Mount Rainier Volcanic Hazards Plan

October 2008

Pierce County Department of Emergency Management

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Chapter 1: OVERVIEW

A. Introduction

Mount Rainier, at 14,410 feet, is the highest peak in the Cascade Range. The mountain is an episodically active volcano with a voluminous cap of ice and snow. For an appreciation of the size of the ice mass, when Mount St. Helens erupted, its ice mass was approximately 4.7 billion cubic feet. Mount Rainier has 156.2 billion cubic feet of ice, approximately 30 times more. This tremendous, steep-sided mass of rock and ice, with its great topographic relief, poses a variety of geologic hazards, not only from the inevitable future eruptions, but also during the intervening periods of repose. Serious hazard to the greatest number of people is from lahars (volcanic mudflows). Prehistoric lahars, some of which flowed all the way to Puget Sound, repeatedly buried the large valleys that drain Mount Rainier. More than 100,000 people now live on the deposits of lahars emplaced within the past 6,000 years.

It is virtually certain that Mount Rainier will erupt again and that lahars, either eruption-related or not, will inundate valley floors that surround the mountain and are densely populated, causing severe social and economic impacts. The timing, of course, is uncertain. There is no way to know whether Mount Rainier's next massive lahar will be generated in the near future or centuries from now. For many people, concern about such a catastrophe is diminished by the uncertainty of timing, by the ignorance of Mount Rainier's geologic record, or by the beauty of the area and the substantial economic investment in areas at risk.

Is there a way to enjoy the benefits of these valleys in complete safety? As unlikely as that is, warnings of impending hazardous events, emergency response planning, public education, appropriate mitigation measures, and plans for post-incident recovery can lessen the impacts of the inevitable. This report is a plan for thoughtfully addressing and preparing for a volcanic hazard crisis at Mount Rainier prior to being under the pressure of an impending or current catastrophe. Although much of the planning and implementation of mitigation and emergency response measures is necessarily the province of a consortium of municipal, county, state, and federal agencies, there is a critical role for personal responsibility as well. Government agencies will do all they can to protect citizens, but individuals must be prepared to get themselves out of harms' way and to be self-sufficient for a minimum of seven (7) days. Pierce County government will do everything in its power to ensure the safety and well being of everyone who lives, works, and visits Pierce County.

B. Plan Purpose

This Mount Rainier Volcanic Hazards Response Plan (hereafter referred to as the Plan) provides an overview of the geological science associated with Mount Rainier, the current status of the river valleys, and the potential impact to the valleys. It identifies warning and public information methods, and outlines actions to ensure getting valley inhabitants to safe ground in a worst-case volcanic scenario. The plan also addresses recovery priorities and mitigation measures to lessen the impact of a re-awakening of this majestic volcano.

C. Plan Organization

The Plan is organized in such a way to reflect a logical sequence of events in realizing the hazard; the four phases of emergency management: Preparedness, Response, Mitigation, and Recovery.

- Chapters 1 – 5 outline the preparedness phase: An overview of the Plan, its intent, participants in the Plan development, a brief review of the situation, and monitoring and warning.
- Chapter 6 addresses the response phase: The ICS organization of field and support operations, evacuation and rescue strategies, and agency responsibilities.
- Chapter 7 outlines collection and sheltering of evacuees
- Chapters 8 – 10 identify mitigation strategies and public information / education efforts.
- Chapter 11 briefly describes recovery priorities and issues.
- Chapter 12 is a glossary of pertinent terms and acronyms.

It also must be stressed that the Plan will always be a work in progress; much the same as the scientific research associated with the geologic changes of the volcano, and the ebb and flow of the populations and businesses that inhabit the river valleys.

Chapter 2: WORK GROUP APPROACH AND PLAN MAINTENANCE

A. History of Plan - Development Effort

Because of its size and unique geographical location, bordering six counties in Washington State and the fact that it is a National Park, Mount Rainier creates some very interesting challenges in terms of the approach to take in preparing a regional response plan to any volcanic or lahar activity.

Early discussions, involving the scientists from the U. S. Geological Survey (USGS) and employees of the Pierce County Department of Emergency Management (PC DEM), and with input from other agencies and jurisdictions, concluded that any effort to develop a plan would have to include a wide range of entities from the federal, state, and local communities. Although Pierce County is the principal county in which the mountain resides, a lahar incident depending on which valley or valleys are impacted has the potential to also affect King, Lewis, and Thurston counties. In addition a tephra eruption could cover a potentially broader area including portions of eastern Washington and perhaps areas further east..

It was decided that such a group would be brought together, co-chaired, at that time, by the Director of PC DEM and the Chief Park Ranger from Mount Rainier National Park. A list of potential participants was established and regular meetings began in the early 1990s and continue to this day under the guidance of the Mitigation, Planning, Exercise, Training, and Public Education Program Manager of PC DEM. The effort is organized as the Mount Rainier Work Group. The Work Group provides oversight and direction for actions aimed at reducing volcanic risk in the Mount Rainier region.

The original concept for the Work Group was to design an operational response plan to deal with future eruptions and lahars at Mount Rainier. It quickly became evident to the Work Group that the issue would not be that simple. The knowledge or education level about the mountain and what it has or could do in the event of any volcanic activity was low, not only among the Work Group members, but also among the political and elected officials involved, and the general population. Therefore, it was apparent from the beginning that a strong public education initiative would also be necessary. Further discussion led to a decision to include a section of the plan dealing with mitigation issues that should be examined as part of the effort to minimize the response component. Later yet it was decided that there should also be a recovery section that deals with developing a plan to restore the community and economy following any kind of event involving the mountain.

B. Organizational Roles in Plan Development

This plan is an Incident Annex of the Pierce County Comprehensive Emergency Management Plan (CEMP). The CEMP outlines policies, authorities, and specific action of Pierce County government in response to, and recovery from an emergency or disaster. The CEMP outlines recommended actions of primary and secondary agencies to provide for a coordinated and NIMS compliant operations.

1. Preparedness / Public Education

The level of knowledge on the hazards that the mountain represents to the communities that surround it is in some ways limited. There was and is a strong assumption by many people that the mountain is "extinct", or at worse "dormant." The public education effort, led by the USGS and PC DEM, and their public education departments, has involved countless public presentations on the mountain to community clubs, political groups, fairs, and any other outreach programs made available. It also has included a scientific approach which involves the schools and the education related venues that have expressed interest in this subject. It is recognized that this must be a long-term effort that may even involve additions or modifications to school curriculum in order to address the long-term education issue for future generations.

2. Response

Over time the Work Group has consisted of local and state law enforcement, fire and emergency medical officials, school officials, private sector, emergency management personnel from the affected cities, towns and counties, and state, federal agencies such as Mount Rainier National Park, United States Forest Service (USFS), and Federal Emergency Management Agency (FEMA). The Work Group developed the Plan to provide guidance for warning and notification, evacuations, security, search and rescue and related components. Due to the multi-disciplinary and multi-jurisdictional composition of the Work Group, and the complex response and operational aspects, the task required significant coordination and planning.

3. Mitigation

The question of addressing the risk of having people and facilities in the potential paths of future lahars is complex and controversial. The valleys draining Mount Rainier are undergoing extreme development pressure as the entire Puget Sound region continues to experience explosive growth issues. The responsibility for land use planning outside of the national park includes many levels of government including the counties, cities and

towns, subdivisions of the counties such as port districts, and Indian reservation and trust lands. All act independently to decide where and how to develop the properties located within their jurisdictions. Currently there is not strong support to limit development within the region, although Pierce County has adopted a policy that limits the types of development in identified volcano hazard areas. However, some feel that the current mountain planning effort is diminishing their property values and creating a fear mentality surrounding the mountain.

4. Recovery

Restoring the community following any disaster is a very difficult process. This issue is even more complicated in Mount Rainier's case. Owing to the potential for widespread damage or even total destruction of homes, businesses and the infrastructure within some areas of the impacted valleys from the initial lahar, it could be months or even years before significant restoration will be accomplished. In addition, recovery efforts will be complicated by years to decades of landscape instability in affected valleys that typically follows lahars. The Work Group will continue to study and address recovery concepts and priorities.

The collaborative nature of the Mount Rainier Work Group has been an excellent forum to address these complex and difficult issues involving Mount Rainier. It has provided a strong venue for ideas to be expressed, solutions to be agreed upon involving a wide range of government entities, and has created an outstanding network of individuals educated to, familiar with, and most importantly, concerned about what Mount Rainier may do in our future. This process has strengthened our community and fostered relationships that will encompass more then just the issues surrounding the mountain.

C. Plan Maintenance

The original Plan was published July 1999. This document represents the second edition. The Work Group will review it every two years to ensure its currency, accuracy, and that it incorporates the latest scientific research, emergency management and incident command principles and procedures, and technological advances associated with telecommunications and warning. PC DEM will lead the revision process, ensuring all stakeholders will have an opportunity to comment on the Plan.

In addition to the revision process is the development and implementation of an exercise program specific to Mount Rainier. Exercises will focus on

the Plan, emergency response and operations, and consequences associated with an eruption. All lessons learned from the exercise activities will be incorporated into the following revision. Due to existing exercise requirements and programs of emergency first responders, it may be impossible to do a lahar-specific exercise every two years. The Work Group recommends a regional exercise dealing with a major lahar scenario be conducted at least every four years.

Chapter 3: SYNOPSIS OF MOUNT RAINIER VOLCANIC HAZARDS

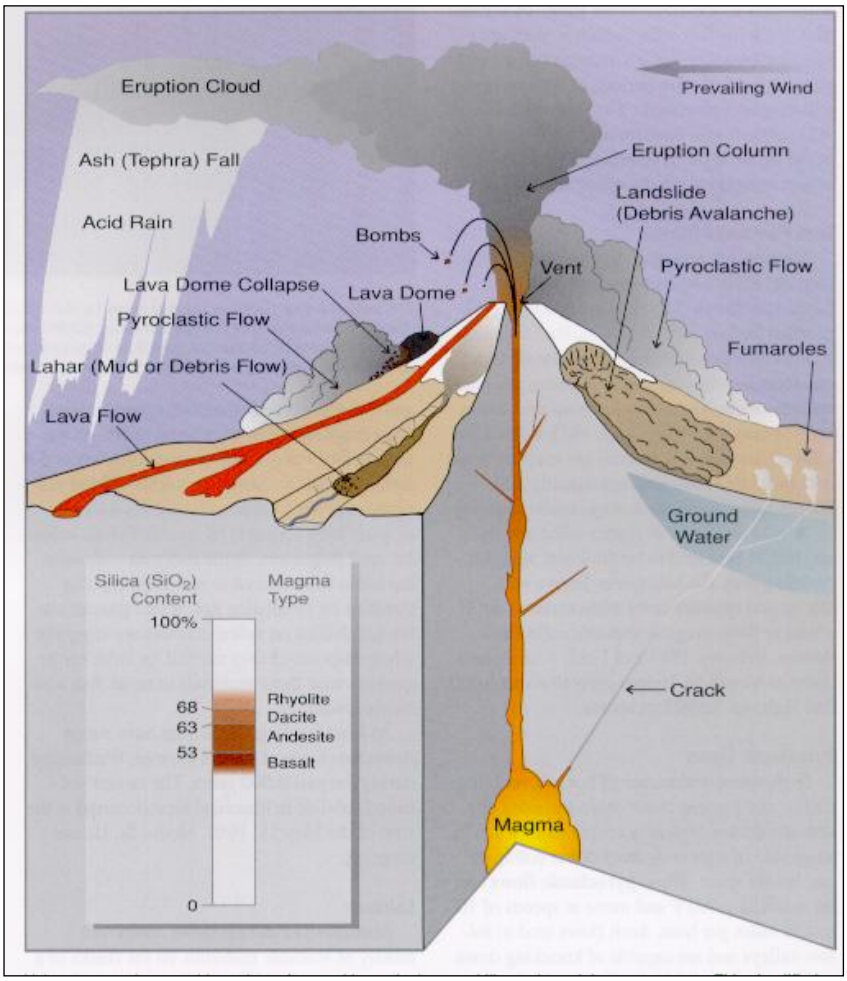
A volcano's past is a good guide to its future behavior. At Mount Rainier, geologists continue to uncover a rich history of volcanic events from the study of the deposits of numerous eruptions and lahars that have occurred since the latest ice age (roughly the past 10,000 years). This record gives critical information about the types, magnitudes, and frequencies of past events and shows which areas were affected by them. It provides the basis for a hazard assessment, including hazard-zone maps (U.S. Geological Survey Open-File Report 98-428). Other information critical to assessing potential hazards come from studies of the structure of the volcano, especially the identification of zones of weakness that might be sources of future landslides and related lahars.

It is commonly difficult to grasp the significance of a hazard with which one has no personal experience. The potential hazards from Mount Rainier are no exception. The written history of Mount Rainier encompasses the period since about A.D. 1820, during which time one or two small eruptions, many small debris flows, and several small landslides occurred. Our knowledge of the prehistoric record makes it clear that the written record is simply too brief to guide us in estimating the future behavior of this half-million-year-old volcano. Interestingly, Native American oral traditions record apparent eruptions and lahars, but offer few details about the character or date of such events.

During the past 10,000 years, eruptions of Mount Rainier did not occur at regular time intervals, but were clustered in eruptive periods that lasted several decades to more than 1000 years. Eruptive periods were separated by apparent dormant intervals that lasted from several centuries to almost 2000 years. Such an irregular pattern of activity makes predicting the onset of future eruptions impossible and highlights the importance of maintaining a robust geophysical-monitoring network on the volcano in order to detect the early-warning signs of volcanic unrest that may herald renewed volcanism.

Typical eruptions of Mount Rainier produce a variety of potentially hazardous events (see Figure 1. Volcanic Hazards and USGS Fact Sheet 2008-3062 in Appendix C). Explosions eject tephra (volcanic rock fragments of all sizes). Sand and dust-sized tephra can drift downwind from the volcano for tens to hundreds of miles. Most of the cone is built of lava flows that oozed from vents and flowed down the steep flanks of the volcano. Both explosions and collapse of active lava flows on steep slopes generate hot pyroclastic flows that swiftly melt snow and glacier ice to produce mixtures of water, rocks, and mud called lahars (or volcanic mudflows) that may sweep many tens of miles down valleys. Landslides of weakened rock can also spawn lahars. Such landslides occur most often during eruptive periods, but can also occur during dormant intervals under certain conditions. Once lahars fill channels, destroy vegetation, and deposit thick layers of mud, rocks, and organic debris on valley floors, years to decades follow during which rapid erosion and high sediment loads severely affect valleys farther downstream. These processes are discussed more fully below.

Figure 1. Volcanic Hazards



Mount Rainier has only rarely produced large-volume eruptions of **tephra** that blanketed areas on the flanks of the volcano with from several to tens of feet of pumice and ash and probably several inches of ash several hundred miles downwind. More typical have been eruptions that deposited one foot or less of ash and pumice on the volcano's flanks, one inch of ash 10 to 20 miles downwind, and just a fraction of an inch 100 miles downwind. Many events probably produced only dustings of ash near the volcano, but such events may have been frequent during eruptive periods. Unlike Mount St. Helens, Mount Rainier is only a moderate producer of tephra. Even so, tephra fallout in populated areas can cause numerous problems and can greatly affect aviation (see USGS Fact Sheet 027-00 in Appendix D).

Due to their high viscosity, past **lava flows** rarely flowed off the cone itself and most remained within the boundaries of Mount Rainier National Park. Lava flows chiefly built the volcano's edifice and much of the summit cone is composed of lava flows emplaced during the past few thousand years.

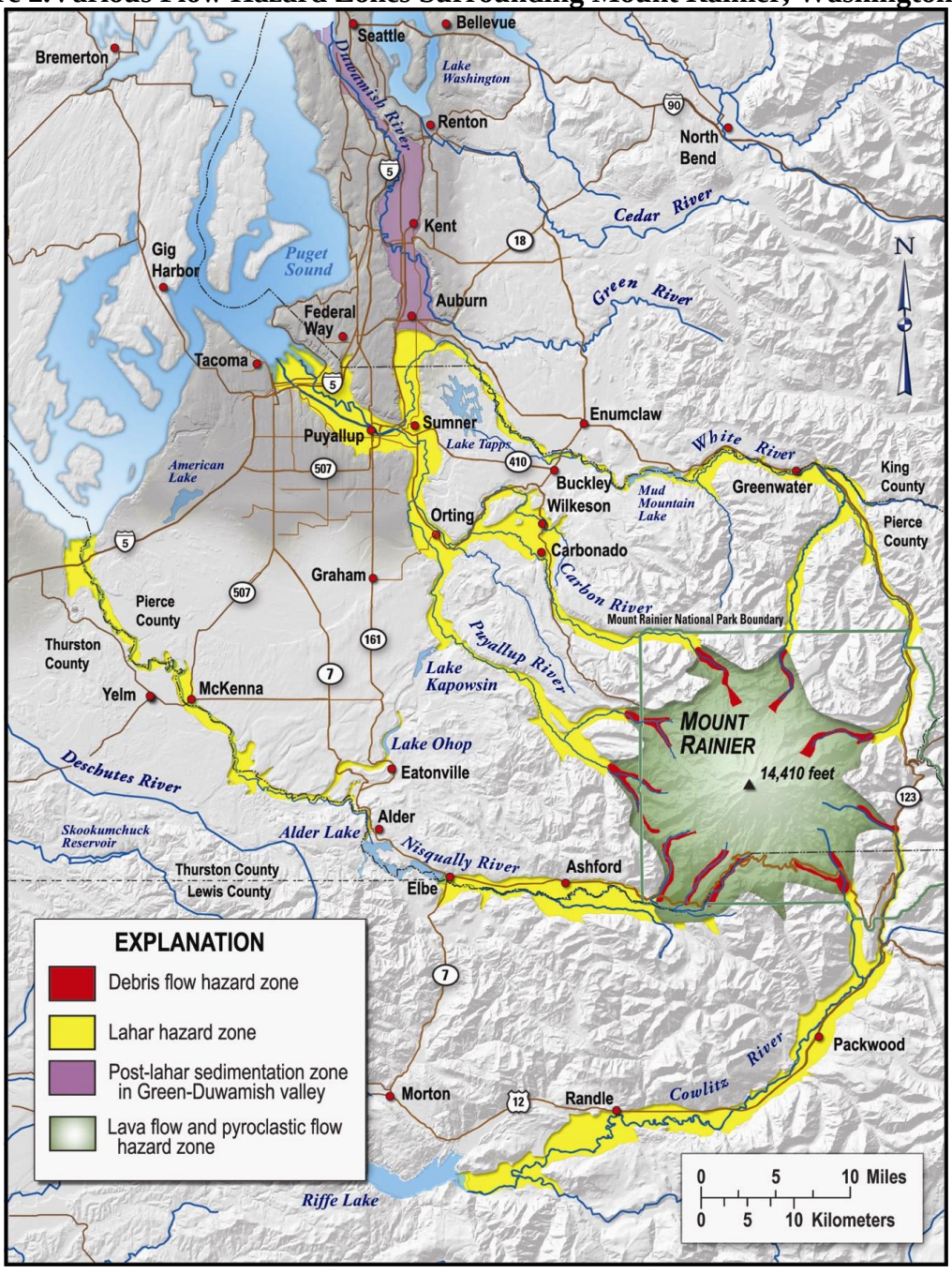
Pyroclastic flows generated by collapse of active lava flows on steep slopes or by explosive eruptions have rarely extended beyond the base of the cone. Pyroclastic flows are rapidly moving and extremely hazardous, making evacuation prior to an event the only effective mitigation. But it is the ability of pyroclastic flows to swiftly melt snow and ice coupled with the large mantle of seasonal snow and glacier ice on Mount Rainier that create ideal conditions for generation of lahars during eruptions.

Lahars look and behave like flowing wet concrete owing to their high concentration of entrained sediment (boulders, gravel, sand, and mud). They flow down valleys, typically as multiple surges led by steep fronts charged with boulders, logs, and any other large debris. They fill pre-existing channels and spread across adjacent valley floors, sweeping away or burying mature forests and any structures in their paths, including bridges, dams, roads, pipelines, and buildings. The larger the volume of a lahar, the more deeply it will inundate a valley, the faster it will flow, and the farther it will travel. Lahars can flow many tens of miles from Mount Rainier and represent the greatest volcanic threat to populated areas.

During the past few thousand years, lahars from Mount Rainier inundated one or more of the surrounding valleys at a frequency of about one sizeable lahar every few centuries. These valleys are becoming increasingly densely settled, and future lahars have the potential to directly affect thousands to tens of thousands of inhabitants. The potential for inundation is depicted on a map of flow hazard zones (Figure 2,below) showing that future lahars as well as post lahar sedimentation, could affect densely populated and economically important areas in several river valleys. Both the ports of Tacoma and Seattle lie at the mouths of rivers that head on the volcano and major bridges and highways cross potential hazard zones. A possible mitigating factor is that all major valleys except the Puyallup have dams that could act as traps for lahars. Although not designed for lahars, Mud Mountain Dam on the White River is a flood-control structure that might provide substantial storage for lahars and minimize downstream damage unless lahars or related floods overtopped it. Likewise Cowlitz Falls, Mossyrock and Mayfield Dams on the Cowlitz River and Alder and LaGrande Dams on the Nisqually form impoundments that could trap lahar sediment if reservoir levels were lowered beforehand.

Most far-traveled lahars at Mount Rainier occurred during eruptive periods, whether generated by pyroclastic flows that swiftly melted snow and ice; by explosive expulsion of a crater lake; or by large landslides of wet, weakened rock on the steep upper flanks. Lahars generated by pyroclastic flows require that magma, or molten rock, rise to a shallow level and drive an explosion or flow out onto the surface to create a lava flow. Rising magma is typically heralded by earthquake swarms, deformation of the cone and immediate area, and release of volcanic gases. Monitoring systems can detect such changes and thereby provide forecasts of impending hazards weeks to months ahead of an eruption. An active lava flow can likewise be monitored for signs of instability or collapse prior to formation of pyroclastic flows. An explosion that empties a crater lake is likely only during periods of volcanic unrest. The timing of lahars formed by large landslides of weakened rock with respect to eruptions is less clear. Rising magma, earthquakes, pressurization of ground water by heating, and deformation of the edifice could trigger landslides early in volcanic unrest, weeks or months before an eruption begins. Such triggers could even occur during intrusive events that fail to generate eruptions. Explosive eruptions themselves could provide triggers for landslides. Such landslides could also be triggered after an eruptive period was underway.

Figure 2.Various Flow Hazard Zones Surrounding Mount Rainier, Washington



Although most landslide-generated lahars at Mount Rainier formed during eruptive periods, at least one perhaps did not. The ~500-year-old Electron lahar started as a landslide from Sunset Amphitheater on the upper west flank of the volcano. The lahar swept through the Puyallup valley depositing as much as 50 feet of mud, boulders, and woody debris near present-day Orting. The cause of the initial Electron landslide is unknown, but a detailed search has failed to find convincing evidence of eruptions near the time of the Electron lahar. The volcano could have erupted around that time, but the eruption was so small that it left no discernible evidence in the geologic record. Other

possible origins are a shallow intrusion of magma that never culminated in an eruption or a non-volcanic event, such as a strong local earthquake.

Recent studies of Mount Rainier show that weakened rock underlies much of the upper west flank of the volcano. Other parts of the volcano have no or small local areas of weakened rock. Thus the Puyallup and, to a lesser extent, Nisqually valleys have the greatest degree of hazard from lahars generated by landslides. A lahar-warning system installed in the Puyallup valley about 17 miles from the volcano's summit is designed to detect lahars large enough to affect settled areas beyond the Park boundary. Detectors cannot be usefully located closer to the volcano because they would send alarms for frequent, small debris flows (see below) whose effects are restricted to areas in, or occasionally, immediately adjacent to, the Park. Once a sizeable lahar is detected, warnings will be issued by multiple systems and initiate evacuation and other emergency responses. Estimated **minimum** travel times for a large lahar in the Puyallup valley are summarized in the following table. The times are estimated from statistics on historical lahars worldwide, which suggest that the front of a large lahar would advance at an average speed of about 20 miles per hour between the detection chute and Orting and about 15 miles per hour between Orting and Commencement Bay.

Table 1 Puyallup Valley Lahar Travel Times

Point along lahar path	Distance from detection chute to downstream location (miles)	Minimum probable travel time[1] from when lahar is detected to downstream location (hours:minutes)
Detection chute[2]	0	0
Orting[3]	15	0:40
Sumner	23	1:05
Puyallup	25	1:20
Commencement Bay	32	1:50

[1] Times rounded to nearest 5 minutes.

[2] Detection chute is located about 17 miles from landslide source area on upper west flank of Mount Rainier. Estimated time for lahar to reach chute and detection be completed is about 30 minutes.

[3] Locations are city centers.

During a period of eruptions, lahars could affect any or all of the valleys that head on the volcano, depending on details such as vent location and eruption duration and character. During eruptions of the past few thousand years, lahars generated by pyroclastic flows have traveled many tens of miles down the White, Cowlitz, Nisqually, and Puyallup River valleys. Some were large enough to reach Puget Sound. Lahars generated by landslides like those of the past few thousand years will chiefly affect valleys to the west—the Puyallup and Nisqually.

Areas on the flanks of Mount Rainier and upper reaches of valleys within Mount Rainier National Park are subject to frequent small rock avalanches and small lahars, which we

refer to as **debris flows** to differentiate them from larger eruption-related or landslide-generated lahars. Debris flows are typically generated by intense rainstorms, rapid snowmelt, or outbursts of water from glaciers. Several occur nearly every year and sometimes affect trails, bridges, and roads in the Park. Even the largest of these events have only minimal affects immediately outside the Park. The Park's geologic hazard plan addresses such events. Brochures and signs at campgrounds, trailheads, and other Park facilities inform visitors of potential hazards from such events.

Chapter 4: SITUATION

Mount Rainier is an episodically active volcano that towers more than 14,000 feet above expanding suburbs in the river valleys that lead to nearby Puget Sound. Geologic study indicates that Mount Rainier has repeatedly produced lahars that today would be catastrophic in size, loss of life, and destruction of infrastructure and property. Ash clouds drifting downwind from the volcano and fallout of ash can also adversely affect air traffic and communities. Due to their potential for harm, our primary focus here is on lahar incidents.

Scientists and emergency management officials classify Mount Rainier lahar incidents into three categories. 1) Debris flows are relatively small in size and destruction potential does not extend far beyond the boundaries of the Mount Rainier National Park. 2) Most lahars occur with warning that the mountain is re-awakening or erupting. The warnings will likely include days to months of increased seismic activity within the mountain, increased glacial melting, and increased gas venting, or evidence that the mountain is erupting. 3) The worst-case scenario, but the least likely, is a large, fast moving lahar with no warning initiated by a sudden landslide of water-saturated, weakened rock.

A. Introduction

With thousands of people now living in the Puget Sound and Western Washington region, the risk from Mount Rainier's hazards has increased. With development and population on the rise, increasing knowledge about Mount Rainier's hazards has brought the risk to the local population to the forefront. Planning to lessen the impact of a volcanic event is critical and must address warning and notification, emergency response and operations, public education strategies, appropriate mitigative measures, and post-incident recovery priorities.

Mount Rainier casts a long shadow, and the region surrounding the mountain is diverse culturally, economically, ecologically, geographically and socially. Due to this diversity, the region has several attractions that bring in millions of visitors each year. The Pierce County's Visitor and Convention Bureau estimates that Pierce County hosts approximately 2.5 million overnight visitors annually. Individually, Mount Rainier National Park hosts approximately 2 million visitors and the Western Washington (Puyallup) Fair, lying in the potential path of a lahar in the Puyallup Valley, has approximately 1.5 million visitors each year. Other attractions located in Pierce County close to the mountain include the Crystal Mountain Resort, Northwest Trek, the Mount Rainier Scenic Railway and the restaurants and businesses located along Highways 7, 706 and 410. Historic communities like Wilkeson, Eatonville, and Buckley.

In Lewis County, the businesses lying along Highway 12 in particular, reap the rewards from the tourist industry heading for the outdoors along the Cowlitz

River, the South Cascades, and the east and south sides of Mount Rainier National Park. The campgrounds along Riffe and Mayfield Lakes and the towns of Morton, Packwood and Randle act as congregation points for those seeking recreational opportunities.

Not only will a Mount Rainier eruption with large lahars directly impact the people of Pierce County and neighboring counties, it will disrupt the region's economy. Unemployment will increase. Many small businesses will not recover. The damage and destruction to the impacted infrastructure may have long-term impacts on the region from which it may not recover in the foreseeable future.

B. Pertinent Information on Potentially Affected Counties

1. Pierce County

a. Population and Demographics

The beauty of the Puget Sound and Western Washington region attracts many people. It is a desirable place to live, work, and play. Permanent residents, workers, and visitors can be equally affected by the hazards of Mount Rainier.

As of July 2008, Pierce County had a resident population of approximately 805,400. The unincorporated population of Pierce County was estimated at 377,660 and the incorporated population was estimated at 427,740.

Within these numbers are the special populations. The following is a sampling of those populations.

- Twenty percent (20%) of the working age adults in Pierce County have a disability that does not require them to be institutionalized.
- Forty-four percent (44%) of retirement age people have a disability.
- Twelve percent (12%) of the population does not speak English as their primary language.
- Ten percent (10%) of the population are seniors, aged 65 and older.

Pierce County's economy includes a large number of businesses. Pierce County's location on Puget Sound with easy access to the trade routes across the Pacific Ocean makes it an ideal center for commerce. As examples, the Port of Tacoma is the sixth largest container port in North America and among the top 25 container ports in the world. The county

also has a large military population. Fort Lewis Army Post, Madigan Army Medical Center, McChord Air Force Base, and Washington Military Department are located in Pierce County with a combined military population of 34,000 and 19,000 civilian employees.

Each and every one of these people has the potential of being affected, directly or indirectly, by the hazards of Mount Rainier. An exact number of people who may be affected by the lahars generated by Mount Rainier cannot be determined due to the changing size and nature of the population and the wide range in possible lahar sizes and distribution. With either the threat of a large lahar or a activation of the lahar warning system due to a spontaneous lahar, it is estimated that up to 100,000 people may need to be evacuated. Furthermore, many more people could be affected by volcanic ashfall; under certain wind conditions, much of the southern Puget Lowland could be affected.

b. Terrain

With an elevation of 14, 410 feet (4,392 meters), Mount Rainier is the tallest of the Cascade volcanoes. With 26 named glaciers, it is also the most heavily glaciated Cascade volcano.

Glaciers and exposed rock cover the higher elevations of the mountain's slopes. In the lower elevations, it is largely covered by old growth forests and flowered meadows.

The Carbon, Cowlitz, Nisqually, Puyallup, and White Rivers all begin on the high slopes of Mount Rainier and run into the lowland drainage basins. The White River borders Pierce County to the north and is connected to the Puyallup River by way of the Stuck River between Puyallup and Sumner. The Nisqually River borders Lewis and Thurston Counties to the south and flows all the way to the Puget Sound. The Carbon and Puyallup Rivers join near Orting and continue to flow into Commencement Bay. The Cowlitz River drains the southeast corner of the National Park. Turning to the west and southwest, it joins the Columbia River at the City of Kelso. These rivers are the sources of interaction between the events occurring on Mount Rainier and the population of both the Puget Sound region and southwest Washington.

c. The Road Network

The geologic and demographic makeup of the Puget Sound region creates unique challenges to the evacuation efforts in Pierce County and other counties that would be impacted by a worst-case scenario lahar. Geologically, most of Pierce County is sandwiched between Puget Sound

and the Cascade Mountain range. A small portion is located to the west of Puget Sound on the Kitsap Peninsula. These natural barriers limit the actual and potential growth of transportation corridors throughout the region. Interstate 5 runs north and south. East / west state routes run through or in the inundation zone and / or the Cascade Mountains. Other natural barriers, the Puyallup and Nisqually rivers, have the potential of isolating Pierce County from the rest of the region.

The Puget Sound region is densely urbanized. Ninety-two percent (92%) of Pierce County's population lives in densely settled urbanized areas. Twenty-five percent (25%) of Pierce County workers commute to other counties for employment. The result is a high volume of commuter and industrial traffic. Even on "normal" days, gridlocks are common with sizeable traffic "backups". Envision an additional ten or twenty thousand cars filled with people desperate to get to safety; the gridlock will be unimaginable.

The road network of Pierce County is a complex system of state, county, local, and private roads. The state route highways and interstates are the most heavily traveled roads in Pierce County.

The state routes in Pierce County consist of the following:

- **Interstate 5:** Extends northerly from the Washington-Oregon border through Tacoma and continues on to the international United States-Canada border.
- **State Route No. 7:** Begins in downtown Tacoma following Pacific Avenue in a southward direction and extends to the Pierce-Lewis county border.
- **State Route No. 16:** Begins at a junction with **Interstate 5** at Tacoma, extends northwesterly by way of the Tacoma Narrows Bridge, and ends at a junction with **State Route No. 3** outside of Pierce County. In a scenario with large lahars flowing down both the Nisqually and Puyallup Valleys all the way to Puget Sound, **State Route 16** could be the only ground route out of Pierce County.
- **State Route No. 161:** Begins at a junction with **State Route No. 7** near La Grande, extends northeasterly through Eatonville and on to Puyallup, then to a junction with **State Route No. 18** outside of Pierce County.
- **State Route No. 162:** Begins at a junction with **State Route 410** at Sumner, extends south and easterly to **State Route 165** near South Prairie.
- **State Route No. 167:** Begins at a junction with **Interstate 5** near Tacoma, extends easterly through the Puyallup/Sumner area and extends northerly to the Auburn / Kent area outside of Pierce County.

- **State Route No. 410:** Begins at a junction with **State Route No. 167** at Sumner, extends easterly through Buckley on past the boundaries of Pierce County.
- **State Route No. 512:** Begins at junction with **Interstate. 5**, south of Tacoma, extends easterly to a junction with **State Route No. 7**, south of Tacoma, and continues on to a junction with **State Route No. 167** near Puyallup.
- **Interstate 705:** Begins at a junction with **Interstate 5** in Tacoma and extends northerly as a feeder route into downtown Tacoma connecting with Schuster Parkway leading to the Old Town portion of the City.

Even though Pierce County has identified and marked lahar evacuation routes. The possibility exists that, with a rapidly generated lahar requiring evacuation, they may become nothing other than parking lots. With a gradually escalating volcanic eruption, threatening a lahar, many people may either elect to self evacuate or in a case where the threat has become imminent the number of people allowed in the danger zone may be limited. It is recommended that everyone who lives in the lahar inundation zone identify several routes to safety and "dry run" all of them so there will be no question as to which way to turn when an evacuation order is broadcast.

2. Lewis County

a. Population and Demographics

As of 2008, Lewis County had a resident population of approximately 74,700. The majority of these citizens lives in the central and western parts of the county, and so is not likely to be directly affected by volcanic hazards other than ashfall. However, several unincorporated communities in the headwaters of the Cowlitz River Valley could be affected by lahars from Mount Rainier. Those communities include Glenoma, Randle, and Packwood with a combined estimated population of 7,100.

Lewis County in the Upper Cowlitz River Valley is largely rural, where over 6,500 people live in areas at risk to lahars and other geologic hazards. In addition, the area hosts another 350,000 to 400,000 visitors during the summer tourist season each year (June through October, or about 3,000 to 5,000 people per day (Mount Rainier National Park and Mount St. Helens National Monuments records, 1995-1997). A much smaller but still substantial number of people visit the area for autumn hunting and winter skiing. Moreover, US Highway 12 supports a significant transit population in approximately 1,700,000 vehicles a year (U.S. Forest Service study) and related commerce because it is one of the few transportation corridors across the Cascade Range.

Residents live and work in developments and private sector infrastructure that exceed $300 million in assessed value (1997 Lewis County Auditor data) as well as facilities built by federal and state governments that exceed several tens of millions of dollars in additional investment. Among the more valuable facilities at risk are the highway system and associated support structures, two lumber mills, two USFS district compounds with associated vehicles and equipment, and a number of small businesses (banks and others, 1998). Two elementary schools and a high school are also at risk.

b. Terrain

Lewis County trends east and west across western Washington from the crest of the Cascades on the east to Pacific County on the west, only 22 miles from tidewater in Willipa Bay.

Eastern Lewis County is composed of rugged mountainous terrain rising up to nearly 8000 feet in the Goat Rocks Wilderness Area along the crest of the Cascades. Along the very northern edge the County's eastern end it incorporates the southern portions of Mount Rainier National Park. This includes going almost to the headwaters of the Cowlitz River and including the lower portions of its tributary the Ohanapecosh River, both which begin on the slopes of the volcano. Slightly further to the west, below the terminus of the Nisqually Glacier, the County boundary follows the Nisqually River out of the Park and then west to the town of Elbe and Alder Lake. From there it no longer follows the river but runs straight west 46 miles where it takes a small jog to the north before continuing west again to Pacific County.

As one travels west across the County from the eastern mountains the landscape gradually looses elevation taking on the character of low mountains, then hills and finally the low farming country of Centralia and Chehalis. It is here that the Newaukum and Skookumchuck Rivers join the Chehalis on its way to Aberdeen, Grays Harbor and the Pacific Ocean.

Further to the west the terrain begins to rise again into gently rolling hills to the boundary with Pacific County.

Slightly further to the south from the City of Chehalis the Cowlitz River after being impeded by Cowlitz Falls, Mossy Rock and Mayfield Dams, enters the low rolling country that extends south to Cowlitz County, Kelso and the Columbia River.

c. Road Network

The road network in Lewis County is made up of federal (National Forest System and U.S. Highway), state, county, and private roads. Since much of the County is forest land there are few roads that lead to towns or communities once you leave the main river valleys.

Routes in Lewis County include the following:

- **Interstate 5:** Extends northerly from the Lewis County/Cowlitz border through Chehalis and Centralia and continues on north into Thurston County eventually reaching the Canadian border.
- **State Route No. 6:** Extends westward from Chehalis initially following the Chehalis River and Rock Creek, leaving the County then climbing over the Willipa Hills and descending to Raymond on Hwy 101 near Willipa Bay.
- **State Route No. 7:** Extends south from the Pierce-Lewis county border (near Elbe) to the town of Morton, where it meets **U.S. Highway 12**.
- **State Route 508:** Parallels Highway 12 from Morton to Interstate 5 from 3 to 5 miles to the north.
- **U.S. Highway 12:** Enters Lewis County along with Interstate 5 from the north and then extends from Interstate 5, eastward through Lewis County occasionally following the path of the Cowlitz River and enters Yakima County at White Pass.
- **State Route No. 123:** Begins at a junction with **U.S. Highway 12** about 6 miles North of Packwood, and extends north to Cayuse Pass and **State Route No. 410**. Provides access to southeastern portion of Mount Rainier National Park.
- **State Route 131:** Begins at **U.S. Highway 12** (in Randle), and extends south to **National Forest roads 23 and 25**. Provides access to Mount St. Helens National Volcanic Monument and the Gifford Pinchot National Forest.
- **Stevens Canyon Road:** Leaves Hwy123 5 miles norrth of the Hwy 12/State Route 123 junction and winds up to Paradise in Mount Rainier National Park.

3. King County

a. Population and Demographics information to be developed

b. Terrain information to be developed

c. King County has an extensive road network linking the various portions of the County together and connecting the County with the surrounding counties. This network is extended to the west by the use of

the Washington State Ferry System linking the mainland portion of the County with Vashon and Bainbridge Islands and the Kitsap Peninsula.

- **Interstate 5:** Extends north from the Pierce/King County border through Seattle and continues on north into Snohomish County and other counties eventually reaching the Canadian border.

4. Thurston County

a. Population and Demographics information unavailable at time of printing

b. Terrain information unavailable at time of printing

c. The road network in Thurston County is made up of federal (National Forest System and U.S. Highway), state, county, and private roads. Since much of the County is forest land there are few roads that lead to towns or communities once you leave the main river valleys.

Interstate 5 is Thurston County's primary transportation corridor. It enters Thurston County from the north near the Nisqually Indian Reservation and travels southeast through Lacey, and then south through Olympia and Tumwater continuing into Lewis County.

- State Route 507 is the primary east-west roadway in southern Thurston County. It connects the cities of Yelm Rainier, and Tenino and the town of Bucoda.

- State Route 510 traverses the northeast portion of Thurston County, running from its western terminus at Interstate 5 near Lacey to its eastern terminus at State Route 507 in Yelm.

- U.S. Route 12 crosses the southwestern corner of Thurston County. It travels from Grays Harbor County to the west, north of the Chehalis Indian Reservation through the community of Rochester until it intersects with I-5 at exit 88 in the town of Grand Mound.

- State Route 8 runs east-west through the northeastern portion of Thurston County. It travels from Grays Harbor County to the west along the northern boundary of the Capital Forest to its intersection with U.S. Route 101.

- U.S. Route 101 enters Thurston County from Mason County to the northwest near Steamboat Island. It runs southeast to Tumwater where it intersects with I-5.

C. Example of Possible Economic Impact from a Large Lahar

A large lahar will not only impact the State of Washington but has the potential to impact the nation.

The **Port of Tacoma** is one of the world's finest deep-water, "gateway" ports. International shippers are now using the Port of Tacoma as their West Coast USA hub because of growth restrictions at the California ports. In 2004 the Port did $26 billion in business, up from $19 billion in 2000. More than 101,000 jobs in Washington State are related to port activities.

Three-quarters (3/4) of the Port's international container cargo services the central and eastern portions of the United States. This is in addition to the local container traffic. Annually, 70% of the goods shipped to the State of Alaska, including food, pass through terminals at the Port of Tacoma. The cargo and goods intended for other destinations such as Chicago and Kansas City are loaded primarily on rail. Other cargo and goods are loaded onto trucks and travel via the road network. Regardless of the mode of transportation, these destinations are east of the region and require passage through the Cascade Mountain range.

Economically, this scenario will devastate the local economy and the quality of life to which we are accustomed. Nationally, some consumer goods will likely become scarce.

D. Shelter and Housing

A large Mount Rainier lahar will result in a tremendous challenge to the region's capacity to find both short and long-term housing for the displaced population. A lahar could in some areas be deeper than the tops of the houses in its path. Not only would individual houses be damaged, but for many families there will be nothing left. Their entire home and belongs would have been either carried away by the lahar or buried by the mud. Infrastructure, like roads, will be buried or scoured out; power lines will be non-existent; and, gas and water lines would have broken when the buildings were destroyed. Exacerbating the problem is the fact that the soft mud and post lahar sedimentation that will follow could prevent repopulation for some period of time, possibly years. Due to the inability of people to return to their homes, up to 100,000 people may need to be sheltered and provided basic human needs for a period that could last for months. Many of them may need to permanently relocate, not just because their homes are destroyed, but also because, depending on the destruction to the economic base,

many of them may need to relocate to seek work.

The other alternative, that the mountain enters an eruptive phase may require areas around the mountain be closed for the safety of the public. This could be especially necessary in the valleys threatened by a pyroclastic flow initiated lahar. Situations like this will require support and housing for individuals and families temporarily displaced for a few months or longer. Evacuation from these areas could become more controversial as time progresses because the threat may never materialize. Housing needs while temporary may have a feel of being permanent. Even with the memory of Mt. St. Helens still in many people's minds, a desire to return home combined with a fear of loosing the belongings that were left behind could put pressure on local authorities to reopen areas closed. A tremendous pressure could develop for citizens to return to communities.

1. Short Term Sheltering

Current sheltering needs for a major incident like a large lahar coming down the Puyallup Valley are not adequate to meet the expected need, even for a very short period of time.

The American Red Cross has been the lead in providing emergency shelter for many years. Serving the communities with both shelter and feeding facilities, the American Red Cross continues to provide shelter for those displaced from their residences for the small scale emergencies that happen on a regular basis. This includes not just the family displaced by a fire but also, for example, those who leave their home temporarily because of a threat of a flood or temporary power outage in a neighborhood. As first responders, the mission of the ARC is to be short term (three days), providing immediate basic needs such as sheltering, clothing, and food. Under normal emergencies, when some residents must stay more than a few days, and as populations in the shelters drop, those residents that are unable to return home are placed in hotels until other arrangements can be made. In a catastrophic incident like the lahar this would not be possible. Some shelters will need to be designated as long term shelters until other arrangements can be made for the residents.

Pierce County Department of Emergency Management has developed a plan for community sheltering. A number of strategically placed shelters will house clients that have been displaced following a disaster. Located out of the valleys these shelters are supported by various agencies, non-profit and governmental. Short term residency is defined as less than five days. Memoranda of Understanding (MOUs) have been signed with the organizations owning the facilities. Further agreements are being negotiated with the region's parks and recreation departments, the local military, and schools and universities to expand the region's catastrophic sheltering capacity.

2. Long Term Housing

In a large lahar scenario, many homes will be destroyed so displacement may be long-term. Depending on the course and depth of the lahar, displacement of the existing river channels, engineering problems with development on new deposits, unstable channels with high sediment loads and continued volcanic activity some areas may take years or even decades to stabilize. In fact some people may not want to, or may never be able to, return to where they once lived.

In the situation where Mount Rainier is threatening to send a lahar down valley due to entering an eruptive phase, local temporary housing will need to be established that may have to house the majority of those evacuated for months or longer depending on the length of the eruptive phase and the perceived threat to the valleys.

Long term recovery support consists first of care teams created from different volunteer and public agencies. They provide information and support to families and individuals following a crisis. Implementation of other services such as food and transportation will be sought by the agencies providing the commodities while maintaining support through the care team members.

Housing concerns and/ or relocation to other states may be necessary. Depending on the actual event, all housing options will be considered. For situations requiring long term support local housing authorities will need to become involved. Due to the lack of immediately available housing, a request for state and federal resources may be necessary.

3. Animal Support

It has been observed in many emergency situations where people are asked to evacuate that they insist on bringing their pets with them. Considered part of the family, many people, especially senior citizens, will refuse to abandon their pets and will not evacuate without them. In some cases this has led to the death of those who refused to evacuate. In order to facilitate the evacuation and sheltering of displaced persons, the housing of companion animals that accompany them requires special consideration. Due to health and safety concerns, pets other than service animals are restricted from entry into essentially all shelters. Separating a family pet during times of crisis adds to the already existing anxiety, fear, and hopelessness experienced by many of the evacuees.

The Pierce County Animal Response Team consist of all the Animal Control agencies in Pierce County. Tacoma/Pierce County Humane Society, Mutt Shack, and many other animal rescue organizations, are involved in planning for and training volunteers, along with local government agencies in disaster response for animals. Pet shelters will be placed outside the general population shelters to

house the pets of shelter clients. Citizens are encouraged to bring their pets in cages or travel crates. Each client is expected to care for their own pet while they reside at the shelter. In order to assist keeping track of pets, they will all be tagged and tracked not only at the initial shelter but if need be, as they are transferred to another shelter.

4. Other Shelter Issues

- Families need to be kept together. This may require placing the medically needy within the shelter with their close relatives.
- With a large number of evacuees mass feeding stations will need to be set up. Volunteer organizations like Emergency Food Network, Salvation Army, the American Red Cross and various religious organizations will cover part of this, but with a very large evacuation will need supplementary assistance.
- All shelter residents will be registered and attempts will be made to reconnect those separated from other family members.

E. Public Safety Organizations

The urbanized, Puget Sound / Western Washington area has large numbers of emergency first responders. The outlying areas do not. Regardless of availability, emergency first responders are professionals, meeting regulatory and performance requirements. The emergency response agencies responding to a volcanic incident will conduct operations in accordance with the incident command system (ICS) / National Incident Management System (NIMS). All responding agencies (state, local, and private sector) shall provide adequate support and equipment in accordance with agency and state policy. Resource requirements beyond local capacity are provided via mutual aid agreements and mobilization of regional and state assets. The Area Command Center (see Chapter 6) will identify and coordinate additional resources.

Other public safety agencies that are not involved in the actual field operation but are critical to the emergency coordination and management of the incident are diverse and may not commonly be recognized as being part of public safety. Those agencies include but are not limited to: school districts, hospitals and public health, Washington State Department of Transportation, National Weather Service, volunteer organizations, and the National Park Service.

Chapter 5: MONITORING AND EMERGENCY NOTIFICATION

A. Monitoring

By law, the USGS has the responsibility to monitor volcanoes and to give timely warnings to the public and public officials about volcanic activity, which, in the Cascades, is a primary function of the Cascades Volcano Observatory (CVO). CVO works closely with its chief partner, the Pacific Northwest Seismic Network at the University of Washington. Scientists rely on a variety of techniques to assess the state of a volcano including seismicity, ground deformation, gas emissions, geochemistry of springs and streams, and a host of visual, photographic, thermal, and satellite observations. A network of telemetered seismometers on and around Mount Rainier provides real-time monitoring of earthquakes. Additional seismometers have been recently installed to increase the effectiveness and robustness of the network. Seven continuous GPS receivers monitor ground movements in real time. An existing array of numerous benchmarks can be resurveyed if weather and snow conditions permit using Global Positioning System receivers (GPS) in order to better define deformation of the volcano's flanks. Other techniques, such as airborne measurements of volcanic gases, are employed sporadically, but would be used frequently during periods of unrest or eruption.

Since the mid-1990s PC-DEM in cooperation with USGS and WEMD has operated the Puyallup valley lahar-warning system. The system, which is installed along the Carbon and Puyallup River valleys, is unique in that its detection component is fully automated. Each river valley has seven instrument sites: Two radio repeaters and five acoustic flow monitors (AFMs). The AFMs detect ground vibrations that are specific to lahar activity and send data through the repeaters to base stations at WEMD and Pierce County Law Enforcement Support Administration (LESA). The computers have USGS designed software that receives, interprets the data, and sounds an audible alarm. Duty officers and dispatchers respond to the alarm by initiating the transmission of the emergency alert system (EAS) message and notifying the public safety and other organizations identified in Attachments 2 and 3.

The upper Nisqually River valley, which is less subject to lahars generated by landslides than the Puyallup, does not have lahar detectors owing to steep terrain, proximity to the mountain, and other issues. The White and Cowlitz River valleys have little risk from lahars generated by landslides, but are likely paths for lahars generated by eruptions. As such, they, along with the Nisqually, would be sites for installation of lahar-detection systems if the volcano becomes restless. USGS-CVO maintains a cache of lahar detectors available for deployment on short notice to restless Cascade volcanoes. Public education campaigns, focusing on

the hazards of the mountain, preparedness, and self-sufficiency are mitigative activities for all areas. Additionally, the public has a responsibility for their own safety, in these valleys and throughout the region.

B. Incident Notification

1. Ground-based Hazards

Description of Volcano Alert Levels

The USGS ranks the alert level at a U.S. volcano using the terms **Normal, Advisory, Watch,** and **Warning** (table 1). These levels reflect conditions at the volcano and the expected or ongoing hazards. Assigning an alert level depends upon monitoring data and interpretation of changing phenomena. Alert levels are not always followed sequentially and escalate or de-escalate depending on volcanic behavior. Volcano-alert notices are accompanied by explanatory text to give fuller explanation of the observed phenomena and to clarify hazard implications to affected groups. Updates that describe the ongoing activity are issued on a regular basis, at increasing frequency at higher activity levels.

Volcanic events are different enough that it is not possible to predetermine a detailed set of geophysical and geochemical criteria for each level that would be applicable universally. The alert-level definitions are guidelines for scientists to use to gauge the level of hazardous activity and for public officials and the public to consider when deciding what actions they need to take. Note that **Watch** is used for both heightened precursory unrest and for minor eruptive activity because both states bear close watching but do not have immediate, major hazardous effects. Because the size, style, and reach of eruptions can vary substantially, a higher level (**Warning**) is needed to highlight very hazardous eruptive activity.

Normal: *Typical background activity of a volcano in a noneruptive state*
This level applies to inactive, non-erupting volcanoes, with allowance for periods of increased steaming, seismic events, deformation, thermal anomalies, or detectable levels of degassing as long as such activity is within the range of typical non-eruptive phenomena seen at a volcano during its monitoring history (or at similar types of volcanoes).

Advisory: *Elevated unrest above known background activity*
This level is declared when a volcano is exhibiting signs of elevated unrest above known background levels. Progression toward eruption is by no means certain. After a change from a higher level, **Advisory** means that volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.

Watch: *Heightened or escalating unrest with potential for eruptive activity <u>OR</u> a minor eruption underway that poses limited hazards*

This level is declared for two situations: (1) when a volcano is exhibiting heightened or escalating unrest with potential for eruptive activity (not necessarily imminent) or (2) when a minor eruption is underway with limited hazardous impact. When changing from **Advisory**, this level implies increased potential for an eruption (timeframe variable). When changing from **Warning**, this level signifies that the volcano is still showing signs of heightened activity that may lead to renewed highly hazardous activity or that the volcano has settled into minor eruptive activity with limited hazards.

Warning: *Major or highly hazardous eruption underway or imminent*
This level is declared by the USGS when a major or highly hazardous eruption appears to be imminent or is confirmed or suspected to be underway. Owing to remoteness or poor weather conditions, some eruptions may not be confirmed visually or by satellite imagery, but ground-based monitoring data may strongly suggest that eruptive activity is occurring; in such cases, the accompanying information will say that a "suspected" rather than a "confirmed" eruption is underway. Accompanying information will indicate in as much detail as possible the eruption's time of onset, duration, size, intensity or explosivity, and impact on the landscape and atmosphere. When the major eruptive period ends or settles into milder, less hazardous activity, the level is downgraded.

Information Statement: *Notable event at a volcano, not necessarily eruptive*
Phenomena such as prominent steam plumes, small avalanches and rock falls, minor mudflows, changes in appearance of a lake in a volcanic crater, and minor seismic activity may occur while a volcano is at a **Normal** level. Most such events are short-lived and lack recognizable precursors and do not necessarily suggest volcanic unrest or major flank instability that would warrant a crisis response. However, owing to public and media inquiries that often result from a notable event, the USGS along with other involved agencies will attempt to verify the nature and extent of the event and issue explanations in the form of an **Information Statement**. An **Information Statement** also may be issued periodically to provide commentary about a significant event or change occurring within higher alert levels.

Aviation Color Codes

Eruptions threaten aviation safety when plumes of volcanic ash are explosively erupted and disperse as airborne clouds in flight paths of jet aircraft. Numerous instances of aircraft flying into volcanic-ash clouds have demonstrated both the economic costs and life-threatening potential of this hazard. The accepted mitigation strategy is to avoid encounters of aircraft with ash clouds, which requires that pilots, dispatchers, and air-

traffic controllers quickly learn of occurrences of explosive eruptions and the whereabouts of airborne ash clouds globally.

For the aviation sector, in accord with recommended ICAO procedures, the USGS issues color-coded activity levels – **Green, Yellow, Orange,** and **Red –** focused on ash hazards (table 2). Color-codes are especially suitable for the aviation sector because pilots, dispatchers, and air-traffic controllers planning or executing flights over broad regions of the globe quickly need to ascertain the status of numerous volcanoes and determine if continued attention, re-routing, or extra fuel is warranted. As with the **Watch** term, **Orange** is used for both heightened precursory unrest and minor eruptive activity, and there are two levels (**Orange** and **Red**) to cover the range of eruption size and impact.

All Volcano Advisories, Watches, and Warnings will include the "Aviation Color Code," clearly identified as such to differentiate it from other hazard statements. In most cases, the term and aviation-specific color code will move together (e.g., **Normal** and **Green**; **Advisory** and **Yellow**; **Watch** and **Orange**; **Warning** and **Red**). However, there may be occasions when activity at a volcano poses a hazard to the aviation sector that is significantly lower than hazards posed to ground-based communities. In those cases, the aviation color code will be lower than what is normally associated with the alert term. An example is a large lava flow heading towards a town (Volcano **Warning** in effect) that is unlikely to produce any ash in flight routes or near an airport (Aviation Color Code **Orange**). Conversely, an ash plume that does not yield significant ash fall onto ground communities but does drift into air routes might warrant a Volcano **Watch** and Aviation Color Code **Red**.

VOLCANO ALERT LEVELS	
NORMAL	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly, but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

2. Aviation Color Code

Table 2. **AVIATION COLOR CODES**	
GREEN	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway with no or minor ash emission *[plume height specified, if possible]*.
RED	Eruption is imminent with significant emission of ash into the atmosphere likely or eruption is underway or suspected with significant emission of ash into the atmosphere *[plume height specified, if possible]*.

C. Communications and Emergency Notification

1. Effective communications are critical to the response and survival of any emergency of significant scope and severity, but history has shown it to be one of the greatest challenges. To add to the challenge, the telephone and cellular systems are often off-line due to damage or overuse. These systems may be off-line for hours and possibly days if the incident causes widespread damage. Alternative methods to obtain emergency information and notification are required in these situations.

2. One emergency notification system common to the public, public safety, and the entire region is the Emergency Alert System (EAS) (see Attachment 1). The EAS, a national warning system, replaced the Emergency Broadcast System several years ago. EAS sends the message, local media broadcasts the message, and the NOAA All Hazards Radio receives the message. The NOAA All Hazards Radio is a reliable way to ensure receipt of emergency notifications and warnings. Televisions and radios also receive the EAS message but must be turned on for any benefit. Future technology will be available for televisions and radios to automatically turn-on when the EAS tones are detected.

All contributors to this document cannot express enough the importance of everyone living within the volcanic hazard area of Pierce County and the neighboring counties purchasing and regularly testing the NOAA All Hazards Radio. It can truly be the difference between life and death.

3. Pierce County DEM has installed and maintained the Lahar Warning System. The system is a network of 25 sirens located throughout the Puyallup River valley, beginning in Orting and ending in Fife. Initially the system was considered to be the primary warning system for the valley but numerous tests have not always resulted in success. The time of day, nearby traffic noise, being inside or outside, and an individual's hearing ability all impact the effectiveness of the siren system in communities along the Puyallup River.

   The Lahar Warning System is wired into the EAS. When a lahar is detected with the warning system, the trigger to blow the sirens also activates the EAS.

4. Actions associated with sending EAS messages (see Attachment 1 EAS Activation Procedures), sounding sirens, or disseminating lahar information are:

   - A lahar is detected and verified by either the AFMs sensing an encroaching lahar, by visual assessment, or by other means.

   - The sirens are triggered and sound the alarm.

   - Simultaneously, pre-recorded (pre-recorded to save critical time) lahar EAS messages are transmitted (See attachment 2 to this chapter). Local EAS messages are scripted and sent by the Law Enforcement Support Agency (LESA), Washington Emergency Management Division (WEMD), PC DEM, or the National Weather Service (NWS).

   - Media will broadcast the message (KIRO 710 AM and KPLU 88.5 FM are legally mandated as the local primary and secondary radio stations to broadcast messages) and the NOAA All Hazards Radio, television and radio receive the message. The message includes a brief description of the emergency and critical, life-saving steps to take, to not call 9-1-1, and listen to the local media for additional information.

   - Additional EAS messages may be sent with incident-specific information. Ensuring that the NOAA All Hazards Radio has a charged battery at all times will ensure the receipt of these messages.

- Simultaneously, WEMD and LESA will begin the emergency notification of public safety responders. Local and regional agencies are notified by LESA. State agencies are notified by WEMD (see Attachments 2 and 3).

- The Pierce County Crisis Communications website will have available information along with websites from other emergency management organizations.

- A regional JIC will open for the continued dissemination of critical information and life-saving actions. The JIC will be staffed with representatives from impacted and stakeholder agencies. See Chapter 8: Emergency Information for additional information on JIC operations.

5. Pierce County E-9-1-1 Administration Program has implemented a "reverse 9-1-1" system called Target Notification. It provides a platform that uses GIS applications to highlight the geographical boundaries of emergencies and disasters, to script incident-specific messages, and provide repeated notifications. Selected Public Safety Answering Points (PSAP) personnel and PC DEM duty officers are authorized to activate the system. Target Notification uses the AT&T non-cellular database and dials each telephone number until it is answered by either a person or a message service. Cellular and systems other than landline telephones are not included in the system.

6. The Puyallup Valley has a local emergency radio station, AM 1580, funded for the public's notification of a lahar coming down the valley and how they should respond. It will also be used for rumor control in the event there is a false alarm or a small debris flow that will not impact the valley. This station, while initially developed for lahar warnings, is an all hazard information station.

7. Tacoma Public Utilities (TPU) owns the Nisqually Hydroelectric Project. The project comprises two dams (LaGrande and Alder) with each having a powerhouse for the purpose of electricity generation. TPU has a responsibility to inform local public safety agencies in the event of an emergency at either or both of the dams or powerhouses. Public safety agencies have the responsibility to inform the public.

   As soon as a lahar on the Nisqually River has been confirmed, TPU notifies LESA. With the assistance of TPU, LESA scripts a message. LESA sends the message via EAS and begins emergency notifications as identified in Attachment 3. If for any reason LESA is unable to promptly send the EAS message, WEMD will be responsible for sending it. Simultaneously, TPU conducts internal emergency notifications and

begins emergency operations.

The following are specific actions taken by TPU in the event of a lahar impacting the Nisqually Project.

Upon receiving notification that a lahar has potentially occurred:

- Confirm situation with TPU and Mount Rainier dispatch
- Evacuate all personnel from powerhouses and areas subject to flooding
- Contact the dam safety engineer to discuss action being taken
- Immediately staff the office and monitor lake levels and cameras
- Consider the dispatch of person(s) to remain in radio or phone contact and observe from an upstream location where visual observation can be made without jeopardizing safety

- If SUFFICIENT FREEBOARD exists (Alder below elevation 1197) no spill need be initiated but spill should be preplanned. Spill levels shall be planned at current inflow plus 500 cubic feet per second (cfs) or current outflow, whichever is greater. Should lake levels begin rising due to a lahar inflow, generation should be shutdown and spill initiated. It is up to the project to use reasonable judgment on when to make this decision based on rate of rise, levels, etc.

- If INSUFFICIENT FREEBOARD exists (Alder Lake above elevation 1197) and no visual observer can be in position within 30 minutes, generation shall be ceased and spill shall be initiated at the level of downstream flow currently being discharged at LaGrande Dam and powerhouse. Should a rise due to the lahar be noted, spill shall be increased by 500 cfs or to a level of previous river inflow plus 500 cfs, whichever is greater.

- If PROJECT OVERTOPS or OVERTOPPING APPEARS IMMINENT initiate the TPU emergency activation plan (EAP) with first message. Follow up EAP notification on estimated level of overtopping and / or failure of the project should occur within 20-30 minutes.

D. References - TBD
E. Terms and Definitions - TBD
F. Attachments
   - Attachment 1: Pierce County Emergency Alert System Activation Procedures
   - Attachment 2: Radio 1580 AM Pre-scripted Messages
   - Attachment 3: Washington Emergency Management Division Notifications
   - Attachment 4: Law Enforcement Support Agencies Notifications

Attachment 1
PIERCE COUNTY
EMERGENCY ALERT SYSTEM
ACTIVATION PROCEDURES

PRIMARY AGENCIES

Pierce County Department of Emergency Management (PC DEM)
Washington State Emergency Management Division (WEMD)

SUPPORT AGENCY

Tacoma – Pierce County Law Enforcement Support Agency (LESA)

I. INTRODUCTION

The Emergency Alert System (EAS) permits federal, state, and local governments to communicate instructions and essential information to the public during emergencies through commercial and public radio, and television broadcast stations. The EAS provides a process for public officials to rapidly disseminate emergency information intended to reduce loss of life and property, and to promote rapid recovery in the event of a natural or man-made disaster, or a terrorist attack on the United States.

The Federal Communication Council (FCC) has regulatory oversight of EAS. EAS replaced the Emergency Broadcast System (EBS) in the mid 1990s. EAS allows for bottom-up (local and state governments) message dissemination as well as top-down (federal government) message dissemination. The EBS allowed only top-down. When an EAS message is sent, it is re-broadcast by area radio and television stations. Even though it is re-broadcast over multiple stations, KIRO NewsRadio 710 AM and KPLU 88.5 FM are FCC mandated to re-broadcast messages generated in the Central Puget Sound.

A. Purpose

This document will identify roles, responsibilities, and procedures for Pierce County when requesting activation of the EAS. It is meant to supplement the Central Puget Sound Emergency Alert System Area Plan.

B. Scope

Procedures identified in this Plan are guidelines for activating the EAS in Pierce County. All guidelines and procedures established by this document and the Central Puget Sound Emergency Alert System Area Plan, including guidelines established for broadcast station providers, will be followed.

II. POLICY

WEMD has primary responsibility for transmitting EAS messages for Pierce County. LESA may offer assistance to WEMD if necessary. The Director of PC DEM, or designee, has primary local responsibility for the authorization of those messages. EAS messages will be utilized as a last resort and when the following criteria are met.

- Lives must be in danger.
- Direction provided via the EAS has the potential to save lives.
- Effective warning cannot be accomplished by any other means.

After the EAS message is transmitted, further instructions and information will be disseminated to the media by the Pierce County Joint Information Center (PC JIC).

Weather related EAS messages will be authorized and transmitted by the National Weather Service. The National Weather Service has transitioned from transmitting only weather related messages an all hazard notification/warning system.

III. SITUATION

A. There will be times when it is critical to warn the public and local officials of imminent or actual emergencies or disasters.

Examples of incidents that may require warning and the use of the EAS include, but are not limited to: earthquake, volcanic activity, severe weather, flooding, and hazardous materials releases. There are many other natural and man-made emergencies or disasters that are addressed in the Pierce County Hazard Identification and Vulnerability Analysis (published separately) that may also meet the criteria for the use of the EAS.

B. Planning Assumptions

- The incident is imminent, or actually occurring, making conventional methods of warning and media notification inadequate.
- Lives must be in jeopardy and will be saved with immediate actions.
- Communications paths will be available among EAS activation points and broadcast stations.
- Other methods of warning will be used in addition to the EAS, whenever possible.
- Radio, television, and cable broadcasters will broadcast EAS messages in a timely manner.

IV. CONCEPT OF OPERATIONS

A. In addition to the Director of PC DEM, or designee, authorized to initiate EAS messages, there are also federal and state authorities that initiate messages of broader scope to warn the public of actual or potential life-threatening incidents. These authorities are the President, and the director of the Washington Emergency Management Division (WEMD).

B. Certain equipment is required to transmit EAS messages. An encoder can generate warnings which may be preset requiring only the pressing of a button. A computer can be used with the encoder to send customized messages. A decoder accepts two (2) attention bursts and translates it into an audio and/or printed message. Messages are limited to two minutes and must contain concise emergency information and instructions. After the message two (2) more attention bursts concludes the transmission.

C. The method of transmitting these messages among local agencies and broadcasters is via UHF radio. By using radios, many broadcasters are able to receive messages at the same time. Those broadcasters outside the frequency range or who do not have decoders will need to receive the message from other broadcasters.

D. Request for Activation

When the incident commander or highest ranking official at the scene of an incident determines that an EAS message must be initiated to save lives, has the potential to same lives, or if there is no other way to warn the public, he/she will contact the authorized individual from their jurisdiction who has the authority to request activation of the EAS. That person will contact LESA by calling 253-798-4063. LESA will immediately contact the WEMD duty officer (1-800-253-5990) and the Pierce County DEM duty officer (253-798-7470). LESA may validate the incident by calling the affected public safety answering point (PSAP).

All requests for activation must meet the following criteria:

- Lives must be in danger.
- Direction provided via the EAS has the potential to save lives.
- Effective warning cannot be accomplished by any other means.

D. Procedures

The decision to authorize the use of the EAS will be based on best available information available at the time of the decision. Informational

sources include the field incident command, immediately accessible subject matter experts, the affected PSAP, and the Director of PC DEM.

All EAS messages will include:

- Name and title of person delivering the message.
- What will happen?
- When it will happen.
- Where it will happen.
- Geographic area affected.
- Emergency protective measures for the public.
- If evacuation is required, identify the hazard area and specify the primary evacuation route(s).
- Reassurance that officials are addressing the incident.

KIRO NewsRadio 710 AM is the primary radio station that the public should monitor for further information and instructions.

PC DEM public information officer will be the point of contact for all media inquiries. The PC EOC will open to support emergency operations. PC DEM will open the PC JIC, if indicated (see Pierce County CEMP ESF 15).

V. RESPONSIBILITIES

A. PC DEM has primary local responsibility authority for activating the EAS for incidents in Pierce County.

PC DEM will:

- Appoint a lead EAS liaison.
- Maintain the EAS so it can be activated 24 hours a day.
- Designate personnel who may initiate EAS messages.
- Train personnel on EAS operating procedures.
- Test the EAS equipment and procedures regularly.
- Open the PC EOC to support emergency operations
- Open the PC JIC to manage the media's and public's need for information.

B. WEMD has primary responsibility for transmitting EAS messages for Pierce County.

WEMD will:

- Appoint a lead EAS liaison.
- Provide an adequate facility / work station for the EAS.
- Cooperate with PC DEM to ensure that personnel are designated and adequately trained to initiate EAS messages.

C. LESA provides support in collecting, verifying, and scripting information in preparation to send an EAS message and follow-up activities.

VI. REFERENCES

Title 47 U.S.C. 151, 154 (i) & (o), 303 ®, 524 (g) & 606; and 47 C.F.R. Part 11, FCC Rules and Regulations, Emergency Alert System

Central Puget Sound EAS Local Plan

Pierce County Hazard Identification and Vulnerability Analysis

Pierce County Comprehensive Emergency Management Plan

VII. TERMS AND DEFINITIONS

None

VIII. ATTACHMENTS

None

Attachment 2
RADIO 1580 AM PRE-SCRIPTED MESSAGES

White River upstream from Greenwater

This is the Law Enforcement Support Agency with an emergency evacuation message from the Pierce County Department of Emergency Management. The following is not a test; I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the White River.

The size of the debris flow is unknown at this time. Those people near the White River upstream from Greenwater could be threatened. If you are near the White River upstream from Greenwater move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the roads areas so that others can evacuate.

I repeat this is not a test. This is the Law Enforcement Support Agency with an emergency evacuation message from Pierce County Department of Emergency Management. This is not a test. A debris flow has been observed coming from Mount Rainier down the White River.

The size of the debris flow is unknown at this time. Those people near the White River from Greenwater could be threatened. If you are near the White River upstream from Greenwater move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

Stay tuned to your local radio station for further details. This an emergency evacuation message from the Law Enforcement Support Agency for Pierce County Department of Emergency Management.

Nisqually River upstream from the Alder Reservoir

This is the Law Enforcement Support Agency with an emergency evacuation message from the Pierce County Department of Emergency Management. The following is not a test; I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Nisqually River.

The size of the debris flow is unknown at this time. Those people near the Nisqually River bed upstream from the Alder Reservoir could be threatened. If you are near the Nisqually River bed upstream from the Alder Reservoir move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

I repeat this is not a test. This is Law Enforcement Support Agency with an emergency

evacuation message from the Pierce County Department of Emergency Management. This is not a test. I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Nisqually River.

The size of the debris flow is unknown at this time. Those people near the Nisqually River bed upstream from the Alder Reservoir could be threatened. If you are near the Nisqually River bed upstream from the Alder Reservoir move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

Stay tuned to your local radio station for further details. This is an emergency evacuation message from the Law Enforcement Support Agency for the Pierce County Department of Emergency Management.

Cowlitz River

This is the Law Enforcement Support Agency with an emergency evacuation message from the Pierce County Department of Emergency Management. The following is not a test; I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Cowlitz River.

The size of the debris flow is unknown at this time. Those people near the Cowlitz River upstream from Packwood could be threatened. If you are near the Cowlitz River upstream from Packwood move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so others can evacuate.

I repeat this is not a test. This is Law Enforcement Support Agency with an emergency evacuation message from the Pierce County Department of Emergency Management. This is not a test. I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Cowlitz River.

The size of the debris flow is unknown at this time. Those people near the Cowlitz River upstream from Packwood could be threatened. If you are near the Cowlitz River upstream from Packwood move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so others can evacuate.

Stay tuned to your local radio station for further details. This is an emergency evacuation message from the Law Enforcement Support Agency for the Pierce County Department of Emergency Management.

Carbon River

This is the Law Enforcement Support Agency with an emergency evacuation message

from the Pierce County Department of Emergency Management. The following is not a test; I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Carbon River.

The size of the debris flow is unknown at this time. Those people near the Carbon River upstream from Highway 165 Bridge could be threatened. If you are near the Carbon River upstream from Highway 165 Bridge move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so others can evacuate.

I repeat this is not a test. This is Law Enforcement Support Agency with an emergency evacuation message from the Pierce County Department of Emergency Management. This is not a test. I repeat this is not a test. A debris flow has been observed coming from Mount Rainier down the Carbon River.

The size of the debris flow is unknown at this time. Those people near the Carbon River upstream from Highway 165 Bridge could be threatened. If you are near the Carbon River upstream from Highway 165 Bridge move to higher ground immediately. Do not delay. Do not call 9-1-1. Move to higher ground immediately. Park your vehicles off the road areas so others can evacuate.

Stay tuned to your local radio station for further details. This is an emergency evacuation message from the Law Enforcement Support Agency for the Pierce County Department of Emergency Management.

Puyallup River

This is the Washington State Emergency Operations Center. The following is not a test. I repeat, this is not a test. A Debris Flow has been observed coming from Mount Rainier down the Puyallup River.

The size of the Debris Flow is unknown at this time. Those people near the Puyallup River upstream from Electron could be threatened. If you are near the Puyallup River upstream from Electron move to higher ground immediately. Do not delay. Do not call 911. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

I repeat, this is not a test. A Debris Flow has been observed coming from Mount Rainier down the Puallup River

The size of the Debris Flow is unknown at this time. Those people near the Puyallup River upstream from Electron could be threatened. If you are near the Puyallup River upstream from Electron move to higher ground immediately. Do not delay. Do not call 911. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

Stay tuned to your local radio station for further details. This is an emergency evacuation message from the Washington State Emergency Operations Center.

Puyallup, Carbon and Nisqually Rivers

This is the Washington State Emergency Operations Center. The following is not a test. I repeat, this is not a test. A lahar has been observed coming from Mount Rainier down the Puyallup and/or Carbon River Valleys and possibly the upper Nisqually River.

This lahar has the potential to bury the valley areas in Pierce and King Counties. People in and around valley areas near the towns of Orting, Sumner, Puyallup Tacoma, Fife, Pacific, Algona, and in the Auburn Valley south of highway 18 are threatened. Areas in the upper Nisqually River Valley above Alder Dam in Pierce, Thurston and Lewis Counties may also be threatened.

If you are in valley areas around the Puyallup, Carbon, and the upper Nisqually Rivers move to higher ground immediately. Do not delay. Do not call 911. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

I repeat, this is not a test. A lahar has been observed coming from Mount Rainier down the Puyallup and/or Carbon River Valleys and possibly the upper Nisqually River.

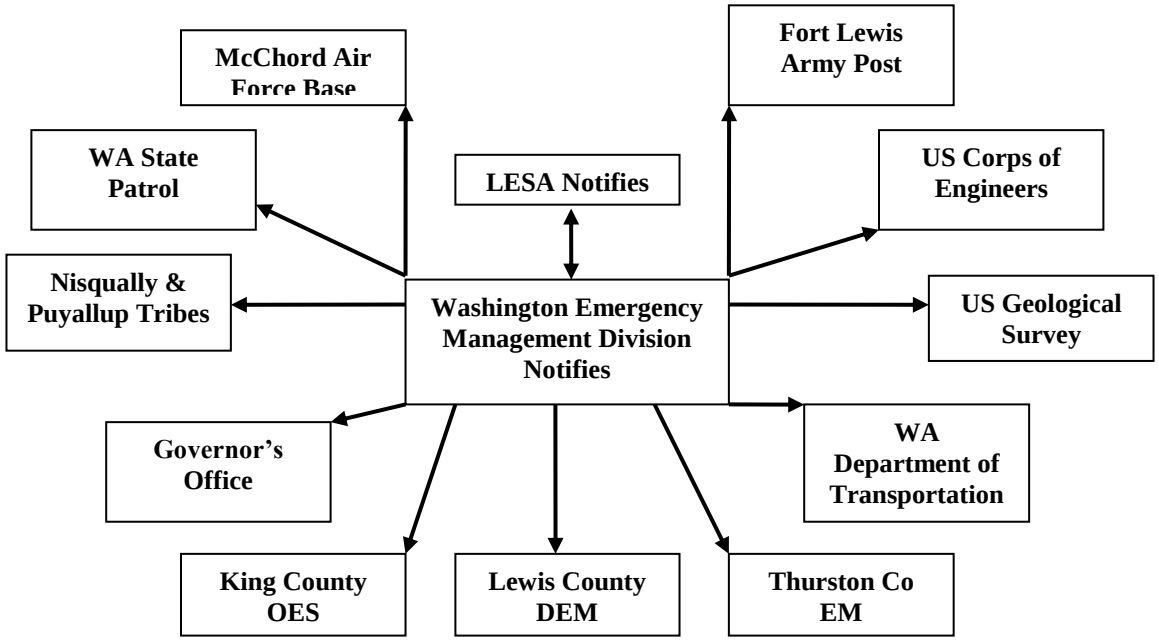
This lahar has the potential to bury the valley areas in Pierce and King Counties. People in and around valley areas near the towns of Orting, Sumner, Puyallup Tacoma, Fife, Pacific, Algona, and in the Auburn Valley south of highway 18 are threatened. Areas in the upper Nisqually River Valley above Alder Dam in Pierce, Thurston and Lewis Counties may also be threatened.

If you are in valley areas around the Puyallup, Carbon, and the upper Nisqually Rivers move to higher ground immediately. Do not delay. Do not call 911. Move to higher ground immediately. Park your vehicles off the road areas so that others can evacuate.

Stay tuned to your local radio station for further details. This is an emergency evacuation message from the Washington State Emergency Operations Center.

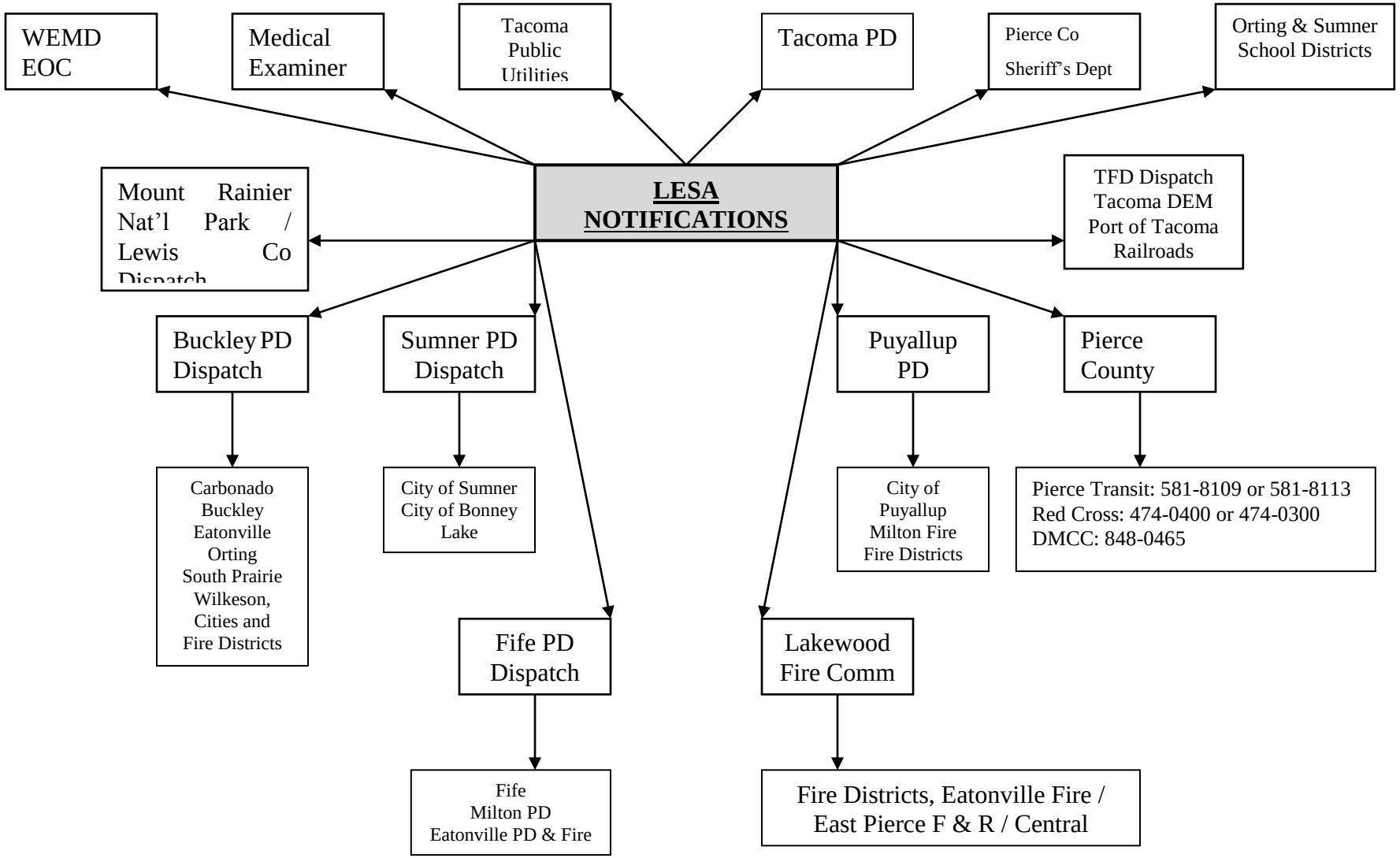
Attachment 3

Washington Emergency Management Division Notifications



Attachment 4

Law Enforcement Support Agency Notifications



Puyallup River Valley Operations Division				Attachment 2
ZONE	**AREA**	**UNIFIED COMMAND**	**STAGING**	**RESPONSIBILIITES**
South Hill	South Hill /	PCSD South Hill	PCSD South Hill	Estabish unified command
Orting PD, Sumner PD, and	Graham	271 John Bananola	271 John Bananola	Assign on-site staging officer
Puyallup PD will join UC		Puyallup 98374	Puyallup 98374	Restrict traffic to southbound routes off SR 512
ASAP after evacuating				Restrict traffic to westbound routes off SR 162
cities				Orting - Kapowsin Hwy
				Notify PC DEM duty officer 253-798-7470
ZONE	**AREA**	**COMMAND POST**	**STAGING**	**RESPONSIBILITIES**
Bonney Lake	SR 410 / SR 167	Bonney Lake PD	Bonney Lake PD	Establish incident command
Buckley PD		18421 Old Buckley Hwy	18421 Old Buckley	Assign on-site staging officer
PCSD Foothills Det.		Bonney Lake 98391	Hwy, Bonney Lake	Restrict SR 410 eastbound traffic
WSP			98391	Restrict traffic into the valley at secondary intersections
King Co Sheriff				
Bonney Lake, Buckley,				
& King Co Public Works				
Pierce Co Fire Zone 8				
WSP	SR 512 /	WSP HQ	WSP Tacoma,	Establish incident command
Lakewood PD	Portland Ave	112 th St S	2502 - 112th St E,	Assign on-site staging officer
Tacoma PD			Tacoma	Restrict SR 512 eastbound traffic
WDOT				Provide traffic controll at I-5 / SR 512 intersection
Pierce Co Fire Zone 7				Restrict traffic into the valley at secondary intersections
Fife	I-5 / Fife	Milton Public Safety Dept	Milton PD	Establish incident command
Edgewood, Tacoma &		1000 Laurel St	1000 Laurel St	Assign on-site staging officer
Federal Way PDs		Milton 98354	Milton 98354	Direct all I-5 traffic to northbound
WSP Seattle Office				Restrict SR 161 eastbound traffic
King Co Sheriff				Restrict traffic into the valley at secondary intersections
Tacoma Public \Works				
WDOT				
Lakewood	Lakewood /	Lakewood Police Dept	Lakewood FD Sta 1	Establish incident command
University Place &	Fort Lewis	5504 - 112TH St SW	10928 Pacific Hwy	Assign on-site staging officer
DuPont PD		Lakewood 98499	SW	Direct all I-5 traffic to southbound
Ft. Lewis MPs				Restrict traffic into the valley at secondary intersections
Pierce Co Fire Zone 8				
ZONE	**AREA**	**COMMAND POST**	**STAGING**	**RESPONSIBILITIES**
Auburn	South King Co	Auburn Police Dept	Auburn FD	Establish incident command
Kent PD			1101 "D" St NE	Assign on-site staging officer
WSP Belleve Office			Auburn 98002	Restrict SR 167 southbound traffic
Auburn Public Works				Restrict traffic into the valley at secondary intersections

Chapter 6: COMMAND AND EVACUATION

A. Introduction

1. Purpose

The goal of this Chapter 6 of the Mount Rainier Volcanic Hazards Response Plan is to outline emergency actions and operations required to successfully evacuate, with minimal confusion and delay, as many people as possible in the path of a lahar. These recommended procedures and considerations are not unique to a volcanic eruption; many of the same procedures and considerations will apply to any mass evacuation effort.

2. Scope

This chapter will focus on the emergency operations necessary in response to a worst-case lahar. The worst-case scenario is a spontaneous, large landslide and resulting lahar in the Puyallup, including its tributary the Carbon, River drainage. This drainage differs from the other drainages because of the greater population density located in the inundation zone and the automated warning system that has been installed in the valley. Most of the concepts and procedures will apply to all river drainages. Unique differences will be addresses separately.

This chapter outlines general operational considerations that may not be hardened policy but are broad objectives that will provide for the greatest protection of life that can be achieved with resources available. It should be used as a guideline for those in command and should not be viewed as a prescribed action plan. More information regarding the roles of public safety providers is found in jurisdictional CEMPs and other pertinent operations plans.

3. All emergency operations will be in compliance with the Incident Command System (ICS) of the National Incident Management System (NIMS).

A Mount Rainier worst case lahar will demand what will likely be the largest and most complex response operations ever taken by Pierce County and Washington State. Individual command post operations will be managed by unified command. The scale and scope of the disaster will require the additional area command management structure. (Refer to the Pierce County Department of Emergency Management Comprehensive Emergency Management Plan, the National Incident Management System (NIMS) and the National Response Framework (NRF) published separately.)

B. Policies and Authorities

1. The Mount Rainier Volcanic Hazards Response Plan is created as a collaborative effort to meet a widely acknowledged need for coordination of evacuation activities in the Puyallup, Carbon, Nisqually, and White River valleys (drainages). Planning participants comprise representatives from law enforcement, fire services, emergency management, public schools, volunteer organizations, emergency dispatch, local military, public non-profit organizations, and subject matter experts from U. S. Geological Survey (USGS), Washington Department of Natural Resources (DNR) and National Park Service (NPS).

2. Chapter 38.52 of the Revised Code of Washington (RCW) and Chapter 118.30 of the Washington Administrative Code (WAC) directly address the structure of governmental emergency management organizations and their responsibilities. RCW 38.52 provides the framework for mutual aid agreements and mandates the use of the Incident Command System / National Incident Management System for all emergency operations. The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288, as amended) addresses the federal government's authority in providing disaster response and recovery assistance.

3. Support agencies and incorporated cities and towns will perform tasks and expend resources under their own authorities, including implementation of mutual aid agreements, in addition to resources received under the authority of this plan.

4. All Pierce County residents, workers, and visitors have a responsibility for their own safety and the safety of those under their care. It is expected that everyone ensure that they are self-sufficient for at least seven (7) days.

5. Due to the multi-jurisdictional, multi-agency, and multi-disciplinary considerations addressed in this plan, there are too many existing emergency policies on the local level to list in this section. The aggregate of these of policies, in some way, reflected throughout the plan.

6. Safety is paramount in the management of this incident as well as all other emergency incidents that occur within the region.

7. Law enforcement is the lead agency in the evacuation and movement of people.

8. **All emergency operations will align with NIMS / ICS.**

C. Situation

1. Disaster Conditions

Mount Rainier may send warnings of its re-awakening at any time. The warnings may lead to an imminent lahar or they may continue indefinitely without any acceleration in volcanic activity. It is imperative to frequently consult with the scientists from USGS Cascades Volcano Observatory (CVO) who monitor the mountain.

Lahars can impact one river drainage or any combination of river drainages. A lahar impacting the Carbon and Puyallup river valleys can impact the Nisqually drainage when certain conditions are met. Large lahars have the potential to isolate Pierce County by making the bridges over the Puyallup and Nisqually rivers impassable.

Based on current real estate footprints, a worst-case lahar would require up to 75,000 people to evacuate from the Puyallup Valley. The Puyallup Valley will have the greatest impact because of the high population density and its continued growth. Time of day will also determine the number that will be in harm's way. At night, while people are sleeping, it is likely that fewer will hear the warnings and delay their evacuation. Confusion on exactly what to do may cause some people to evacuate who were never in danger. With only limited roads out of the valley, everyone may not survive a worst-case scenario. The Nisqually and White River drainages have far less population density. The Upper Nisqually has 1,200.

When faced with a worst-case lahar, everyone in harms way needs to evacuate as quickly as possible. Everyone will be evacuating together, including public safety providers. Public safety providers may have time to assist others as they continue to evacuate themselves but no one can expect it. No fire fighter, police officer, or any other public safety provider will be expected to enter or remain in harms way to rescue others.

In order to optimize the chances for survival of a worst-case scenario, people in the inundation zone are responsible to know the dangers associated with living, working, or visiting the Puyallup, Carbon, Nisqually, White or any other Mount Rainier drainage. Individuals, families and business must remain informed, prepared, and ready to act any time of the day.

2. Planning Assumptions

a. Loss of life and property will occur with a catastrophic event.

b. No public safety units or personnel will be committed into the hazard zone.

c. Not all public safety personnel will be available due to being directly impacted by the lahar, or the inability to report to work or staging location due to inundation location.

d. Field communications will be adversely impacted, either directly or indirectly, due to damage to the telecommunications infrastructure or the overuse of communications systems (radio frequencies, cellular phone or land line).

e. People will spontaneously evacuate areas when there is actual or perceived danger.

f. People will evacuate by any means available.

g. Some people will evacuate, even when they are not in danger

h. Debris and mud will make streets and highways impassable and leave people stranded.

i. Transportation routes will be overwhelmed with evacuees. Vehicles will be abandoned, worsening the congestion. The grid-lock could seriously hinder evacuation efforts.

j. Seasonal and holiday visitors to the Mount Rainier National Park will significantly impact the evacuation efforts of the Upper Nisqually Valley.

k. Displacement from homes due to a lahar may last days, weeks, or months. The total destruction of many homes will cause displacement for some people for a much longer time. Ongoing eruptive activity, engineering problems of development on new deposits, unstable channels on high sediment loads could make some areas uninhabitable for years to decades.

l. A worst-case lahar will negatively impact the region's ability for economic recovery.

m. Unpredictable volcanic activity and associated risks will make advisory messages and recommended safety actions difficult.

n. Due to the large number of people evacuating out of the hazardous area(s), all lanes of traffic will flow in the direction of safety.

3. Limitations

The information and recommendations included in this plan have been prepared utilizing the best information and planning assumptions available at the time of its preparation. There is no guarantee implied by this plan that in emergency or disaster situations a perfect response will be practical or possible. This plan should be used as a guideline with consideration given to the unique needs of each and every situation.

D. Concept of Operations

1. General Pre-incident

Public safety agencies will maintain a state of readiness that is no different from any other type of emergency. Apparatus will be operational, equipment and supplies will be inventoried; personnel will be trained, and drilled. In addition to this state of readiness, all public safety personnel should be educated to the challenges of a worst-case lahar response.

Public safety agencies in the lahar inundation zone will assess the mission essential status of their personnel, apparatus, and equipment. They will identify appropriate staging locations, collection sites, ingress and egress route identification, and additional considerations to preserve life safety.

Those fire departments directly in the path of an oncoming lahar will stage at the following locations.

Orting Fire Department
- Washington Soldiers Home and Colony
  1301 Orting – Kapowsin Highway
- Buttes Drive East and Orville Road
- Military Road and SR 162

Orting Fire District #18
- Station 18-2
  19210 Patterson Road
- Station 18-3
  14919 Orting – Kapowsin Highway (top of Cemetery Hill)

Sumner Fire Department

Puyallup Fire Department

Riverside Fire and Rescue
- Central Pierce Fire and Rescue Station 6-7
  8119 Canyon Road East

It is recommended that the police departments also located on the valley floor stage their equipment that is not involved in evacuating their jurisdiction or joining unified command at these same locations.
Other pre-incident public safety actions include researching vendors, updating relationships, reviewing mutual aid agreements, taking measures to preserve essential records, escalating public information and outreach efforts, re-evaluating budgets, ensuring alternate work locations, briefing elected officials, passing special ordinances and resolutions, and considering long-term societal and economic aspects of a disaster of this magnitude and consequence.

2. Direction and Control provides for effective management, authority, and cooperative execution of life safety and emergency management activities. Coordinated field command and operations implemented by incident command structure are critical to safe and rapid evacuation of residents in the Carbon, Puyallup, Nisqually, and White river drainages off Mount Rainier. Effective coordination is dependent on continued communications among field command and the WEMD Emergency Operations Center (area command).

All emergency operations will align with the Incident Command System / National Incident Management procedures and policies. This provides for common standards in scene management, organization, and terminology.

It provides a means for the establishment of a common set of incident objectives and strategies during the multi-agency, multi-jurisdiction response to this worst care scenario. Incident / unified command allows for maintaining individual agency / jurisdiction authority, responsibility, and accountability.

3. Specific Operational Concepts

a. Due to the unique hazards associated with a worst-case scenario lahar inundating the river valleys, the affected public safety agencies will be evacuating along with everyone else that is in harms way. As a result, the public safety agencies from communities in the path of the lahar do not have a role in the incident / unified command that is initially established. These agencies are dedicated to evacuating their cities' residents, families, and themselves as quickly as possible. They will join incident / unified command when it is appropriate.

No public safety personnel will be dispatched into areas impacted by a lahar.

b. Any warning from the mountain will allow for life saving operations, but the duration of the warning will greatly impact the effectiveness of those

operations. The operations include but are not limited to: Evacuation of general population, relocation of special needs populations, procurement and stockpiling supplies, pre-staging personnel and equipment, and arranging for the possibility of long-term housing.

c. Airspace restrictions will be mandated if an eruption or lahar is imminent or upon the onset of a spontaneous lahar.

d. Mount Rainier National Park Rangers and staff will coordinate the evacuation of the park. The increase of seasonal and holiday visitors to the park and wilderness areas will significantly impact the evacuation effort.

e. Public safety providers who cannot reach their normal place of work are to report to the nearest staging area or EOC, and report to the incident commander / EOC manager.

4. Operational Guidelines

Traffic on major routes on the impacted valley(s), (Carbon, Puyallup, Nisqually, or White) will be restricted in order to move as many people as quickly as possible out of the hazardous area(s). After clearing all traffic, roads into these areas will be closed to traffic attempting to re-enter the evacuated valley(s).

Direction of travel (all lanes) on the major routes out of the impacted valley(s) will be in one direction, away from the hazardous area(s). Due to the large numbers of people evacuating from the hazardous areas, all lanes of traffic will flow in the direction to safety.

There will be no designated route open for anyone attempting to enter the hazardous area(s). All possible routes will be used to get people out of harms' way.

Public safety agencies and equipment outside affected areas will respond to locations known to be evacuation routes (see evacuation route map) and assist in the evacuation of displaced persons. Initial law enforcement actions will be to close all access and isolate the affected and threatened areas, and prevent incoming traffic in order for all lanes to be used for outgoing traffic.

The first public safety provider arriving at the incident becomes the incident commander. Evacuation is a law enforcement activity, therefore, if necessary, the incident commander will be re-assigned to a qualified officer or deputy. Unified command will be organized as soon as possible.

As response resources are depleted or unavailable and essential resources and systems are non-functional, the emergency first responders can only make every reasonable effort to respond based on the situation, and available information and resources at the time the decisions are being made

Pierce County DEM will dispatch a type 3 incident management team (IMT) to support field operations as soon as it is available. The IMT will report to unified command unless, the impacted area(s), severity of impact, and availability of team members dictate otherwise.

5. Agency / discipline-specific Operations

- PC DEM

  Maintain and test the lahar warning system.

  Provide Mount Rainier and lahar hazard public education and outreach.

  Lead the Mount Rainier Work Group effort.

  The Pierce County DEM duty officer will be in the first notification layer. The PC EOC will open with level 3 staffing to support field operations. Follow respective agency policies in requesting representatives.

  Send a liaison to the area command post (WEMD EOC).

  Coordinate and dispatch a type 3 IMT to support field incident / unified command.

  A local proclamation of emergency will be processed immediately, followed by requesting a governor's proclamation of emergency. A worst-case lahar will quickly qualify as a presidential declaration of emergency.

  The Mobile Operations Command Center (MOCC) and the Tactical Area Command (TAC-1) will be dispatched to locations determined by unified or area command.

- Fire Services (ESF 4)

  A major distinguishing factor in a lahar large enough to cause consequence is that fire services will be evacuating out of harm's way just like everyone else in the lahar path. For the fire services not in the lahar path, they will not endanger themselves to assist evacuation and rescue efforts. Available fire services will report to the closest zonal incident command location (see ???)

and join the command structure.

Evacuating fire services will assist in the alerting and warning of residents as they move to higher ground. If adequate time, they will assist in the evacuating of residents in need.

A fire zone coordinator will report to the Pierce County EOC. Regional and state fire mobilization will be requested if indicated.

- Law Enforcement (ESF 13)

  In the worst-case scenario lahar, municipal police departments (Orting, Sumner, Puyallup, and Fife) of incorporated cities in the inundation area are responsible for the evacuation of their populations. They will be evacuating to higher ground when it is no longer safe for them to remain in the affected area.

  The Washington State Patrol is the primary mutual aid agency for rapid response in the affected area for traffic control and perimeter security.

  A law enforcement representative will report to the Pierce County EOC. Law enforcement mobilization will be requested if indicated.

- Public Works (ESF 3)

  Pierce County Department of Public Works, Transportation Division will be notified when other public safety agencies are notified. Pierce County does not have public works facilities in the affected areas but some of the incorporated cities do.

  A public works representative will report to the Pierce County EOC.

  Public works in the affected areas are required to do additional emergency planning that will address critical inventory and personnel, egress routes and staging locations. Plans will address what actions will be taken as they are moving to higher ground, e.g., placing barricades and jersey barriers evacuation route intersections. Pierce County Public Works will control those traffic lights under their jurisdiction to all green in the desire direction of traffic.

  Public works departments not in the inundation area will join incident command located throughout the region.

- Search and Rescue (ESF 9)

Search and rescue operations will begin as soon as conditions are safe. PCSD is the lead agency for search and rescue operations in the hazard area. SAR will be coordinated at unified command.

Regional aviation assets will be deployed to conduct aerial searches will occur as soon as possible to look for stranded individuals and damage assessments. The regional aviation assets are coordinate by WEMD.

USAR will be requested with the presidential declaration of emergency

- Washington Emergency Management Division (WEMD)

  Open the WEMD EOC and function as the lead agency for area command. Staff area command with impacted jurisdictions and agencies.

  Activate necessary ESFs to adequately support field response and recovery operations.

  Coordinate and dispatch regional aviation assets as appropriate, based on the priorities of the emergency.

  Provide direction and legal counsel as appropriate and / or requested.

  Process local proclamations of emergency for governor's approval.

  Coordinate operations with other counties and other appropriate agencies.

- USGS / CVO

  Provide scientific oversight and technical design of the lahar-detection component of the warning system. Provide on-site consultation when requested.

  Staff area command post (WEMD EOC), when activated, with appropriate subject matter experts

  Provide Mount Rainier and lahar hazard public education and outreach.

  Participate in the Mount Rainier Working Group.

  Along with Pacific Northwest Seismic Network, maintain volcano-monitoring systems and acquire, archive, and disseminate real-time information. USGS-CVO issues alert-level notifications and volcano

updates.

- DNR

  Provide scientific oversight. Provide on-site consultation when requested.

  Staff area command post (WEMD EOC), when activated, with appropriate subject matter experts

  Participate in the Mount Rainier Working Group

6. Specific Division Operations of the Carbon, Puyallup, Nisqually, and White River Drainages

   Scientists have determined that due to the geologic make-up of Mount Rainier a lahar generated by a landslide is most likely to travel down the Puyallup River. A worst-case scenario would likely send the lahar down the Nisqually, too. A landslide-generated lahar is unlikely in the White; however, all valleys are equally at risk from lahars generated by eruptions swiftly melting snow and glacier ice. Regardless, this section includes operational considerations for all three river valleys.
   [the comments here try to reflect differences among the valleys, especially that the onle large lahars likely to affect the White will come from eruptions, not from landslides]
   Large lahars will probably affect more than one county. The Nisqually borders Pierce, Lewis and Thurston counties. The White borders Pierce and King counties. The Carbon and Puyallup rivers are contained within Pierce County but evacuees will be housed in all neighboring counties. A worst-case scenario lahar will have huge impact on the economy of the entire region.

   Due to the multi-disciplinary, multi-agency response required of an incident of this scale and scope, an area / unified command configuration is required. Initial response will organize as incident command but will transition into unified and then area command as soon as possible. Unified command will be established in each impacted county. WEMD will be area command. In Pierce County, the impacted river valley(s) will become geographical divisions under unified command.

   a. The Carbon and Puyallup River Division is divided into six (6) geographic zones. The zones are roughly aligned with major roads and well-known jurisdictions. The 6 zones are Bonney Lake Police Department, WSP Portland Ave Headquarters, Milton Police Department, Lakewood Fire Station 1, and Auburn Fire Department.

b. The Upper Nisqually Valley Division is approximately 19 miles in length beginning slightly north of Alder Dam and extending eastward along SR-706 through the communities of Alder, Elbe, and Ashford, terminating at the Nisqually entrance to Mount Rainier National Park.

The Upper Nisqually Division is divided into two (2) geographic zones to optimize emergency operations and communications. They are the Ashford Zone and the Eatonville Zone. The Ashford Zone headquarters, Tahoma Woods, is located in an area that could be impacted by a lahar. If this occurs all operations will be coordinated at the Eatonville Zone.

c. The Upper White River Division is divided into four (4) zones to optimize emergency operations and communications. The four zones are Greenwater, Crystal River Ranch, Crystal Villages, and Recreational. If vehicular traffic is restricted due to hazards, all operational zones will be managed through the Greenwater Zone.

E. References

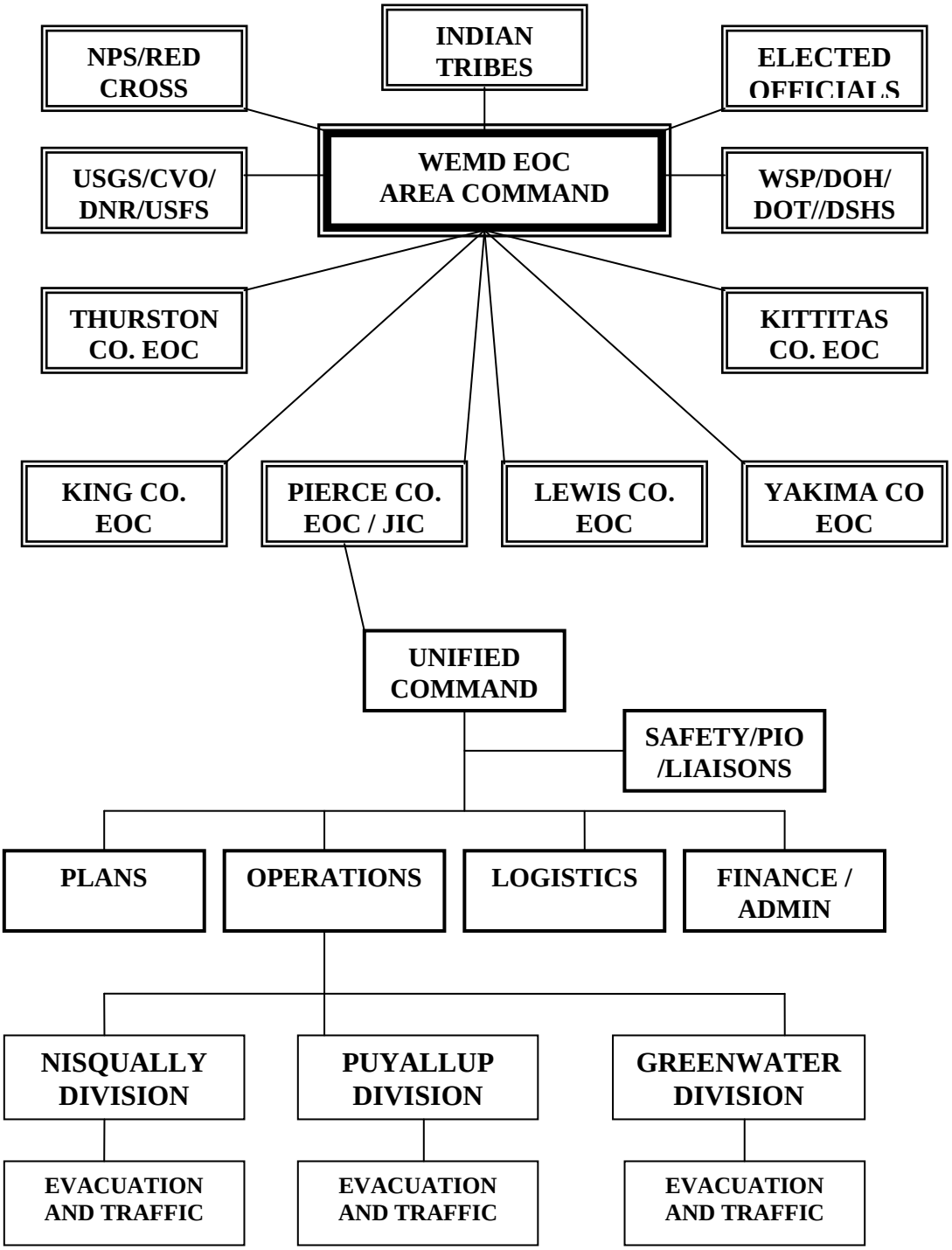
None

F. Attachments

Attachment 1: Recommended Unified Area Command Configuration

Attachment 1

RECOMMENDED AREA COMMAND CONFIGURATION



Chapter 7: COLLECTION AND SHELTERING

A. Introduction

Ensuring the safety of the thousands of people who live, work, and play in the Mount Rainier river valleys is the purpose of this Plan. Not knowing when the mountain will reawaken instills an urgency in making sure the valley inhabitants know what to do, are prepared to do it, and are quick to respond when it happens.

Regardless of the degree of awareness and preparedness, evacuating the thousands of people from the river valleys will be a tremendous challenge. The Carbon and Puyallup valleys are estimated to have between 35,000 to 50,000 people at different times throughout the day. Due to the large population of the Carbon and Puyallup river valleys, they will be the most challenging. The Nisqually and White River valleys have smaller populations but are more isolated with fewer resources. The Upper Nisqually valley has an estimated resident population of 2,000 people, but ½ million people drive through it each year on their way to Mount Rainier. The upper White River has a year-round residency of approximately 5,000 which significantly increases during the ski season when skiers pass through to get to Crystal Mountain Ski Resort.

1. Purpose

   a. This chapter will identify recommended actions for valley inhabitants, other than public safety providers, to take when threatened by an oncoming lahar. It outlines the public safety operations necessary to support those actions.

   b. Resourceful thinking and problem-solving strategies on behalf of the private facilities and local governments have resulted in evacuation plans that outline the best-possible chances to survive a worst-case lahar with the resources available at any given time.

2. Scope

   This chapter addresses the collection, sheltering, and accountability of evacuated persons from the Mount Rainier river valleys.

B. Policies

1. No public safety personnel will be dispatched into areas that are hazardous due to a lahar or an approaching lahar.

2. All individuals have a responsibility for their own personal safety.

3. Residents are to plan and be prepared for seven (7) days of self-sufficiency.

4. As response resources may be depleted or unavailable, and essential systems may be rendered non-functional, public safety providers will make every reasonable effort to respond based on the situation, and currently available information and resources.

5. Support agencies and incorporated cities and towns will perform tasks and expend resources under their own authorities, including implementation of mutual aid agreements, in addition to resources received under the authority of this Plan.

C. Hazards and Conditions

1. Situation

a. In the worst-case scenario of a large landslide initiating lahars with little or no warning, lahars may flow down both the Puyallup and Nisqually river valleys. If major highways are damaged or severed, relocation of evacuees into King, Thurston, and Lewis counties may be difficult. Such lahars are unlikely in the White River valley; rapid melting of snow and ice by eruptions is the process by which large lahars would be generated there. Impacted river valleys may be uninhabitable for years.

b. The restricted transportation infrastructure of the region adds to the challenge of evacuation. Pierce County and the other metropolitan counties along the I-5 corridor are sandwiched between the Cascade Mountains and the Puget Sound. The main eastbound routes, I-90, SR 410, and SR 12, all travel through the Cascade Range. The Narrows Bridge spans the one westbound route (SR 16) out of Pierce County and experiences regular gridlocks from daily commuter traffic. Other than the Narrows Bridge, the only westward transportation resource is the ferry system.

2. Assumptions

a. People will spontaneously evacuate areas when there is actual or perceived danger. Some people may not evacuate regardless of danger.

b. People will evacuate by vehicle and others will evacuate on-foot. Some of those starting out in a vehicle may wind up on-foot.

c. Individuals will evacuate even when they are not in harm's way.

d. Transportation routes will be overwhelmed with people attempting to get to higher ground and out of harm's way. Vehicles will break down or run out of gas. Gridlocks will occur, resulting in people abandoning their cars.

e. Evacuees may be displaced for hours, days, or possibly weeks. Some areas may remain uninhabitable for years or decades.

f. Debris may make evacuation routes impassable and leave people stranded.

g. The increase of seasonal and holiday visitors to the Mount Rainier National Park and the Crystal Mountain Ski Resort will impact the evacuation efforts of the upper Nisqually and White rivers.

h. Some people, especially those within the Mount Rainier National Park boundaries will be so close to danger that they will only have time to escape uphill with maybe as little as the clothes they are wearing.

D. Concept of Operations

1. General

a. After emergency notification and warning, collection is the next coordinated operation associated with evacuation. It is the first phase in a three phase evacuation process. The other two phases are sheltering and short-term housing.

b. With notification of a large-scale event requiring evacuation of any of the Mount Rainier river drainages, all persons located in the area will rapidly begin to evacuate. Some events will be of such a magnitude that quick action to get to high ground will be the only life saving action available.

DON'T HESITATE … EVACUATE

c. Public safety providers may assist in the evacuation of valley residents as they are evacuating themselves, but that is an individual choice and not a policy of this Plan. They will not be assigned operations that put them in harm's way. Therefore, in the worst-case scenario, public safety providers will not be available to manage the evacuation of those, including special populations, located on the valley floor. The responsibility of evacuating the residents from these facilities falls on those charged with their safety and well-being. For any scenario other than the worst-case, public safety assistance will be available.

d. Evacuating pedestrian traffic, or vehicular traffic having difficulty reaching shelter locations, is to report to the pre-identified collection sites (listed below). They are located just outside the lahar inundation zone. All other vehicle traffic is to stop at pre-identified shelter locations (see below) regardless of the need to remain at shelter or relocate to relatives' homes or other destination. Registration of evacuees will occur at collection sites or shelter, whichever one

the evacuee reaches first. Registration and the resulting accountability is critical to search and rescue operations once the lahar has stabilized enough to permit these operations.

e. When a lahar is detected and verified, regardless of river valley(s), Pierce County DEM will initiate emergency notification and warning as will neighboring counties impacted by the lahar. See Chapter 5 for additional information.

f. Public safety providers identified in Chapter 6 will report to the designated command post. Other public safety providers will ready themselves for mutual aid response operations. Emergency management personnel, subject matter experts, other governmental agencies, and identified stakeholders will report to their respective EOCs and initiate operations. Area command will be located at the WEMD EOC at Camp Murray. Mission essential personnel are to automatically respond and not wait for telephone or other notification.

g. The key stakeholders and concerned residents from communities in the Carbon, Puyallup, upper Nisqually, and upper White River valleys have participated in the development of lahar emergency response plans and preparedness training. These activities were provided and/or coordinated by respective emergency management departments and USGS.

2. Special Populations

Special populations living in the Mount Rainier river valleys pose additional challenges to rapid evacuation. The special populations in the Puyallup river valley are the elderly, the infirm, and the handicapped. The following is a listing of the populations meeting this description in the valley.

Orting:
Soldiers' Home
Sumner:
Franklin House
Stafford Suites
Kincaid Apartments
Puyallup:
City of Puyallup is coordinating with facilities within city limits.
Riverside:
None
Edgewood:
None

3. Collection Sites

Collection sites are pre-identified locations along the edges of the worst-case lahar scenario where pedestrian traffic can assemble. They are different from shelter locations in that they are temporary and can be considered the first stage in the evacuation process, at least for those on foot or those who started out in vehicles but for whatever reason wound up on foot. Transit busses will travel among the collection sites, collect the evacuees, and drive them to shelter locations.

Collection sites along the lahar inundation borders, identified by jurisdiction, are:

Unincorporated Pierce County:
- Frontier Park (21718 Meridian E, Graham)
- 410 Mall

Carbon and Puyallup Rivers:
- Orting:
  - Pierce County Public Works gravel pit
  - The Buttes housing development
- Sumner:
  - Corliss Gravel (64th St and 166th Ave)
  - Brian Stowe (2400 block of West Valley Ave)
- Puyallup:
  - Pierce College Puyallup
  - Semiconductor Plant (1500 block of 39th)
  - Bradley Park (2323 – 7th St SE, Puyallup)
- Riverside:
  - Waller Road Elementary School (6312 Waller Rd E)
  - Fruitland Elementary School (1515 Fruitland Ave)
  - Lidford Playfield (58th and 44th Avenue E)
- Fife:
  - Church at the top of 62nd and 10th
- Edgewood:
  - Open field at the top of 36th
- Milton:
  - Milton Senior Center

Upper Nisqually River:
- Eatonville Middle School

With notification of a large-scale event requiring evacuation during school hours, children and personnel of the Columbia Crest Elementary School will evacuate to the Eatonville Middle School collection site (207 Carter Street

East) as quickly as possible.

Upper White River / Greenwater area:
Gravel pit located at MP 5.5 of USFS 70 Road
Slippery Creek Road MP
King County Fairgrounds – registration done by Enumclaw Fire Department and American Red Cross
Packwood Mill Facilities – registration done by Packwood Fire Department and Lewis County EOC

4. Registration and Accountability

a. The accountability of those who did or did not safely evacuate from the Mount Rainier river valleys is paramount. Registration will begin at either the collection site or the shelter, whichever one the evacuee arrives at first. It will help to organize the search and rescue operations. It also provides a method for loved ones to locate each other.

b. All persons evacuating from the impact valley(s) are to register with a local authority or representative of their whereabouts upon reaching safety. That registration will begin at either the collection site or shelter, whichever the evacuee reaches first. *A toll free number will be established as soon as possible by the WEMD* for evacuees, who had not registered, to do so by telephone as soon as possible. This toll free number will be publicized by the media and other news sources in order to reach as many people as possible.

c. Pierce County DEM is researching an electronic, real-time network of PDAs (personal data assistants) that will be at the pre-identified collection sites and shelter locations. The network will be able to communicate with the WebEOC program being used in the majority of the region's EOCs. This network is expensive and will require a training and maintenance program. Pierce County DEM is exploring possible funding sources to purchase and support this network.

Without this real-time PDA network, the registration process will be done with forms, clipboards, and pens. Regardless of the method used, it will be accomplished by neighborhood volunteers, living in areas outside of the inundation zone, agreeing to fulfill the responsibilities of the role. Public safety personnel will be unable to perform this function. They are obligated to the evacuation of the impacted river valley(s).

Regardless of the location and circumstances, evacuees must register with local emergency management authorities. It is critical for the delivery and coordination of prompt search and rescue, and other life-saving operations.

5. Sheltering

a. There are two different scenarios when identifying sheltering and short-term housing. One scenario results in conditions that will allow for the evacuees to relocate outside of the county, both north and south. The other results in such severe conditions that relocating to King and Thurston counties would be impossible due to the closures and possible damage to the bridges that span the Puyallup and Nisqually rivers. Regardless of either scenario, the western corridor out of the county over the Narrows Bridge will be a way to relocate out of county.

b. The local Red Cross Chapters will coordinate the sheltering operations in facilities with Red Cross agreements, regardless of scenario. In a worst case scenario, the sheltering and short-term housing demands may be beyond the capacity of the Red Cross Mount Rainier Chapter. In this event, mass sheltering will occur in open areas with temporary structures such as tents and modular structures. All appropriate locations and facilities will be made available if necessary.

Currently identified shelters large enough to house large numbers of people are:

Pierce County
- University of Puget Sound Fieldhouse – corner of N 18th and Lawrence St, Tacoma
- Pacific Lutheran University Auditorium – 12100 Park Ave S, Tacoma
- Clover Park Technical College – 4500 Steilacoom Blvd SW, Lakewood
- Pierce College Puyallup – 1601 – 39th Ave SE, Puyallup
- Microchip Technology facility – 1111 – 39th Ave SE, Puyallup

Note: Fort Lewis will house all military and military dependants. The facility is not open to military retirees and the general population.

Thurston County
- St. Martin's Pavilion
- North Thurston High School
- Thurston County Fairgrounds
- Evergreen State College

King County

- Weyerhauser and others as coordinated by the local Red Cross chapters

6. Family Reunion

As soon as practicable, the Pierce County Department of Emergency Management in cooperation with the Red Cross Mount Rainier Chapter will establish a toll free number for family and loved ones to call to check on the safety and whereabouts of evacuees. This number will be broadcast over all media and crisis communications channels.

A family assistance center will open and be staffed with clergy, mental health professionals, volunteers, and others appropriate to provide assistance and evacuee information. This family assistance center must have an open and direct information link with the Pierce County Emergency Operations Center and the Pierce County Joint Information Center.

7. Short-term Housing

The same two scenarios (able to leave the county and unable to leave the county) with the same challenges apply to short-term housing. The local housing authorities with the help of the Red Cross will coordinate the housing arrangements in cooperation with numerous support agencies.

8. Repopulation

The geologic characteristics of a lahar complicate the repopulation of any community buried by a lahar. Considering that lahars have the consistency of wet cement, it may take weeks, month, or years to stabilize and solidify to the point of supporting roads, homes, and business, everything needed to make a community. In some areas, the landscape may remain unstable for decades.

When the scientific experts determine that the ground is ready to rebuild, an acceptable level of public safety and utilities services, such as law enforcement, emergency medical services, water and sanitation, must be in place before any repopulation is permitted.

Prioritized and coordinated restoration of services must precede any re-entry. Rebuilding communities will be dependent on science, economics, land planning, and desire.

E. References
F. Attachments

Chapter 8: MITIGATION

A. Introduction

Scientific studies show that Mount Rainier poses a wide array of potential hazards on its flanks, lahar hazards in river valleys downstream from the volcano, and tephra hazards in downwind areas. Lahars are the principal far-traveled hazard, have potentially catastrophic consequences in terms of casualties and property losses, and as such are the focus of this Plan. The probability of large lahars is greatest during times that the volcano is restless or erupting, but some types of lahars can occur when the volcano is quiet. When volcanoes become restless and move toward eruption, they typically provide days to months of warning in the form of earthquakes, ground deformation, gas emissions, and other signs. Current monitoring systems and planned improvements provide scientists with real-time information about the state of the volcano, and will detect precursory activity. Onset of precursors will initiate intensified monitoring efforts, 24/7 watches, and issuance of alert-level notifications, forecasts, and supporting information. Precursory activity and eruptions of Mount Rainier generate lahars in several ways. Eruptions can swiftly melt some of the voluminous mantle of snow and glacier ice that entrains abundant rock debris to produce lahars. Increase in heat output can melt snow and ice in the summit crater to produce a lake that can be expelled by explosions. Movement of magma into the volcano or eruptions can trigger large landslides from areas of weakened rock, the largest and most hazardous of which lies on the upper west flank at the head of the Puyallup River.

The large volume of weakened rock at the head of the Puyallup River valley may also be susceptible to landslides and lahar generation during times that the volcano is quiet. About 500 years ago a large lahar swept through the Puyallup valley at a time of no apparent eruptive activity. A large local earthquake or some other cause might trigger another large landslide and send a lahar down the Puyallup and perhaps the adjacent Nisqually valley with little or no warning. Such an event constitutes a worst-case scenario and guided development of the lahar-warning system in the populous Puyallup valley.

B. Purpose

Hazard mitigation strategy is a set of recommended actions to take to lessen or remove the vulnerability to a hazard and attempts to remove as many people as possible from harm's way. This section addresses a mitigation strategy for renewed activity at Mount Rainier.

Optimally, mitigation strategies and their subsequent implementation occur before the disaster. The next best option is to implement them immediately after the disaster. The goals of hazard mitigation strategies are to:
Protect life and property
Ensure emergency services
Increase public preparedness

Establish and strengthen partnerships for implementation
Preserve or restore natural resources
Promote a sustainable economy

C. Scope

This section provides an overview of the Mount Rainier mitigation strategies that are more thoroughly addressed in the Pierce County Natural Hazards Mitigation Plan (published separately). The emphasis is on Pierce County since the largest population potentially at risk, works and resides in the Carbon and Puyallup River valleys.

D. Organization

Mitigation is one of the four phases (preparedness, response, recovery, and mitigation) of emergency management. Mitigation strategy development and implementation are not a function conducted during the response and portions of the recovery operations from the disaster, regardless of cause. Mitigation falls under the planning section of the incident command system.

E. Planning Assumptions

1. Mitigation strategy development and implementation is required to lessen the vulnerability of any lahar from Mount Rainier.

2. Stakeholders will actively participate in the development and implementation of mitigation strategies.

3. Mitigation strategy development and implementation requires community input and financial support.

4. Lives could be lost and property damaged will occur in a lahar of any significant size.

5. People have a responsibility for their own safety.

F. Concept of Operations

The process to achieve regional mitigation goals begins by identifying mitigation measures – specific actions or process that help mitigate risk for the region. The planning process of data-collection, research, and public participation leads to the development of these measures. This process ensures that the measures speak to the risks specific to the region and that these measures are achievable. A risk assessment is central to the process of selecting mitigation measures from regional goals.

The outcomes of a risk assessment illustrate the hazards to which the region has the most

vulnerability and provides focus for the region's mitigation measures. Once measures are identified, they are further defined in terms of the goals they address as well as the hazards they mitigate. The next step is to prioritize the measures.

The process for measure prioritization relies upon the region's identified risks, and vulnerabilities, the planning team's local expertise, public participation, and the authority and priority of elected officials. The process allows for emphasis on the extent to which each measure is cost-effective. While it may be important to emphasize a positive cost / benefit review in the prioritizing of mitigation measures, it is also important to emphasize the influence of local political factors, community needs and values, historic properties, and habitat and environmental issues upon the selection of specific mitigation measures. Therefore, the prioritization process addresses the region's unique needs in terms of ability to be implemented and the extent to which it would mitigate one or more relevant hazards.

In order to promote implementation of the mitigation measures, they are grouped based on the level at which they will be implemented. See Attachment1.

G. References

- King, Lewis, Pierce, and Thurston Counties Comprehensive Emergency Management Plans
- WEMD Comprehensive Emergency Management Plan
- Pierce County Natural Hazards Mitigation Plan

H. Terms and Definitions

Lahar – Indonesian word for a mudflow from a volcano; at Mount Rainier the term, lahar, is reserved for large flows that extend beyond boundaries of Mount Rainier National Park.

Magma – Molten rock that rises to shallow levels in volcanoes and drives eruptions.

Tephra – Airborne volcanic ejecta of any size; in downwind areas it is typically sand- and dust-size material.

I. Attachments

Attachment 1

Attachment 1 - Mitigation Implementation Measures

Implementation Mechanism	Mitigation Measure	Lead Jurisdiction(s) / Department(s)	Timeline (years)	Plan Goals Addressed					
				Life and Property	Emergency Services	Public Preparedness	Partnerships for Implementation	Natural Resources	Sustainable Economy
Volcanic Hazard									
Hazard Mitigation Forum: Multi-jurisdictional implementation mechanism	Evacuation Planning: New Roads and Development	PC DEM; Transportation Division (PC PWU)	1-2	✓	✓	✓			
	Mount Rainier Closure Zones	PC DEM; USGS; CVO; Mount Rainier National Park	5	✓	✓	✓			
	Bridge for Kids	B4Ks; PC DEM; WA EMD; Orting School District; City of Orting	5	✓	✓		✓		
	Dam Draw Down Agreements	PC DEM; Facility Owners	5	✓			✓	✓	
	Lahar Flow Control	PC DEM	5	✓				✓	✓
Hazard Mitigation Committee: County-wide implementation mechanism	176th Street East Extension	PC PWU	5	✓					
	Tax or Insurance Disincentives	PC PALS	5	✓		✓		✓	
Public Education	Public Education: Lahar	PC DEM	Ongoing	✓		✓			
	Public Education: Volcanic Ashfall	PC DEM	5	✓		✓			
	Public Education: Education for Self Warning and Evacuation	PC DEM	5	✓		✓			
	Public Education: Evacuation Routes	PC DEM	1-2	✓	✓	✓	✓	✓	✓
	Public Education: Bus Driver Evacuation Training Program	PC DEM; Valley School Districts	5	✓	✓				✓

Chapter 9: EMERGENCY INFORMATION

A. Introduction

Warning the public of Mount Rainier eruptions and lahars will be challenging, especially if the worst-case scenario of a landslide-generated lahar occurs with little or no warning. This section addresses both possibilities; events that occur with warning as well as those that occur without .

B. Purpose

When the mountain does re-awaken, providing timely, accurate, and thorough information regarding hazards and the emergency actions necessary to get out of danger is with a collaborative effort among local officials, subject matter experts and scientists, and the media. This is coordinated through the Joint Information Center (JIC). While individual agencies and affected parties will continue to address their specific roles and duties, the JIC will serve as the focus of public affairs information relating to an incident of regional magnitude.

C. Scope

The JIC is responsible for seven functional areas:
Crisis Communications
Information Coordination
Media Relations / Public Information
Community Relations
VIP Relations
Productions
Support and Staffing

D. Organization

The JIC is an extension of the National Incident Management System (NIMS) / Incident Management System (ICS). It is managed by a lead public information officer (PIO), affected agency public affairs leads, and enough staffing to perform all JIC responsibilities

Depending on the severity of the volcanic disaster, the JIC will be located at the Washington Emergency Management Division at Camp Murray or at another site. JIC participants will likely be:

- Emergency Management Authorities from Pierce, King, Lewis, and Thurston Counties
- National Park Service (NPS)

- Puyallup Tribe of Indians (PTOI)
- U.S. Forest Service (USFS)
- U.S. Geological Survey (USGS)
- Washington Department of Natural Resources (WDNR)
- Washington Emergency Management Division (WEMD)
- Appropriate Elected Officials and Authorities
- Others as required

E. Planning Assumptions

Mount Rainier National Park, neighboring public officials, subject matter experts, and other affected stakeholders will disseminate emergency public information by whatever means available during a volcanic emergency.

During extended response and recovery operations, agency PIOs may be required to staff the JIC for extended periods. This may impact their ability to serve their individual agencies. Alternate agency PIOs must be identified to fill the void. If agencies are in compliance with the COOP standard of a redundancy of three for all mission essential personnel, this should not cause hardship on the respective agency.

F. Concept of Operations

1. Television and Radio Broadcasters

During and after a lahar emergency, the media should be considered to be a critical asset.

Emergency Alert System (EAS) messages are broadcast via television, radio, and cable. By Federal Communication Commission regulation, all EAS regions have a primary and secondary radio frequency assigned for this function. All other broadcast media participate to ensure as many people as possible receive the warning. In the region around Mount Rainier, the primary station is KIRO 710 AM and the secondary, KPLU 88.5 FM.

Broadcast media is the most effective way to get all other emergency information disseminated to the largest audience possible. Positive relationships among the media, scientists, and local authorities will begin long before the disaster and will enhance cooperation during the disaster.

Cooperation is critical to ensure consistent, accurate information without speculation and rumor is reported. News media will seek information regardless of source. It is best for the JIC to be pro-active and make contact with appropriate media as early as possible after the onset of the

worst-case scenario lahar or any other volcanic activity.

2. NOAA All Hazards Radio

The NOAA All Hazards Radio is a reliable way to ensure receipt of emergency notifications and warnings. Televisions and radios also receive the EAS message but be on to received the messages.

3. The Puyallup Valley has a local emergency radio station, AM 1580, funded for the public's notification of a lahar coming down the valley and how they should respond. It will also be used for rumor control in the event there is a false alarm or a small debris flow that will not impact the valley. This station, while initially developed for lahar warnings, is an all hazard information station.

4. Joint Information Center

a. JIC operations is a extension of ICS and EOC operations.

b. The JIC most likely will be co-located with the area command at WEMD EOC. The WEMD EOC is located at Camp Murray, WA.

c. The JIC participants will strive to comply with the following precepts:

- Develop and maintain a pre-crisis rapport between scientists and public officials.
- Build effective communication with non-technical, well-defined language.
- Strive for consensus among involved scientists regarding likely hazards.
- Publicly discuss hazards, uncertainties, and levels of acceptable risk.

d. The EOC manager or other appropriate individual will select a media-savvy spokesperson to represent the local authorities, public safety agencies, and scientists for live interviews regarding the disaster

e. The JIC, through the EOC operations section, must ensure that the emergency first responders are informed as well as the public. Good, reliable information will support effective field command and operations.

f. The EOC manager with the support of the public information manager, is responsible for the entire JIC operation.

g. All disseminated information is approved by the EOC prior to

release. This is coordinated by the public information manager.

h. All section chiefs are responsible for continuity and timely flow of information between sections and section members.

i. JIC operations will be managed by the public information officer. The JIC is divided into seven functional sections. Each functional section has specific responsibilities. Each section will have an assigned section chief to guide and coordinate section responsibilities.

Crisis Communications

- Maintain open communications with the public information officer.
- Maintain current and accurate information on the agency websites.
- Liaison with technical staff to ensure operability.
- Support the interactive capacity of the website.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

Information Coordination

- Maintain open communications with the public information officer.
- Collect information / situation reports regarding the status of the emergency.
- Collect, verify, and analyze information from all available sources.
- Solicit information from essential service points of contact and other affected agencies / jurisdictions.
- Develop news releases and other materials as assigned by the public information manager.
- Maintain maps and status boards.
- Manage rumor control and obtain verification of all information prior to release.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

Media Relations / PIO

- Maintain open communications with the public information officer.
- Conduct on-air press conferences.
- Set-up media hotline.

- Maintain a running log of all information disseminated and time of dissemination.
- Coordinate interviews and coordinate transportation if necessary.
- Set-up on-scene press conferences.
- Establish and post media briefing times and locations.
- Monitor other media to prevent redundancy, misinformation, and rumor.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

Community Relations

- Maintain open communications with the public information officer.
- Determine informational needs of the community.
- Provide information to the public concerning the status of the disaster and how to obtain relief services.
- Arrange meetings with citizens.
- Establish citizens' hotline.
- Determine need to establish information centers.
- Convey citizen issues and concerns to the public information manager.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

VIP Relations

- Maintain open communications with the public information officer.
- Represent JIC and respective agency.
- Gather related information from local, state, and federal agencies.
- Coordinate points of contact for agency representatives requesting expedient information from JIC.
- Coordinate visits and tours for officials and / or VIPs.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

Productions

- Maintain open communications with the public information officer.

- Prepare news releases, updates, fact sheets, maps and other graphics materials based on information collected by the information coordination section.
- Prepare written and graphics material for public dissemination, news conferences, and public meetings.
- Prepare maps, status boards, and other graphics materials to support JIC operations.
- Section chief will ensure necessary templates are available to writers.
- Section chief will oversee news release production and troubleshoot any problems or needs encountered writing staff.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

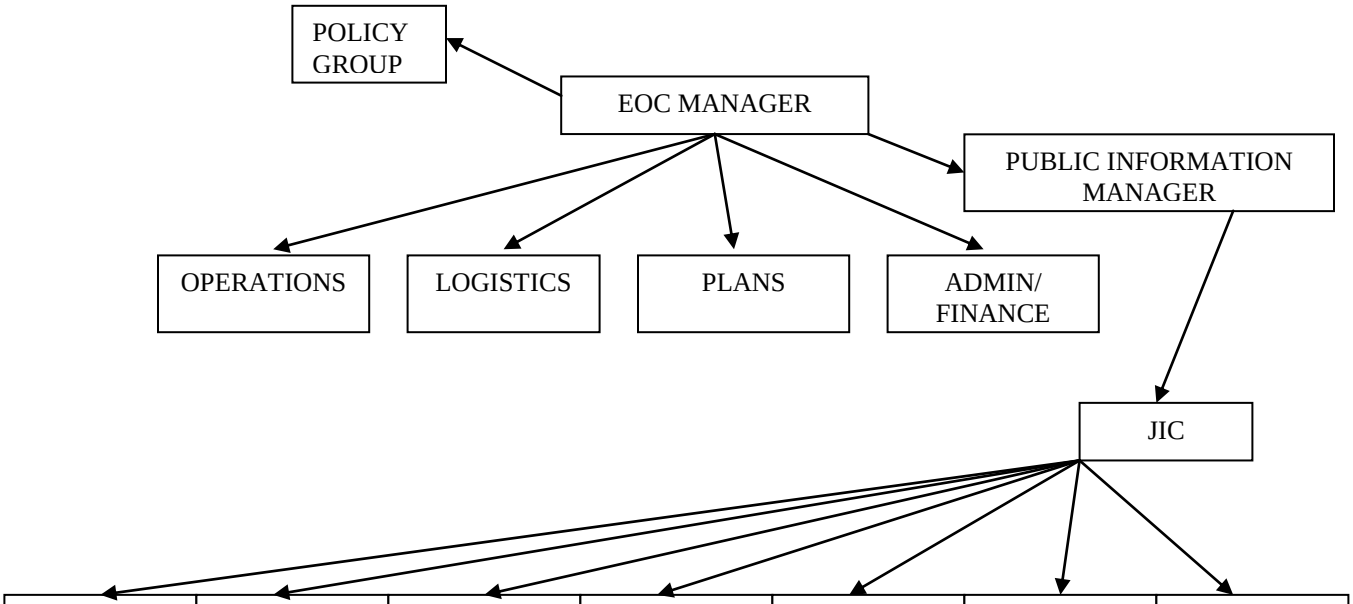
Support and staffing

- Maintain open communications with the public information officer.
- Set up JIC.
- Obtain necessary resources.
- Answer telephones, take messages, collect and deliver faxes.
- Perform clerical support such as copying, stocking information dissemination, etc.
- All information disseminated by this section will be approved by the public information officer prior to dissemination.
- Brief on-coming section chief of operational status.

G. References

Pierce County Joint Information Center Plan
Pierce County Emergency Operations Center Plan
Pierce County NIMS / NRP Implementation Plan

Attachment 1
JOINT INFORMATION CENTER ORGANIZATION CHART



CRISIS COMMUNICA-TIONS	INFORMATION COORDINA-TION	MEDIA RELATIONS / PIO	**COMMUNITY RELATIONS**	VIP RELATIONS	PRODUCTION	SPPORT AND STAFFING
MAINTAIN CURRENT AND ACCURATE WEBSITE	GATHER AND VERIFY SPECIFIC INFORMATION PROVIDE INFORMATION TO COMMUNICA-TIONS MANAGER FOR DISSEMIN-ATION MAINTAIN MAPS AND STATUS BOARDS PROVIDE STAFFING FOR: OPERATIONS, PLANNING, LOGISTICS, AND FINANCE SECTION LIAISON	RESPOND TO INQUIRIES FROM MEDIA VERBALLY OR IN WRITING, AS APPROPRIATE SET-UP MEDIA HOTLINE COORDINATE INTERVIEWS/ PROVIDE ESCORT SET-UP FOR ON-SITE PRESS CONFER-ENCES CONDUCT ON-AIR PRESS CONFER-ENCES	DETERMINE INFORMATION NEEDS OF LOCAL COMMUNITY ARRANGE MEETINGS WITH CITIZENS ESTABLISH CITIZEN HOTLINE/DE-TERMINE NEED TO ESTABLISH INFO CENTERS CONVEY CITIZEN ISSUES/ CONCERNS TO COMMUNICA-TIONS MANAGER AND SECTIONS CHIEFS UTILIZE COMMUNITY CABLE ASSESS IF INDICATED	REPRESENT RESPECTIVE AGENCY LIAISON WITH OTHER AGENCIES, LOCALS, STATE AND FEDS FOR INFORMATION COORDINATE POINTS-OF-CONTACT FOR AGENCY REPS REQUESTING EXPEDIENT INFO FROM JIC COORDINATE VISITS AND TOURS FOR OFFICIALS OR VIPs	PREPARE NEWS RELEASES, UPDATES, FACT SHEETS, MAPS AND OTHER GRAPHICS MATERIALS PREPARE WRITTEN AND GRAPHICS MATERIALS FOR PUBLIC DISSEMINA-TION, NEWS CONFER-ENCES, PUBLIC MEETINGS PREPARE MAPS, STATUS BOARDS AND OTHER GRAPHICS MATERIALS TO SUPPORT JIC OPERATIONS MONITOR WEB AND/OR INTERNET FOR UPDATES	JIC SET-UP ANSWER PHONES AND TAKE MESSAGES JIC SUPPORT ACTIVITIES: COPYING, STOCKING, INFORMATION DISSEMINA-TION OTHER DUTIES AS ASSIGNED BY COMMUNICA-TIONS MANAGER

Chapter 10: Public Education/Long-term Maintenance of Public Awareness & Preparedness

1. Introduction

The Mount Rainier public awareness team, comprising representatives from scientific, educational, land management, and emergency management groups, has developed a multi-pronged approach to encourage public understanding of hazards and involvement in community, business, and personal preparations. This message or one with similar language is used consistently in all resources provided for the public, business interests, educators, public officials, and the media. The team recommends that these messages be used in future resources.

A. Purpose

Anecdotal history illustrates repeatedly that the degree of preparedness of an individual, family, business, etc. is inversely proportionate to the impact of an emergency or disaster on that individual, family, or business. Although not realistic, the best case scenario is a well-informed public, well prepared public of the dangers of living in the shadow of Mount Rainier. More likely scenarios are that people move, have no interest, are misinformed, choose to not be informed, believe widely accepted myths, or never find the time.

The goal of Mount Rainier and preparedness education is to change peoples' behavior; to become informed of the dangers of living in the shadow of the mountain and the life-saving impact of being prepared.

B. Scope

This section addresses strategies to educate the public on the hazards of Mount Rainier and to maintain awareness and preparedness. The methods to educate and maintain level of awareness and preparedness are varied. They are accomplished through public outreach campaigns such as information dissemination at health and safety fairs, subject-specific presentations, and programs such as PC-NET (Pierce County Neighborhood Emergency Teams). This section deals with the importance of informational content delivered in the campaigns.

2. Policies

Under the authority of this plan, the educators and subject matter experts qualified to participate in these public outreach campaigns are members of public safety departments and scientists (geologists, volcanologists, hydrologists, etc.) informed

about the hazards of Mount Rainier, individual and family preparedness, and teaching methodologies.

The message of the outreach campaigns will be consistent to ensure that, regardless of who provides it, the Mount Rainier information will be in agreement with the other messages being disseminated and will be based on historical outcomes and the latest research.

3. Situation

Ensuring an aware and prepared public is a difficult task. In spite of the amount of available information on Mount Rainier, its volcanic history, and the current scientific findings; and daily reminders about the need to be prepared, many people do not participate. Even when a community becomes active, it may be short-lived. It is difficult to change peoples' behaviors and when those behaviors do change, they may revert back to old habits.

Therefore, public educators and their campaigns must be taken to where people work and play and conducted repeatedly.

4. Concept of Operations

A. Messages:

1. Principal Science and Preparedness Messages

- Mount Rainier is an active volcano, with capability to erupt during our lifetimes.

- Volcanoes provide warning signs that they are going to erupt weeks to months or more in advance, due to the ascent of magma that causes measurable events, such as earthquakes, ground deformation, and gas release.

- Part of the immense cover of snow and ice (1 cubic mile of perennial snow and glacier ice) can be melted during eruptions, providing meltwater for lahars (volcanic mudflows).

- Lahars are the principal hazards at Mount Rainier. Most often they happen during eruptions, though landslides in soft rock can generate lahars at other times.

- Areas most at risk are the floors of valleys that head on Mount Rainier.

- If you sense approaching ground tremor and rumbling, go to high ground.

- Areas affected by lahars and areas farther downstream may be subject to shifting river channels and flooding for years to decades.

- Do not evacuate if you are on high ground and not in the path of an encroaching lahar. You will add to the congestion and make evacuation more difficult for those in danger.

2. General Preparedness:

Learn: Learn about volcanic hazards and how they affect your community. Determine whether you live, work, or go to school in a volcanic hazard zone.

Inquire: Find out what steps local officials have taken to prepare for volcanic events. Ask public officials how they advise you to respond.

Plan: Develop plans for your family and business so that you are prepared for natural hazards and emergencies.

3. Science Messages:

Of some sixty (60) lahars in the past 10,000 years, almost all occurred during eruptive periods. Eruptions give precursory warnings of days to months, so lahars triggered by eruptions can be anticipated.

The gigantic Osceola Mudflow was twenty times larger than any other lahar since the Ice Age and was clearly triggered by an eruption. A key condition that led to the Osceola, extensive weakening of rocks in the summit and core of the volcano, no longer exists. Such a huge lahar is improbable now.

Only the west side of the volcano remains susceptible to a lahar caused by avalanching of weakened rocks, which means such lahars threaten only the Puyallup and Nisqually valleys.

Only one of the large lahars caused by avalanching of weakened rock remains uncorrelated to eruptions—the 500-year-old Electron lahar that flowed through Orting town site. Concern about its origin led to deployment of the Puyallup valley lahar warning

system.

No lahar in the past 10,000 years has entered Elliot Bay or Lake Washington, or generated tsunamis there.

Erosion and re-deposition of eruption-generated lahars closer to the volcano formed Rainier sand deposits along the Duwamish Waterway. Eruption would precede such lahars. Safety procedures could limit threat to life; but buildings and infrastructure would be vulnerable.

Debris flows, smaller version of lahars, are common in the upper valleys within Mount Rainier National Park during non-eruptive times. Debris flows are caused by excessive snowmelt or intense rainfall. Debris flows happen usually in mid-to late summer and during the first winter storms of late fall.

B. Long-term Public Awareness Plan

During 1998, the Mount Rainier Working public awareness team developed a plan to enhance long term public awareness of volcanic hazards. Members work independently and in collaborations to present consistent and up-to-date messages about Mount Rainier volcano.

C. Agency outreach efforts:

1. Washington Emergency Management Division

- Annual posters commemorate May as Volcano Awareness Month
- "The Beautiful Mountain in the Sky" booklet for primary school students
- Assessments of volcano awareness in communities
- Support for evacuation roadside signage

2. Pierce County Emergency Management

- Lahar warning and notification system installed
- Testing of notification system
- Evacuation plan
- Volcanoes included in all-hazard communication
- Development and maintenance of PIO call down
- Joint Information Center (JIC) plan
- Media interviews
- PC-NET (Pierce County Neighborhood Emergency Teams)

3. Thurston County Emergency Management

   - Volcanoes included in all-hazards education
   - County is preparing a volcano addendum to the Thurston Regional Hazards Mitigation Plan

4. Mount Rainier National Park

   - Geohazards Awareness Plan developed and in use
   - Museum Exhibits developed—for visitors at Paradise and Sunrise (to be installed within next several years)
   - Roadside interpretive signage (all park)
   - Evacuation plan and evacuation signage
   - Curriculum development with USGS-CVO
   - Hosts annual teacher workshop "Living with a Volcano in your Backyard"
   - Media interviews

5. United States Geological Survey

   - Traveling exhibits "Living With a Volcano in your Backyard"
   - Prepared presentation "Living with a Volcano in your Backyard: Mount Rainier Volcanic Hazards – a Prepared Presentation for use by Public Officials and Educators"
   - Mount Rainier fact sheet "Mount Rainier—Learning to Live with Volcanic Risk"
   - Curriculum posting on USGS-CVO website in progress "Living with a Volcano in your Backyard—an Educators Guide with Emphasis on Mount Rainier"
   - Scientist involvement at council and public meetings
   - Public presentations
   - Media interviews

6. Non-Government Groups:

   - Bridge for Kids
   - Raised public awareness about lahar hazards in the Puyallup valley

7. Orting and Sumner School Districts

   - Emergency Radio communication and evacuation plans tested
   - Community education about lahars and district policies
   - Classroom teaching about Mount Rainier volcano

Attachment 1

*Outreach Projects and Commitments in Progress**; Resources for public officials, business interests, educators, the public and media***

1. Update Website information

Description: Updated and linked websites for information about volcano history and hazards, emergency preparations, and educational materials, and 2006 Mount Rainier Response Plan

Source: WEMD, USGS, NPS, PCDEM, County Emergency Educators

Date of Availability: ongoing

Agency Commitments: WEMD, USGS, NPS, PCDEM and perhaps others will continue to pursue website links that improve availability of information.

2. National Park Service Interpretive Work

Description: Interpretative staff at Mount Rainier National Park maintains and performs their "Geohazards Awareness Plan" that brings geohazards information to park interpretative activities; exhibits reflect most recent information about volcano history and hazards

Source: National Park Service (NPS), USGS

Date of Availability: ongoing

Agency Commitments: NPS will continue maintenance and performance of the Geohazards Plan. USGS provides current information to NPS during trainings and informal communication.

3. Update Perilous Beauty video

Description: Video will be updated and/or replaced, and made available as DVD

Source: USGS, PCDEM

Date of Availability: 2008

Agency Commitments: USGS and partners will update or replace video within 2 years.

4. Update Mount Rainier information products— prepared presentation, display, Mount Rainier material on USGS website

Description: Prepared presentation and display will be updated when time allows; website presentation upgraded

Source: USGS

Date of Availability: prepared presentation and display approximately 2010; website upgrade by 2009

Agency commitments: USGS will evaluate necessary timing for updates of prepared presentation and exhibit. Website upgrade will be ongoing.

5. Volcano Awareness Month (VAM) Products and Services

Description: Media advisory, annual poster or other products commemorate VAM each May; obtain official state declaration of VAM

Source: WEMD, USGS, NPS, Forest Service.

Date of Availability: 2007
Agency commitments: A product and media advisory will be developed and announced in May of each year; VAM official declaration during 2007.

6. **Bridge for Kids**
Description: Public Awareness of lahar hazards, construction of bridges for evacuation purposes
Source: Bridge for Kids, PCDEM
Date of Availability: ongoing
Agency commitments: Bridge for Kids and its partners will continue to advocate for effective evacuation facilities in the mid-Puyallup valley.

7. **Training of Public Information Officers (PIOs) about Volcanic Hazards and Practice of PIO plan**
Description: Seek and create training opportunities for PIOs in the State of Washington regarding Mount Rainier.
Source: WEMD, County Emergency Educators, USGS
Date of Availability:
Agency commitments: Training will be done on request; team members will pursue additional opportunities.

8. **Seminars and workshops for public officials and business interests**
Description: Seek and create training opportunities for businesses and officials
Source: PCDEM, USGS
Date of Availability: 2006
Agency Commitments: USGS, and county emergency management agencies will pursue opportunities to present information about volcanic hazards and suggested responses.

9. **Educator Guide "Living with a Volcano in your Back yard—an Educator's Guide with Emphasis on Mount Rainier"**
Description: This curriculum addresses Cascade volcanoes—histories and hazards, with emphasis on Mount Rainier volcano. The educator's guide is being written by the NPS, USGS, and teachers in the vicinity of Mount Rainier
Source: USGS, Mount Rainier National Park; available on USGS-CVO website
Date of Availability: 2006
Agency Commitments: The agencies above will see the educator's guide through to completion, advertise its availability, and distribute to a select number of schools.

10. **Workshop for Educators "Living with a volcano in your Back Yard"**
Description: This multi-day workshop is aimed at middle school educators. Participants perform activities in the educator guide, take field trips, and focus attention on teaching about Mount Rainier in their

classroom. The class may be provided in abbreviated form on request

Source: NPS, USGS

Date of Availability: Available in summers, once annually

Agency Commitments: NPS and USGS intend to offer the workshop annually or more frequently as resources allow and interest exists.

11. Multiple hazards education

Description: The same areas that are at risk from volcanic hazards are also at risk from Earthquakes, flooding, and landslides. We plan to explore ways to better integrate volcanic hazards into multi-hazards education and to provide a more accurate representation of hazards for any given area

Source: USGS, WaDNR, County Emergency Educators

Date of Availability: Available now

Agency Commitments: USGS and WaDNR will continue to pursue methods for making hazard assessments interdisciplinary.

12. Media Training and Materials Distribution

Description: Media Training about volcano hazards will be done as considered necessary by circumstances; packets of materials about volcanic hazards and suggested emergency responses for the media will be explored.

Source: WEMD, USGS, WaDNR, County Emergency Educators

Date of Availability: as needed.

13. Poster: "Eruptions in the Cascade Range During the Past 4,000 years"

General Information Product 63 (GIP63)

Description: Educational poster showing the known volcanic eruptions in the Cascades for the last 4000 years.

Source: USGS

Date of Availability: Available now.

14. Poster: "Geologic Hazards at Volcanoes"

General Information Product 64 (GIP64)

Description: Educational poster showing the various hazards that exist in relation to volcanoes.

Source: USGS

Date of Availability: Available now

Agency Commitments: The above agencies will pursue a recommendation on the necessity of press packets.

Attachment 2

Time-line for Completion of Products and Services

	Available /Ongoing	2006	2007	2008	2009	2010	2011	Unknown
General Public								
WEMD—Strengthen all hazards preparedness messages; Improve links to science websites, Official designation for Volcano Awareness Month)			**					
PC DEM and WEMD—"Volcano Evacuation Routes" signs installed	*							
NPS—personal interpretation, product distribution	*							
NPS—exhibits and signage, Geohazards Awareness Plan	*		**					✔
USGS—Update Perilous Beauty video	*							✔
USGS—Update Rainier Fact Sheet	*			**				
USGS—Upgrade Rainier web pages	*				✔			
Emergency Managers, USGS, NPS—Volcano Awareness Month products	✔							
Bridge for Kids—Ongoing Awareness Campaign; eventual bridge completion	*							✔
Public Officials								
USGS Upgrade prepared talk as a CD	*							✔
Emergency managers, NPS and USGS—PIO training and annual practice of PIO plan	*	**	**	✔	✔	✔	✔	✔
Emergency Manager, USGS— Seminars for businesses and officials		**						
Educators								
USGS, NPS—Living with a volcano…" curriculum posted on website	*	**						
NPS, USGS—Workshops for Educators	*	**	**	**	✔	✔	✔	
Educators, Emergency managers, NPS—Multi-hazards education	*	**	**	**	✔	✔	✔	
Media								
NPS, USGS—Periodic Media training								✔

* Indicates present availability but update or completion required

** Indicates completion as of September 2008

✔ Indicates target date for completion

Attachment 3

Information Contacts

Emergency Preparedness Information Contacts		
American Red Cross (ARC)	(702) 531-0227 (Emergency Only)	http://www.redcross.org
ARC Lewis County Chapter	(360) 748-4607	http://www.rainier-redcross.org/
ARC Tacoma/Pierce County Chapter	(253) 474-0400	http://www.rainier-redcross.org/
ARC Thurston/Mason County Chapter	(360) 352-8575	http://www.rainier-redcross.org/
ARC Yakima Valley Chapter	(509) 457-1690	http://www.yakimaredcross.org/
Disaster Educators of Preparedness Puget Sound/WSU Co-op Extension/King County for preparedness tapes	(206) 296-3425 (800) 325-6165 or ext. 63425	8:30 - 4:30 M-F Preparedness tapes available 24 hours http://www.metrokc.gov/wsu-ce/
FEMA Region 10 (WA, OR, ID, AK)	(425) 487-4600	http://www.fema.gov/reg-x/
King County Office of Emergency Management	(206) 296-3830	http://www.metrokc.gov/prepare/

Lewis County Dept. Of Public Services-Emergency Management Division	(360) 740-1151	http://www.co.lewis.wa.us
Pierce County Dept. Of Emergency Management	(253) 798-6595	http://www.co.pierce.wa.us
Thurston County Emergency Management	(360) 754-3360	http://www.co.thurston.wa.us/em/
State of WA Military Department - Emergency Management Division	(253) 512-7000 (800) 258-5990	http://emd.wa.gov

Mount Rainier Geologic Hazards and Emergency Preparedness Information Contacts		
(DNR-DGER) Library 1111 Washington St. SE Olympia, WA	(360) 902-1473	http://www.dnr.wa.gov/geology/ Hours: 8 - 4:30 M-F
King County Office of Emergency Management	(206) 296-3830	http://www.metrokc.gov/prepare/
Lewis County Dept. Of Public Services-Emergency Management Division	(360) 740-1151	http://www.co.lewis.wa.us
Natural Hazard Center at University of Colorado, Boulder	(303) 492-6818	http://www.colorado.edu/hazards/

Information Center for Disasters		
Pierce County Dept. Of Emergency Management	(253) 798-6595	http://www.co.pierce.wa.us
Thurston County Emergency Management	(360) 754-3360	http://www.co.thurston.wa.us/em/
USGS Volcano Hazards Program		http://volcanoes.usgs.gov
U.S. Geological Survey (USGS) Science Information Center	(888) 275-8747	http://www.usgs.gov
Washington State Dept of Natural Resources (Geology & Earth Resources)	(360) 902-1440	http://www.dnr.wa.gov/geology/

Attachment 4
Resources

Mount Rainier Hazards and Histories--General Reading:

Driedger, C., and Scott, W., 2008, **Mount Rainier—Living Safely with a volcano in Your Backyard**: U.S. Geological Survey Fact Sheet 2008-3062, 4 p. http://pubs.usgs.gov/fs/2008/3062/fs2008-3062.pdf

Dzurisin, D., Stauffer, P.H., and Hendley II, J.W., 1997, **Living with volcanic risk in the Cascades**: U.S. Geological Survey Fact Sheet 165-97 (revised 2008), 2 p. http://vulcan.wr.usgs.gov/Volcanoes/Cascades/Publications/FS165-97/

Harris, Stephen L., 2005, **Fire Mountains of the West—The Cascade and Mono Lake volcanoes**: Missoula, Mont., Mountain Press Publishing Company, 454 p

Hoblitt, R. P., Walder, J.S., Driedger, C.L., Scott, K. M., Pringle, P.T., Vallance, J. W., 1998, **Volcano Hazards from Mount Rainier, Washington, Revised 1998:** U.S. Geological Survey Open-File Report 98-428, 11 p., 1 pl.

Myers, Bobbie, Brantley, Steven R., Stauffer, Peter H., and Hendley II, James W., 1998, **What are Volcano Hazards?:** (revised 2008): U.S. Geological Survey Fact Sheet 002-97, 2 p. http://vulcan.wr.usgs.gov/Hazards/Publications/FS002-97/

USGS—Cascades Volcano Observatory, 1994, **Preparing for the Next Eruption in the Cascades**: USGS Open-File Report 94-585, 4p. http://vulcan.wr.usgs.gov/Volcanoes/Cascades/Publications/OFR94-585/

Walder, J.S., and Driedger, C.L., 1993, **Glacier-generated debris flows at Mount Rainier,** U.S. Geological Survey Fact Sheet, Open-File Report 93-124 2 p. http://vulcan.wr.usgs.gov/Volcanoes/Rainier/Publications/OFR93-124/

Volcanic Ashfall:

USGS-Volcano Hazards Program website, **Volcanic Ash—What it can do and how to prevent damage:** (a summary of material from many publication resources) *http://volcanoes.usgs.gov/ash/*

Casadevall, Thomas J., editor, 1994, **Volcanic Ash And Aviation Safety:** Proceedings of the First International Symposium on Volcanic Ash and Aviation Safety. (Held in Seattle, WA during 07/91) U.S. Geological Survey Bulletin 2047, 450 p

Federal Emergency Management Agency, Region X, 1984, Bentley, Forrest G., Chief Researcher, **The Mitigation of Ash Fall Damage to Public Facilities: Lessons Learned from the 1980 Eruption of Mount St. Helens, Washington**. 70 p

Kennedi, C.A., Brantley, S.R., Hendley II, J.W., Stauffer, P.H., 2000, **Volcanic ash fall—A "Hard Rain" of abrasive particles**: U.S. Geological Survey Fact-Sheet 027-00 (revised April 2002), 2 p. *http://vulcan.wr.usgs.gov/Hazards/Publications/FS027-00/*

Novak, Terry and Zais, Richard, 1981, **How to Manage Your Ash**, Public Management, January/February 1981, p.12-15.

Warwick, Richard A., 1981; **Four Communities Under Ash After Mount St. Helens**: Program on Technology, environment and man, monograph no. 34, Institute of Behavioral Science, University of Colorado, 146 p

Washington Military Department Emergency Management Division and U.S. Geological Survey, Cascades Volcano Observatory, 1999, **Volcanic ashfall--How to be prepared for an ashfall**: Washington Emergency Management Division and U.S. Geological Survey, 3-page tri-fold. [online version: *http://emd.wa.gov/5-prog/prgms/eq-tsunami/vol-ash-english.pdf* , accessed October 25, 2005]

Educational Products:

Dent-Cleveland, Laurie, 1003, **The beautiful mountain in the sky—How to be safe if a lahar flows down the mountain**: Washington Military Department—Emergency Management Division, Elementary Edition K-6 Booklet: 24 p. [online version: *http://emd.wa.gov/5-prog/prgms/pubed/04-campaign/EMD%20Lahar%20K-6.pdf* , accessed October 25, 2005]

Driedger, C.L., Faust, L., Lane, L. Smith, M., Smith R., 1998, **Mount Rainier—the volcano in your backyard, poster and activity guide for educators**: U.S. Geological Survey miscellaneous publication, 2p

Driedger, C.L., Faust, L., **Living with a volcano in your backyard**: (Mount Rainier Traveling Community Exhibit"—tabletop exhibit for loan)

Driedger, C.L., Wolfe, E.W., Scott, K.M., 1998, **Living with a volcano in your backyard: Mount Rainier volcanic hazards — a prepared presentation for use by public officials and educators**: U.S. Geological Survey open-file report 98-519, 38 slides, 16 p

Driedger, C., Doherty, A., and Dixon, C. (Project Coordinators), 2005, **Living with a Volcano in your Backyard -- An Educator's Guide with Emphasis on Mount Rainier**: U.S. Geological Survey and National Park Service, General Interest Publication 19, web-published. *http://vulcan.wr.usgs.gov/Outreach/*

Johnston, D., Paton, D., Driedger, C., Houghton, B., Ronan, K., 2001, **Student Perceptions of Hazards at Four Schools Near Mount Rainier, Washington, USA**: Journal of the American Society of Professional Emergency Planners, Volume VIII – 2001, p. 41-51.

Federal Emergency Management Agency and American Red Cross, 1993, **Helping children cope with disaster**: FEMA L-196, ARC 4499, 4 p. [online version: *http://www.ohsep.louisiana.gov/factsheets/helpkidswdisasters.pdf* , accessed October 25, 2005]

Volcano Monitoring:

LaHusen, Richard, 2005, **Acoustic flow monitor system—User Manual**: U.S. Geological Survey, Open-File Report 02-429, 16 p. [online at: *http://vulcan.wr.usgs.gov/Projects/AFM/Publications/OFR02-429/OFR02-429.pdf*]

USGS Website about Mount Rainier Lahar Detection System: http://volcanoes.usgs.gov/Products/Warn/warn.html

Scarpa, Roberto, and Tilling, R.I., 1996, eds., **Monitoring and mitigation of volcano hazards**: New York, Springer-Verlag Walter de Gruyter & Co., 841 p

Videos:

IAVCEI, 1997, **Reducing volcanic risk**: International Association of Volcanology and Chemistry of Earth's Interior and United Nations Educational Scientific and Cultural Organization, video 24 minutes.

IAVCEI, 1997, **Understanding volcanic hazards**: produced by Maurice Kraft for United Nations Educational Scientific and Cultural Organization and International Association of Volcanology and Chemistry of Earth's Interior, video 26 minutes.

U.S. Geological Survey, 1996, **Perilous Beauty — The Hidden Dangers of Mount Rainier**: 29-minute video.

Additional Video Information at:
http://volcanoes.usgs.gov/Products/sproducts.html#video

Chapter 11: RECOVERY

A. Introduction

Following any disaster, restoring the community, while mitigating future impacts, is always a difficult process. This issue is even more important due to the potential widespread damage that the volcano could unleash and to hazardous events continuing for years to decades. There are some within the emergency management community that feel that this is the single most important issue in dealing with a disaster. The Mount Rainier Work Group will continue to study and address this recovery issue into the future.

This chapter provides a brief overview of the initial actions required of the recovery process.

B. Situation

Lahars and ash fall invoke a multitude of recovery issues ranging from the short-term to the long-term. Short-term concerns will include comprehensive damage assessment, FEMA registration, debris clean-up and removal, temporary housing, sheltering, mental and physical health, etc. Longer term concerns include property rights and claims, land use decisions, rebuilding rights and locations, decision-making authorities, economic sustainability, and future mitigation measures, among others. In the event of a lahar and other volcanic incidents, the work group will provide a crucial role in recommending recovery actions and priorities.

C. Concept of Operations

1. While the response phase is underway, the recovery phase begins. Recovery begins with conducting rapid damage assessments; also called windshield surveys (see Attachment). These assessments are called "windshield surveys" because they can be done while public safety responders are enroute to a destination. Due to buried roads, "drive through" assessments will be impossible, but other critical information can still be obtained. This information can be called into a 9-1-1 dispatch center or the jurisdictional emergency operations center (EOC). Windshield surveys not only visually survey damages; they identify situations still requiring response operations. Dollar-loss estimates are not determined at this level of damage assessment. Dollar-loss estimates are determined in the following, more formal assessments.

2. Individual damage assessments (IDA) provide rough estimates of the type, extent, and probable costs of damages to life and property. These assessments begin in the response phase. The lead jurisdictional EOC (for Pierce County, it is the Pierce County EOC) will be requesting IDA

information from political jurisdictions and special purpose districts within the first few hours of the onset of the emergency. It provides the initial dollar-loss estimates. Collecting and compiling these initial estimates begin the process of proclaiming a local state of emergency. The local state of emergency is proclaimed by the highest elected official from the respective impacted jurisdiction. This proclamation is required in order to proceed to requesting a governor's proclamation of an emergency. In a worst-case scenario lahar, which this Plan addresses the approved governor's proclamation of emergency will proceed to requesting a presidential declaration of emergency.

3. Another damage assessment titled the preliminary damage assessment (PDA). The PDAs are conducted by organized teams comprised of representatives from local, state, and federal agencies. The PDA verifies that the impacted communities have indeed suffered a disaster and qualify the extent of damages. The federal government may require PDAs prior to declaring a presidential state of emergency.

4. Due to the catastrophic damages expected from a worst-case scenario lahar a presidential declaration of emergency may be approved without these verifying damage assessments and qualifying proclamations of emergency. A presidential declaration of emergency qualifies presidential approval for use of federal resources, and physical and economic injury loans intended for the recovery from a disaster.

5. As the response phase begins to wind down and recovery becomes the priority, Pierce County and other impacted counties will form a recovery and restoration task force that will address issues and make recommendations that will aid the regional authorities in making comprehensive decisions and maximizing post-disaster state and federal resources. Comprised of experts regarding the volcanic hazard, the Mount Rainier Work Group will be relied upon to provide guidance and expertise during the recovery phase. It will provide a forum for more detailed discussion and idea sharing following an incident.

D. Re-entry / Repopulation / Relocation

1. A worst-case scenario lahar will bury land and structures in areas that have been built on previous lahars. Land and structures on the perimeter of the inundation zone may be damaged. Transportation corridors may be impassable. Utilities may be inoperable. Some schools will be closed. In general, the impacted area will be uninhabitable for weeks, months, even decades.

2. Re-entry will occur after appropriate officials, authorities, and subject

matter experts determine the impacted areas to be safe. Destruction may be to such an extent that repair and rebuilding may be impossible until the ground and rivers stabilize. Relocation of communities, schools, and businesses may be the best option considering since repopulation may not occur for decades.

3. The challenges, variables, and complexities associated in determining re-entry, repopulation, and relocation issues, additional planning is needed to identify these and other recovery issues in detail.

E. References

Referenced documents are found on the WEMD website (www.emd.wa/gov)

F. Attachment

"Windshield Survey" Form

DAMAGE ASSESSMENT CHECKLIST OR "WINDSHIELD SURVEY" FORM

FACILITY SURVEY

1. Ensure safety and check situation of personnel
2. Move apparatus to a safe location
3. Make a site survey of facilities, apparatus and equipment
4. Secure station utilities as necessary
5. Report information to headquarters station
6. Headquarters Station - Collect information and relay to Zone Coordinators
7. Zone Coordinators report information to DEM duty officer or Pierce County EOC (253.798.7470)

AREA SURVEY

1. As best as possible perform "Windshield Survey" of the jurisdiction
2. Only respond to immediate life threatening emergencies when indicated
3. Report information to headquarters station as soon as possible
4. Headquarters Station - Collect information ad relay to Zone Coordinator
5. Zone Coordinators report information to DEM duty officer or Pierce County EOC (253.798.7470)

DAMAGE RATING FOR EARTH-QUAKES

Category 1 - Felt
Category 2 - Windows Broken
Category 3 - Walls damaged or down
Category 4 - Building Off Foundation
Category 5 - Total Collapse

DAMAGE RATING FOR FIRE

Category 1 - No Fire
Category 2 - Exterior Damage Only (Habitable)
Category 3 - Exterior / Interior Damage (Habitable)
Category 4 - Exterior / Interior Damage (Uninhabitable)
Category 5 - Total Loss / Burned to Ground

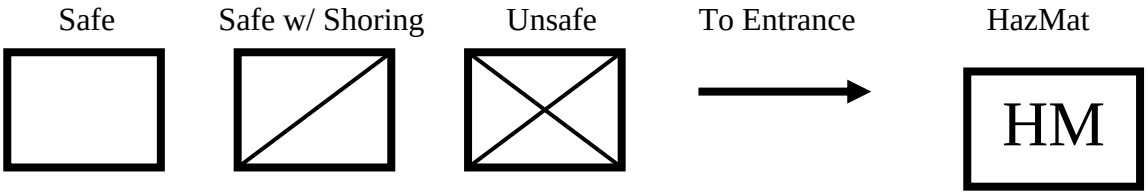
INFO NEEDED

1. Status of high life-hazard occupancies and other life hazards
2. Status of major transportation routes
3. Rough tally of damage to structures using Damage Rating scale
4. Other significant information and resource needs
5. Keep good records (ICS 214 Unit Log recommended)

SAFETY CONSIDERATIONS ON-SCENE OR IN BUILDINGS

1. Check for Safe Atmosphere
2. Ensure an Escape Route
3. Identify Incident Commanders
4. Identify Safety Officers
5. Establish Check-In
6. Do Accountability (Passport)

BUILDING MARKINGS



PRIORITIES - Full Resources

1. Protect Life
2. Protect Property
3. Protect Environment

PRIORITIES - Limited Resources

1. Life Safety
2. Exposure Protection

CIVILIAN CONVERGENT VOLUNTEERS

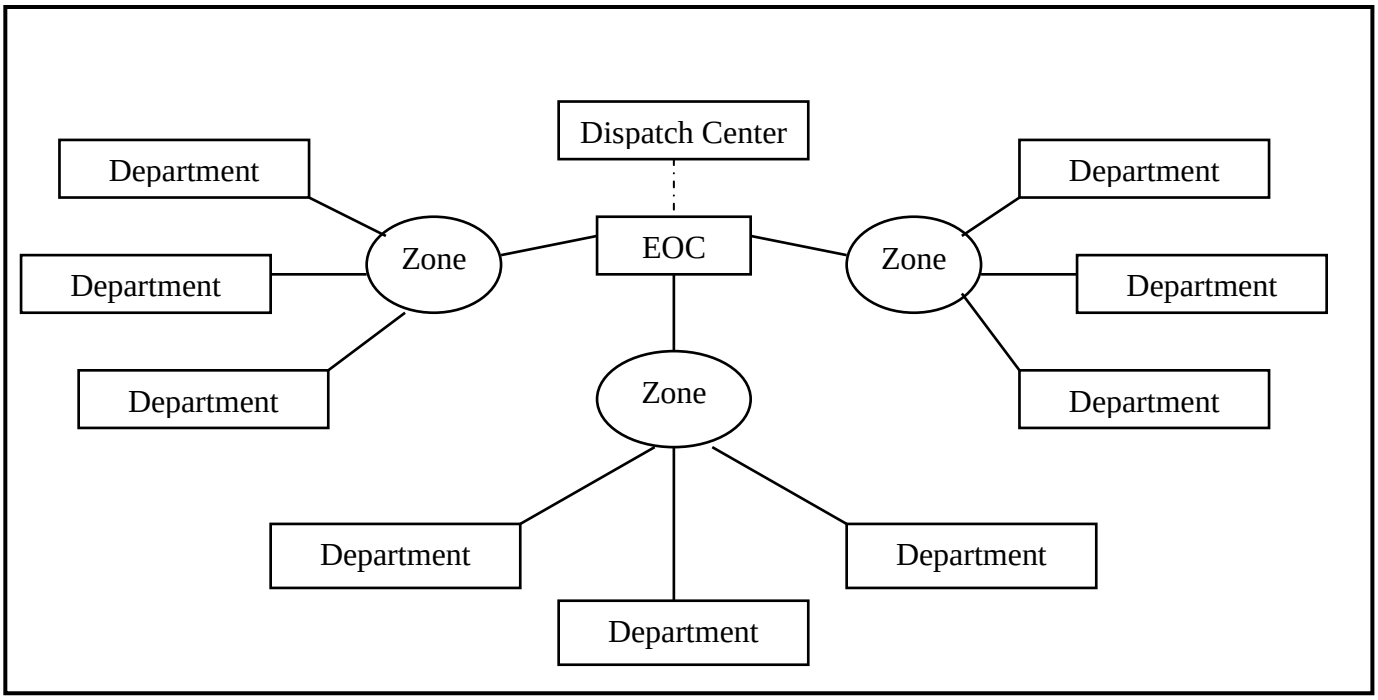
1. To register for DEM, document name, address, phone and social security number.
2. Document actual time volunteer was committed to operations.
3. Maintain constant supervision of volunteers.
4. Minimum age is 16.
5. Ensure they are properly equipped for work assignment. Arrange for equipment if necessary.
6. Organize into groups of 4 - 5 and assign a crew leader. Crew leaders must be supervised by local fire services, law enforcement or other county personnel.
7. Arrange for feeding if indicated.
8. Document instructions and actions.

COMMUNICATIONS

The High Incident Response Load plan (HIRL) will be activated when incoming 9-1-1 call traffic is greater than dispatch resources. FireComm and other dispatch centers will triage incoming calls into "Priority" and "Pending" and forward them on the operational frequency to the individual department of district command.

Damage assessment information and requests for assistance are sent by individual departments through the respective Zone Coordinator or directly to the Fire Coordinator in the EOC, if the Zone is not activated.

Basic Concept for Coordinated Management - Field Command to Department, Department to Zone, Zone to Pierce County EOC. Fire Coordinator coordinates with Dispatch Centers.


Dispatch Center
Department
Department
Department
Zone
EOC
Zone
Department
Department
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Zone
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Department
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Department

Appendices

Appendix A: GLOSSARY

Debris Flow: - A flowing mixture of water and solid debris that moves down a river channel. At Mount Rainier the USGS uses the term solely for small non-eruptive events related to slope failure, rainfall or glacier outbursts.

Detection Chute – The area along a river valley where the sequence of sensors is located to detect a lahar and send a signal to dispatch centers informing them of it.

Freeboard – distance between the water line and the top of the dam.

Target Notification – a "reverse 9-1-1 system"

Lahar – Indonesian word for a mudflow from a volcano. At Mount Rainier, the term, lahar, refers to large flows that extend beyond the boundaries of Mount Rainier National Park.

Lava flow – Mass of hot, partially molten rock that emerges from a vent and moves downslope.

Pyroclastic Flow – Avalanches of hot ash, rock fragments, and gas that move at high speeds down the sides of a volcano during explosive eruptions or when the edge of a thick, viscous lava flow or dome breaks apart or collapses.

Tephra – Airborne volcanic ejecta of any size.

Viscosity - a measure of a fluid's resistance to flow. It describes the internal friction of a moving fluid. A fluid with high viscosity resists flowing while a fluid with low viscosity flows easily.

Appendix B: Acronyms

CEMP – Comprehensive Emergency Management Plan
CVO – Cascades Volcano Observatory
FEMA – Federal Emergency Management Agency
GPS – Global Positioning System
ICS – Incident Command System
LESA (Law Enforcement Support Agency) – the primary public safety answering point (9-1-1 dispatch center) for Pierce County.
MOU – Memorandum of Understanding
NIMS – National Incident Management System
PC DEM – Pierce County Department of Emergency Management
TPU – Tacoma Public Utilities
USFS – United States Forest Service
USGS – United States Geological Survey
WEMD – Washington Emergency Management Division

Appendix C: 2008 Fact Sheet

USGS
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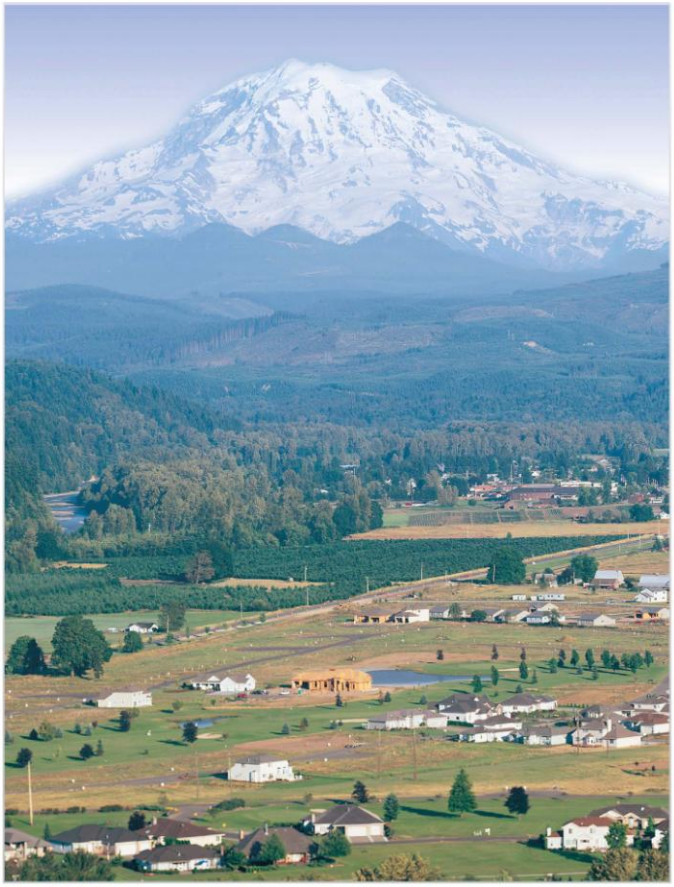
U.S. GEOLOGICAL SURVEY—REDUCING THE RISK FROM VOLCANO HAZARDS

Mount Rainier—Living Safely With a Volcano in Your Backyard

Majestic Mount Rainier soars almost 3 miles (14,410 feet) above sea level and looms over the expanding suburbs of Seattle and Tacoma, Washington. Each year almost two million visitors come to Mount Rainier National Park to admire the volcano and its glaciers, alpine meadows, and forested ridges. However, the volcano's beauty is deceptive—U.S. Geological Survey (USGS) research shows that Mount Rainier is one of our Nation's most dangerous volcanoes. It has been the source of countless eruptions and volcanic mudflows (lahars) that have surged down valleys on its flanks and buried broad areas now densely populated. To help people live more safely with the volcano, USGS scientists are working closely with local communities, emergency managers, and the National Park Service.



The flat floor of the Puyallup River valley near Orting, Washington, is formed by deposits of the 500-year-old Electron lahar, which surged down from Mount Rainier (in background). Lahars, or volcanic mudflows, are rapidly flowing slurries of mud and boulders that destroy or bury most manmade structures in their paths. Lahars from Mount Rainier can travel for tens of miles along river valleys and reach Puget Sound. (USGS photograph by D.E. Wieprecht.)

Mount Rainier, an active volcano currently at rest between eruptions, is the highest peak in the Cascade Range. Its edifice, capped by snow and 25 glaciers, has been built up by untold eruptions over the past 500,000 years. It last erupted in 1894–95, when small summit explosions were reported by observers in Seattle and Tacoma. Mount Rainier's next eruption might be of similar or larger size and could produce volcanic ash, lava flows, and avalanches of intensely hot rock and volcanic gases, called "pyroclastic flows." Some of these events swiftly melt snow and ice and could produce torrents of meltwater that pick up loose rock and become rapidly flowing slurries of mud and boulders known as "lahars." In contrast to lava flows and pyroclastic flows that are unlikely to extend farther than 10 miles from the volcano's summit and remain within Mount Rainier National Park, the largest lahars can travel for tens of miles and reach Puget Sound. Volcanic ash will be distributed downwind, most often toward the east, away from Puget Sound's large population centers. Airborne plumes of volcanic ash can greatly endanger aircraft in flight and seriously disrupt aviation operations. Although seldom life threatening, volcanic ash fallout on the ground can be a nuisance to residents, affect utility and transportation systems, and entail substantial clean-up costs.

U.S. Department of the Interior
U.S. Geological Survey

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2008

Armero, Colombia, was battered in 1985 by lahars generated by an eruption of glacier-clad Nevado del Ruiz volcano. More than 20,000 people died in the city. Note empty street blocks where structures were swept away. Tragically, safety lay nearby in areas of higher ground. (USGS photograph by R.J. Janda.)

Lahars Pose the Greatest Risk

At Mount Rainier, the risk from lahars is greater than from lava flows, volcanic ash fall, or other volcanic phenomena because some pathways for future lahars are densely populated and contain important infrastructure such as highways, bridges, ports, and pipelines. Lahars look and behave like flowing concrete, and they destroy or bury most manmade structures in their paths. Past lahars probably traveled 45 to 50 miles per hour and were as much as 100 feet or more thick where confined in valleys near the volcano. They thinned and spread out in the wide valleys downstream, slowing to 15 to 25 miles per hour. Deposits of past lahars are found in all of the valleys that start on Mount Rainier's flanks.

How Hazardous is Mount Rainier?

Mount Rainier has erupted less often and less explosively in recent millennia than its well-known neighbor, Mount St. Helens. However, the proximity of large population centers in valleys susceptible to lahars from Mount Rainier makes it a far greater threat to life and property than Mount St. Helens for the following reasons:

- **Population and development at risk—**About 80,000 people and their homes are at risk in Mount Rainier's lahar-hazard zones. Key infrastructure such as major highways and utilities cross through these zones, which also contain economically important businesses, hydroelectric dams, and major seaports.
- **Size and frequency of lahars—**During the past several thousand years large lahars have reached the Puget Sound lowland on average at least once every 500 to 1,000 years. Smaller flows not extending as far as the lowland occurred more frequently. If future large lahars happen at rates similar to those of the past, there is roughly a 1-in-10 chance of a lahar reaching the Puget Sound lowland during an average human lifespan.
- **There may be little or no advance warning—**Studies by U.S. Geological Survey (USGS) scientists show that at least one of Mount Rainier's recent large landslide-generated lahars may have occurred when the volcano was quiet and not providing the warning signs typical of a restless and erupting volcano. In such a rare case, the only warning could be a report that a lahar is already underway.

Two Types of Lahars

Mount Rainier can generate two types of lahars that can threaten surrounding valleys:

- **Meltwater-generated lahars—**Mount Rainier supports more than one cubic mile of glacial ice—as much as all other Cascade Range volcanoes combined. During past eruptive episodes, swift melting of snow and ice by pyroclastic flows and other events caused numerous lahars. Such lahars would be preceded by events that warn of an impending eruption.
- **Landslide-generated lahars—**Landslides can be triggered when molten rock (magma) intrudes into a volcano and destabilizes it, as happened at Mount St. Helens in 1980, or they may be triggered by large earthquakes. They may also be the result of the eventual failure of rocks that were weakened by the action of acidic fluids. Magma releases gases and heat creating hot, acidic ground water that, over time, can convert hard volcanic rock into weak, clay-rich rock by a process called hydrothermal alteration. When masses of water-saturated clay-rich rock slide away, they transform rapidly into a lahar. Although most large landslides at Mount Rainier occurred during eruptive periods and were probably triggered by magma intrusion or by explosive eruptions rocking the volcano, the origin of at least one, the 500-year-old Electron lahar, may not be related to eruptions. This lahar left deposits as much as 20 feet thick, and buried an old-growth forest in the vicinity of modern-day Orting.

Are All Parts of the Volcano Susceptible to Landslides?

The west flank of Mount Rainier, including the head of the Puyallup River, has the greatest potential for unleashing large landslides that become far-traveled lahars, because it has the largest amount of weakened clay-rich rock at high altitude. Therefore, the Puyallup River valley and, to a lesser extent, the Nisqually River valley, whose basin includes some of the weakened rock, are at most risk from such events. Little Tahoma Peak on the east side of the volcano and many other cliffs and steep slopes can fail in landslides, such as one in December 1963 that traveled several miles, but such events are too small to generate lahars. In contrast to landslides, lahars generated by eruptions could descend any of the valleys originating on Mount Rainier.

Long-Term Effects of Lahars

Lahars fill stream channels and bury valley floors with deposits of boulders, sand, and mud a few feet to tens of feet thick. These deposits readily erode as rivers and streams reestablish their channels, shedding abundant sediment downstream over years to decades. Because of this, downstream valley floors initially unaffected by a lahar may later suffer increased flooding and progressive burial by remobilized sediment. Recent studies have revealed extensive layers of sandy sediment from Mount Rainier that extend to the Port of Seattle along the Green and Duwamish River valleys. This sediment was rapidly eroded from the deposits of lahars caused by eruptions about 1,000 years ago, even though the lahars themselves did not extend much past present-day Auburn, which lies about 20 miles south of downtown Seattle.

Debris Flows Threaten Areas in Mount Rainier National Park

Almost annually, water released from glaciers or runoff from intense rainfall incorporates rocks and sediment to form "debris flows" that affect valleys

on the flanks of Mount Rainier. Such debris flows behave like lahars, but are typically of such small size that they seldom travel beyond the base of the volcano and only affect vulnerable areas within the boundaries of Mount Rainier National Park. Summer and autumn are the seasons during which debris flows are most common—times when glaciers are producing large amounts of meltwater and intense rains can fall on little-vegetated, snow-free areas with abundant loose debris. Because debris flows pose risks to park visitors and infrastructure, especially trails, roads, and bridges, Mount Rainier National Park educates staff and visitors about hazards from debris flows and how to avoid them by moving off valley floors.

Past Lahars Provide Clues About Future Hazards

Lahars leave behind thick layers of boulders, mud, and logs on valley floors. Geologists use this and other evidence to assess future hazard potential and to map zones in river valleys heading on Mount Rainier that could be inundated by future lahars. Not all valleys would necessarily be affected during a given eruption or large landslide, nor would all lahars in a valley be large enough to extend to hazard-zone boundaries. Lahar hazard zones mapped by the USGS are being used to guide the development of hazard-area regulations in comprehensive land-use plans by counties and cities that lie at the foot of Mount Rainier.

Lahar Warning System Reduces Risk

Because there is higher level of risk from lahars generated by landslides on the west flank of Mount Rainier, the USGS, Pierce County Department of Emergency Management, and Washington State Emergency Management Division have established a lahar warning system. A detection component consists of arrays of monitors that record the ground vibrations of a lahar. Computerized evaluation of data assesses the presence of a flowing lahar and issues an automatic alert to emergency-management agencies. Emergency managers can then initiate appropriate response measures. City, county, and State agencies design and maintain notification procedures, evacuation routes, and public-education programs.

If a large lahar were generated in the upper Puyallup River valley without the precursors that typically herald volcanic unrest and eruption, it could arrive at the City of Orting as little as 40 minutes after the initial warning is sounded. Time could be short, and successful mitigation will depend on effective notification of people at risk, public understanding of the hazard, and prompt response by citizens. This system for automatic detection and notification of a lahar reduces—but does not eliminate—risk in the lahar pathways.

Monitoring and Emergency Planning Are Ongoing

The USGS, in cooperation with the Pacific Northwest Seismic Network at the University of Washington, continuously monitors Mount Rainier and assesses potential hazards stemming from volcanic activity. Volcanoes often show signs of unrest, such as increased seismicity (earthquakes) and emission of volcanic gases and swelling of the volcano, days to months in advance of an eruption. When unrest is detected, scientists will notify emergency-management officials and increase monitoring efforts.

The Mount Rainier Volcanic Hazards Response Plan, which was created by cooperating local, county, State, and Federal agencies, is on the Web at http://www.co.pierce.wa.us/pc/Abtus/ourorg/dem/EMDiv/Mt%20Rainier%20VHRP.htm. The plan describes the responsibilities of agencies and how they will communicate with each other and the public during a volcanic crisis.

What to Do if Threatened by a Lahar or Debris Flow

Know the signs of debris flows and lahars. Experience from around the world shows that moving to high ground off the valley floor is the only way to ensure safety during a lahar. When hiking in valleys on the slopes of Mount Rainier during late summer or during intense rainfall, be alert for the signs of an approaching debris flow—ground shaking and roaring sound—and move up the valley wall to higher ground. The same is true for lahars, but, because they affect much larger areas, people need to move out of threatened areas before lahars get close. Lahars are almost always preceded by volcanic unrest, so in most instances there will be time to warn people when there is an increased risk. Obtain a NOAA weather radio to receive alerts about possible lahars, as well as other natural hazards (for further information on the Web go to http://www.weather.gov/nwr.).

HOW TO PREPARE FOR A LAHAR OR OTHER VOLCANO HAZARD

Volcano evacuation signs direct traffic to safety on higher ground in Pierce County, Washington (USGS photograph by C.L. Driedger).

Learn: Determine whether you live, work, or go to school in a lahar hazard zone. Learn about all volcanic processes that could affect your community.

Plan: Develop an emergency plan with your family so that you are prepared for natural hazards and emergencies.

Inquire: Ask public officials to advise you about how to respond during any emergency.

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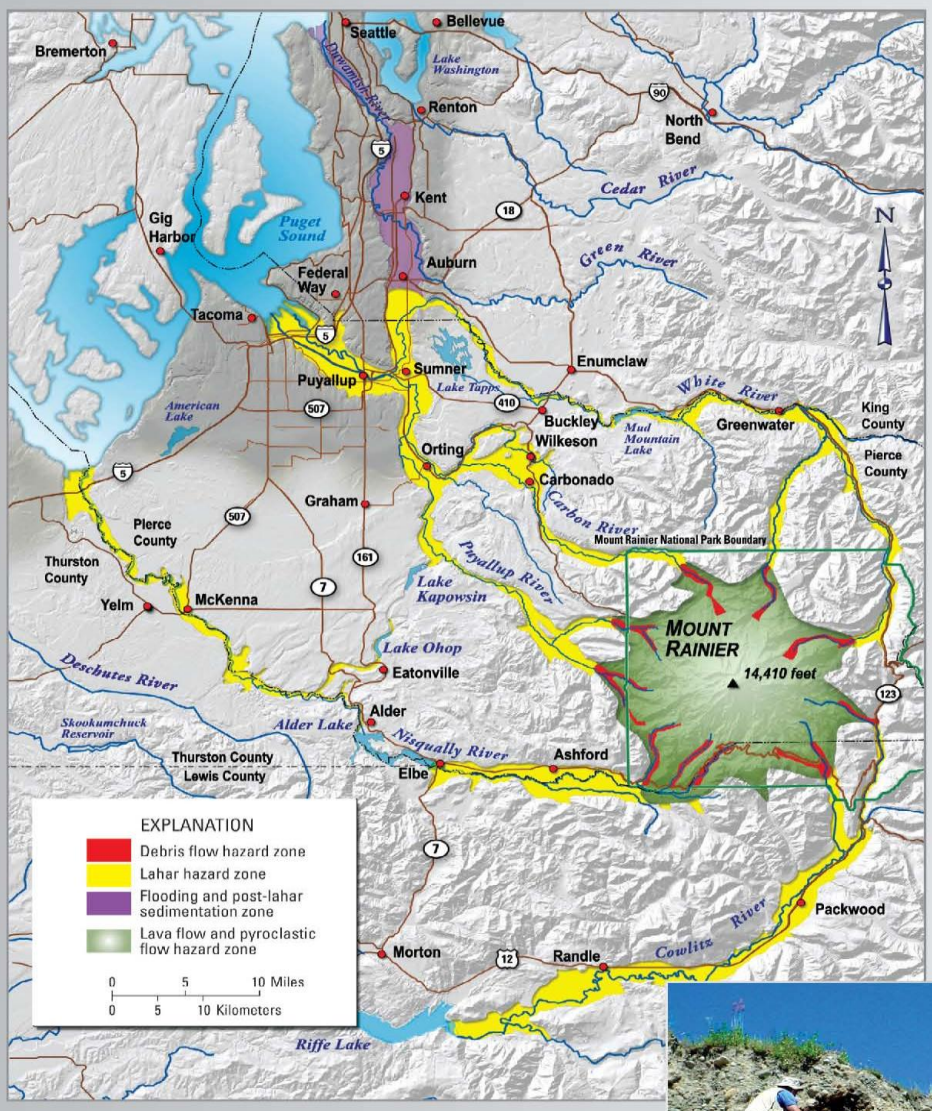
http://www.pnsn.org/RAINIER/welcome.html

This Fact Sheet supersedes Mount Rainier—Living with Perilous Beauty ((Fact Sheet 065-97) and Mount Rainier—Learning to Live with Volcanic Risk (Fact Sheet 034-02).

See also Volcano Hazards from Mount Rainier, Washington (U.S. Geological Survey Open-File Report 98-428).

This Fact Sheet and any updates to it are available online at http://pubs.usgs.gov/fs/2008/3062/.

HAZARD ZONES FOR DEBRIS FLOWS, LAHARS, LAVA FLOWS, AND PYROCLASTIC FLOWS FROM MOUNT RAINIER



This map shows areas that could be affected by debris flows, lahars, lava flows, and pyroclastic flows from Mount Rainier if events similar in size to past events occurred today. Because small lahars are more common than large ones, most lahars would be less extensive than the hazard zone shown on the map and a few would be more extensive. The lahar hazard is not equal in all valleys. For example, the greatest hazard from lahars generated by landslides is on the west side of the volcano because it contains the largest amount of hydrothermally weakened rock. Scientists continue to reevaluate the hazard zones as they learn more about the volcano. Dams and reservoirs on several rivers could lessen the extent of future lahars by trapping all or much of the flow, but they could also increase a lahar's extent if a lahar displaced reservoir water and caused dams to fail. A zone of flooding and post-lahar sedimentation is shown only in the Green and Duwamish River valleys (see Long-Term Effects of Lahars), because in other valleys it is included in the lahar hazard zone. Dark-gray shading indicates urbanized areas. (Map simplified from U.S. Geological Survey Open-File Report 98-428.)

Geologists study the deposits of past lahars to assess potential future hazards. Here a U.S. Geological Survey geologist samples a log buried in a bouldery lahar deposit east of Enumclaw, Washington. This 5,600 year-old deposit, called the Osceola Mudflow, was formed when a massive landslide on the east side of Mount Rainier traveled north and west along the White River valley. (USGS photograph by A. Durant.)

Appendix D: Volcanic Ash Fall – A "Hard Rain"

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U.S. GEOLOGICAL SURVEY—REDUCING THE RISK FROM VOLCANO HAZARDS

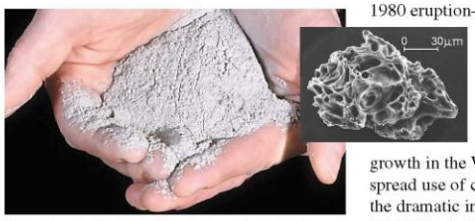
Volcanic Ash Fall—A "Hard Rain" of Abrasive Particles

Volcanic ash consists of tiny jagged particles of rock and natural glass blasted into the air by a volcano. Ash can threaten the health of people and livestock, pose a hazard to flying jet aircraft, damage electronics and machinery, and interrupt power generation and telecommunications. Wind can carry ash thousands of miles, affecting far greater areas and many more people than other volcano hazards. Even after a series of ash-producing eruptions has ended, wind and human activity can stir up fallen ash for months or years, presenting a long-term health and economic hazard.

This surreal-looking photo shows an enormous cloud of volcanic ash approaching the small town of Ephrata, Washington, on the morning of May 18, 1980. The ominous cloud was from Mount St. Helens, 145 miles to the west. The volcano had begun to erupt explosively less than 3 hours earlier, catching many communities downwind unprepared for the destructive rain of gritty ash that followed. (Copyrighted photo courtesy of Douglas Miller.)

On the morning of May 18, 1980, many people in eastern Washington noticed dark, threatening clouds approaching from the west. Most thought the clouds were part of one of the enormous thunderstorms common in late spring. However, what they did not know was that at 8:32 a.m. Mount St. Helens had erupted explosively, blasting an enormous column of volcanic ash and gas more than 60,000 feet into the air.

As the clouds drifted overhead, a rain of ash began to fall, plunging much of the region into darkness that lasted all day. Homes, farms, and roads were quickly covered by as much as 4 inches of gritty ash. The smallest ash particles penetrated machinery and all but the most tightly sealed structures. By the end of the day, more than 500 million tons of ash had fallen onto parts of Washington, Idaho, and Montana. The ash prevented travel throughout much of eastern Washington because of poor visibility, slippery roads, and ash-damaged vehicles, stranding more than 10,000 people and isolating many small communities.



Volcanic ash, like this 1980 ash from Mount St. Helens, Washington, is made up of tiny jagged particles of rock and glass (see inset; magnified 200 times). Long and severe exposure to such ash particles, without protective breathing equipment, can be dangerous and harmful. For people with heart and lung ailments, inhaling ash can cause serious respiratory problems.

More than $1 billion in property and economic losses was caused by Mount St. Helens' 1980 eruption—much of it by ash. Future large explosive eruptions in the United States are certain to produce widespread ash falls and are likely to cause even greater losses. Since 1980, rapid population and economic growth in the Western United States, widespread use of computers and electronics, and the dramatic increase in jet-airline traffic, especially over the North Pacific, have made more people and property in the Nation vulnerable to the effects of volcanic ash. Knowing the characteristics of volcanic ash and being prepared when a volcano shows signs of restlessness can significantly reduce the potential economic and health impacts of airborne and falling ash.

What is Volcanic Ash?

Small jagged pieces of rocks, minerals, and volcanic glass the size of sand and silt (less than 1/12 inch or 2 millimeters in diameter) erupted by a volcano are called volcanic ash. Very small ash particles can be less than 1/25,000th of an inch (0.001 millimeter) across.

Though called "ash," volcanic ash is not the product of combustion, like the soft fluffy material created by burning wood, leaves, or paper. Volcanic ash is hard, does not dissolve in water, is extremely abrasive and mildly corrosive, and conducts electricity when wet.

Volcanic ash is formed during explosive volcanic eruptions. Explosive eruptions occur when gases dissolved in molten rock (magma) expand and escape violently into the air, and also when water is heated by magma and abruptly flashes into steam. The force of the escaping gas violently shatters solid rocks. Expanding gas also shreds magma and blasts it into the air, where it solidifies into fragments of volcanic rock and glass.

Once in the air, hot ash and gas rise quickly to form a towering eruption column, often more than 30,000 feet high. Larger rock frag-

U.S. Department of the Interior
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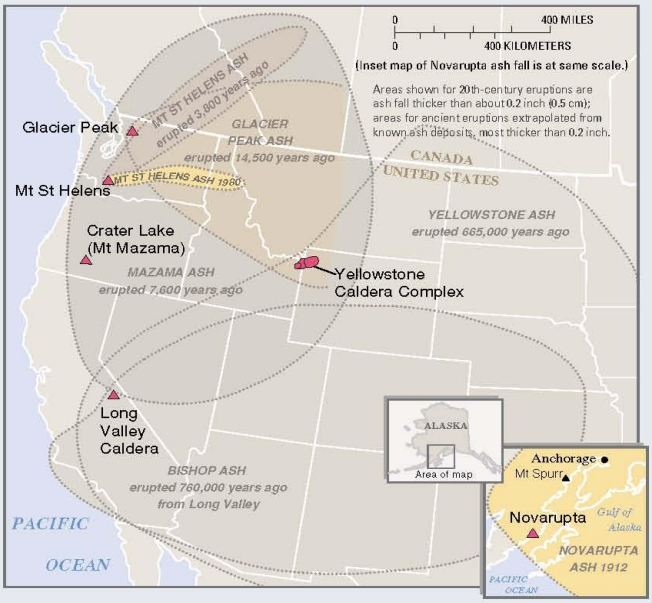
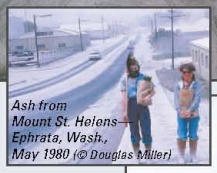
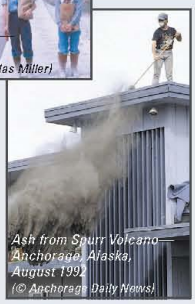
VOLCANIC ASH FALL FROM SOME ANCIENT AND MODERN ERUPTIONS IN THE WESTERN UNITED STATES



Ash from Mount St. Helens—Yakima, Wash., May 1980



Ash from Mount St. Helens—Ephrata, Wash., May 1980 (© Douglas Miller)



Ash from Spurr Volcano—Anchorage, Alaska, August 1992 (© Anchorage Daily News)

Ash fall from the two largest eruptions in the United States in the 20th century (yellow) is dwarfed by ash fall from ancient eruptions. More than $1 billion in losses was caused by Mount St. Helens' 1980 eruption—much of it by ash. Ash falls from future eruptions are certain to be widespread and hazardous. To reduce health risks, people should avoid breathing ash, wear dust masks and goggles, not use contact lenses, and stay indoors when possible.

ments more than 2 inches across ejected by the explosion typically fall within a few miles of the eruption site. However, wind can quickly blow fine ash away from the volcano to form an eruption cloud. As the cloud drifts downwind from the erupting volcano, the ash that falls from the cloud typically becomes smaller in size and forms a thinner layer. Ash clouds can travel thousands of miles, and some even circle the Earth.

Some Effects of Volcanic Ash

When volcanic ash accumulates on buildings, its weight can cause roofs to collapse, killing and injuring people. A dry layer of ash 4 inches thick weighs 120 to 200 pounds per square yard, and wet ash can weigh twice as much. The load of ash that different roofs can withstand before collapsing varies greatly—flat roofs are more likely to collapse than steeply pitched ones.

Because wet ash conducts electricity, it can cause short circuits and failure of electronic components, especially high-voltage circuits and transformers. Power outages are common in ashfall areas, making backup power systems important for critical facilities, such as hospitals.

Eruption clouds and ash fall commonly interrupt or prevent telephone and radio communications in several ways, including physical damage to equipment, frequent lightning (electrical discharges), and either scattering or absorption of radio signals by the heated and electrically charged ash particles.

Volcanic ash can cause internal-combustion engines to stall by clogging air filters and also damage the moving parts of vehicles and machinery, including bearings and gears. Engines of jet aircraft have suddenly failed after flying through clouds of even thinly dispersed ash. Roads, highways, and airport runways can be made treacherous or impassable because ash is slippery and may reduce visibility to near zero. Cars driving faster than 5 miles per hour on ash-covered roads stir up thick clouds of ash, reducing visibility and causing accidents.

Ash also clogs filters used in air-ventilation systems to the point that airflow often stops completely, causing equipment to overheat. Such filters may even collapse from the added weight of ash, allowing ash to invade buildings and damage computers and other equipment cooled by circulating outside air.

Agriculture can also be affected by volcanic ash fall. Crop damage can range from negligible to severe, depending on the thickness of ash, type and maturity of plants, and timing of subsequent rainfall. For farm animals, especially grazing livestock, ash fall can lead to health effects, including dehydration, starvation, and poisoning.

Like airborne particles from duststorms, forest fires, and air pollution, volcanic ash poses a health risk, especially to children, the elderly, and people with cardiac or respiratory conditions, such as asthma, chronic bronchitis, and emphysema.

The best time for communities, businesses, and homeowners to make preparations for a rain of volcanic ash is before an eruption occurs. When an explosive eruption does occur, warning of advancing ash clouds may precede actual ash fall by only minutes or hours. By developing community emergency-response plans that can be activated when a volcano is threatening to erupt, the harmful and disruptive effects of ash can be greatly reduced. So that the public can be warned of impending eruptions and advancing ash clouds, the U.S. Geological Survey (USGS) and cooperating organizations operate instrument networks that monitor more than 40 active volcanoes in the United States.

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COOPERATING ORGANIZATIONS
Federal Aviation Administration
National Oceanic and Atmospheric Administration, National Weather Service

For more information contact:
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David A. Johnston Cascades Volcano Observatory
5400 MacArthur Blvd., Vancouver, WA 98661
Tel: (360) 993-8900, Fax: (360) 993-8980
http://vulcan.wr.usgs.gov/
or
Alaska Volcano Observatory
4200 University Drive, Anchorage, AK 99508
Tel: (907) 786-7497, Fax: (907) 786-7425
http://www.avo.alaska.edu/
or
U.S. Geological Survey Volcano Hazards Program
http://volcanoes.usgs.gov/

See also *What are Volcano Hazards?* (USGS Fact Sheet 002-97) and *Volcanic Ash—Danger to Aircraft in the North Pacific* (USGS Fact Sheet 030-97)

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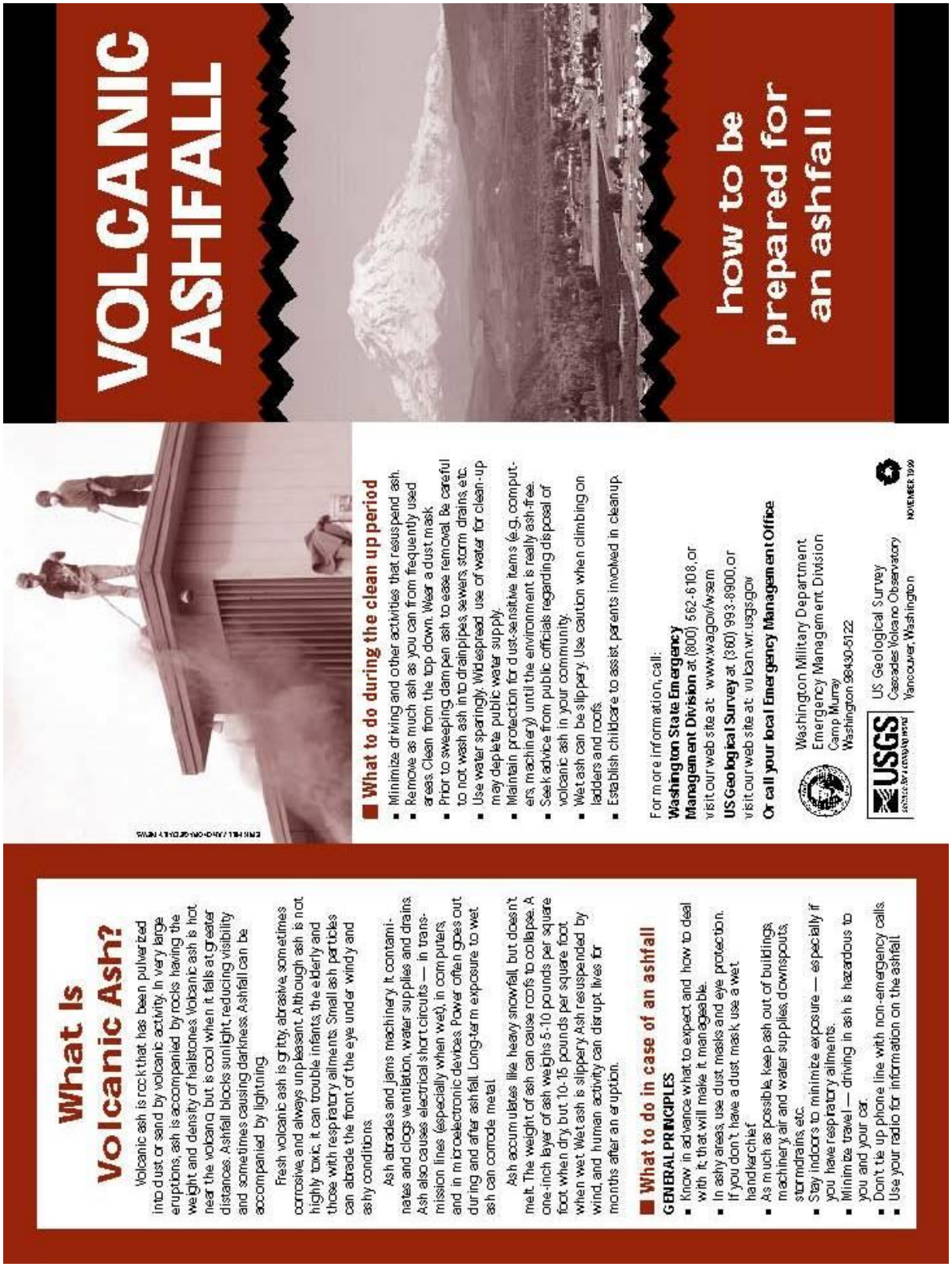
Appendix E: Volcanic Ashfall: State Trifold



What Is Volcanic Ash?

Volcanic ash is rock that has been pulverized into dust or sand by volcanic activity. In very large eruptions, ash is accompanied by rocks having the weight and density of hailstones. Volcanic ash is hot near the volcano but is cool when it falls at greater distances. Ashfall blocks sunlight, reducing visibility and sometimes causing darkness. Ashfall can be accompanied by lightning.

Fresh volcanic ash is gritty, abrasive, sometimes corrosive, and always unpleasant. Although ash is not highly toxic, it can trouble infants, the elderly and those with respiratory ailments. Small ash particles can abrade the front of the eye under windy and ashy conditions.

Ash abrades and jams machinery. It contaminates and clogs ventilation, water supplies and drains. Ash also causes electrical short circuits — in transmission lines (especially when wet), in computers, and in microelectronic devices. Power often goes out during and after ashfall. Long-term exposure to wet ash can corrode metal.

Ash accumulates like heavy snowfall, but doesn't melt. The weight of ash can cause roofs to collapse. A one-inch layer of ash weighs 5-10 pounds per square foot when dry, but 10-15 pounds per square foot when wet. Wet ash is slippery. Ash resuspended by wind, and human activity can disrupt lives for months after an eruption.

What to do in case of an ashfall

GENERAL PRINCIPLES

- Know in advance what to expect and how to deal with it, that will make it manageable.
- In ashy areas, use dust masks and eye protection. If you don't have a dust mask, use a wet handkerchief.
- As much as possible, keep ash out of buildings, machinery, air and water supplies, downspouts, stormdrains, etc.
- Stay indoors to minimize exposure — especially if you have respiratory ailments.
- Minimize travel — driving in ash is hazardous to you and your car.
- Don't tie up phone line with non-emergency calls.
- Use your radio for information on the ashfall.

What to do during the clean up period

- Minimize driving and other activities that resuspend ash.
- Remove as much ash as you can from frequently used areas. Clean from the top down. Wear a dust mask.
- Prior to sweeping, dampen ash to ease removal. Be careful to not wash ash into drainpipes, sewers, storm drains, etc.
- Use water sparingly. Widespread use of water for clean-up may deplete public water supply.
- Maintain protection for dust-sensitive items (e.g., computers, machinery), until the environment is really ash-free.
- Seek advice from public officials regarding disposal of volcanic ash in your community.
- Wet ash can be slippery. Use caution when climbing on ladders and roofs.
- Establish childcare to assist parents involved in cleanup.

VOLCANIC ASHFALL

how to be prepared for an ashfall

For more information, call:
Washington State Emergency Management Division at (800) 562-6108, or visit our web site at: www.wagov/wsem
US Geological Survey at (360) 993-8900, or visit our web site at: vulcan.wr.usgs.gov
Or call your local Emergency Management Office

Washington Military Department
Emergency Management Division
Camp Murray
Washington 98430-5122

USGS US Geological Survey
Cascades Volcano Observatory
Vancouver, Washington

NOVEMBER 1999

What to do before an ashfall

Whether in a car, at home, at work or play, you should always be prepared. Intermittent ashfall and resuspension of ash on the ground may continue for years.

YOUR HOME

Keep these items in your home in case of any natural hazards emergency:

- Extra dust masks.
- Enough non-perishable food for at least three days.
- Enough drinking water for at least three days (one gallon per person per day).
- Plastic wrap (to keep ash out of electronics).
- First aid kit and regular medications.
- Battery-operated radio with extra batteries.
- Lanterns or flashlights with extra batteries.
- Extra wood, if you have a fireplace or wood stove.
- Extra blankets and warm clothing.
- Cleaning supplies (broom, vacuum, shovels, etc.).
- Small amount of extra cash (ATM machines may not be working).

YOUR CHILDREN

- Explain what a volcano is and what they should expect and do if ash falls.
- Know your school's emergency plan.
- Have quiet games and activities available.

YOUR PETS

- Store extra food and drinking water.
- Keep extra medicine on hand.
- Keep your animals under cover, if possible.

YOUR CAR

Any vehicle can be considered a movable, second home. Always carry a few items in your vehicle in case of delays, emergencies or mechanical failures.

- Dust masks and eye protection.
- Blankets and extra clothing.
- Emergency food and drinking water.
- General emergency supplies: first aid kit, flashlight, fire extinguisher, tool kit, flares, matches, survival manual, etc.
- Waterproof tarp, heavy tow rope.
- Extra air and oil filters; extra oil; windshield wiper blades and windshield washer fluid.
- Cell phone with extra battery.

What to do during and after an ashfall

YOUR HOME

- Close doors, windows and dampers. Place damp towels at door thresholds and other draft sources; tape drafty windows.
- Dampen ash in yard and streets to reduce resuspension.
- Put stoppers in the tops of your drainpipes (at the gutters).
- Protect dust sensitive electronics.
- Since most roofs cannot support more than four inches of wet ash, keep roofs free of thick accumulation. Once ashfall stops, sweep or shovel ash from roofs and gutters. Wear your dust mask and use precaution on ladders and roofs.
- Remove outdoor clothing before entering a building. Brush, shake and pre-soak ashy clothing before washing.
- If there is ash in your water, let it settle and then use the clear water. In rare cases where there is a lot of ash in the water supply, do not use your dishwasher or washing machine.
- You may eat vegetables from the garden, but wash them first.
- Dust often using vacuum attachments rather than dust cloths, which may become abrasive.
- Use battery operated radio to receive information.

YOUR CHILDREN

- Follow school's directions for care of children at school.
- Keep children indoors; discourage active play in dusty settings. Dust masks do not fit well on small children.

YOUR PETS

- Keep pets indoors. If pets go out, brush or vacuum them before letting them indoors.
- Make sure livestock have clean food and water.
- Discourage active play in dusty settings.

YOUR CAR

- If possible, do not drive; ash is harmful to vehicles.
- If you must drive, drive slowly, use headlights, and use ample windshield washer fluid.
- Change oil, oil filters, and air filters frequently (every 50 to 100 miles in heavy dust, i.e., less than 50 feet visibility; every 500 to 1,000 miles in light dust).
- Do not drive without an air filter. If you cannot change the air filter, clean it by blowing air through from the inside out.
- If car stalls or brakes fail, push car to the side of the road to avoid collisions. Stay with your car.