011).



Figure 25. Testalinden lake dam breach.



Figure 26. Testalinden lake dam breach.



Figure 27. Downstream face of dam breach.



Figure 28. Deposition area on the fan.



Figure 29. Mud flow deposit and destroyed house.

Further information

The brief case histories presented here are largely pictorial in nature. Some of these sites have been studied by consulting engineers, but unfortunately the findings are not in the public domain. Using the date and location of each event, an interested reader can usually find more information from the archives of the closest newspaper. In addition, there are many more locations where slope failures have occurred in the south Okanagan. A Google Earth compilation of these locations in a kmz file has been assembled by Dr. Tannant at the University of British Columbia and is available to anyone that is interested. There are about 50 sites documented so far.

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