



# WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

## RECENT DEBRIS FLOWS AT MOUNT RAINIER

Mount Rainier is a young volcano whose slopes are undergoing rapid change by a variety of geologic processes, including debris flows. Debris flows are churning masses of water, rock and mud that travel rapidly down the volcano's steep, glacially carved valleys, leaving in their wake splintered trees, picnic sites buried in mud, and damaged roads.

Debris flows at Mount Rainier are most frequently caused by unusually high streamflows that mobilize large volumes of loose rock and soil. Indeed, debris flows typically contain as much as 65-70 percent rock and soil by volume and have the appearance of wet concrete. These flows invariably begin in remote areas nearly inaccessible to people, but may move rapidly downstream into areas frequented by visitors.

People who have witnessed debris flows at Mount Rainier report that only 1-2 minutes may pass between the time the roaring sound of an approaching debris flow is heard and the time the flow rushes past. These flows typically have steep, bouldery snouts—up to 10-20 meters (30-60 feet) high in the most constricted parts of a stream valley—followed by a churning mass of mud, rock, and broken trees. Their deafening noise is often accompanied by strong local winds, thick dust clouds, and violent ground shaking. Debris flows at Mt. Rainier travel downstream at speeds of 5-10 meters per second (10-20 miles per hour) or more.

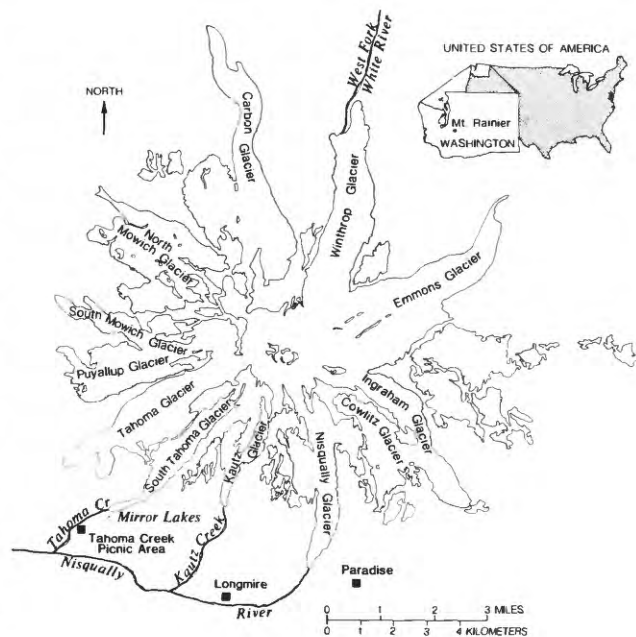
Debris flows usually follow stream channels and construct their own "levees" as they move, but their exact paths are unpredictable. As a debris flow moves downstream from Mount Rainier's steep flanks onto relatively gentle slopes, the flow's bouldery snout may stop temporarily, clogging the stream channel; the moving mass behind the snout may then overtop the banks and continue downstream, cutting a new channel, perhaps across trails or roads, or through forest and campgrounds. Debris flows at Mount Rainier typically come to rest after perhaps 30 minutes to an hour, leaving muddy, bouldery deposits from which muddy water drains for a period of a few hours to a few days. Near the valley mouth, however, the only hint of the havoc upstream might be a small increase in water level and sediment in transport in the stream.

The causes of Mount Rainier's debris flows are poorly understood. Some occur during or shortly after periods of intense rainfall, especially in autumn. Most, however, occur during periods of hot, sunny weather and may be triggered by glacial outburst floods, also called by the Icelandic term "jökulhlaup" (pronounced "yo-kul-h-loip"). Jökulhlaups originate from water stored in ice-dammed lakes, cavities within the glacier ice, or at the glacier bed. At Mount Rainier, there is no evidence of either ice-dammed lakes or subglacial lakes due to volcanic activity; the mountain's jökulhlaups are probably due to sudden, unpredictable drainage of meltwater from small cavities within or at the bed of glaciers. Jökulhlaups are known to have been

released from four glaciers on Mount Rainier: the Nisqually, Kautz, South Tahoma, and Winthrop glaciers.

The best-studied recent debris flows are those that have moved along Tahoma Creek, which is fed by South Tahoma Glacier. Research since 1989 (jointly sponsored by the National Park Service and the U.S. Geological Survey) has shown that the rock debris in these flows comes from an area of unstable, rock-covered stagnant ice—once part of South Tahoma Glacier—just downstream of Glacier Island. As that stagnant ice wastes away over the next several decades, it will likely continue to be a readily available source of rock for debris flows.

Debris flows at Mount Rainier may have causes unrelated to either intense rainfall or jökulhlaups. Several times during about the last 6000 years, debris flows enormously larger than any ever observed (or described here) were triggered by huge rock avalanches and travelled far beyond the park boundaries.



Schematic diagram of major glaciers on Mount Rainier

Visitors can see effects of recent debris flows at the following sites:

**KAUTZ CREEK**—The largest debris flow since the establishment of the park occurred October 2-3, 1947, when heavy rains apparently triggered a jökulhlaup from Kautz Glacier. The flood waters passed over the lowest part of the glacier, eroding a gorge through the ice, then transformed into a debris flow as they continued downvalley. Nine kilometers (5-1/2 miles) downstream from the glacier, the "Nisqually-Longmire Road" (equivalent to Highway 706 west of the park entrance) was buried by 9 meters (28 feet) of mud and debris. An estimated 40 million cubic meters (50 million cubic yards) of rock and soil were moved, including boulders up to 4 meters (13 feet) in diameter. Although Kautz Creek has subsequently cut down through those deposits, visitors to the park will notice that they are driving uphill as they approach the creek. To observe deposits of the 1947 event, along with upright dead trees partly buried by those deposits, stop at the parking lot on the east side of Kautz Creek. Smaller debris flows have moved along Kautz Creek in 1961, 1985, 1986, and perhaps at other times.

From Longmire, hike the Wonderland Trail about 3 kilometers (2 miles) to where it crosses Kautz Creek. Boulders strewn across the valley there were deposited by the 1947 debris flow. Note the splintered trees that lined a former stream channel, and trees that lie buried horizontally in older debris-flow deposits. Above the boulder-strewn region and amid the forest lie moss-covered logs downed by previous debris flows.

**NISQUALLY RIVER**—Jökulhlaups from the Nisqually Glacier damaged or destroyed bridges over the Nisqually River in 1926, 1932, 1934, and 1955. The present bridge has not been damaged by subsequent floods, which occurred in 1968, 1970, 1972, 1985, and perhaps on other occasions.

At the Glacier Bridge over the Nisqually River, observe the levees constructed by debris flows in the 1930's and 1950's. Twisted reinforcing bar and weathered concrete are all that remain of the 1930's-vintage bridge foundation about 100 meters (100 yards) upstream.

**TAHOMA CREEK**—At least 20 debris flows have moved down Tahoma Creek since 1967, including at least one in every year from 1986 through 1990. These most recent debris flows have carved a deep canyon through a zone of rock-covered stagnant ice below the terminus of South Tahoma Glacier.

Approximately 5 kilometers (3 miles) up the Westside Road from the junction with the Nisqually-Longmire Road, you can observe effects of the debris flows of 1986-1990, which buried a picnic area, destroyed the lowest part of the Tahoma Creek trail, and repeatedly damaged the Westside Road, on one occasion stranding some visitors and their automobiles. Farther downstream, at the base of Mount Wow, Tahoma Creek has eroded a new channel that exposes stumps of trees buried by older debris flows. At the highway bridge, the debris flows have left little evidence except for ephemeral mud marks on rocks and vegetation.

South Tahoma Glacier and the uppermost part of Tahoma Creek are visible from Mirror Lakes, near Indian Henry's Hunting Ground. Observe the gorge through which debris flows have passed from the Wonderland Trail suspension bridge, which crosses Tahoma Creek about 3 kilometers (2 miles) upstream of the destroyed picnic area. Erosion by passing debris flows has deepened the gorge beneath the bridge from 10 meters (30 feet) to 25 meters (80 feet) since 1986. A pair of hikers who chose to cross the bridge during a debris flow in 1987 were splattered with mud and hit by small rocks.

## PRECAUTIONS FOR VISITORS

Be alert when visiting areas prone to debris flows. Do not be caught in or near stream channels. If you hear the onrush of a debris flow or note a rapid rise in water level, move quickly up the stream embankment, away from the stream channel and to higher ground. Do not try to escape by moving downstream; debris flows move faster than you can run. Observe Park Service regulations, especially those provided for your safety in areas prone to debris flows. Here, as in most areas in other national parks, natural processes such as floods and debris flows are allowed to occur without human intervention.

## FURTHER READING

Crandell, D.R., 1969, The geologic story of Mount Rainier: U.S. Geological Survey Bulletin 1292, 43 p.

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Driedger, C.L., and Fountain, A.G., 1989, Glacier outburst floods at Mount Rainier, Washington State, U.S.A.: *Annals of Glaciology*, v. 13, p. 51-55.

Scott, K.M., Pringle, P.T., and Vallance, J.W., in press, Sedimentology, behavior and hazards of debris flows at Mount Rainier, Washington: U.S. Geological Survey Professional Paper 1447-C.



Debris flow at Tahoma Creek, July 26, 1988. Photograph by G.G. Parker.

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