

Chapter 4.8

Volcanic Hazards Risk Assessment

Introduction

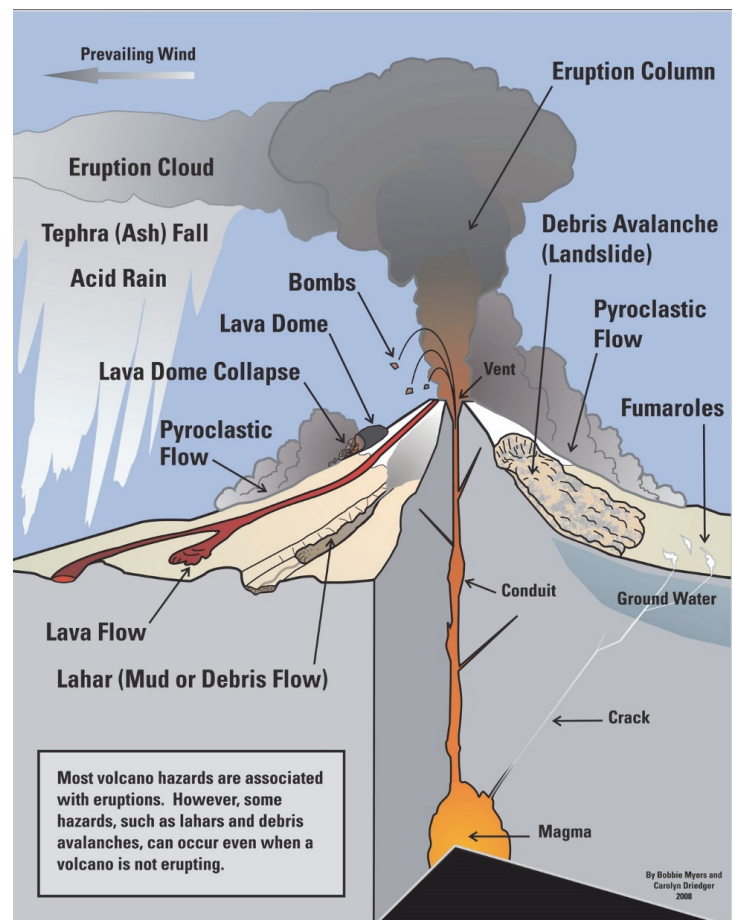
Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams are part of the 1,200-mile Cascade Range of volcanoes extending from British Columbia to northern California. All five Washington Cascade mountains are classified as high threat volcanoes by the United States Geological Survey (USGS). The May 1980 eruption of Mount St. Helens resulted in a federal disaster declaration for Thurston County. Because it is the most active volcano, it will continue to pose a threat to Thurston County. Mount Rainier, at 14,410 feet above sea level and located only 30 miles from Thurston County's border, is the South Puget Sound Region's dominant volcanic threat.

Definition

There are numerous volcanic hazards including volcanic landslides, lava flows, and pyroclastic flows.

Only two volcanic hazards pose direct threats to areas within Thurston County and are the focus of this risk assessment: volcanic ash and lahar (Figure 4.8.1).

Figure 4.8.1 Volcanic Hazards



Graphic courtesy of USGS.

Volcanic Ash

Ash or tephra is the term for any type and size of rock fragment that travels in an airborne path from a forceful volcanic eruption. Cascade volcanoes can produce a hazardous column of suspended debris that subsequently falls to the ground in the direction of prevailing winds. A tephra column can travel for hundreds of miles and deposit ash in significant quantity. Both the thickness of the deposition and the size of the particles decrease with increasing distance from the site of eruption. Ash particles are less than 0.08-inch in diameter.

Lahar

Cascade volcanoes and their lower elevation valleys are ideal settings for massive debris flow- and mudflow-disasters because of the immense quantity of ice, water, rock, and sedimentary materials available that can suddenly mobilize downslope under the action of gravity. Such events, triggered by volcanoes, are known as lahars. The USGS describes a lahar as follows:

A lahar is a flowing mixture of water-saturated debris that moves downslope under the force of gravity. Debris flows consist of material varying in size from clay to blocks several tens of meters in maximum dimension. When moving, they resemble masses of wet concrete and tend to flow downslope along channels or stream valleys. Debris flows are formed when loose masses of unconsolidated wet debris become unstable. Water may be supplied by rainfall or by melting of snow or ice. Debris flows may be formed directly if lava or pyroclastic flows are erupted onto snow and ice. Debris flows may be either hot or cold, depending on their manner of origin and temperature of their constituent debris.¹



Removal of ash from Mount Saint Helens near the Yakima Airport. Photo courtesy of the Yakima Herald

Area of Impact

Volcanic Ash

No geographical analysis was performed to assess volcanic ash vulnerabilities for this hazard's risk assessment as there are no documented or mapped scenarios for Tephra hazards in Thurston County. It's plausible that some or all of Thurston County could receive ash from a dusting to greater depths from Mount Rainier or other Cascade volcanoes under the right wind conditions.

Lahar

For the purposes of the hazard risk assessment, the lahar hazard area in Thurston County is defined as the USGS mapped Case 1 Lahar inundation area (Map 4.8.1). General building stock and critical facilities were overlaid with the

lahar inundation map. General building stock and critical facilities data with known property replacement cost values were overlaid with the lahar map to estimate population exposure, building exposure, and dollar-value estimates of damage to characterize a hazard risk rating (see Impacts and Vulnerabilities).

Volcanologists consider a Case 1 lahar originating from Mount Rainier the most appropriate scenario for hazard mitigation planning.² This type of lahar event is best historically represented by the Electron Mudflow (see Extent and Previous Incidents sections for more information about historic Lahars). The risk of this lahar type exceeds that of all smaller but more frequent flows. In addition, the risk is increased by a potential to occur without a major volcanic eruption, which may not afford downstream populations an early warning. A

non-eruptive event could be initiated by non-magmatic seismic activity, by steam eruptions, or just by gravity in places where a failure plane has been loosened by clay and hydrothermal fluids.

Scientific research and mapping of hydrothermally altered rocks on Mount Rainier's high altitude slopes suggests that the west flank of the mountain, including the head of the Puyallup River, has the greatest potential for generating large landslides that are likely to initiate far-reaching lahars.³ The Puyallup River valley, and to a lesser extent, the Nisqually River valley, whose basin also includes weakened rock, are at the most risk from large landslide-generated lahars. Lahars generated by eruptions could descend any of the mountain's valleys.⁴

Communities Most Vulnerable to a Lahar

Based on the Case 1 lahar scenario, properties along the Nisqually River Valley are the most susceptible to lahar hazards. Following the Nisqually River southeast to northwest, the following general vicinities and communities along the Nisqually River may be most affected under this scenario:

- Properties north of Clear Lake along Peissner Rd SE and Hobson Rd SE
- Properties northeast of Bald Hills Rd near Cook Rd SE and Dan Cook St SE

- McKenna Elementary School (Pierce County), Yelm Community School District
- Wa He Lut Indian School
- Properties between the Nisqually River and the Yelm Urban Growth Area Boundary near Bridge St SE and Flume Rd SE
- Properties northeast of Yelm in the northeast section of the Nisqually Pines residential community near Port Orford Blvd SE, Heather Ln SE, and Briar St SE
- The City of Centralia Power Plant off Mud Run Road
- Properties on the Nisqually Indian Reservation adjoining the Nisqually River migration zone
- Virtually all properties in the Nisqually Valley from Durgin Rd SE north to the Puget Sound.

Extent

Volcanic Ash

The severity of the hazard depends on the depth and geographic extent of ash deposition. Ash can travel great distances and cover areas over hundreds or thousands of square miles.

Lahar

Lahar - Scientific literature for Cascade lahars identifies several size and origin classifications. The USGS has summarized two types of Mount Rainier lahar events that could threaten communities within the Nisqually River valley:

Meltwater Generated Lahar - A volcanic eruption can produce an explosive event which releases a mixture of hot gases and rock debris, known as a pyroclastic flow. A pyroclastic flow behaves almost like a fluid and flows down the topography of the mountain. This hot churning debris flow swiftly melts snow and ice and subsequently mixes with the meltwater to form a lahar. Such lahars are often preceded by volcanic events or seismic activity which can provide some warning of an impending eruption. Geological evidence indicates that several of Mount Rainier's past lahars were formed by this phenomenon.

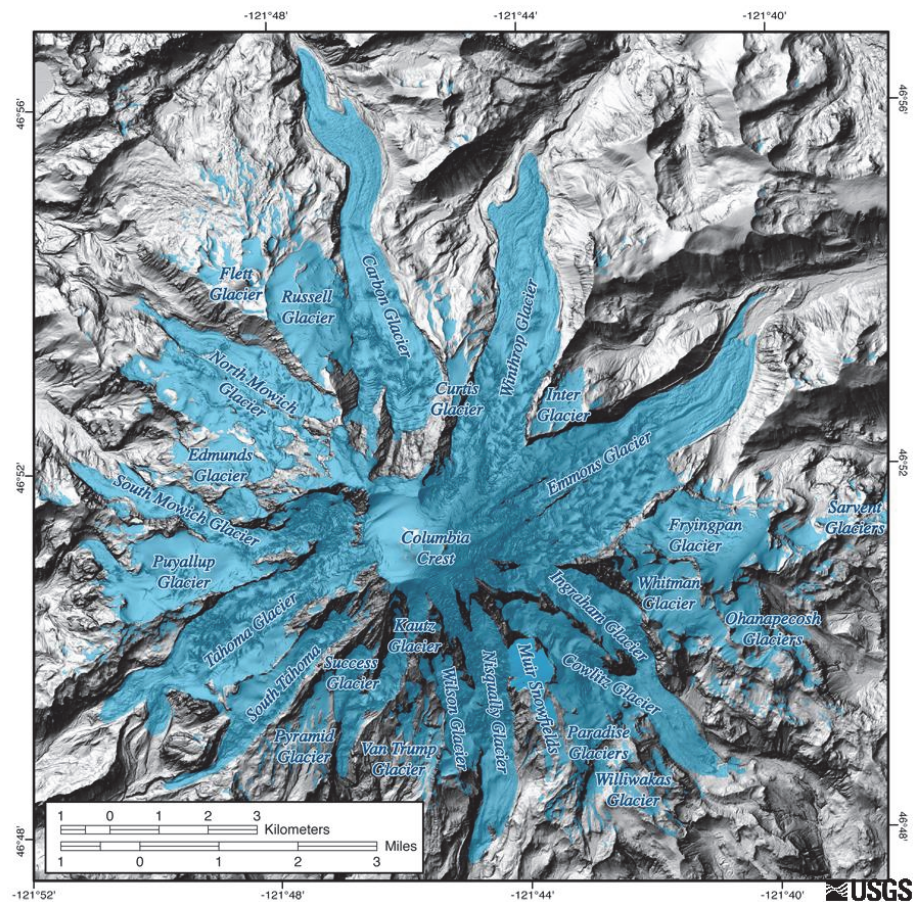
Landslide Generated Lahars - Landslides can occur on the flanks of Mount Rainier that can displace significant volumes of earth and water to form a substantial lahar. Magma can rise and force pressure against the internal structures of a mountain causing deformation and destabilization of the mountain's edifice. A modern example of this type of effect occurred with the bulge that formed on the north flank of Mount St. Helens in the months preceding the May 18, 1980 eruption. This bulge eventually collapsed creating one of the largest known landslides in modern times. Earthquakes can also initiate a landslide of unstable structures. Landslides can also occur from an eventual failure of a rock mass's cohesive strength. Rocks can be weakened by the chemical action of acidic fluids that are created from volcanic gases, heat and ground water. Over time, this acidic fluid infiltrates the rock and eventually converts the hard volcanic rock into weak, clay-rich rock. This process is called hydrothermal alteration or metamorphism. These altered rocks and water-saturated clay-rich deposits could eventually slough away from the mountain from the force of a volcanic eruption. These landslides can rapidly transform into a lahar. Many large scale lahars on Mount Rainier have formed in this fashion. Hydrothermally altered rock landslides have also produced lahars without the trigger of a volcanic eruption. One such lahar, known as the 500-year-old Electron Mudflow, is believed to have originated without a volcanic eruption. No eruptive volcanic deposits have been discovered that coincide with the age of this lahar. This lahar deposited debris as high as 20 feet thick, and contains remnants of an old-growth forest in the vicinity of the City of Orting in Pierce County.

Origin, Course, and Timing of Lahar

At 14,410 feet, Mount Rainier is the highest peak in the Cascade Range and remains an active volcano. It is estimated to contain nearly one cubic mile of glacial ice, more than all the other Cascade volcanoes combined (see Figure 4.8.2).⁵ The sheer volume, mass, rate of speed, and churning contents of a massive debris flow could destroy virtually all human made structures in its path. Past Cascade lahars surged nearly 45 to 50 miles per hour at steep slopes and were 100 feet or more

thick. Scientists have identified more than 60 lahars originating from Mount Rainier in the past 10,000 years. Deposits of past lahars are found in all the valleys that originate on Mount Rainier’s flanks.⁶ The Washington State Hazard Mitigation Plan states that more than 150,000 people live on historic lahar deposits in the Puget Sound lowlands. The USGS rates the risk of a large lahar from Mount Rainier to the surrounding Western Washington population, as the Puget Sound Region’s greatest volcanic hazard.

Figure 4.8.2 The Glaciers of Mount Rainier



Glaciers of Mount Rainier overlaid on base map LIDAR image. Steep Cascade volcanoes, rich with glaciers, and their lower elevation valleys are ideal settings for massive debris flow- and mudflow-disasters. Graphic courtesy of USGS.

The USGS has studied artifacts from past lahars to predict future impacts. Deposits are analyzed to determine the type, frequency, and magnitude of past events. Through these studies, scientists predicted a potential inundation hazard in the lower Nisqually River valley caused by a lahar entering and possibly flowing beyond Alder Reservoir. Because Alder Dam exists for power generation, Alder Lake is never empty. Scientists are concerned that a lahar entering the reservoir could either cause dam failure or catastrophically displace a significant volume of the stored water.

The Alder Dam and the Alder Lake Reservoir, owned and operated by Tacoma Power for power generation, creates uncertainty about the potential lahar flow dynamics downstream from the dam. This dam is vulnerable to a Case 1 Lahar. The travel time of a Case 1 flow from the edifice of Mount Rainier to the reservoir may be less than two hours. High reservoir water levels do not offer sufficient capacity to contain the volume of the lahar flow. Scientists report that the reservoir is most vulnerable to failure caused by a wave of translation, because the relatively confined valley upstream can convey a large lahar without great volume loss.⁷ A wave of translation would likely cause water to overtop the dam and send waves of water downstream from the reservoir. Smaller lahars entering the reservoir may not pose immediate risks for downstream flooding but could increase the rate of sedimentation for the dam and thereby shorten its term of operation.

The Tacoma Power “Emergency Action Plan for the Nisqually Hydroelectric Project FERC Project No. 1862 [LaGrande and Alder Dams)” includes the following excerpt:

Another possible [hazard] event is that of a lahar or mudflow originating from Mt. Rainier. Travel time of a lahar or mudflow to Alder Lake is estimated between 0.5 and 4.2 hours. Most lahars having sufficient volume to cause a significant rise in the lake level will travel in less than 2 hours. Because of the rapid nature of the inflow, it is not possible to affect any meaningful advance spill to increase reservoir capacity. An advance spill of 20,000 cubic feet per second for one hour will only yield approximately half-foot of reservoir capacity at full lake. Therefore, should lake levels rise rapidly (>3 feet/hour) no spill is recommended and evacuation to an observation post should be made. The combined outflow of both a large spill and overtopping may be more adverse than would result from overtopping only. In the unusual case of a lahar causing more gradual rise in inflow, spill could be implemented, but is not recommended unless reduction in spill can be made remotely. Rapid evacuation should be planned prior to local operation of the spillway.

Sensors and gauges at the Alder Dam would provide indication of changes in the level of water at the reservoir. Tacoma Power will notify multiple state and local emergency response agencies if failure of the Alder or LaGrande dams appeared imminent. Residents within the Nisqually River valley could evacuate to higher ground if given sufficient warning of a catastrophic dam failure. The Alder and LaGrande Sequential Dam Failure Flood Inundation zones approximate the USGS's extent of the inundation zone for a Case 1 lahar in the Nisqually River valley (Map 4.8.1).

Should a Case 1 lahar adversely affect the Alder dam, flood inundation could occur at the Nisqually River bridge at SR507 (McKenna, Pierce Co.) in two hours and 30 minutes. The inundation would peak at this same location in four hours and 36 minutes.⁸

Previous Incidents

May 18, 1980. Mount St. Helens Eruption. DR 623

Volcanic Ash

The 1980 eruption of Mount St. Helens emitted an ash column over 10 miles high. Over the course of the day of the eruption, winds blew nearly 540 million tons of ash to the east.⁹ Fallout from the ash created complete darkness in Spokane, nearly 250 miles away; dropping one half inch of ash only a few hours after the start of the eruption. Preceding the May 18 eruption, other eruptions dusted layers of ash in areas of Thurston County.

Lahar

No lahars have impacted Thurston County in modern times. The USGS reports that during the May 18, 1980 eruption of Mount St. Helens, approximately 2.3 billion cubic meters (3 billion cubic yards) of material was deposited in the upper 27 km (17 mi) of the North Fork Toutle River valley resulting in massive lahars.

Historic Lahars Originating from Mount Rainier

Lahars originating from Mount Rainier were interspersed by thousands of years. They varied in size and magnitude. Past Nisqually River valley lahars are known to have flowed down the slopes of Mount Rainier all the way to the Puget Sound. The USGS provides the following short history of major lahar events originating from Mount Rainier:

The largest lahar originating from Mount Rainier is known as the Osceola Mudflow. This cohesive lahar occurred about 5,600 years ago, and was at least 10 times larger than any other known lahar from Mount Rainier. It was caused by a large debris avalanche composed mostly of hydrothermally-altered material, and may have been triggered by magma forcing its way into the volcano. Osceola deposits cover an area of about 550 square kilometers (212 square miles) in



Remnants of the Lahar on the Toutle River from the May 18, 1980 Mount St. Helens. Photo courtesy of USGS.

the Puget Sound lowland, extending at least as far as the City of Kent, and to Commencement Bay, now the site of the Port of Tacoma. The communities of Orting, Buckley, Sumner, Puyallup, Enumclaw, and Auburn are also wholly or partly located on top of deposits of the Osceola Mudflow and, in some cases, of more recent debris flows as well.

At least six smaller debris avalanches have spawned lahars in the past 5,600 years. One of these, the Electron

Mudflow, which was derived from a slope failure on the west flank of Mount Rainier about 600 years ago, has not been correlated with an eruption. The Electron Mudflow was more than 30 yards deep where it entered the Puget Sound lowland at the community of Electron. Its deposits at Orting are as much as 6 yards thick and contain remnants of an old-growth forest.

Probability of Occurrence

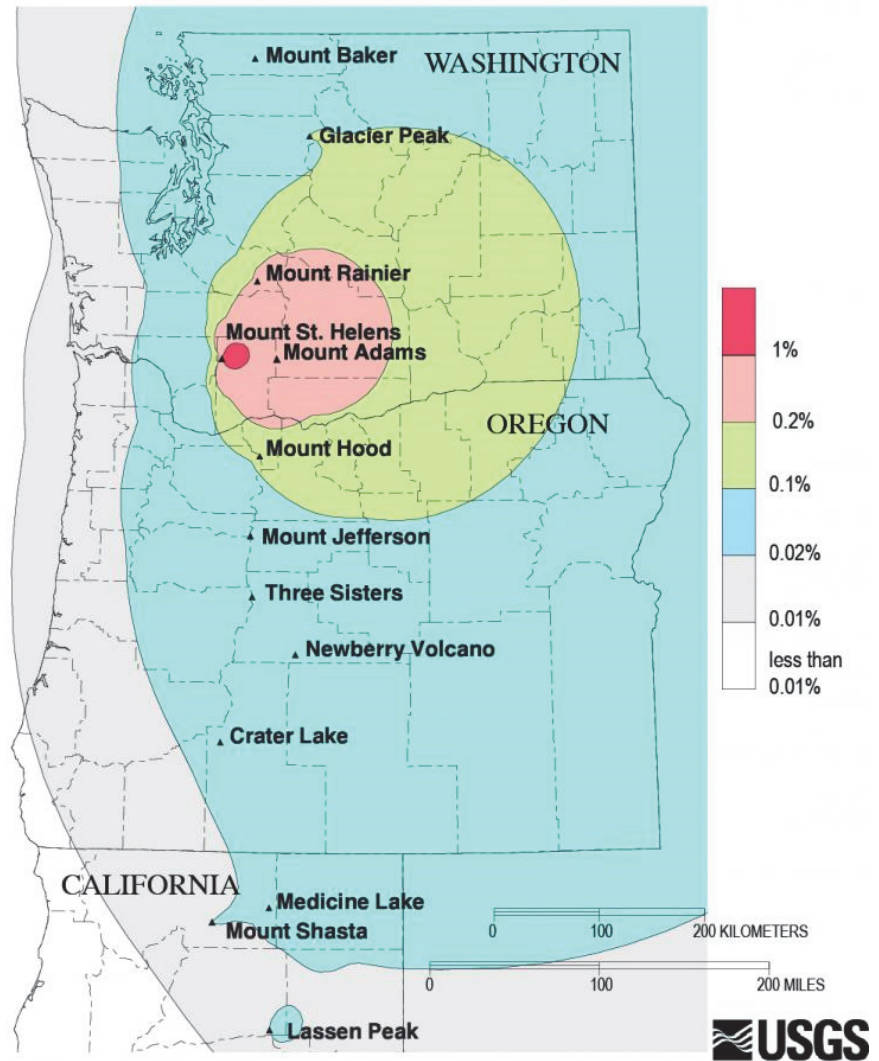
Volcanic Ash

USGS reports that Mount Rainier has only produced moderate quantities of ash in past eruptions. The eruptions of Mount St. Helens in 1980 deposited a scant layer of ash in Thurston County, but the fallout did not pose a significant hazard to the region. Thurston County winds prevail from the south and west, therefore ash is more likely to disperse east of the Cascades. If Mount Rainier or Mount St. Helens were to erupt, a resultant ash plume would require an easterly wind to deposit ash in Thurston County. The USGS calculated a 0.02 percent annual probability for a significant ash deposit of one centimeter or greater for the southeastern tip of the county and 0.01 percent for most of the county and its most populated areas (Figure 4.8.3).¹⁰ There is a low probability of a volcanic tephra event impacting Thurston County.

Lahar

The historical occurrences of lahars are classified by size. The largest lahar, historically represented by the Osceola mudflow, is designated a Case M Lahar for a maximum lahar event. Scientists offer this scenario as “low probability and high consequence,” with the implication that the risk may be unacceptable

Figure 4.8.3 Probability of Cascades Tephra Hazard



Annual probability of the deposition of 1 centimeter (0.4 inch) or more of tephra (ash) from eruptions in the Cascade Range. Graphic courtesy of USGS.

at even very small probabilities.¹¹ This lahar is estimated to occur about every 10,000 years. When compared with other historic lahars from postglacial times, scientists consider this maximum lahar a statistical outlier. There is no geologic record of a Case M Lahar affecting Thurston County.

A Case 1 lahar is estimated to have a recurrence interval of approximately every 500 to 1,000 years. The Washington State Hazard Mitigation Plan indicates there is a 1 in 100 to 1 in 500 annual probability of occurrence of lahar inundating the Nisqually River. The probability of a Case 1 Lahar is low.

Vulnerabilities and Impacts – Volcanic Ash

Because no geographical analysis was performed to assess volcanic ash vulnerabilities, a summary of ash impacts to people, systems, resources, and activities is limited. A quarter inch or more of ash fall will disrupt nearly every mode of transportation. Ash fall obscures visibility and wet ash creates hazardous driving conditions. Excess ash will delay transportation and will limit response times for emergency responders. Aircrafts are especially vulnerable as ash can disable engines, therefore air transportation would be grounded in the affected area while conditions pose a hazard. Inhalation of ash particles can cause respiratory irritation and pose more serious problems for people with respiratory diseases; but this can be mitigated by simply avoiding exposure. Ash can destroy crops, impact livestock access to

pastures, contaminate lakes and streams, clog stormwater systems, and damage exposed motors and outdoor mechanical systems. Three inches of ash begins to exceed load capacities of some building rooftops and can cause structural failure. Failure may also occur with lower depths of ash when combined with excess precipitation. Wet ash is known to cause power lines to short. Ash removal and disposal would likely be the greatest cost to both the public and private sectors. The 1980 eruption of Mount St. Helens posed a major nuisance for communities in Eastern Washington. In Yakima, ash removal took ten weeks and cost \$2.2 million.¹²

Vulnerabilities and Impacts – Lahar

The risk assessment for volcanic hazards is based on the USGS Mount Rainier Case I Lahar Scenario for the Nisqually River Valley and is summarized in the remainder of this section.

Impacts to People

Lahars are very dangerous and can occur without volcanic eruptions. People who live or work in the Nisqually Valley or near the mouth of the Nisqually River are at greater risk from lahar hazards than any other areas of Thurston County. Lahar damage principally occurs by impact from large boulders or logs carried in the lahar's flow. Lahar forces present high drag and buoyancy forces that are created by its dense fluids. Lahars can cause damage by abrasion, blunt force trauma, drowning, and burial. With enough warning, people

can evacuate from the Valley or retreat to higher ground. Lahars will destroy most human structures in their paths. People who lose their homes will experience housing insecurity and are likely to experience grief and other mental stress.

An estimated 2,284 people who live in Unincorporated Thurston County in the Nisqually River Valley are potentially at risk for lahar hazards (Table 4.8.1).

Table 4.8.1 Thurston County Population Residing in the Potential Lahar Hazard Areas

Jurisdiction	Population	Population Exposed	% Population Exposed
Bucoda	610	0	0%
Lacey	58,180	0	0.1%
Olympia	56,370	0	4.3%
Rainier	2,510	0	0.5%
Tenino	2,030	0	0.1%
Tumwater	26,360	0	0.8%
Yelm	10,680	0	0.1%
Unincorporated	143,760	2,284	1.6%
Total Planning Area	300,500	2,284	0.8%

Impacts to Structures and Systems

Buildings and other structures in the path of a debris flow can be buried or carried away. Because of their relatively high density and viscosity, Lahars can move and even carry away vehicles and other objects as large as bridges.

The following major bridges/routes are located within the Case I inundation zone and could be adversely impacted: State Route 507 Bridge between Yelm and McKenna, Old Pacific Highway, and Interstate 5. There are also three railroad bridge crossings: The Tacoma Rail Mountain Division railroad, the Yelm Prairie Line (non-operational – to be converted to a shared use trail), and the BNSF Railway mainline near I-5. The Centralia City Light Yelm Hydroelectric Project plant could also be impacted. A large lahar that inundated downstream below the Nisqually Hydroelectric Project would have major transportation and economic disruptions for a significant number of communities and Joint Base Lewis McChord along the South Sound I-5 Corridor.

There are 817 residential units, 35 commercial buildings, and four educational facilities located in lahar hazard areas in Thurston County. In total, there are 857 buildings valued over \$258 million that are exposed to potential lahar hazard areas (Tables 4.8.2 and 4.8.3).

Table 4.8.2 Number of Structures in the Lahar Inundation Areas

Jurisdiction	Number of Structures in Lahar Inundation Areas							Total
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	
Bucoda	0	0	0	0	0	0	0	0
Lacey	0	0	0	0	0	0	0	0
Olympia	0	0	0	0	0	0	3	0
Rainier	4	0	0	0	0	0	0	0
Tenino	0	0	0	0	0	0	0	0
Tumwater	0	3	0	0	0	0	0	0
Yelm	0	0	0	0	0	0	0	0
Unincorporated Thurston County	817	35	1	0	0	0	0	4
Total	817	35	1	0	0	0	0	4

Table 4.8.3 Value of Structures and Contents in the Potential Lahar Inundation Areas

Jurisdiction	Total Buildings	Total Residential Buildings	Total Building & Contents Value	Buildings Exposed	Total Building & Contents Exposed	% Total Value
Lacey	18,985	17,637	\$17,357,526,547	0	\$0	0.0%
Olympia	18,242	16,257	\$19,116,213,011	0	\$0	0.0%
Rainier	875	814	\$393,003,023	0	\$0	0.0%
Tenino	751	651	\$404,778,123	0	\$0	0.0%
Tumwater	9,513	8,408	\$9,362,171,728	0	\$0	0.0%
Yelm	3,139	2,827	\$2,077,637,133	0	\$0	0.0%
Unincorporated Thurston County	53,104	817	\$24,765,596,428	857	\$258,088,648	1.0%
Total Planning Area	104,854	817	\$73,540,652,648	857	\$258,088,648	0.4%

There are approximately 16 community lifeline assets that are located in potential lahar hazard areas (Table 4.8.4). Exposed assets include electrical substations, water facilities, a school, and several state highway bridges.

Table 4.8.4 Thurston County Community Lifelines located in the Lahar Inundation Areas

Location in Planning Area	Comm-unications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Trans- portation	Total
Bucoda	0	0	0	0	0	0	0	0
Lacey	0	0	0	0	0	0	0	0
Olympia	0	0	0	0	0	0	0	0
Rainier	0	0	0	0	0	0	0	0
Tenino	0	0	0	0	0	0	0	0
Tumwater	0	0	0	0	0	0	0	0
Yelm	0	0	0	0	0	0	0	0
Unincorporated Thurston County	0	2	5	0	0	1	8	16
Total Planning Area	0	2	5	0	0	1	8	16

Impacts to Natural, Cultural, and Historic Resources

Should a large lahar flow extend beyond the Nisqually Hydroelectric Project, it would have direct adverse impacts on downstream natural, cultural, and historic community assets. A lahar could have long-term impacts on Nisqually River fish and wildlife habitat which in turn would have significant cultural, economic, and sustenance impacts for the Nisqually Indian Tribe. Approximately 145 students are enrolled at the Wa He Lut Indian School, located in the Case 1 Lahar Inundation Zone. The school is an important educational, cultural, social center for the Nisqually people and the school’s families and educators. The Billy Frank Jr. Nisqually National Wildlife Refuge is one of the highest quality and ecologically diverse estuaries on the Puget Sound. The loss of habitat restoration investments would have a lasting adverse impact on salmon and other sensitive wildlife species.

Impacts to Activities

The loss of bridges and impacts to roads will disrupt the transportation system creating delay. Major disruptions to the transportation system will in turn will impact the region's economy.

Risk Ratings

Social Vulnerability Rating and National Risk Index

Social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. As a consequence enhancing risk component of the National Risk Index, a Social Vulnerability score and rating represent the relative level of a community's social vulnerability compared to all other communities at the same level. A community's Social Vulnerability score measures its national rank or percentile. A higher Social Vulnerability score results in a higher Risk Index score. The lahar inundation area encompasses portions of Thurston County that range from relatively low to relatively high social vulnerability. Map 4.8.2 shows assets in Thurston County that are located in potential lahar hazard areas by census tract social vulnerability ratings.

The Federal Emergency Management Agency National Risk Index (NRI) provides a National Risk Index score and rating. The rating represents a community's relative risk for lahar when compared to the rest of the United States. According to the NRI, Thurston County's volcanic hazard risk index rating is "relatively high" at 95.5. The NRI reports an estimated volcanic hazard annual loss of approximately \$14 million.

Community Hazard Risk Ratings for the Lahar Hazard Areas

The countywide lahar risk ranking score is 6 – a low risk rating. Lahar risk varies from none to low for most communities. Tables 4.8.5 and 4.8.6 show community and special purpose lahar hazard risk ratings. The details of the lahar hazard risk assessment calculations are shown in Appendix C.

Table 4.8.5 Community Lahar Hazard Risk Ratings

Municipal Plan Participants	Lahar Hazard	
	Risk Ranking Score	Risk Rating
Bucoda	0	Low
Lacey	0	Low
Olympia	0	Low
Rainier	0	Low
Tenino	0	Low
Tumwater	0	Low
Yelm	0	Low
Unincorporated Thurston County	6	Low
Total Planning Area	6	Low

Table 4.8.6 Special Purpose District Lahar Hazard Risk Ratings

Special Purpose District Plan Participants	Lahar Hazard	
	Risk Ranking Score	Risk Rating
East Olympia Fire District	0	Low
Intercity Transit	0	Low
Lacey Fire District	3	Low
McLane Black Lake Fire District	0	Low
Olympia School District	0	Low
SE Thurston Fire Authority	3	Low
South Bay Fire District	0	Low
The Evergreen State College	0	Low
Thurston PUD	6	Low
West Thurston Regional Fire Authority	0	Low

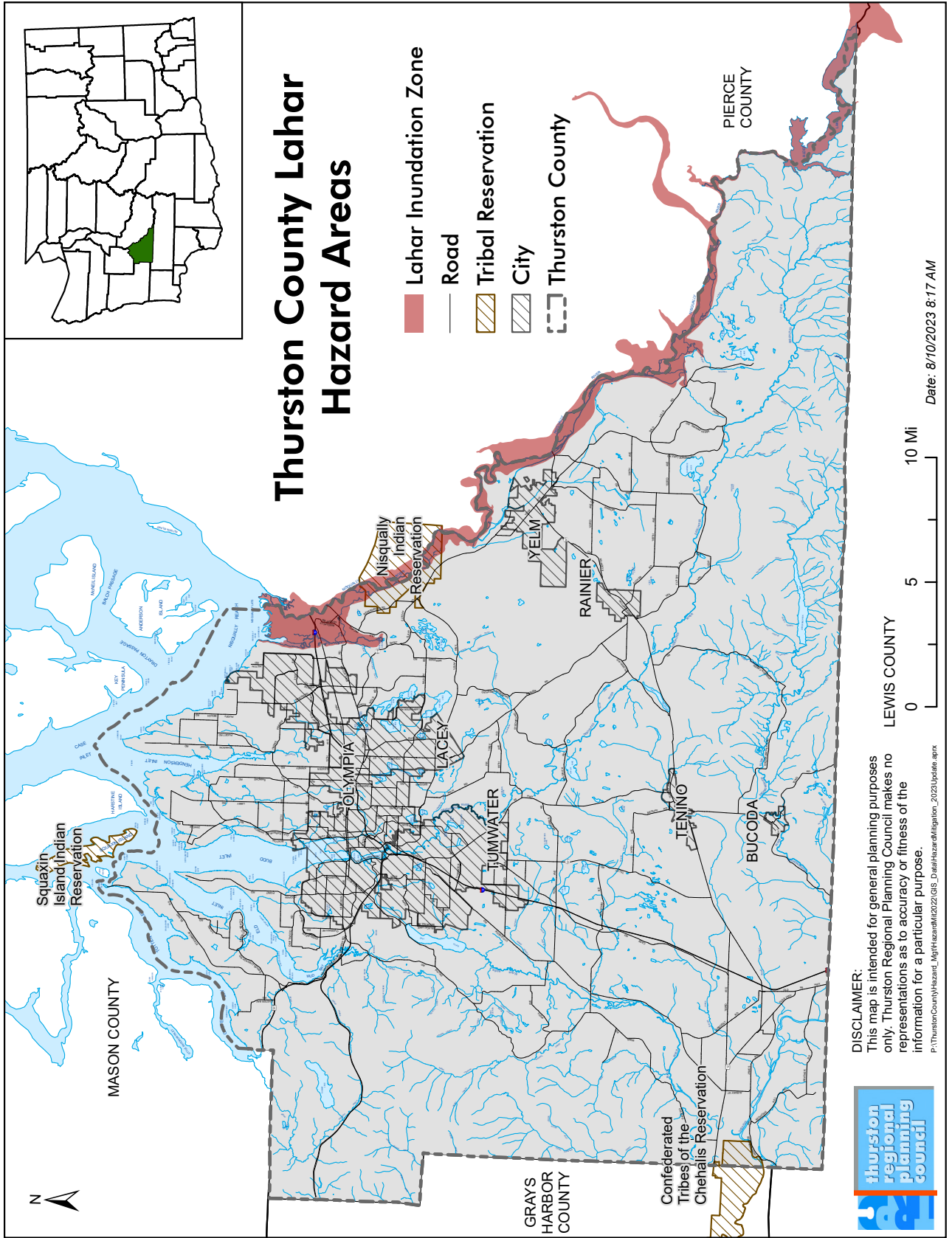
Changes in Lahar Hazard Risks Since Last Plan Update

A different methodology was used to estimate hazard risks and the vulnerability of community assets since the plan was last updated. It is not possible to perform a regional assessment of any changes in lahar hazard risks since the previous plan was adopted.

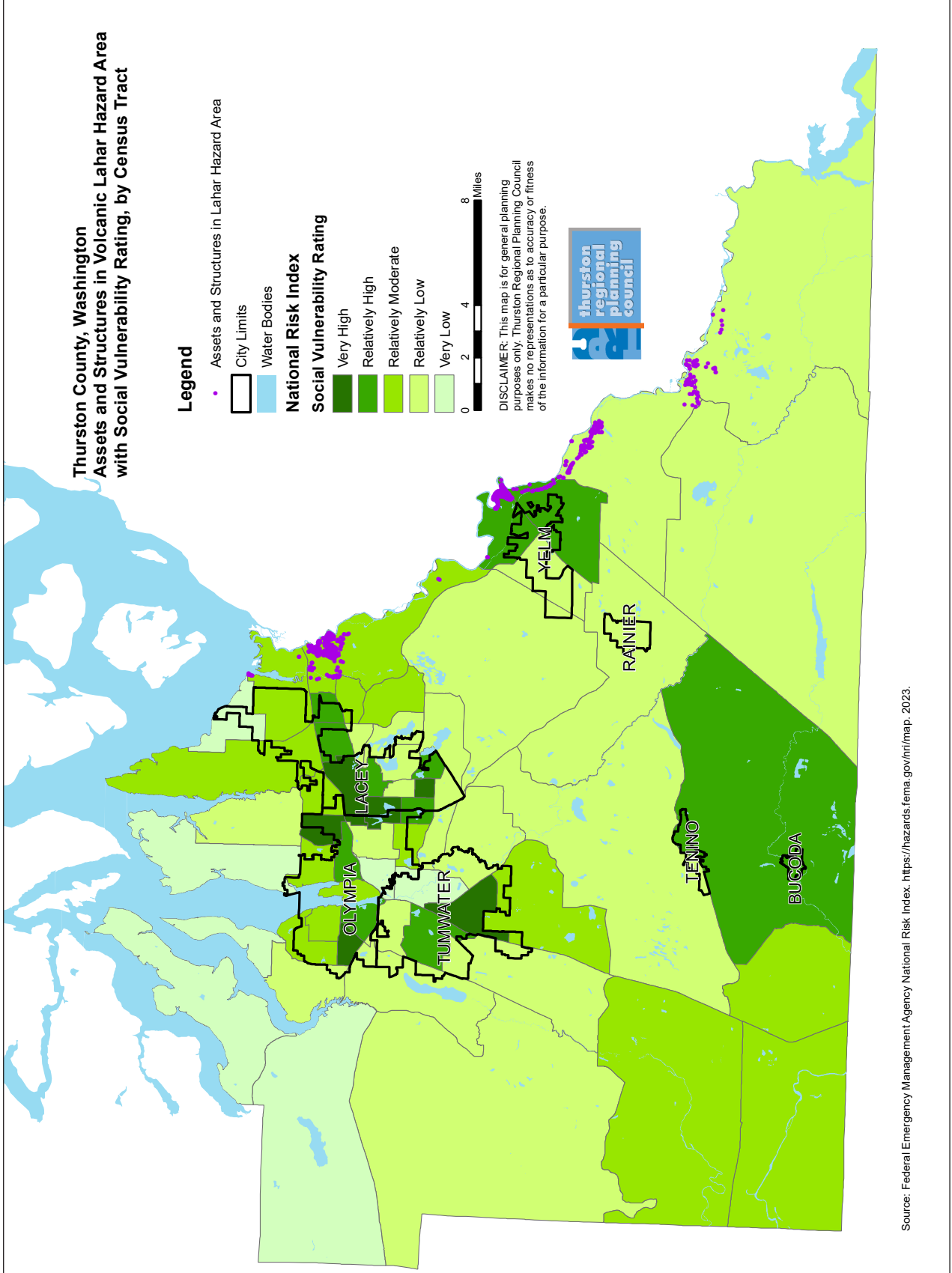
Connection to the Regional Mitigation Strategy

The Hazard Mitigation Planning Workgroup identified a regional initiative, Evacuation Route Planning for Catastrophic Dam Failure and Volcanic Lahar. This initiative will develop an evacuation plan for potential dam failure and lahar hazards in coordination with residents, businesses, and other stakeholders. The plan will include routes, alert notification protocols, signs, staging areas, public education, emergency sheltering needs, operational plans, and training for organizations and personnel who would be involved in evacuation operations.

Map 4.8.1 Lahar Hazard Areas of Thurston County



Map 4.8.2 Exposed Assets and Structures in Lahar Inundation Area and Thurston County Social Vulnerability Index Rating by Census Tract



Endnotes

- ¹Miller. 1989. Potential Hazards from Future Volcanic Eruptions in California: USGS Bulletin 1847.
- ²Hoblitt,R.P., et.al. 1998. Volcano Hazards from Mount Rainier, Washington, Revised 1998: U.S. Geological Survey Open-File Report 98-428
- ³Reid, Mark, E. et.al. 2001. Volcano Collapse Promoted by hydrothermal Alteration and Edifice Shape, Mount Rainier, Washington. *Geology*. V29; No.9.
- ⁴Scott, K.M., et.al. 1995. Sedimentology, Behavior, and Hazards of Debris Flows at Mount Rainier Washington. U.S. Geological Survey Professional Paper 1547.
- ⁵Driedger, Carolyn, L. and Scott, William, E. 2008. Mount Rainier - Living Safely With a Volcano in Your Backyard. USGS Fact Sheet 2008-3062.
- ⁶Ibid.
- ⁷Tacoma Power. 1999. Emergency Action Plan for the Nisqually Hydroelectric Project FERC Project No. 1862.
- ⁸Scott, K.M., et.al. 1995. Sedimentology, Behavior, and Hazards of Debris Flows at Mount Rainier Washington. U.S. Geological Survey Professional Paper 1547.
- ⁹Tilling,Robert, I. et.al. 1990. Eruptions of Mount St. Helens: Past, Present, and Future, U.S. Geological Survey Special Interest Publication.
- ¹⁰Hoblitt,R.P., et.al. 1998. Volcano Hazards from Mount Rainier, Washington, Revised 1998: U.S. Geological Survey Open-File Report 98-428 Map Plate 2.
- ¹¹Oral Communication from William E. Scott, Geologist, Cascades Volcano Observatory, U.S. Geological Survey, October 7, 2008.
- ¹²Ibid.

Image next page - Lahar (dark deposit on snow) on Mount Saint Helens after the March 19, 1982, eruption. Photo courtesy USGS.

