

CHAPTER 17. VOLCANO/LAHAR

17.1 GENERAL BACKGROUND

There hazards related to volcanoes and volcanic eruptions are distinguished by the different ways in which volcanic materials and other debris flow from the volcano. The molten rock that erupts from a volcano (lava) forms a hill or mountain around the vent. The lava may flow out as a viscous liquid, or it may explode from the vent as solid or liquid particles.

17.2 HAZARD PROFILE

17.2.1 Past Events

Figure 17-1 and Table 17-1 summarize past eruptions in the Cascades. In the 1980 Mount St. Helens eruption, 23 square miles of volcanic material buried the North Fork of the Toutle River and there were 57 human fatalities.

Glacier Peak in eastern Snohomish County is one of the major Cascade stratovolcanoes. The mountain is thought to have erupted as recently as the 18th century. With the exception of Mount St. Helens, Glacier Peak has historically produced larger and more explosive eruptions than any other Washington volcano. One event at Glacier Peak was more than three times the size of Mount St. Helens' 1980 eruption. Since the end of the last glacial episode about 14,000 years ago, Glacier Peak has erupted at least a dozen times.

Prehistoric evidence of lahars of the sort experienced during the 1980 eruption of Mount St. Helens have been described by U.S. Geological Survey scientists studying Glacier Peak. Although a major volcanic debris flow is a rare occurrence, its potential volume and destructive force are such that the possibility deserves mention. The Town of Darrington and much of northeast Snohomish County could be affected by a large flow following the White Chuck and Sauk River drainage channels. An ancient lahar is responsible for diverting the flow of the Sauk from its original path to Puget Sound via the North Fork of the Stillaguamish, blocking it east of Darrington so that it was forced to capture the Skagit's headwaters.

17.2.2 Location

Map 17-1 shows the Glacier Peak lahar inundation zone in Snohomish County. Figure 17-1 shows the location of the Cascade Range volcanoes, most of which have the potential to produce a significant eruption. The Cascade Range extends more than 1,000 miles from southern British Columbia into northern California and includes 13 potentially active volcanic peaks in the U.S. Figure 17-2 shows probabilities of *tephra* accumulation from Cascade volcanoes in the Pacific Northwest (*tephra* is fragmented rock material ejected by a volcanic explosion).

DEFINITIONS

Lahar—A rapidly flowing mixture of water and rock debris that originates from a volcano. While lahars are most commonly associated with eruptions, heavy rains, and debris accumulation, earthquakes may also trigger them.

Lava Flow—The least hazardous threat posed by volcanoes. Cascades volcanoes are normally associated with slow moving andesite or dacite lava.

Stratovolcano—Typically steep-sided, symmetrical cones of large dimension built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs, rising as much as 8,000 feet above their bases. The volcanoes in the Cascade Range are all stratovolcanoes.

Tephra—Ash and fragmented rock material ejected by a volcanic explosion

Volcano—A vent in the planetary crust from which magma (molten or hot rock) and gas from the earth's core erupts.

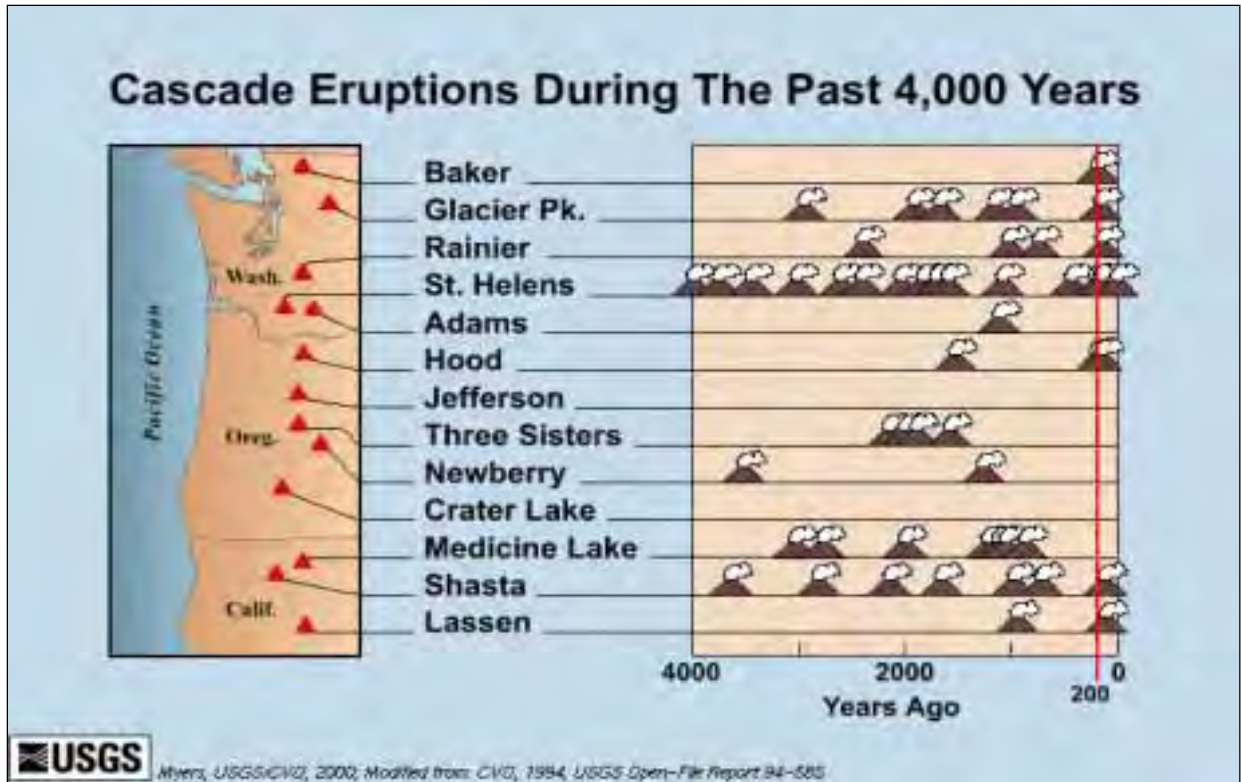


Figure 17-1. Past Eruptions in the Cascade Range

Volcano	Number of Eruptions	Type of Eruptions
Mount Adams	3 in the last 10,000 years, most recent between 1,000 and 2,000 years ago	Andesite lava
Mount Baker	5 eruptions in past 10,000 years; mudflows have been more common (8 in same time period)	Pyroclastic flows, mudflows, ash fall in 1843.
Glacier Peak	8 eruptions in last 13,000 years	Pyroclastic flows and lahars
Mount Rainier	14 eruptions in last 9000 years; also 4 large mudflows	Pyroclastic flows and lahars
Mount St Helens	19 eruptions in last 13,000 years	Pyroclastic flows, mudflows, lava, and ash fall

Three major Cascade volcanoes other than Glacier Peak are relatively close to Snohomish County: Mount Rainier is 60 miles to the south; Mount St. Helens is 110 miles to the south; and Mount Baker is 35 miles to the north. Mount Adams, also 110 miles to the south but on the east side of the Cascade Range, poses a lower threat because of the direction of prevailing winds. Mount Hood in Oregon constitutes a low hazard because of distance, direction of prevailing winds, and evidence that its previous ash eruptions were confined to its immediate vicinity.

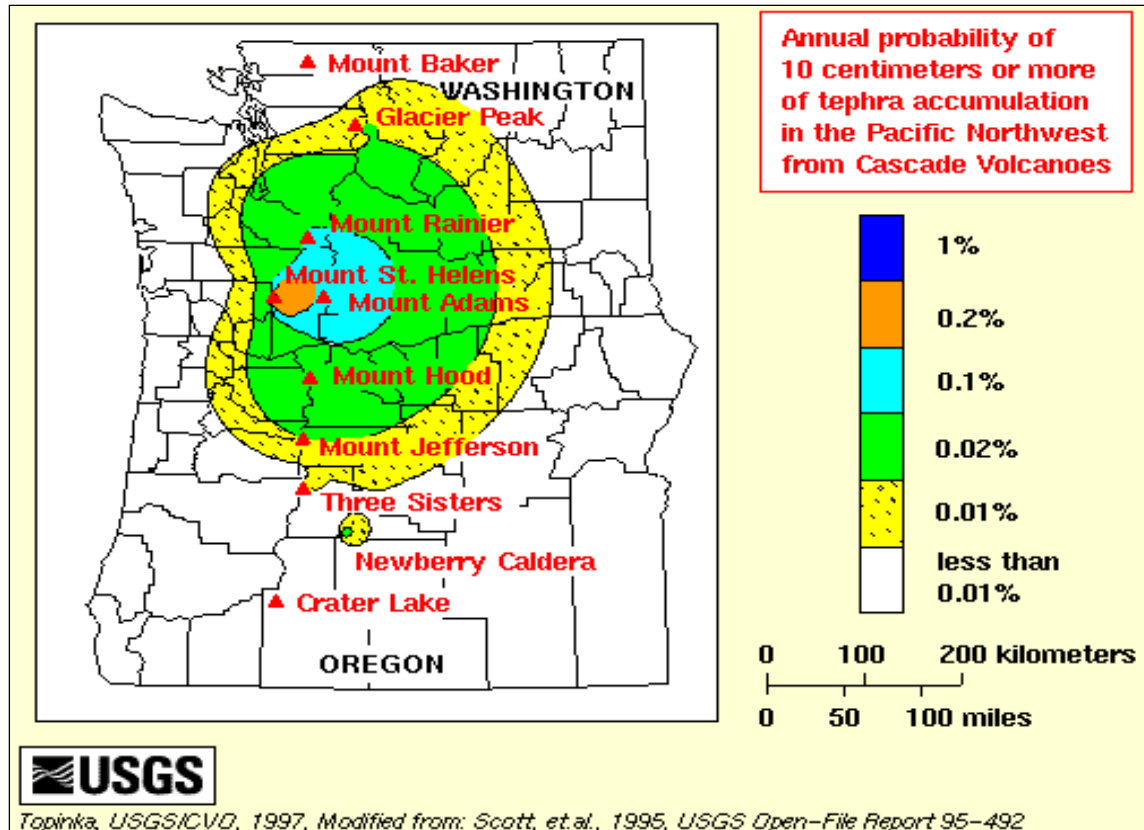


Figure 17-2. Probability of Tephra Accumulation in Pacific Northwest

17.2.3 Frequency

Many Cascade volcanoes have erupted in the recent past and will be active again in the foreseeable future. Given an average rate of one or two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience; however, in the past hundred years, California's Lassen Peak and Washington's Mount St. Helens have erupted with terrifying results. The U.S. Geological Survey classifies Glacier Peak, Mt. Adams, Mt. Baker, Mt. Hood, Mt. St. Helens, and Mt. Rainier as potentially active volcanoes in Washington State. Mt. St. Helens is by far the most active volcano in the Cascades, with four major explosive eruptions in the last 515 years.

17.2.4 Severity

The explosive disintegration of Mount St. Helens' north flank in 1980 vividly demonstrated the power that Cascade volcanoes can unleash. A 1-inch deep layer of ash weighs an average of 10 pounds per square foot, causing danger of structural collapse. Ash is harsh, acidic and gritty, and it has a sulfuric odor. Ash may also carry a high static charge for up to two days after being ejected from a volcano. When an ash cloud combines with rain, sulfur dioxide in the cloud combines with the rain water to form diluted sulfuric acid that may cause minor, but painful burns to the skin, eyes, nose, and throat.

17.2.5 Warning Time

Constant monitoring of all active volcanoes means that there will be more than adequate time for evacuation before an event. Since 1980, Mount St. Helens has settled into a pattern of intermittent, moderate and generally non-explosive activity, and the severity of tephra, explosions, and lava flows have

diminished. All episodes, except for one very small event in 1984, have been successfully predicted several days to three weeks in advance. However, scientists remain uncertain as to whether the volcano's current cycle of explosivity ended with the 1980 explosion. The possibility of further large-scale events continues for the foreseeable future.

17.3 SECONDARY HAZARDS

The secondary hazards associated with volcanic eruptions are mud flows and landslides.

17.4 CLIMATE CHANGE IMPACTS

Large-scale volcanic eruptions can reduce the amount of solar radiation reaching the Earth's surface, lowering temperatures in the lower atmosphere and changing atmospheric circulation patterns. The massive outpouring of gases and ash can influence climate patterns for years. Sulfuric gases convert to sub-micron droplets containing about 75 percent sulfuric acid. These particles can linger three to four years in the stratosphere. Volcanic clouds absorb terrestrial radiation and scatter a significant amount of incoming solar radiation, an effect that can last from two to three years following a volcanic eruption.

17.5 EXPOSURE

Snohomish County is most exposed to a Glacier Peak eruption that generates a lahar that would travel down the Sauk, Stillaguamish and Skagit Rivers and out to the ocean. All that is in the path of the lahar is potentially exposed to damage. This was used to analyze exposure to a lahar in Snohomish County.

17.5.1 Population

Population counts of those exposed to the volcano hazard were generated by analyzing census blocks that intersect with the lahar hazard zones. Census blocks do not follow the same boundaries as the lahar zones. Therefore, the methodology used to generate these estimates evaluated census block groups whose centers are in the lahar zones or where the majority of the population most likely lives in or near the lahar zone. HAZUS-MH estimated the number of buildings within the lahar zone within each block, and then estimated the total population by multiplying the number of residential structures by the average Snohomish County household size of 2.65 persons per household. Using this approach, it was estimated that the exposed population is 24,425 (3.47 percent of the total county population).

17.5.2 Property

Most of the County would be exposed to ash fall and tephra accumulation in the event of a volcanic eruption. Property located along the lahar inundation areas would be most exposed to lahar flows. Table 17-2 lists the total number of Snohomish County structures located in the lahar zones and their values. The majority of these properties are in unincorporated Snohomish County; the rest are in the cities of Arlington, Darrington, and Stanwood.

17.5.3 Critical Facilities and Infrastructure

Infrastructure exposed to lahar inundation includes bridges that cross the Stillaguamish, Sauk and Skagit Rivers in the lahar zone, as well as the section of the BNSF Railway where it crosses the Stillaguamish River and outflows from the Skagit River. All transportation routes are exposed to ash fall and tephra accumulation, which could create hazardous driving conditions on roads and highways and hinder evacuations and response. Three school facilities are exposed to lahar outflow zones. These facilities are located in Stanwood and Darrington. There are also three fire stations in the lahar outflow area and 39 base critical facilities. Table 17-3 summarizes the exposed critical facilities in the County.

TABLE 17-2. SNOHOMISH COUNTY STRUCTURES EXPOSED TO VOLCANO/LAHAR					
Jurisdiction	Buildings Exposed	Assessed Value			% of Total Assessed Value
		Structure	Contents	Total	
Arlington	395	\$57,206,200	\$45,921,150	\$103,127,350	4.6%
Darrington	686	\$75,657,750	\$61,798,420	\$137,456,170	99.5%
Stanwood	2,135	\$518,580,600	\$427,080,970	\$945,661,570	100.0%
Unincorporated County	6,001	1,056,270,700	754,268,950	1,810,539,650	4.7
Total	9,217	\$1,707,715,250	\$1,289,069,490	\$2,996,784,740	3.20%

TABLE 17-3. CRITICAL FACILITIES EXPOSED TO LAHAR HAZARDS	
Medical and Health Services	1
Government Function	7
Protective Function	5
Schools	4
Hazmat	0
Other Critical Function	2
Bridges	61
Water	1
Waste Water	2
Communications	1
Power	1
Total	85

17.5.4 Environment

The environment is highly exposed to the effects of a volcanic eruption. Even if the related ash fall from a volcanic eruption were to fall elsewhere, it could still be spread throughout the County by the surrounding rivers and streams. A volcanic blast would expose the local environment to many effects such as lower air quality, and many other elements that could harm local vegetation and water quality.

17.6 VULNERABILITY

17.6.1 Population

The entire population of Snohomish County is vulnerable to the damaging effects of volcanic ash fall in the event of a volcanic eruption. The elderly, very young and those who experience ear, nose and throat problems are especially vulnerable to the tephra hazard. Since there is generally adequate warning time before a volcanic event, the population vulnerable to the lahar hazard consists of those who choose not to evacuate or are unable to evacuate. The latter includes the elderly and the very young.

17.6.2 Property

There are currently no generally accepted damage functions for volcanic hazards in risk assessment platforms such as HAZUS-MH. Therefore the planning team was not able to generate damage estimates for this hazard. All properties listed in Tables 17-2 are vulnerable to the lahar hazard in Snohomish County. These lahar inundation areas are the outflow areas of past volcanic eruptions and are potential outflow areas for future volcanic eruptions. The most vulnerable structures would be those that are located closest to the lahar outflow areas, and those that are not structurally sound.

Also vulnerable are other properties that are located throughout the County that are subject to ash fall. Among these properties, the most vulnerable structures are those that are not as structurally sound and may collapse under the excessive weight of tephra and possible rainfall.

17.6.3 Critical Facilities and Infrastructure

Transportation routes that intersect with the lahar inundation zone are most vulnerable, especially depending on their structural stability. This would include roads, bridges and the BNSF Railway. The most vulnerable spots are those that directly intersect with a lahar outflow area and are not structurally sound. Those in the direction of wind would also be vulnerable to tephra and ash fall accumulations.

Utilities are vulnerable to damage from lahars due to the debris that may be carried. Water treatment plants and wastewater treatment plants are vulnerable to contamination from ash fall and debris that may be carried by a lahar. Most vulnerable are those that are located on or near parcels that intersect with the lahar outflow area or those that receive input from area streams and rivers that lahar flow through.

17.6.4 Environment

The environment is very vulnerable to the effects of a volcanic eruption. Snohomish County rivers and streams are vulnerable to damage due to ash fall, especially since ash fall can be carried throughout the County by means of the Stillaguamish, Skagit and Sauk Rivers. The sulfuric acid contained in volcanic ash could be very damaging to area vegetation, waters, wildlife and air quality. A lahar could be very damaging to area rivers and streams and could redirect water flow and cause changes in water courses.

17.7 FUTURE TRENDS IN DEVELOPMENT

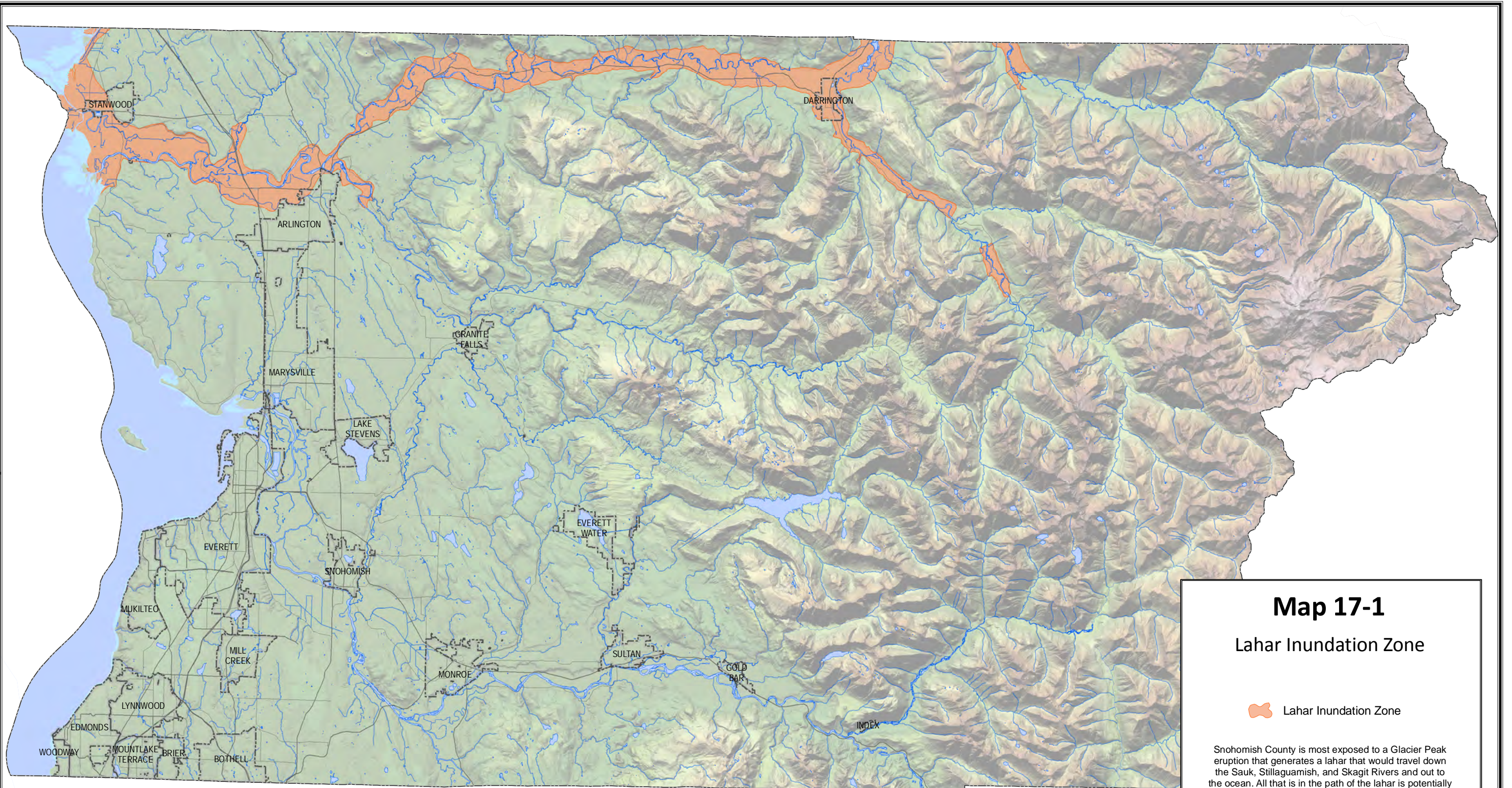
Lahar zones are not identified as “critical areas” as under the Washington State GMA. However, most of the lahar zones overlap the 100-year and 500-year floodplains in Snohomish County, which are identified critical areas under the GMA. Therefore, a mechanism is in place within the planning area to look at potential impacts from lahar on future development.

17.8 SCENARIO

In the event of a volcanic eruption in Snohomish County, there would probably not be any loss of life, due to adequate warnings. However, there could be great loss of property, especially in Arlington, Darrington, Stanwood and areas of unincorporated county. There would also be the possibility of severe environmental impacts due to lahar flows in area rivers and streams. A large area could be affected by ash fall. The most severe impacts would be on the environment.


17.9 ISSUES

Since volcanic episodes have been fairly predictable in the recent past, there is probably not much concern about loss of life, but there is concern about loss of property and infrastructure and severe environmental impacts.



Map 17-1

Lahar Inundation Zone

 Lahar Inundation Zone

Snohomish County is most exposed to a Glacier Peak eruption that generates a lahar that would travel down the Sauk, Stillaguamish, and Skagit Rivers and out to the ocean. All that is in the path of the lahar is potentially exposed to damage. The USGS Lahar Inundation Zone depicts lahar hazard for a Glacier Peak eruption based on previous outflow routes.

United States Geological Survey (USGS)



Snohomish County disclaims any warranty of merchantability or warranty of fitness for any particular purpose of this map, either express or implied. Snohomish County makes no representation or warranty concerning the content, accuracy, currency, completeness, or quality of data depicted on this map. Any user of this map assumes all responsibility for its interpretation and use. Any user relying on any of the County's GIS products does so at his or her own risk. All critical information should be independently verified. Snohomish County shall not be liable to the user for damages of any kind, including lost profits, lost savings, or any other incidental or consequential damages related to the providing of data or its use. The user agrees to hold Snohomish County harmless from and against any damage, loss, or liability arising from any use of this map.

Tetra Tech, Inc.
 May 2010

Data Sources:
 Snohomish County
 US Geological Survey
 Washington State Department of Natural Resources
 Division of Geology and Earth Resources

