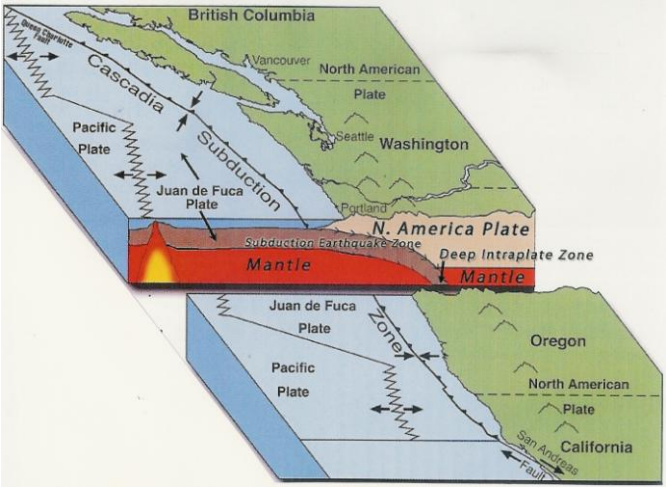
EARTHQUAKE HAZARDS

Cascadia Subduction Zone (CSZ) Earthquakes

The Cascadia Subduction Zone is a geologically complex area off the Pacific Northwest coast from Northern California to British Columbia. In simple terms, several pieces of oceanic crust (the Juan de Fuca Plate, Gorda Plate and other smaller pieces) are being subducted (pushed under) the crust of North America. This subduction process is responsible for most of the earthquakes in the Pacific Northwest as well as for creating the volcanoes in the Cascades.



Intraplate Earthquakes

These quakes occur within the subducting oceanic plate. These earthquakes occur quite deep in the earth. Ground shaking from such earthquakes would be very strong near the epicenter and strong ground shaking would be felt throughout all of Multnomah County, with the level of shaking decreasing towards eastern Multnomah County.

Crustal Earthquakes

Crustal earthquakes occur within the North American plate, above the subducting plate. These earthquakes are possible on faults mapped as active or potentially active as well as on unmapped (unknown) faults.

Earthquakes from Volcanic Activity

There appears to be a link between the subducting plate and the formation of volcanoes some distance inland from the off-shore Cascadia fault zone (OEM, 2015). Therefore, volcanic activity in the Cascades can trigger seismic activity that impacts Multnomah County.

FLOOD HAZARDS

River Flooding

River flooding occurs when river or stream water levels rise and spill over the banks. This type of flooding often results from prolonged rainfall over a large geographic area and/or melting snowpack. River flooding is an important natural process that adds sediment and nutrients to fertile floodplain areas. Rivers can also change course over time, called channel migration, which can change where rivers crest in their banks. Because the Willamette and Columbia Rivers are also influenced by tides, significant coastal storms can exacerbate flooding.

Includes channel migration: damage from bank erosion as river channels naturally migrate.

Urban Flooding

Urban flooding occurs when rain falls on impervious surfaces, such as buildings, concrete, and pavement, because these surfaces are unable to absorb and then slowly release rainfall like forests and fields can. As such, the risk of urban floods increases as development increases. During heavy rainstorms, runoff from buildings, streets and other impervious surfaces can exceed the capabilities of the existing stormwater drainage infrastructure and result in flooded streets, parking lots, yards, and basements. Storm drains may back up with yard waste or other flood debris leading to further localized flooding. The grading of developed property can also alter drainage direction of water from one property to another.

Levee Failure Inundation Area

Levees are designed to protect against a certain level of flooding. However, levees can and do decay over time. Levees can also be overtopped or breached during large floods. Levee and dam breaches can result in catastrophic flooding (FEMA, 2015).

Dam Failure Inundation Area

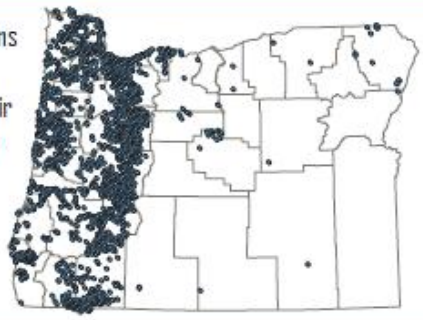
Dams are an important resource in the United States, providing many functions that include recreation, flood control, irrigation, water supply, and hydroelectric power, but they can also be breached with little warning. Levee and dam breaches can result in catastrophic flooding (FEMA, 2015).

LANDSLIDE HAZARDS

Oregon Geology Fact Sheet

Landslide Hazards in Oregon

Landslides affect thousands of Oregonians every year. Protect yourself and your property by knowing landslide types, their triggers and warning signs, how you can help prevent landslides, and how to react when one happens.



9,500 landslides were reported in Oregon in winter 1996 -97 ▶

Common landslide triggers in Oregon
- intense rainfall
- rapid snow melt
- freeze/thaw cycles
- earthquakes
- volcanic eruptions
- human
  - changing the natural slope
  - concentrating water
- combinations of the above

COMMON LANDSLIDE TYPES	TRIGGERS AND CONDITIONS	EXAMPLES

SLIDES — downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone). Commonly occurs along an existing plane of weakness or between upper, relatively weak and lower, stronger soil and/or rock. The main modes of slides are translational and rotational.

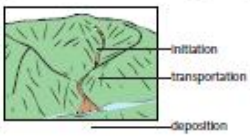
Slides are commonly triggered by heavy rain, rapid snow melt, earthquakes, grading/removing material from bottom of slope or adding loads to the top of the slope, or concentrating water onto a slope (for example, from agriculture/landscape irrigation, roof downspouts, or broken water/sewer lines).

Slides generally occur on moderate to steep slopes, especially in weak soil and rock.

translational slide *rotational slide*
(most slides are combinations of translational and rotational movement)

FLOWS — mixtures of water, soil, rock, and/or debris that have become a slurry and commonly move rapidly downslope. The main modes of flows are unchannelized and channelized. Avalanches and lahars are flows.

unchannelized flows—
left: earth flow;
right: debris avalanche



channelized flow

Flows are commonly triggered by intense rainfall, rapid snow melt, or concentrated water on steep slopes. Earth flows are the most common type of unchannelized flow. Avalanches are rapid flows of debris down very steep slopes.

A channelized flow commonly starts on a steep slope as a small landslide, which then enters a channel, picks up more debris and speed, and finally deposits in a fan at the outlet of the channel.

Debris flows, sometimes referred to as rapidly moving landslides, are the most common type of channelized flow. Lahars are channelized debris flows caused by volcanic eruptions.

debris avalanche (unchannelized flow)

earth flow (unchannelized flow)

channelized debris flow

lahar aftermath (note the flow height indicated by stained trees)

SPREADS — extension and subsidence of commonly cohesive materials overlying liquefied layers.

Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer. Spreads usually occur on very gentle slopes near open bodies of water.

spread

TOPPLES / FALLS — rapid, nearly vertical, movements of masses of materials such as rocks or boulders. Toppling failures are distinguished by forward rotation about some pivotal point below or low in the mass.

Topples and falls are commonly triggered by freeze-thaw cycles, earthquakes, tree root growth, intense storms, or excavation of material along the toe of a slope or cliff. Topples and falls usually occur in areas with near vertical exposures of soil or rock.

topple

fall

Landslide diagrams modified from USGS Landslide Fact Sheet FS2004-3072. Photos — Translational slide: Johnson Creek, OR (Landslide Technology). Rotational slide: Oregon City, OR, January 2006. Debris avalanche flow: Cape Lookout, OR, June 2005 (Ancil Nance). Earth flow: Portland, OR, January 2006 (Gerrit Huizenga). Channelized debris flow: Dodson, OR, 1996 (Ken Cruikshank, Portland State University). Lahar: Mount St. Helens, WA, 1980 (Lyn Topinka, USGS/Cascades Volcano Observatory). Spread: induced by the Nisqually earthquake, Sunset Lake, Olympia, WA, 2001 (Steve Kramer, University of Washington). Fall: Portland, OR (DOGAMI). Topple: I-80 near Portland, OR, January 2006 (DOGAMI).

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VOLCANIC HAZARDS

Ashfall

Ashfalls result when explosive eruptions blast rock fragments into the air. Such blasts may include tephra (solid and molten rock fragments). The largest rock fragments (sometimes called “bombs”) generally fall within two miles of the eruption vent. Smaller ash fragments (less than about 0.1”) typically rise into the area forming a huge eruption column. In very large eruptions, ash falls may total many feet in depth near the vent and extend for hundreds or even thousands of miles downwind.

Blast effects

Blast effects may occur with violent eruptions, such as Mount St. Helens in 1980. Most volcanic blasts are largely upwards. However, the Mount St. Helens blast was lateral, with impacts 17 miles from the volcano. Similar or larger blast zones are possible in future eruptions of any of the major Cascades volcanoes.

Lahars or mudflows

Lahars or mudflows are common during eruptions of volcanoes with heavy loading of ice and snow. These flows of mud, rock and water can rush down channels at 20 to 40 miles an hour and can extend for more than 50 miles. For some volcanoes, lahars are a major hazard because highly populated areas are built on lahar flows from previous eruptions.

Landslides or debris flows

Landslides or debris flows are the rapid downslope movement of rocky material, snow and/or ice. Volcano landslides can range from small movements of loose debris to massive collapses of the entire summit or sides of a volcano. Landslides on volcanic slopes may be triggered be eruptions or by earthquakes or simply by heavy rainfall.

Note: Lava flows and pyroclastic flows are also types of volcanic hazards, but none of the jurisdictions identify these hazards as impacting their area.

Lava flows

Lava flows are eruptions of molten rock. Lava flows for the major Cascades volcanoes tend to be thick and viscous, forming cones and thus typically affecting areas only very near the eruption vent. However, flows from the smaller mafic volcanoes may be less viscous flows that spread out over wider areas. Lava flows obviously destroy everything in their path.

Pryroclastic flows

Pyroclastic flows are high-speed avalanches of hot ash, rock fragments and gases. Pyroclastic flows can be as hot as 1500 F of and move downslope at 100 to 150 miles per hour. Pyroclastic flows are extremely deadly for anyone caught in their path.

WILDFIRE HAZARDS

Structure fires

Structure fires are fires where structures and contents are the primary fire fuel. Structure fires and the other common types of fire are most often confined to a single structure or location, although in some cases they may spread to adjacent structures.

Wildland fires

Wildland fires are fires where vegetation (grass, brush, trees) is the primary fire fuel and thus involve few or no structures.

Wildland/Urban Interface (WUI)

WUI fires are fires where the fire fuel includes both structures and vegetation. The defining characteristic of the wildland/urban interface area is that structures are built in or immediately adjacent to areas with essentially continuous vegetative fuel loads. When wildland fires occur in such areas, they often spread quickly and structures in these areas may become additional fuel sources for wildland fires.

SEVERE WEATHER HAZARDS

Severe Winter Storms

Heavy Rainfall

The impact of heavy rainfall depends on both the total inches of rain and the intensity of rainfall (inches per hour or inches per day). Flash floods, which are produced by episodes of intense heavy rains (usually 6 hours or less) or dam failures, are rare in western Oregon but do present a potential hazard. Heavy rainfall can also trigger landslides in areas with saturated soil. In winter months, rainfall also includes the amount of rain plus snow melt, also known as a rain-on-snow event.

Windstorm

Wind speeds associated with winter storms vary depending on meteorological conditions and on local topography. The level of wind hazard in much of Multnomah County is higher than many locations in western Oregon, other than the immediate coast, because of the unusually high winds common in the Columbia Gorge. Higher elevations, such as on Mount Hood, have higher levels of wind hazards.

Snow and Ice

Winter storms can involve snow and ice. Higher elevations receive much higher snowfall than areas at lower elevations.

Other Severe Weather

Other severe weather events including severe thunderstorms, hail, lightning, tornadoes and drought/heatwave, tend to occur in Multnomah County during summer months. These events are less frequent and have a lesser impact on the communities in this Plan than do severe winter storms. Typically, these events are too minor to be recorded and damage is very localized. As such, little data is available for these hazards. None-the-less, these types of severe weather impact our communities to some extent and should be mentioned.