Chapter 2 RISK ASSESSMENT

In This Chapter

The Oregon NHMP Risk Assessment chapter is divided into three sections: (a) Introduction, (b) State Risk Assessment, and (c) Regional Risk Assessment. Following is a description of each section.

1. **Introduction:** States the purpose of the risk assessment and explains risk.
2. **State Risk Assessment:** Includes the following components:
    - Oregon Hazards: Profiles each of Oregon's hazards by identifying each hazard, its generalized location, and presidentially declared disasters; introduces how the state is impacted by climate change; characterizes each hazard that impacts Oregon; lists historic events; identifies the probability of future events; and introduces how climate change is predicted to impact each hazard statewide.
    - Oregon Vulnerabilities: Includes an overview and analysis of the state's vulnerability to each hazard by identifying which communities are most vulnerable to each hazard based on local and state vulnerability assessments; providing loss estimates for state-owned/leased facilities and critical/essential facilities located in hazard areas; and identifying seismic lifeline vulnerabilities.
    - Future Enhancements: Describes ways in which Oregon is planning to improve future state risk assessments.
3. **Regional Risk Assessment:** Includes the following components for each of the eight Oregon NHMP Natural Hazard Regions:
    - Summary: Summarizes the region's statistical profile and hazard and vulnerability analysis and generally describes projected impacts of climate change on hazards in the region.
    - Profile: Provides an overview of the region's unique characteristics, including a natural environment profile, social/demographic profile, economic profile, infrastructure profile, and built environment profile.
    - Hazards and Vulnerability: Further describes the hazards in each region by characterizing how each hazard presents itself in the region; listing historic hazard events; and identifying probability of future events based on local and state analysis. Also includes an overview and analysis of the region's vulnerability to each hazard; identifies which communities are most vulnerable to each hazard based on local and state analysis; provides loss estimates for state-owned/leased facilities and critical/essential facilities located in hazard areas; and identifies the region's seismic lifeline vulnerabilities.

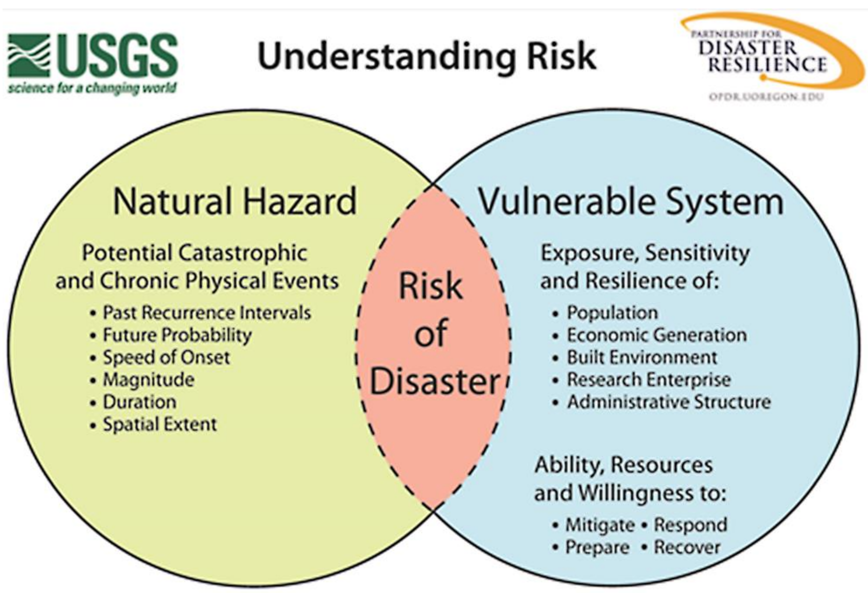
2.1 Introduction

Requirement 44 CFR §201.4(c)(2), [The plan must include] risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.

The purpose of the Oregon NHMP Risk Assessment is to identify and characterize Oregon's natural hazards, determine which jurisdictions are most vulnerable to each hazard, and estimate potential losses to vulnerable structures and infrastructure and to state facilities from those hazards.

It is impossible to predict exactly when natural hazards will occur or the extent to which they will affect communities within the state. However, with careful planning and collaboration, it is possible to minimize losses that can result from natural hazards. The identification of actions that reduce the state's sensitivity and increase its resilience assist in reducing overall risk — the area of overlap in **Figure 2-1**. The Oregon NHMP Risk Assessment informs the State's mitigation strategy, found in **Chapter 3**.

Figure 2-1. Understanding Risk



Source: Wood (2007)

Assessing the state's level of risk involves three components: characterizing natural hazards, assessing vulnerabilities, and analyzing risk. Characterizing natural hazards involves determining hazards' causes and characteristics, documenting historic impacts, and identifying future probabilities of hazards occurring throughout the state. The section in this risk assessment titled "Oregon Hazards" characterizes each of the state's natural hazards.

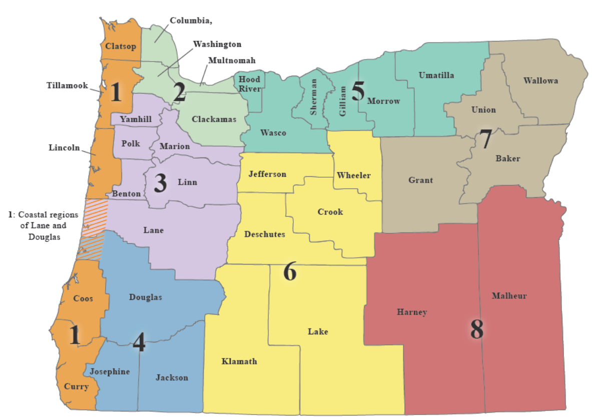
A vulnerability assessment combines information from the hazard characterization with an inventory of the existing (or planned) property and population exposed to a hazard and attempts to predict how different types of property and population groups will be affected by each hazard. Vulnerability is determined by a community's exposure, sensitivity, and resilience to natural hazards as well as by its ability to mitigate, prepare for, respond to, and recover from a disaster. The section Oregon Vulnerabilities identifies and assesses the state's vulnerabilities to each hazard identified in the Oregon Hazards section of this risk assessment.

A risk analysis involves estimating damages, injuries, and costs likely to be incurred in a geographic area over a period of time. Risk has two measurable components: (a) the magnitude of the harm that may result, defined through vulnerability assessments; and (b) the likelihood or probability of the harm occurring, defined in the hazard characterization. Together, the "Oregon Hazards" and "Oregon Vulnerabilities" sections form the risk analysis at the state level.

This Plan also analyzes risk at the regional level. Regional risk assessments begin with a description of the region's assets in the Regional Profile section. The Profile is followed by a characterization of each hazard and identification of the vulnerabilities and potential impacts of each hazard. Regions are defined in the Oregon NHMP Natural Hazards Regions map (**Figure 2-2**):

- **Region 1 – Coast:** Clatsop, Tillamook, Lincoln, coastal Lane, coastal Douglas, Coos, and Curry Counties;
- **Region 2 – Northern Willamette Valley/Portland Metro:** Colombia, Clackamas, Multnomah, and Washington Counties;
- **Region 3 – Mid/Southern Willamette Valley:** Benton, Lane, Linn, Marion, Polk, and Yamhill Counties;
- **Region 4 – Southwest:** Douglas (non-coastal), Jackson, and Josephine Counties;
- **Region 5 – Mid-Columbia:** Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties;
- **Region 6 – Central:** Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties;
- **Region 7 – Northeast:** Baker, Grant, Wallowa, and Union Counties; and
- **Region 8 – Southeast:** Harney and Malheur Counties.

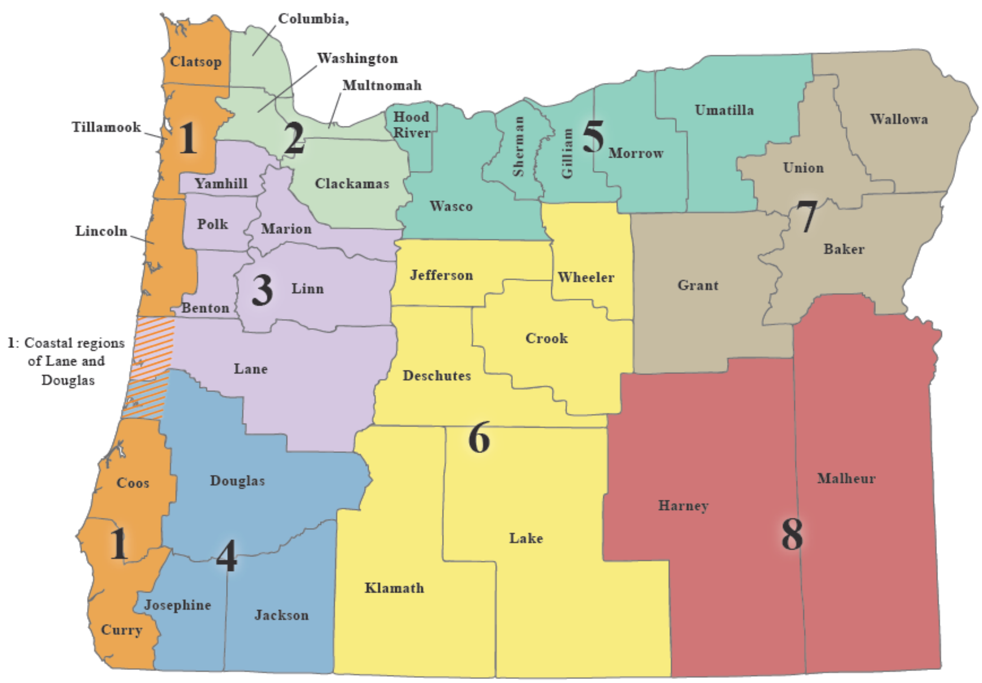
Figure 2-2. Oregon NHMP Natural Hazards Regions



2.3 Regional Risk Assessments

The purpose of the Regional Risk Assessment is to assess risks at a regional scale by profiling the characteristics, natural hazards, and vulnerabilities within the eight Oregon NHMP Natural Hazard Regions (Figure 2-81). Each region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

Figure 2-81. Oregon NHMP Natural Hazards Regions



Each Regional Risk Assessment includes three sections:

1. The **Summary** provides a general overview of (a) the Regional Profile, (b) the Regional Hazards and Vulnerability, and (c) how climate change models predict hazards in the region will be impacted based on statewide data.
2. The **Profile** section provides an overview of the region's unique characteristics including profiles of the natural environment, social and demographic situation, economic environment, infrastructure, and built environment.

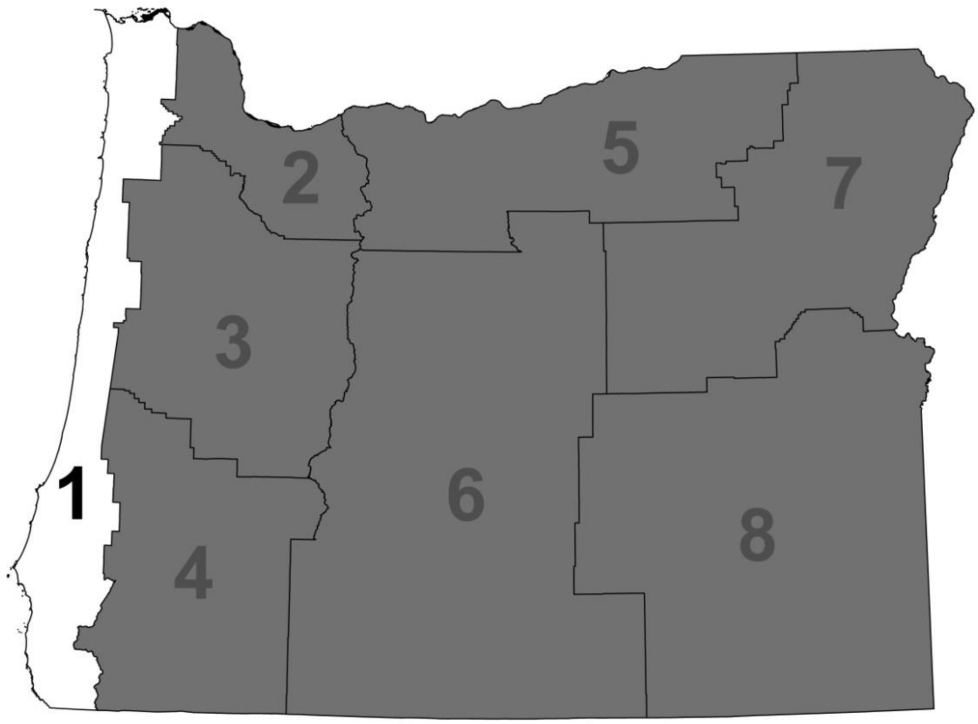
   The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability and allows policy makers to better understand how to prepare for, mitigate, and reduce vulnerability (Cutter et al., 2003; Cutter, 2006).

3. The **Hazards and Vulnerability** section first identifies each hazard and its characteristics in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities to and potential impacts from each hazard in the region are described including the identification and analysis of the region's State owned/leased facilities and critical/essential facilities located within hazard zones and seismic lifeline vulnerabilities.

Regional Risk Assessments add to the current body of literature and technical resource guides available to Oregon communities. The three levels of government — federal, state, and local — will find the Regional Risk Assessments useful when assessing natural hazards and vulnerabilities and when planning mitigation activities. Local governments can use the Regional Risk Assessments in the development of their jurisdiction's natural hazards mitigation plan. Information from these assessments is intended to be used as a springboard for more detailed community profiles. Likewise, information from local plans helps to inform the Oregon NHMP risk assessment overall.

2.3.1 Region 1: Oregon Coast

Clatsop, Coos, Curry, Lincoln, and Tillamook Counties and coastal areas of *Douglas and *Lane Counties



*Note: Where data specific to the coastal areas of Douglas and Lane Counties are available, the data are used in the Region 1 Risk Assessment. Where data are available only for the county as a whole, the data are reported in the Region 3 (Lane County) and Region 4 (Douglas County) Risk Assessments.

2.3.1.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed toward these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 1 is driven in part by a high percentage of tourists, homeless persons, seniors, and disabled populations. In addition, education levels and median household incomes across the region are below statewide numbers. Conversely, communities along the coast have high levels of homeownership, indicating an ability to better withstand economic hardship during natural disaster events.

Coastal communities were hit particularly hard by the financial crisis that began in 2007 and continue to suffer from low job recovery rates, especially in Curry, Coos, and Lincoln Counties. There are relatively few key industries and employment sectors in the region, and wages are lower than the state average. Coastal economies are becoming more reliant upon tourism, which peaks in the spring and summer months. Consequently, the area is particularly vulnerable during winter months when fewer employment opportunities exist.

A Cascadia Subduction Zone (CSZ) earthquake will be catastrophic to infrastructure along the coast. Following a CSZ event, access to and from coastal communities will be limited along US-101, major roadways, and bridges. Railroads that support transport of freight and cargo and access to the Southwest Regional Airport will also be compromised and will have implications statewide.

Currently, there are no power plants or major dams in the region, requiring energy to be transmitted long distances from other states and Canada. These energy conveyance systems are vulnerable to severe but infrequent natural hazards, such as a Cascadia Subduction Zone (CSZ) event. The proposed Jordan Cove Liquid Natural Gas facility will provide a local energy supply. Older, centralized storm and wastewater infrastructure is also vulnerable to flood events.

Most of the region's drinking water is sourced from surface water that is vulnerable to flooding, erosion, and landslides. These hazard events could result in pollution entering waterways that supply the region with drinking water.

Region 1 is developing at a slower pace than the rest of the state. Growth that is occurring is primarily in Tillamook and Curry Counties. The region has a high number of mobile home units. Almost half of all housing in Clatsop and Curry Counties was built before current seismic and floodplain management standards, creating a greater risk to damage to loss. Due to the coast's geology and geomorphology, development is limited to low-lying areas often subject to coastal hazards. New tsunami risk information and development guidance developed by the State are available to help communities develop land use planning strategies to reduce tsunami hazard risk.

Hazards and Vulnerability

Region 1 is affected by nine of the 11 natural hazards that affect Oregon communities. Dust storms and volcanoes do not directly impact the area.

Coastal Hazards: The Oregon coast is increasingly threatened by wave-induced erosion, wave runup and overtopping, wind-blown sand, and coastal landslides. Clatsop, Tillamook, Lincoln, and Curry Counties are principally vulnerable to these hazards. Development in low-lying areas subject to erosion or adjacent to estuaries is of particular concern. There are 28 state facilities in the region's coastal erosion zone, valued at approximately $7 million. Of these, one is a critical/essential facility. An additional five non-state critical/essential facilities are also located in this hazard zone.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. While uncommon, when they do occur they can be problematic — impacting community water supplies and creating forest conditions conducive to wildfires.

Earthquakes and Tsunamis: Three types of earthquakes affect Region 1: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) the offshore Cascadia fault. The CSZ is the chief earthquake hazard for coastal communities. The return rate for this type of catastrophic event is 530 years. The probability of such an event occurring in the next 50 years is 7–12%.

Tsunamis may take the form of distant or local events. The CSZ earthquake and local tsunami event have the potential to affect the entire coastline through severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding. In addition to causing significant loss of lives and development, a CSZ earthquake and local tsunami would dramatically affect the region's critical infrastructure, including principal roads and highways, bridges, tunnels, dams, and coastal ports. The region has the most seismically vulnerable highway system in the state. Seismic lifelines will be fragmented along US-101 and along east-west routes that connect the region to the rest of the state.

There are 1,300 state facilities in Region 1. Of these, the following are in earthquake or tsunami zones:

- All 1,300 state-owned/leased facilities, valued at over $336 million, are in the earthquake zone. Of these, 186 are critical/essential facilities.
- 676 state-owned/leased facilities, valued at approximately $134 million, are in the tsunami hazard zone. Of these, 98 are critical/essential facilities.
- In addition, there are 913 non-state-owned critical/essential facilities in the earthquake hazard zone. Of these, 243 are in the tsunami zone.

Floods: Coastal communities are impacted by riverine flooding, tsunami flooding, and ocean flooding from high tides and wind-driven waves. Low lying areas adjacent to bays or the ocean are more susceptible to flooding, which can be intensified by high tides. Northern counties are considered highly vulnerable to riverine flood damage because the area is more densely populated and has more of the region's infrastructure. Local highways are susceptible to wave action because of their location and geology. There are 151 state facilities, valued at approximately $23 million, located in the region's flood hazard zone. Of these, five are critical/essential facilities. An additional 85 non-state critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Many landslides occur along the coast and Coast Range Mountains. Rain-induced landslides can occur during winter months, and earthquakes can trigger landslides at any time. US-101, principal roadways, and rail lines are exposed to landslides. Landslides have the potential to cause injuries and fatalities along these transportation systems. Landslides can also sever transportation systems, causing temporary but significant economic damage regionally and beyond. There are 1,300 state facilities in Region 1 in this hazard zone. These facilities have an estimated value of over $336 million. Of these, 186 are critical/essential facilities. An additional 913 non-state critical/essential facilities are also located within this hazard zone.

Volcanoes: Though the volcanic Cascade Range is outside the region, there is some risk that volcanic ashfall, lahars, and mud flows may impact communities within Region 1 following a volcanic event.

Wildfires: Though cool moist weather makes the region less susceptible to wildfire than some other areas in the state, some of the largest fires have occurred in Region 1. Wildfire events typically take place in late summer. Areas with high levels of dry vegetation (gorse, timber, etc.) are most susceptible to wildfire. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 1, Douglas County has a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, and Fire Effects, making it especially vulnerable. Other vulnerable areas are located within wildland-urban interface communities. There are 796 state facilities located in Region 1's wildfire hazard zone with a value of approximately $186 million. Of these, 98 are critical/essential facilities. An additional 408 non-state critical/essential facilities are also located in the wildfire hazard zone.

Windstorms: In general, winds generated offshore and traveling inland in a northeasterly direction can create windstorms in all counties along the coast. Windstorms affect the region annually, especially between October and March. They can impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as the coastline, grasslands, and farmland.

Winter Storms: Colder weather, snow, ice, sleet, higher precipitation, and high winds can impact the Oregon Coast annually. Heavy ice can down trees causing widespread power outages and road closures that can isolate communities. Communities that are particularly susceptible to winter storms include Astoria, Canon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay, and Newport.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 1 include coastal hazards, drought, wildfire, flooding, and landslides. Research shows that sea levels and wave heights along the Oregon Coast are rising and are expected to increase coastal erosion and coastal flooding. In addition, climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas in Region 1 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return intervals. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. While winter storms and windstorms affect Region 1, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.1.2 Profile

Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

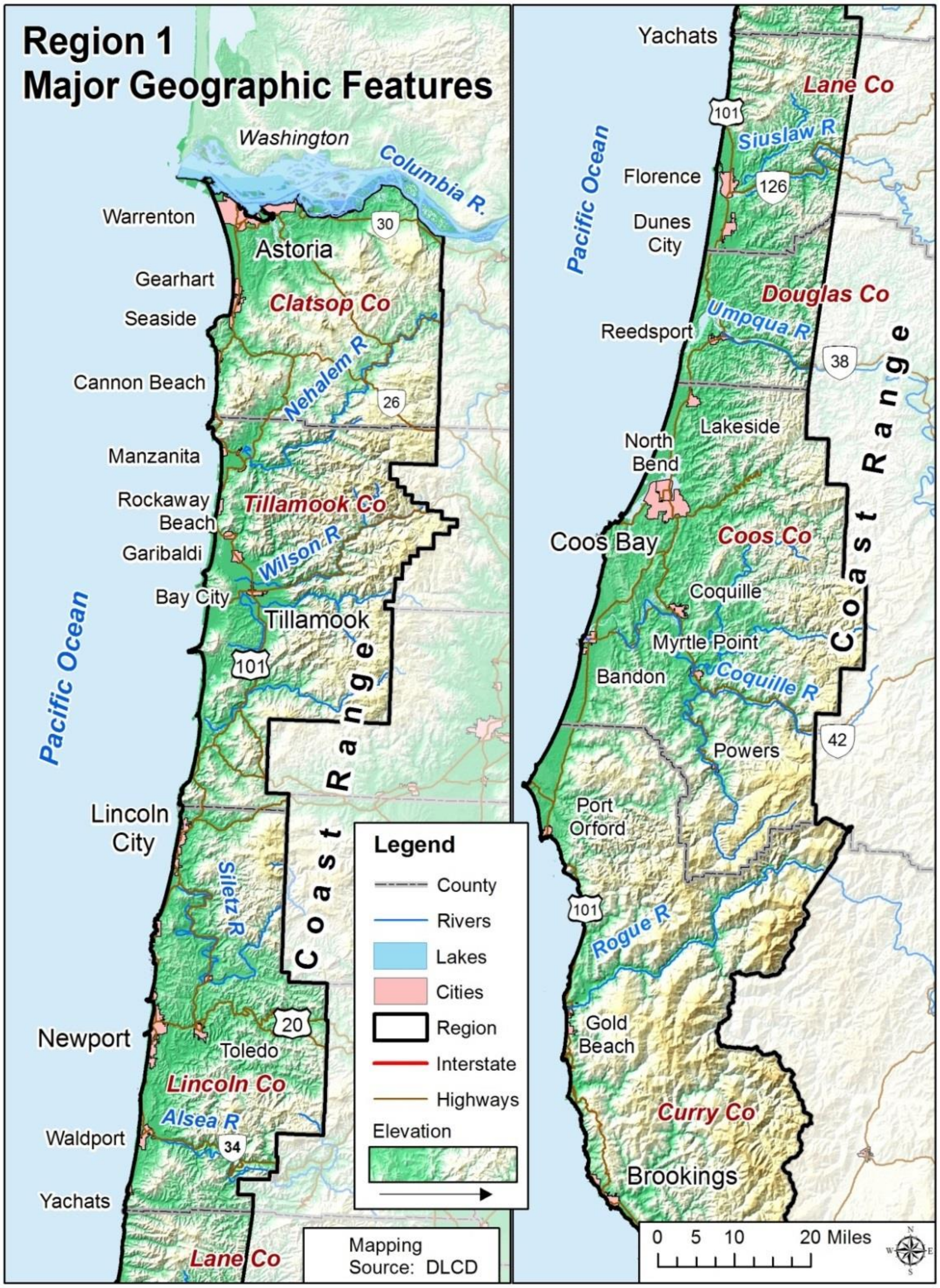
Natural Environment

Geography

The Oregon Coast is approximately 17,063 square miles in size, and includes Clatsop, Coos, Curry, Lincoln and Tillamook Counties, and coastal areas of Douglas and Lane Counties. The Coast Range mountains and waterways shape the region's topography. Region 1 begins at the Pacific Ocean on the west side and continues eastward beyond the Coast Range to the major valleys in the east. It extends from Washington State in the North to the California border in the south. Major rivers in the region include the Siuslaw, Umpqua, Nehalem, Rogue, Yaquina, Siletz, Nestucca, Trask, Wilson, Coos, and Coquille. **Figure 2-82** shows the dominant mountain ranges, major watersheds, and political boundaries of Region 1.

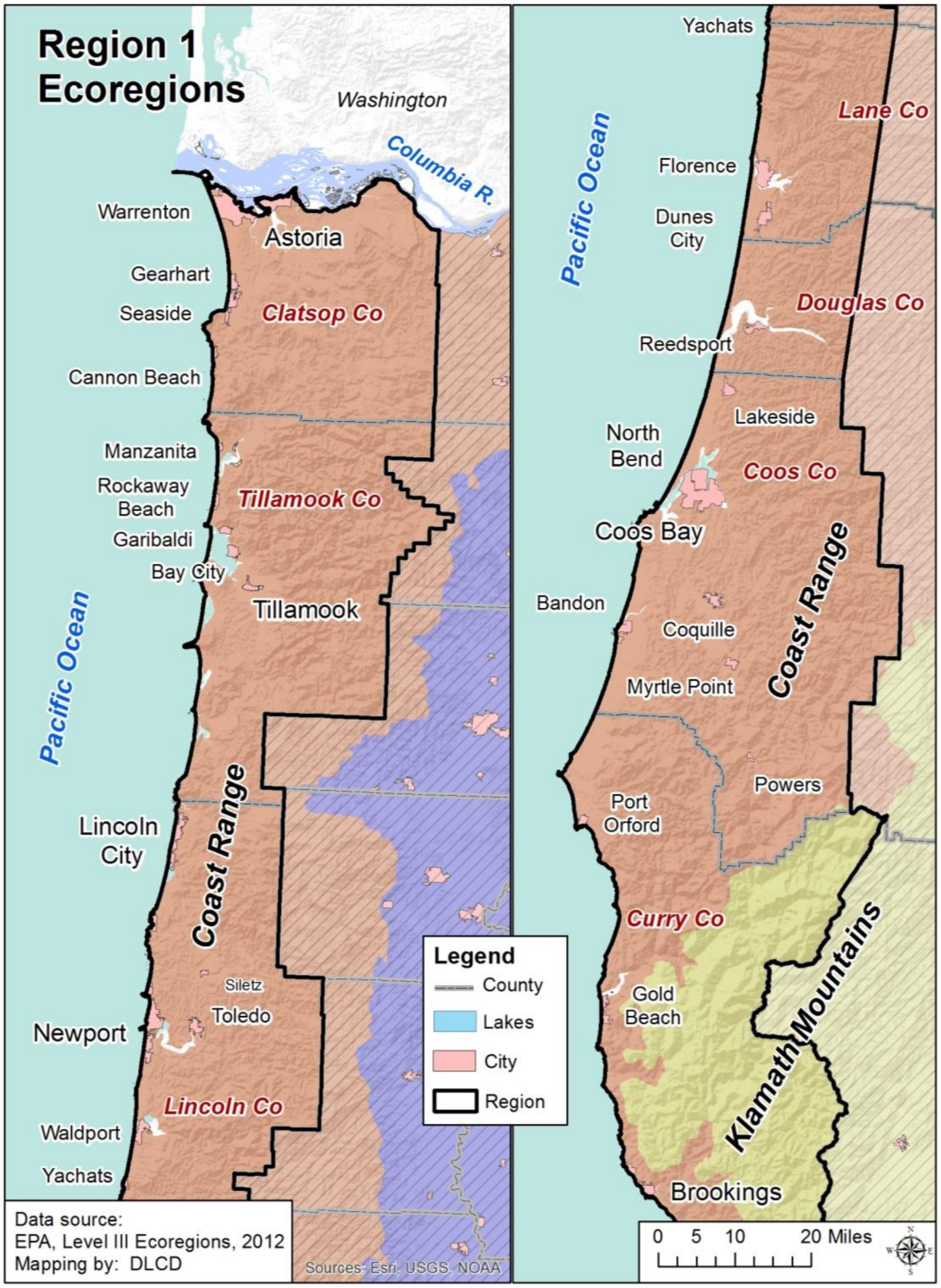
The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 1 is comprises two ecoregions: the Coast Range and a smaller area of the Klamath Mountains (**Figure 2-83**).

Figure 2-82. Region 1 Major Geographic Features



Source: USGS, NGA, NASA, CGIAR

Figure 2-83. Region 1 Ecoregions



Coast Range: The Coast Range is Region 1's dominant ecoregion. Mountains in the Coast Range are low in elevation and high in precipitation, creating lush evergreen forests. Naturally occurring diverse forests have given way to monocrop plantings for timber harvest. The Oregon Coast Range is volcanic in origin and is drained by hundreds of creeks, streams, rivers, and lakes. Sedimentary soils are more prone to failure following clear cuts and road building than are areas with volcanic soils, which may be of concern as commercial Douglas fir forests are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. Sedimentary soils create more concerns for stream sedimentation than areas with volcanic soils. Low lands include beaches, dunes, forests, lakes, marshes, and streams. Many wetlands in the ecoregion have been converted to dairy pastures (Thorson et al., 2003).

Klamath Mountains: The majority of the Klamath Mountains found in Region 1 are classified as the Coastal Siskiyous. This area has a wet, mild maritime climate. Land cover is a mix of hard- and soft-wood forests, which is far more diverse than the predominantly coniferous forests of the Coast Range. Logging, recreation, rural residential development, and mining activities are common in this ecoregion (Thorson et al., 2003).

Climate

This section covers historic climate information. For estimated future climate conditions and possible statewide impacts refer to the **State Risk Assessment**.

The Oregon Coast has a predominantly mild climate with localized variation in precipitation levels. Precipitation occurs predominantly in the winter months, mostly in the form of rain due to the region's low elevation. Wet winters and dry summers impact risk to drought, floods, landslides, and wildfires. Winter storms are often accompanied by high winds. Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-50. Average Precipitation and Temperature Ranges in Region 1 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Klamath Mountains*	45–130	32/50	49/82
Coast Range*	50–200	30/52	48/78

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 1.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised.

Between 2000 and 2013 the region's growth lagged behind the state by 11%. Growth in Coos County, the region's largest county, has been flat, while Curry County had the region's greatest percentage increase in population. Coastal communities are projected to continue to grow at a slower rate than the state, with Lincoln County expected to experience the greatest growth in the region and Coos County to experience the least.

Table 2-51. Population Estimate and Forecast for Region 1

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 1	188,287	194,365	3.2%	201,941	3.9%
Clatsop	35,630	37,270	4.6%	38,461	3.2%
Coos	62,779	62,860	0.1%	64,098	2.0%
Curry	21,137	22,300	5.5%	23,087	3.5%
Lincoln	44,479	46,560	4.7%	49,535	6.4%
Tillamook	24,262	25,375	4.6%	26,760	5.5%

Sources: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. More than 14,000 tourists visited and stayed at least one night at the Oregon Coast in 2013. The average travel party along the Oregon Coast contained three people, and the majority of these trips originated from Oregon or California. Communities in the northern and central coast attracted more tourists than the southern communities, and Lincoln County received the largest single-county share of tourists. Between 2011 and 2013, visitors in Region 1 mostly lodged in hotels, motels, campgrounds, or vacation homes rather than in private homes (Dean Runyan Associates, 2014).

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-52. Annual Visitor Estimates in Person Nights in Region 1

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 1	14,368	—	14,669	—	15,388	—
North Coast	5,362	100%	5,537	100%	5,857	100%
Hotel/Motel	2,278	42.5%	2,394	43.2%	2,686	45.9%
Private Home	714	13.3%	738	13.3%	746	12.7%
Other	2,370	44.2%	2,405	43.4%	2,425	41.4%
Clatsop	3,082	100%	3,180	100%	3,410	100%
Hotel/Motel	1,671	54.2%	1,742	54.8%	1,954	57.3%
Private Home	467	15.2%	481	15.1%	487	14.3%
Other	944	30.6%	957	30.1%	969	28.4%
Tillamook	2,280	100%	2,357	100%	2,448	100%
Hotel/Motel	607	26.6%	652	27.7%	733	29.9%
Private Home	247	10.8%	257	10.9%	259	10.6%
Other	1,426	62.5%	1,448	61.4%	1,456	59.5%
Central Coast*	5,350	100%	5,392	100%	5,626	100%
Hotel/Motel	2,146	40.1%	2,134	39.6%	2,315	41.1%
Private Home	761	14.2%	780	14.5%	801	14.2%
Other	2,443	45.7%	2,478	46.0%	2,510	44.6%
Lincoln	4,004	100%	4,045	100%	4,233	100%
Hotel/Motel	1,857	46.4%	1,853	45.8%	2,004	47.3%
Private Home	573	14.3%	589	14.6%	604	14.3%
Other	1,574	39.3%	1,604	39.7%	1,626	38.4%
South Coast	3,656	100%	3,740	100%	3,905	100%
Hotel/Motel	1,230	33.6%	1,261	33.7%	1,389	35.6%
Private Home	1,015	27.8%	1,028	27.5%	1,042	26.7%
Other	1,411	38.6%	1,451	38.8%	1,474	37.7%
Coos	2,235	100%	2,296	100%	2,406	100%
Hotel/Motel	843	37.7%	875	38.1%	970	40.3%
Private Home	796	35.6%	806	35.1%	815	33.9%
Other	596	26.7%	615	26.8%	621	25.8%
Curry	1,421	100%	1,444	100%	1,500	100%
Hotel/Motel	387	27.2%	386	26.7%	420	28.0%
Private Home	219	15.4%	222	15.4%	227	15.1%
Other	815	57.4%	836	57.9%	853	56.9%

*Central Coast also includes the coastal portions of Douglas and Lane Counties; data is not aggregated for coastal portions of these counties within the report. See Region 3 (Lane) and Region 4 (Douglas) profiles for the entire county tourism data.

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). In Region 1, roughly 7% more people identify as having a disability than do people throughout the state. Over one third of all disabled persons in the region reside in Coos County. A quarter of the people in Curry County have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-53. People with a Disability by Age Groups in Region 1, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 1	190,678	38,347	20.1%	2,200	6.1%	16,126	39.2%
Clatsop	36,381	6,447	17.7%	540	7.1%	2,335	37.3%
Coos	62,026	14,000	22.6%	824	6.9%	5,911	43.9%
Curry	22,180	5,547	25.0%	221	6.2%	2,629	42.5%
Lincoln	45,632	8,746	19.2%	409	5.1%	3,679	36.8%
Tillamook	24,459	3,607	14.7%	206	4.1%	1,572	30.4%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of the homeless population in Region 1 is either single adult males or families with children. Communities located along major transportation corridors tend to have higher concentrations of homeless people. Between 2009 and 2011, the number of homeless people more than doubled in Coos County and almost tripled in Clatsop County. The greatest percent increase in the region, though, was in Tillamook County, with more than a 22% rise in number of homeless persons.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-54. Homeless Population Estimate for Region 1

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 1	696	1,504	1,892	1,364
Clatsop	137	184	407	243
Coos	390	821	991	734
Curry	105	133	93	110
Lincoln	48	82	41	57
Tillamook	16	284	360	220

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 1 is similar to that of the state, roughly 50:50 (U.S. Census Bureau, 2010). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (U.S. Census Bureau, 2010).

Age

Region 1 has 7% more seniors than the state average. This is likely due to a high number of retirees in the region. A higher percentage of seniors requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Children also represent a vulnerable segment of the population. Though the share of children in Region 1 is less than the share of children statewide, at least 16% of all people in each coastal county are under 18 years old. Almost one third of all children in the region live in Coos County. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. In addition, parents may lose time and money when their children’s childcare facilities and schools are impacted by disasters.

Table 2-55. Population by Vulnerable Age Groups, in Region 1, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 1	193,595	36,181	18.7%	41,648	21.5%
Clatsop	37,068	7,583	20.5%	6,368	17.2%
Coos	62,937	11,932	19.0%	13,674	21.7%
Curry	22,344	3,592	16.1%	6,240	27.9%
Lincoln	45,992	8,040	17.5%	10,090	21.9%
Tillamook	25,254	5,034	19.9%	5,276	20.9%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. In the Oregon Coast Region, most residents speak English as their primary language. However, in every county along the Coast, 1–3% of the total population does not speak English "very well." Communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-56. English Usage in Region 1, 2012

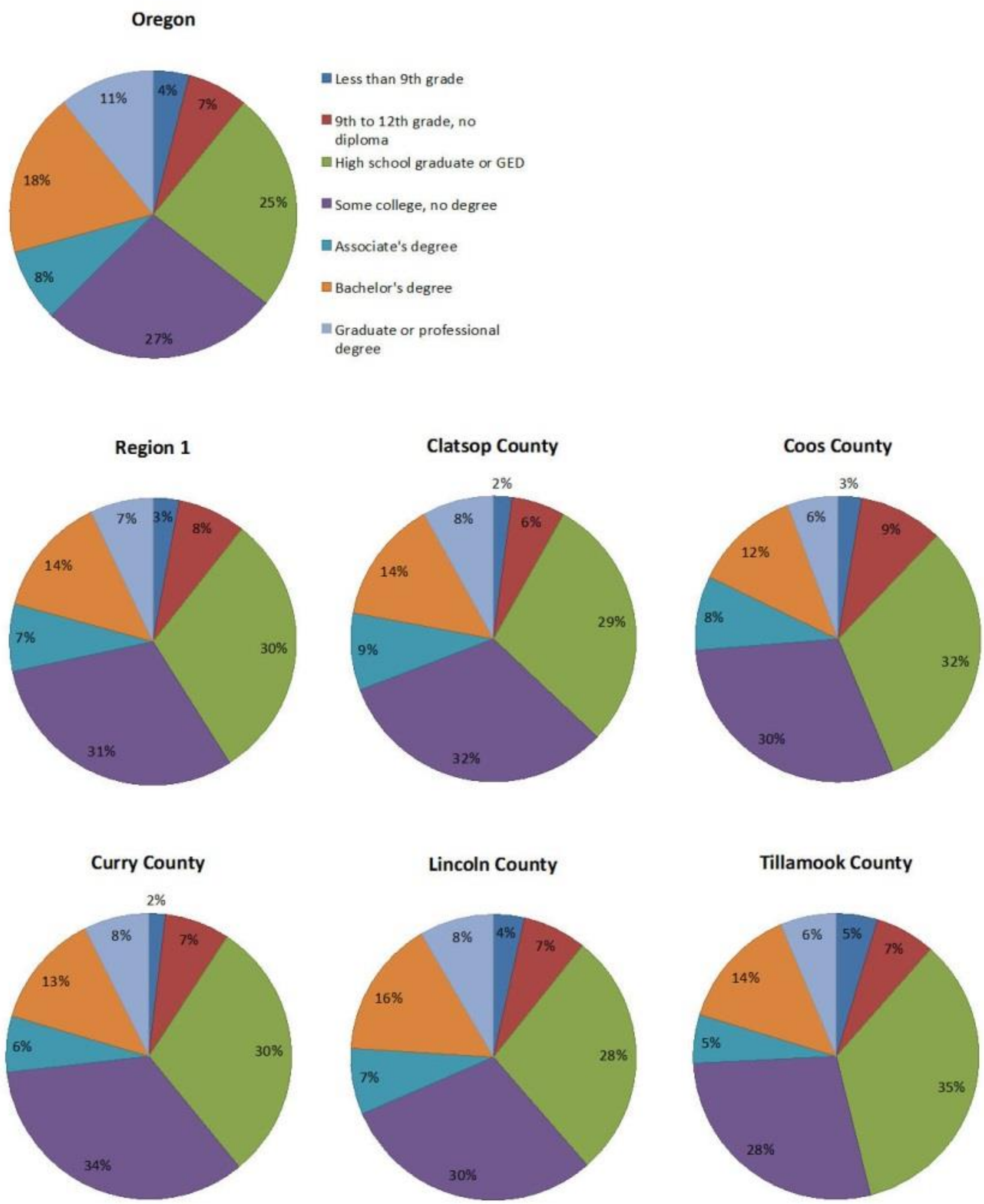
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 1	179,730	97.7%	4,281	2.3%
Clatsop	34,027	97.0%	1,070	3.0%
Coos	58,969	98.7%	798	1.3%
Curry	21,227	98.9%	230	1.1%
Lincoln	42,374	96.9%	1365	3.1%
Tillamook	23,133	96.6%	818	3.4%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (e.g., Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person's and community's ability to understand warning information and to access resources before and after a natural disaster. Region 1 has a greater percentage of people with a high school or General Education Development (GED) degree and a lower percentage of people with a bachelors or master's degree than statewide numbers. About one third of the population in each of the coastal counties has some college education. Clatsop and Lincoln Counties have the highest percentage of people with an associate's degree or more in the region.

Figure 2-84. Educational Attainment in Region 1, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

In Region 1, the greatest impacts from the financial crisis that began in 2007 occurred in southern counties (Coos, Curry, and Douglas) that were already affected by high levels of joblessness and less diverse economies. Median household incomes remain $6,000 to $12,000 lower than the statewide numbers. Coos and Curry Counties continue to have the lowest median household incomes in the region.

Table 2-57. Median Household Income in Region 1

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 1	N/A	N/A	N/A
Clatsop	$43,263	$44,330	2.5%
Coos	$39,334	$37,853	-3.8%
Curry	$38,714	$38,401	-0.8%
Lincoln	$40,849	$41,996	2.8%
Tillamook	$41,578	$41,869	0.7%

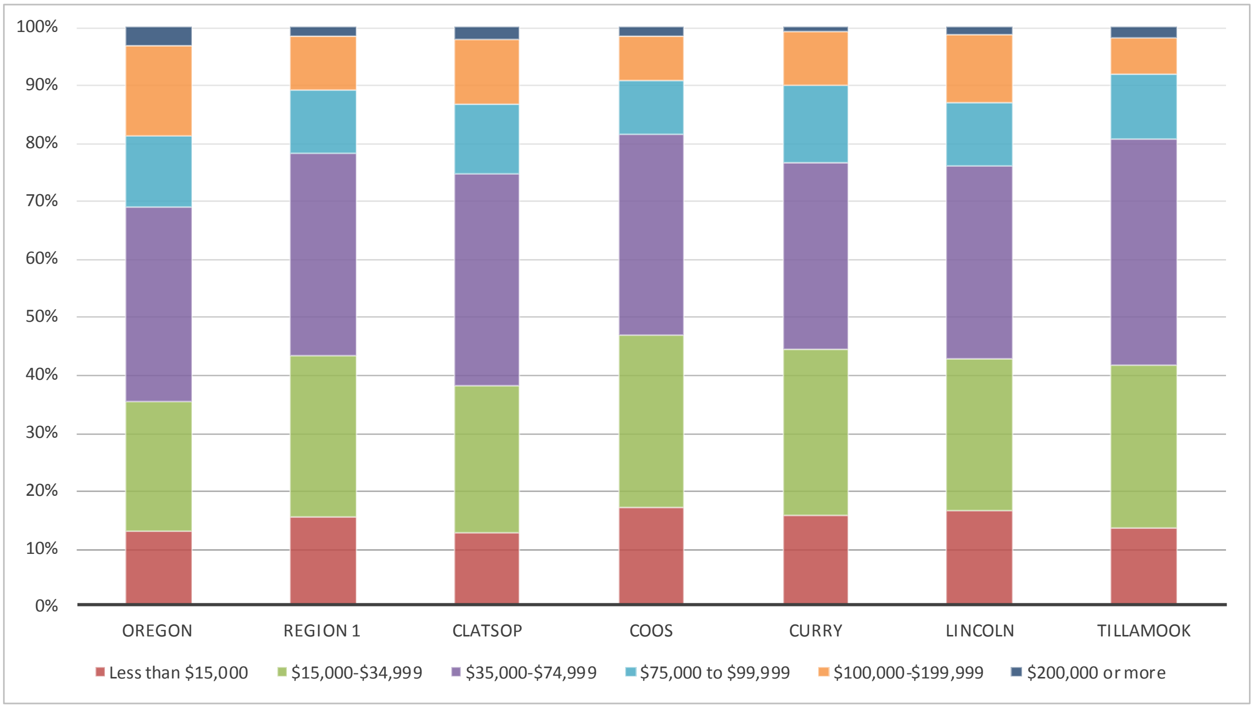
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Compared to statewide numbers, a higher percentage of households earn less than $35,000 per year in Oregon's coastal communities. Clatsop and Lincoln Counties have the highest percentage of households in upper income brackets. Nonetheless, compared to the state, 9% fewer households in coastal communities are in the top income brackets earning $75,000 or more.

Figure 2-85. Median Household Income Distribution in Region 1, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

There are 5% more individuals and children in coastal communities living in poverty than across the state. Clatsop County has had by far had the greatest increase in poverty — at least 15% more than other counties in the region and almost 10% more than the state. Poverty has decreased in Lincoln and Curry Counties.

Table 2-58. Poverty Rates in Region 1, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 1	30,893	16.3%	5.5%	7,958	22.6%	4.5%
Clatsop	5,725	15.8%	27.1%	1,829	25.0%	37.3%
Coos	10,661	17.3%	3.6%	2,659	23.1%	0.3%
Curry	3,048	13.7%	3.9%	531	14.8%	-8.4%
Lincoln	7,262	16.0%	-6.9%	1,618	20.5%	-14.8%
Tillamook	4,197	17.2%	12.2%	1,321	26.7%	14.9%

*Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover following a natural disaster and homeownership, versus renting, is often linked to having more wealth (Cutter et al., 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Homeownership is higher among Oregon Coastal communities, compared to the state average. Almost one fifth of the housing stock are second or seasonal homes or used recreationally by tourists. Clatsop County has the highest percentage of renters in the region. Coos and Curry Counties have the highest vacancy rates. Homeownership being an indicator of resiliency, coastal communities are doing quite well as they have a strong homeowner base.

Table 2-59. Housing Tenure in Region 1, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 1	84,526	56,191	66.5%	28,335	33.5%	8,346	7.3%
Clatsop	15,757	9,814	62.3%	5,943	37.7%	1,647	7.6%
Coos	26,567	17,672	66.5%	8,895	33.5%	2,750	9.0%
Curry	10,320	7,162	69.4%	3,158	30.6%	1,517	12.1%
Lincoln	21,039	13,945	66.3%	7,094	33.7%	1,738	5.7%
Tillamook	10,843	7,598	70.1%	3,245	29.9%	694	3.8%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 1 is predominantly composed of family households. The region's percentage of single-parent households is slightly lower than the state average but still equates to 7% of households (roughly 6,000 people).

Table 2-60. Family vs. Non-family Households in Region 1, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 1	84,526	52,009	61.5%	32,517	38.5%	26,443	31.3%
Clatsop	15,757	9,825	62.4%	5,932	37.6%	4,893	31.1%
Coos	26,567	16,171	60.9%	10,396	39.1%	8,215	30.9%
Curry	10,320	6,298	61.0%	4,022	39.0%	3,317	32.1%
Lincoln	21,039	12,725	60.5%	8,314	39.5%	6,802	32.3%
Tillamook	10,843	6,990	64.5%	3,853	35.5%	3,216	29.7%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-61. Family Households with Children by Head of Household in Region 1, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 1	17,303	20.5%	1,914	2.3%	4,124	4.9%	11,265	13.3%
Clatsop	3,873	24.6%	393	2.5%	1,035	6.6%	2,445	15.5%
Coos	5,205	19.6%	543	2.0%	1,230	4.6%	3,432	12.9%
Curry	1,763	17.1%	271	2.6%	331	3.2%	1,161	11.3%
Lincoln	3,969	18.9%	381	1.8%	947	4.5%	2,641	12.6%
Tillamook	2,493	23.0%	326	3.0%	581	5.4%	1,586	14.6%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The demographic analysis shows Region 1 is particularly vulnerable to a hazard event in the following ways:

- Many tourists visit the central and north coast, especially Lincoln County.
- Region 1 has a significantly higher proportion of disabled residents than the state overall, particularly Coos and Curry Counties.
- The homeless population in Coos and Clatsop Counties has risen dramatically in recent years.
- Region 1 has a higher percentage of seniors in its counties than the state overall.
- Region 1 higher percentages of people with less education and lower percentages of people with higher education than the state as a whole.
- Median incomes are below the state average in all coastal counties.
- Clatsop County has seen a significant increase in the number of households living in poverty.

Economy

Employment

The Oregon Coast Region enjoys some economic advantages due to its coastal location. In addition, the region’s close proximity to the Coast Range, California, Washington, and the beach itself provides year-round sporting and tourism activities.

Since the financial crisis that began in 2007, job recovery in Region 1 has lagged behind statewide numbers. However, unemployment rates in Region 1 have been steadily declining since 2009 and there has been significant job growth since 2012. Curry County has the highest unemployment rate in the region. Coos County has the largest labor force and the second highest unemployment rate. Despite its slowly growing economy, the region’s average salary remains 25% to 29% lower than the state average.

“The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster” (Cutter et al., 2003). Spring and summer months bring more jobs to the region, as the weather improves and tourism, construction, fishing, and retail trade increases. Therefore, Oregon’s coastal economy is more vulnerable during winter months when tourism drops and in turn employment opportunities that support those industries decreases.

Table 2-62. Employment and Unemployment Rates in Region 1, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	**Total**	**Percent**	**Total**	**Percent**
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 1	90,368	82,699	91.5%	7,669	8.5%
Clatsop	19,984	18,621	93.2%	1,363	6.8%
Coos	27,479	24,772	90.1%	2,707	9.9%
Curry	8,689	7,770	89.4%	919	10.6%
Lincoln	21,916	20,121	91.8%	1,795	8.2%
Tillamook	12,300	11,415	92.8%	885	7.2%

Source: Oregon Employment Department, 2014

Table 2-63. Unemployment Rates in Region 1, 2009-2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 1	11.0%	11.1%	10.3%	9.6%	8.5%	-2.5%
Clatsop	9.0%	9.3%	8.7%	7.8%	6.8%	-2.2%
Coos	12.8%	12.6%	11.5%	10.8%	9.9%	-3.0%
Curry	13.0%	12.8%	12.2%	11.7%	10.6%	-2.4%
Lincoln	10.5%	10.7%	10.1%	9.4%	8.2%	-2.3%
Tillamook	9.4%	9.7%	9.1%	8.6%	7.2%	-2.2%

Source: Oregon Employment Department, 2014

Table 2-64. Employment and Payroll in Region 1, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 1	70,445	$32,971	73.3%
Clatsop	16,888	$33,680	74.8%
Coos	21,579	$33,332	74.1%
Curry	6,180	$31,801	70.7%
Lincoln	17,329	$32,387	72.0%
Tillamook	8,469	$32,685	72.6%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 1 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Leisure and Hospitality; (d) Education and Health Services; and (e) Manufacturing. Natural-Resources industries (wood products, fishing, etc.) remain key industries of in Region 1. However, of growing importance are industries that rely upon the emerging retirement and seasonal tourist populations (the leisure and hospitality sector).

Table 2-65. Covered Employment by Sector in Region 1, 2013

		Clatsop County		Coos County		Curry County		Lincoln County		Tillamook County	
Industry	**Region 1**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	70,445	16,888	100%	21,579	100%	6,180	100%	17,329	100%	8,469	100%
Total Private Coverage	78.7%	14,241	84.3%	16,017	74.2%	5,031	81.4%	13,497	77.9%	6,684	78.9%
Natural Resources & Mining	3.8%	441	2.6%	979	4.5%	298	4.8%	310	1.8%	661	7.8%
Construction	3.7%	658	3.9%	674	3.1%	332	5.4%	652	3.8%	300	3.5%
Manufacturing	9.3%	2,149	12.7%	1,657	7.7%	564	9.1%	1,080	6.2%	1,133	13.4%
Trade, Transportation & Utilities	18.2%	2,925	17.3%	4,085	18.9%	1,187	19.2%	3,332	19.2%	1,289	15.2%
Information	0.9%	151	0.9%	187	0.9%	65	1.1%	174	1.0%	43	0.5%
Financial Activities	3.2%	526	3.1%	669	3.1%	238	3.9%	561	3.2%	257	3.0%
Professional & Business Services	6.8%	711	4.2%	2,266	10.5%	428	6.9%	989	5.7%	405	4.8%
Education & Health Services	11.1%	2,116	12.5%	2,502	11.6%	671	10.9%	1,667	9.6%	898	10.6%
Leisure & Hospitality	18.0%	3,915	23.2%	2,352	10.9%	1,028	16.6%	4,096	23.6%	1,315	15.5%
Other Services	3.6%	651	3.9%	646	3.0%	218	3.5%	631	3.6%	381	4.5%
Private Non-Classified	0.0%	(c)	—	(c)	—	(c)	—	6	0.0%	(c)	—
Total All Government	21.3%	2,647	15.7%	5,562	25.8%	1,150	18.6%	3,833	22.1%	1,785	21.1%
Federal Government	1.5%	206	1.2%	323	1.5%	84	1.4%	352	2.0%	107	1.3%
State Government	3.8%	450	2.7%	963	4.5%	174	2.8%	694	4.0%	386	4.6%
Local Government	16.0%	1,990	11.8%	4,276	19.8%	892	14.4%	2,788	16.1%	1,292	15.3%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Retail businesses are concentrated in the larger cities of the region and disruption of the transportation system could sever the connectivity between people living throughout the region and these retail hubs.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. Following a natural disaster, residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Education and Health Services: The importance of Health and Social Assistance industries is underscored in Region 1 because of the increasing number of retirees and individuals with a disability. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population. Following a disaster, Health and Social Assistance industries will play important roles in emergency response and recovery.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Clatsop and Tillamook Counties.

Revenue by Sector

In 2007, Manufacturing, Trade (Retail and Wholesale), and Healthcare and Social Assistance were the highest revenue grossing industries in Region 1. Combined, these three industries generated 84% of the region's total revenue, nearly $5.9 billion. Manufacturing represented nearly 60% of revenue within Tillamook County. Trade accounted for approximately 40% of all revenue within the region. Interruptions to these sectors, such as those likely to occur following a natural disaster, would result in significant revenue loss for the region.

According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 1 is expected to occur in the following sectors: (a) Education and Health services; (b) Government; (c) Trade, Transportation, and Utilities (including retail trade); (d) Leisure and Hospitality; and (e) Professional and Business Services. Of growing importance are industries that support the growing retirement and seasonal tourist populations in coastal communities, i.e., health, leisure, and hospitality industries.

Table 2-66. Revenue of Top Industries (in Thousands of Dollars) in Region 1, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 1	$6,987,691	39.3%	33.9%	11.0%
Clatsop	$1,800,769	37.8%	38.0%	8.0%
Coos	$1,859,888	52.5%	15.0%	17.7%
Curry	$586,151	38.7%	32.5%	10.5%
Lincoln	$1,675,051	36.3%	34.8%	9.3%
Tillamook	$1,065,832	24.0%	59.5%	6.9%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Identifying sectors with a large number of businesses, and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 1, 19% of all businesses. Retail Trade is the largest sub-category within this sector, with 14% of all businesses. The Leisure and Hospitality sector has the second largest number of business units. Other Services, Professional and Business, and Construction round off the top five sectors in the region. Many of these are small businesses employing fewer than 20 employees. Due to their small size, these businesses are particularly sensitive to temporary decreases in demand that may occur following a natural hazard event. Collectively these businesses represent two thirds of the business units in the region, so a negative impact on them will have a multiplied ripple effect through the region.

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. The economic analysis of the region shows the following situations increase Oregon Coastal communities' level of vulnerability to natural hazard events:

- Higher unemployment than the state average in Curry, Coos, and Lincoln Counties;
- Low average salaries across the region; and
- A regional economy heavily dependent on seasonal employment and few key industries.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

There are two primary modes of transportation in the region: highways and railroad. There are also many small airports scattered throughout the region that are used for passenger and freight service.

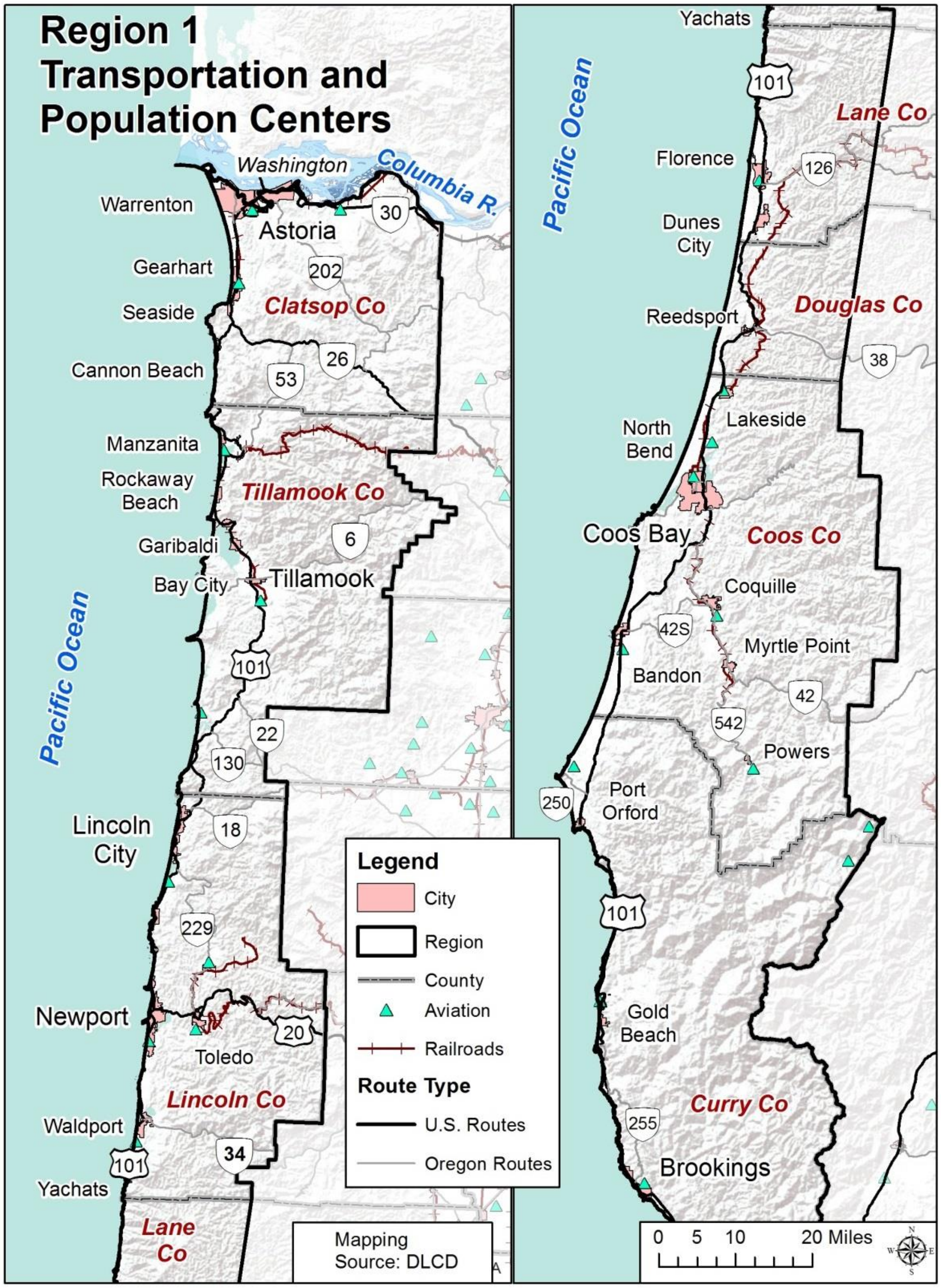
Roads

Most of the population bases in Region 1 are located along the region's major freeway, US-101. US-101 runs north-south and is the only continuous passage for automobiles and trucks traveling along the Oregon Coast. Coastal communities are connected to the interior of the state by many routes.

Natural hazards and emergency events disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Localized flooding can render roads unusable. A severe winter storm or tsunami has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 1, see **Seismic Lifelines**.

Figure 2-86. Region 1 Transportation and Population Centers



Source: Department of Land Conservation and Development, 2014

Bridges

As mentioned, the region's bridges are highly vulnerable to seismic activity. Non-functional bridges disrupt local and freight traffic, emergency operations, and sever lifelines. These disruptions exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems maintained by the region's counties and cities.

Table 2-67 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). 29% of the region's bridges are distressed or deficient. About 42% of the region's ODOT bridges are distressed.

Table 2-67. Bridge Inventory for Region 1

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 1	125	299	42%	64	361	18%	16	24	67%	11	37	30%	216	749	29%	57
Clatsop	27	68	38%	9	51	18%	13	19	68%	2	8	25%	51	150	34%	19
Coos	18	58	30%	10	113	9%	1	2	50%	3	11	27%	32	186	17%	6
Curry	14	29	41%	6	31	19%	0	0	—	0	0	—	20	65	31%	7
Lincoln	21	68	31%	20	85	24%	2	2	100%	2	3	67%	45	158	28%	10
Tillamook	45	76	48%	19	81	23%	0	1	0%	4	15	27%	68	190	36%	15

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total of Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run throughout Region 1 support cargo and trade flows. All of the region's rail lines are short lines and freight routes, connecting the coast to larger rail lines and inland metropolitan areas. Curry County is the only coastal community without rail service. The region's rail providers are the Portland & Western Railroad (PNWR), Port of Tillamook Bay Railroad (POTB), and the Coos Bay Rail Link (CBRL). The PNWR lines in Clatsop County connect Astoria and the Portland Metro Area. The POTB line connects Tillamook to inland railways operated by PNWR. Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014). Though there is no commuter rail line in the region, there is a local passenger line.

Rails are sensitive to storms. Disruptions in the rail system can result in economic losses. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Southwest Oregon Regional Airport is the only commercial airport in the region and is the fifth busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated and administered by Coos County Airport District. It serves two hubs and two air carriers (Southwest Regional Airport, n.d.).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-68. Public and Private Airports in Region 1

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Heliport**	**Private Heliport**	**Total**
Region 1	16	6	0	10	32
Clatsop	2	1	0	4	7
Coos	4	2	0	2	8
Curry	3	2	0	1	6
Lincoln	4	1	0	2	7
Tillamook	3	0	0	1	4

Source: FAA Airport Master Record (Form 5010), 2014

Ports

Ports in the Oregon Coast Region are a major contributor to the local, regional, and national economies. Oregon's ports have historically been used for timber transport and commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and infrastructure (river, rail, road, and air) and by promoting fresh seafood, fishing trips, and ecotourism. Oregon's coastal ports are divided by region: north, central and south (Coastal Oregon Marine Experiment Station, n.d.). The North Coast ports include: Astoria, Nehalem, and Garibaldi (including Tillamook Bay). The Astoria

Port includes facilities for cruise ships while the Port of Garibaldi/Tillamook Bay encompass more than 1,600 acres of industrial zoned land. The central coast ports include: Newport, Toledo, Alsea, and Siuslaw. The Newport and Siuslaw are active fishing ports that also provide an array of businesses catering to tourists. South coast ports include Umpqua, Coos Bay, Bandon, Port Orford, Gold Beach, and Brookings-Harbor. The Port of Coos Bay is Oregon's largest coastal deep-draft harbor and supports cargo ships that link to the Coos Bay Rail Link (Coastal Oregon Marine Experiment Station, n.d.). The Port of Brookings-Harbor is the busiest recreational port in Oregon with more than 31,000 visitor trips for more than 95,000 recreational boaters (Port of Brookings-Harbor, http://www.port-brookings-harbor.com).

Energy

Electricity

There are no power plants in Region 1. The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving the region. The Blachly-Lane Electric Cooperative, Coos-Curry Electric Cooperative, and Western Oregon Electric Cooperative serve portions of the region. The Bandon Municipal Utility District serves an area around the City of Bandon in Coos County. In addition, the Tillamook People's Utility District, Central Lincoln People's Utility District, and Consumers Power Inc. provide electricity for portions of Region 1.

Hydropower

There are no major dams in the Oregon Coast region, but just east of the region, in the Cascades, there are several major dams — Bonneville, Round Butte, Lookout Point, Carmen-Smith, Detroit, and Pelton dams — that combined have maximum generating capacities of over 100 megawatts of electricity that service the state (Loy, 2001).

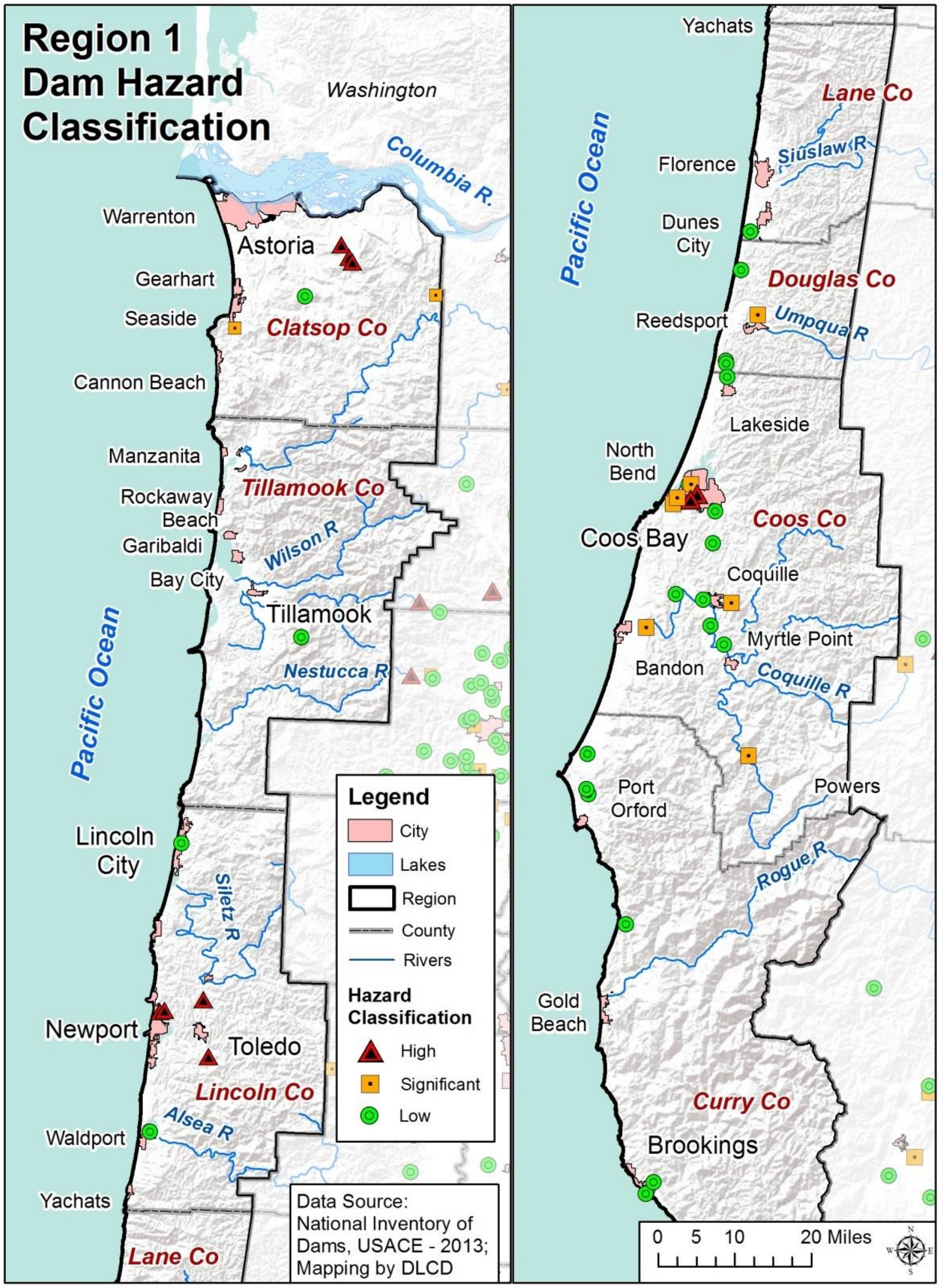
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. Most recently, major dam failures have occurred near Hermiston in 2005 and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology to inventory all large dams located in Oregon. The majority of dams along the Oregon Coast are located in Coos County (26). There are 11 High Threat Potential dams and 9 Significant Threat Potential dams in the region.

Table 2-69. Threat Potential of Dams in Region 1

	Threat Potential			Total Dams
	High	Significant	Low	
Region 1	11	9	35	55
Clatsop	4	1	1	6
Coos	2	8	16	26
Curry	0	0	8	8
Lincoln	5	0	2	7
Tillamook	0	0	8	8

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-87. Region 1 Dam Hazard Classification



Source: National Inventory of Dams, 2013

Natural Gas

Natural gas provides about 12% of the region's energy. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. The Jordan Cove Energy Project is a proposed liquefied natural gas (LNG) storage facility and power plant within the Port of Coos Bay. If built, this facility would provide LNG storage (320,000 cubic meters), liquefaction capacity (6 million metric tons per year), and sendout capacity (1,000,000 decatherms per day) via the Pacific Connector Gas Pipeline. It would include marine facilities — a single LNG marine berth and a dedicated tractor tug dock — and the South Dunes Power Plant capable of providing energy for the facility and the local grid (Jordan Cove Energy Project, L.P., n.d.). If developed, the pipeline would extend 235 miles through both public and private lands. **Figure 2-88** shows existing LNG pipelines (in blue) and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Figure 2-88. Liquefied Natural Gas Pipelines in Region

Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

Most of the Oregon Coast's oil and gas pipelines are connected to main lines that run through the Willamette Valley. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy, and is therefore crucial to consider during the natural hazard planning process. A network of electrical transmission lines, owned by Bonneville Power Administration and Pacific Power, runs through the region. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas serves the central portion of the Oregon Coast (Loy, 2001). These electric, oil, and gas lines may be vulnerable to severe, but infrequent, natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Parts of Region 1 are included in the Southern Oregon, the South Valley, and the North Coast Operational Areas under The Oregon State Emergency Alert System Plan (OEM, 2013), which also includes parts Jackson, Josephine and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) that in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 36, Coos Bay;
- KOBI-TV Channel 8, Coos Bay;
- KOBI-TV Channel 25, Coos Bay; and
- KOBI-TV Channel 7, Coos Bay.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband providers serve Region 1. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors such as I-5, US-199, etc. (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 1 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for Region 1 are (Oregon OEM, 2013):

- KIX-37, 162.550 MHZ, Brookings;
- WIX-32, 162.400 MHZ, Coos Bay;
- WNG-596, 162.425 MHZ, Port Orford;
- WNG-674, 162.525 MHZ, Florence;

- WZ-2509, 162.525 MHZ, Reedsport;
- KIH-33, 162.550 MHZ, Newport;
- WWF-95, 162.475 MHZ, Tillamook;
- KOGL, 89.3 MHZ, Gleneden Beach;
- KTMK, 91.1 MHZ, Tillamook; and
- KWAX-FM, 91.3 MHZ, Toledo.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 1 is served by Amateur Radio Emergency Service (ARES) District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 1 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Clatsop County: WA7FIV, KD7IBA;
- Tillamook County: KF7ARK;
- Lincoln County: none available at this time;
- West Lane County: K7BHB;
- Douglas County: K7AZW;
- Coos County: KE7EIB; and
- Curry County: W7VN.

Water

Drinking water, stormwater, and wastewater systems all possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 1 the majority of the municipal drinking water supply is primarily obtained from surface water. Each county's water is drawn from several major waterways, including the Youngs, Nehalem, Wilson, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, and Rogue Rivers. Most urbanized areas also have infrastructure for groundwater wells in case of a surface water shortage. Because of high levels of turbidity in streams during heavy rain events, many communities are investing in new well fields. However, groundwater drawn within the floodplain is often heavy in iron, causing undesirable odor and taste, although no health risks have been associated with heavy iron levels. Earthquakes pose a major threat to the region's water supply because of the risk of dam failure at the region's reservoirs.

Rural residents may get water primarily from groundwater wells. These wells generally have low flow levels due to the region's predominantly volcanic soils. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources, although the coast is less subject to concerns about arsenic than inland areas of Oregon.

Water rights for rivers and streams in the region have reached a tipping point due to low summer water flows. New water rights cannot be purchased in Region 1. However, conservation approaches now allow landowners to share or sell a portion of their water rights to downstream users. To supplement high demand during summer irrigation, many farmers in the region are turning to above-ground water storage gathered from streams in the winter.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enters surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers) flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 1, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction’s storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, lower speeds, and lower temperatures. No jurisdictions in Region 1 refer to LID techniques in their stormwater management plans. Requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community’s resilience to flooding and seismic events, among other hazards.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack, or poor condition, of infrastructure can negatively affect a community’s ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance in infrastructure systems help create system resiliency (Meadows, 2008).

The effects of road, bridge, rail, and airport failures on the economy and residents could be devastating. Of special concern is the impact to US-101 and bridges following a Cascadia earthquake event and resulting tsunami. This infrastructure is at risk of damage, collapse, and blockage by landslides, flooding, and debris.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Transmission lines extend long distances to provide the region with power, making the system and region more vulnerable to possible disruptions and infrastructure damage during a disaster event. The proposed Jordan Cove LNG facility, if developed, would provide a local energy supply.

Multiple telecommunication systems can help boost the area’s ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from the region’s major transportation corridor along US-101. This may present a communication challenge in the wake of a disaster. Encouraging residents to keep AM/FM radios available for emergency situations could aid in communicating important messages throughout the region.

Older centralized water systems are particularly vulnerable to hazard events. The region is also at risk of pollutants entering waterways through stormwater runoff and combined sewer overflows (CSOs) during high-water events. The implementation of decentralized LID stormwater systems can increase the region’s capacity to better manage high-precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is the 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, http://www.oregon.gov/LCD/docs/goals/goal7.pdf).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Over the 10 year period between 2000 and 2010, growth in urban areas in Region 1 was only half that of the state. However, two counties — Curry and Tillamook — experienced more than 30% urban growth. Rural development in the coastal communities decreased by 3% overall, growing only slightly in Lincoln and Coos Counties. Notably, rural populations declined by 22% in Curry County.

The percent growth of housing units in urban areas was twice that in rural areas. Curry and Tillamook Counties experienced at least 3 times more urban growth than other counties in the region. Lincoln and Tillamook Counties experienced the most growth in rural housing units.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. Population centers include the Cities of Astoria, Tillamook, Newport, Florence, Coos Bay, Brookings, and some unincorporated areas.

Table 2-70. Urban and Rural Populations in Region 1

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 1	103,534	111,575	7.8%	84,753	82,155	-3.1%
Clatsop	20,976	22,604	7.8%	14,654	14,435	-1.5%
Coos	38,999	38,864	-0.3%	23,780	24,179	1.7%
Curry	10,030	13,702	36.6%	11,107	8,662	-22.0%
Lincoln	27,640	28,730	3.9%	16,839	17,304	2.8%
Tillamook	5,889	7,675	30.3%	18,373	17,575	-4.3%

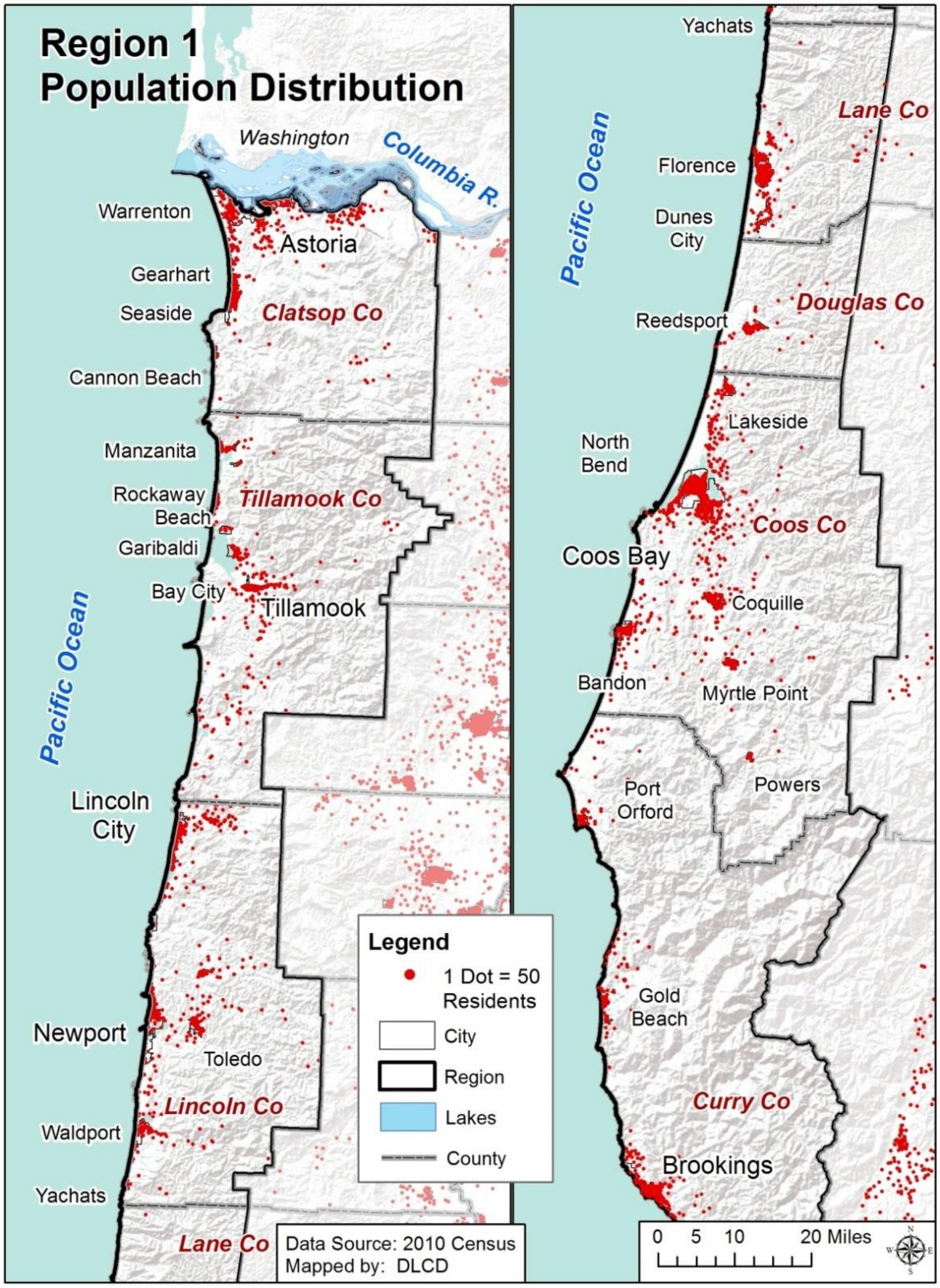
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002, and 2010 Decennial Census, Table P2

Table 2-71. Urban and Rural Housing Units in Region 1

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 1	54,599	61,938	13.4%	48,534	51,783	6.7%
Clatsop	11,639	12,866	10.5%	8,046	8,680	7.9%
Coos	17,957	18,578	3.5%	11,290	12,015	6.4%
Curry	5,331	7,428	39.3%	6,075	5,185	-14.7%
Lincoln	17,152	19,534	13.9%	9,737	11,076	13.8%
Tillamook	2,520	3,532	40.2%	13,386	14,827	10.8%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002, and 2010 Decennial Census, Table H2

Figure 2-89. Region 1 Population Distribution



Source: U.S. Census, 2012

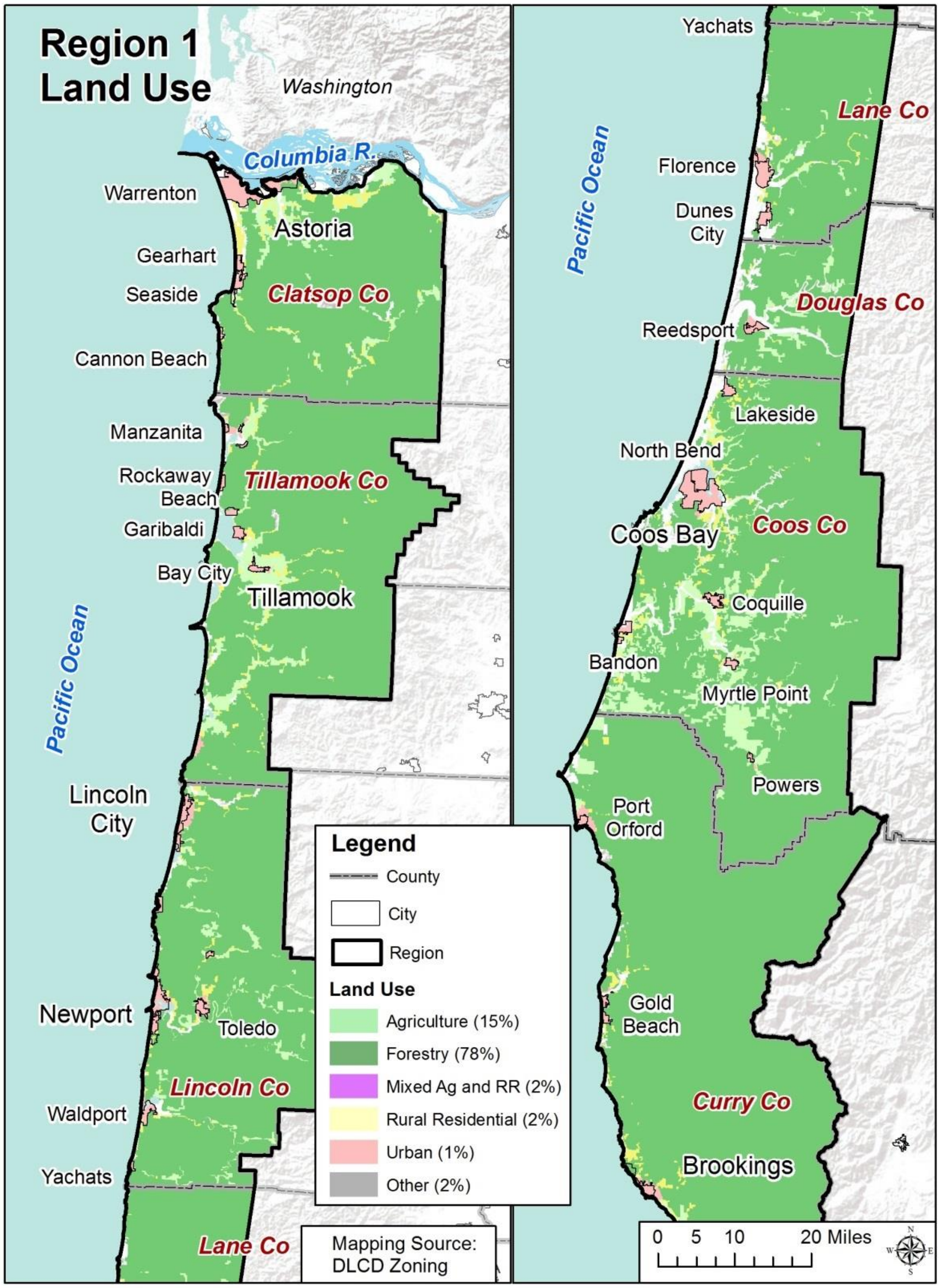
Land Use Patterns

Just over half of the land ownership of the Coast Region is private, with an additional 35% in federal ownership. The vast majority of this land is dedicated to forestry. From the period of 1974 to 2009 the north coast area has had the lowest conversion rate of private land from resource land uses to low-density residential and urban uses (Lettman, 2011). Overall, the coastal communities have experienced little development in the past 5 years, although recently building permitting has increased, mostly for infill of existing subdivisions (DLCD, internal communication, 2014).

The first liquefied natural gas export terminals on the Oregon Coast are proposed in Warrenton and Coos Bay. The Coos Bay project would also support the first power generation plant on the Coast. These projects are the focus of several State, Federal, and local permitting issues, including whether they are consistent with the Coastal Zone Management Act.

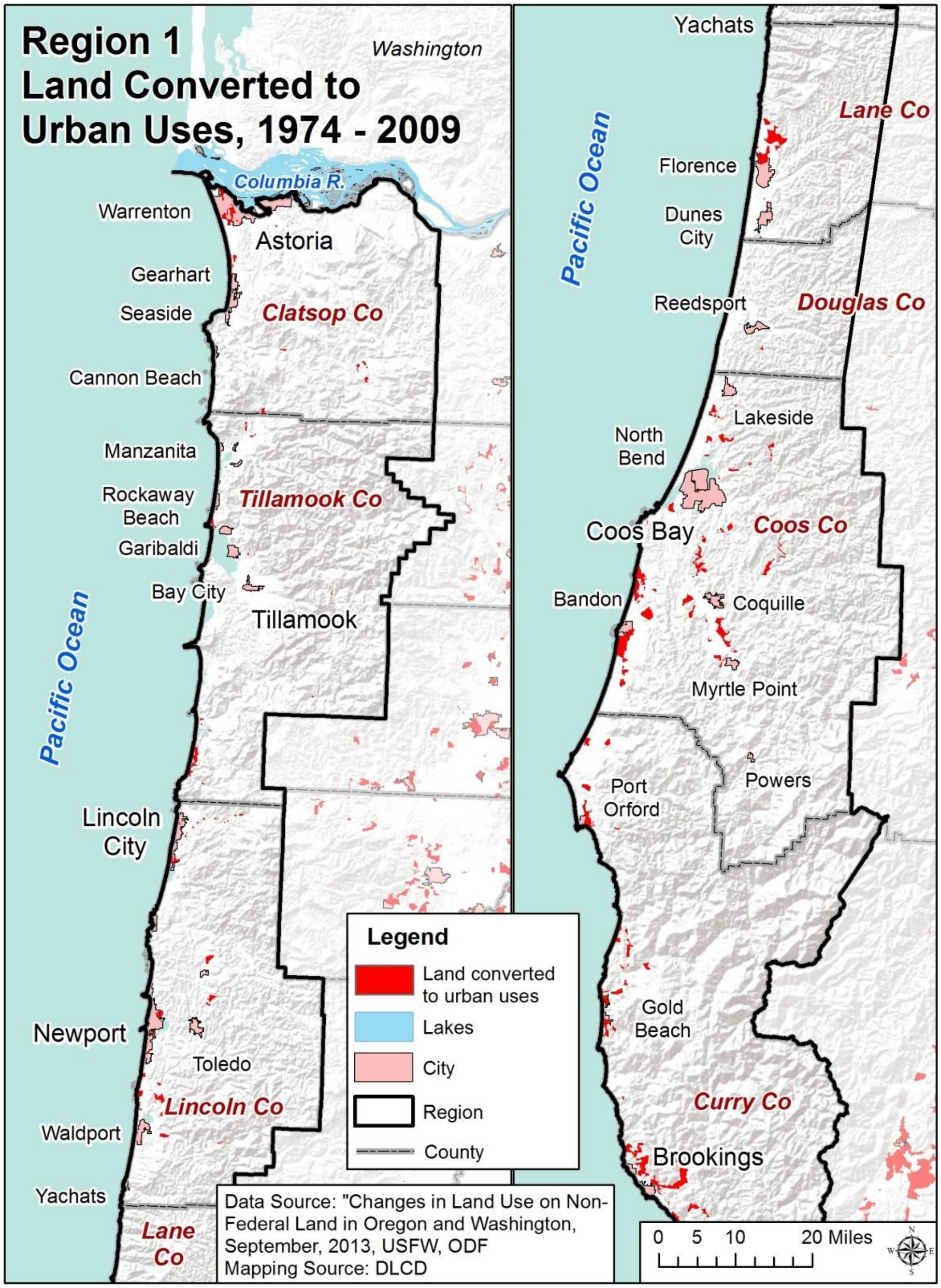
During 2012-2013, the Department of Geology and Mineral Industries released new tsunami inundation maps displaying five scenarios of a potential impact of a Cascadia Subduction Zone tsunami, reflecting the full range of what was experienced in the past and is projected for the future. Then in January, 2014, the Department of Land Conservation and Development distributed *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf). This guide is intended to help communities develop land use planning strategies to reduce tsunami hazard risk.

Figure 2-90. Region 1 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-91. Region 1 Land Converted to Urban Uses, 1974–2009



Source: Lettman (2013), http://www.oregon.gov/odf/RESOURCE_PLANNING/land_use_in_OR_WA_web_edited.pdf

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Over 71% of the region's housing stock is single-family homes. There are roughly the same share of multi-family units and mobile units across the region, 14%. Fifty-eight percent of all mobile homes are located in Coos and Lincoln Counties. In Curry County almost a quarter of all homes are mobile units. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-72. Housing Profile for Region 1, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 1	113,554	81,174	71.5%	16,310	14.4%	15,440	13.6%
Clatsop	21,563	15,669	72.7%	4,586	21.3%	1,282	5.9%
Coos	30,569	22,105	72.3%	3,867	12.7%	4,468	14.6%
Curry	12,569	7,980	63.5%	1,439	11.4%	2,971	23.6%
Lincoln	30,516	20,998	68.8%	4,777	15.7%	4,490	14.7%
Tillamook	18,337	14,422	78.6%	1,641	8.9%	2,229	12.2%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-73) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for a Cascadia Subduction Zone (CSZ) catastrophic earthquake event (Judson, 2012). Therefore, homes built before 1994 within an earthquake hazard zone are more vulnerable to damage and loss caused by seismic events. Less than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. Note: This does not reflect the number of structures that are exposed to seismic activity.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Almost 40% of the region's housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than 47% of homes in Clatsop and Coos Counties were built prior to 1970. Note: This does not reflect the number of structures that are built within special flood hazard areas.

Table 2-73. Age of Housing Stock in Region 1, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 1	113,554	44,465	39.2%	37,214	32.8%	31,875	28.1%
Clatsop	21,563	10,236	47.5%	5,474	25.4%	5,853	27.1%
Coos	30,569	14,448	47.3%	9,547	31.2%	6,574	21.5%
Curry	12,569	3,423	27.2%	5,228	41.6%	3,918	31.2%
Lincoln	30,516	10,072	33.0%	11,106	36.4%	9,338	30.6%
Tillamook	18,337	6,286	34.3%	5,859	32.0%	6,192	33.8%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood damage is minimized. **Table 2-74** shows the initial and current FIRM effective dates for Region 1 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-74. Community Flood Map History in Region 1

	Initial FIRM	Current FIRM
Clatsop County	July 3, 1978	Sept. 17, 2010
Astoria	Aug. 1, 1978	Sept. 17, 2010
Cannon Beach	Sept. 1, 1978	Sept. 17, 2010
Gearhart	May 15, 1978	Sept. 17, 2010
Seaside	Sept. 5, 1979	Sept. 17, 2010
Warrenton	May 15, 1978	Sept. 17, 2010
Coos County	Nov. 15, 1984	Mar. 17, 2014
Bandon	Aug. 15, 1984	Mar. 17, 2014
Coos Bay	Aug. 1, 1984	Mar. 17, 2014
Coquille	Sep. 28, 1984	Mar. 17, 2014
Lakeside	Aug. 1, 1984	Mar. 17, 2014
Myrtle Point	July 16, 1984	Mar. 17, 2014
North Bend	Aug. 1, 1984	Mar. 17, 2014
Curry County	Apr. 3, 1978	Sep. 25, 2009
Brookings	Sep. 18, 1985	Sep. 25, 2009
Gold Beach	Nov. 15, 1985	Sep. 25, 2009
Port Orford	Jan. 29, 1980	Sep. 25, 2009
Douglas County	Dec. 15, 1978	Feb. 17, 2010
Reedsport	Apr. 3, 1984	Feb.17, 2010
Lane County	Dec. 18, 1985	June 2, 1999
Dunes City	Mar. 24, 1981	June 2, 1999 (M)
Florence	May 17, 1982	June 2, 1999
Lincoln	Sep. 30, 1980	Dec. 18, 2009
Depoe Bay	Oct. 15, 1980	Dec. 18, 2009
Lincoln City	Apr. 17, 1978	Dec. 18, 2009
Newport	Apr. 15, 1980	Dec. 18, 2009
Siletz	Mar. 1, 1979	Dec. 18, 2009
Toledo	Mar. 1, 1979	Dec. 18, 2009
Waldport	Mar. 15, 1979	Dec. 18, 2009
Yachats	Mar. 1, 1979	Dec. 18, 2009
Tillamook County	Aug. 1, 1978	Aug. 20, 2002
Bay City	Aug. 1, 1978	Aug. 1, 1978
Garibaldi	Apr. 17, 1978	Apr. 17, 1978
Manzanita	May 1, 1978	Jan. 12, 1982
Nehalem	Apr. 3, 1978	Dec. 7, 1982
Rockaway	Sep. 29, 1978	Oct. 12, 1982
Tillamook, City	May 1, 1978	Apr. 16, 2004
Wheeler	Nov. 16, 1977	Nov. 16, 1977

Note: M means no base flood elevation.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 1 can be found in **Table 2-75**. The region contains 4.6% of the total value of state-owned/leased critical/essential facilities, valued at over $336 million. A third of these facilities are located in Clatsop County.

Table 2-75. Value of State-Owned/Leased Critical and Essential Facilities in Region 1

	Total Property Value (State Facilities)	Percent of State Total
Oregon	$7,339,087,023	100%
Region 1	$336,073,104	4.6%
Clatsop	$116,767,199	1.6%
Coos	$59,977,786	0.8%
Curry	$13,782,834	0.2%
Douglas	$3,063,701	0.0%
Lane	$43,742,674	0.6%
Lincoln	$38,634,005	0.5%
Tillamook	$60,104,905	0.8%

Source: DOGAMI

Built Environment Trends and Issues

Trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Most counties in Region 1 experienced little development over the last 5 years. The exceptions are Tillamook and Curry Counties, where population increased by roughly 30% and the number of housing units increased by 40%.

New tsunami inundation maps created by DOGAMI provide coastal communities new tsunami risk information. In response, DLCD's publication *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (http://www.oregon.gov/lcd/ocmp/docs/publications/tsunamiguide20140108.pdf) was developed to help communities develop land use planning strategies to reduce tsunami hazard risk.

The region has nearly double the state's percentage of mobile homes — Curry County has the region's highest percentage. Almost half of all housing in Clatsop and Curry Counties was built prior to 1970 — prior to current seismic and floodplain management building standards. The cities in Tillamook County have FIRMs that are not as up to date as other areas of the state and therefore may not accurately represent flood risk.

2.3.1.3 Hazards and Vulnerability

Coastal Hazards

Characteristics

The Pacific Northwest (PNW) coast of Oregon is without doubt one of the most dynamic coastal landscapes in North America, evident by its long sandy beaches, sheer coastal cliffs, dramatic headlands and vistas, and ultimately the power of the Pacific Ocean that serves to erode and change the shape of the coast. Coastal communities in Oregon are increasingly under threat from a variety of natural hazards, including coastal erosion (both short and long term), landslides, earthquakes, and potentially catastrophic tsunamis generated by the Cascadia Subduction Zone (CSZ). Over time, these hazards are gradually being compounded, in part due to the degree of development that has evolved along the Oregon coast in recent decades. A particular concern is that the local geology and geomorphology of the region have restricted development to low-lying areas, chiefly along dunes, barrier spits, or along coastal bluffs present along the open coast that are subject to varying rates of erosion, and to low-lying areas adjacent to the numerous estuaries that make up the coast. All of these sites are highly susceptible to increased impacts as erosion processes and flood hazards intensify, driven by rising sea level and increased storminess.

Historic Coastal Hazard Events

Table 2-76. Historic Coastal Erosion and Flood Hazard Events in Region 1

Date	Location	Description
Jan. 1914	Newport	damage (Nicolai Hotel)
1931	Rockaway	coastal damage from December storm
Oct–Dec. 1934	Waldport and Rockaway	flooding (Waldport) coastal damage (Rockaway Beach)
Dec. 1935	Cannon Beach and Rockaway Beach	coastal damage
Jan. 1939	coastwide	severe gale; damage coastwide severe flooding (Seaside, and Ecola Creek near Cannon Beach): • multiple spit breaches (southern portion of Netarts Spit) • storm damage (along the shore of Lincoln City and at D River) • flooding (Waldport) • extensive damage (Sunset Bay Park) • storm surge overtopped foredune (Garrison Lake plus Elk River lowland)
Dec. 1940	Waldport	flooding
1948	Newport	wave damage (Yaquina Arts Center)
Jan. 1953	Rockaway	70-ft dune retreat; one home removed
Apr. 1958	Sunset Bay State Park and Newport	flooding (Sunset Bay); wave damage (Yaquina Arts Center in Newport)
Jan–Feb. 1960	Sunset Bay State Park	flooding
1964	Cannon Beach	storm damage
Dec. 1967	Netarts Spit, Lincoln City, Newport, and Waldport	damage: coastwide State constructed wood bulkhead to protect foredune along 600 ft section (Cape Lookout State Park campground) flooding and logs (Lincoln City) wave damage (Yaquina Arts Center, Newport) flooding (Waldport) storm damage (Beachside State Park washed up driftwood (Bandon south jetty parking lot)
1971–73	Siletz Spit	high-tide line eroded landward by 300 ft February 1973, one home completely destroyed; spit almost breached logs through Sea Gypsy Motel (Nov. 1973)
1982–83	Alsea Spit	northward migration of Alsea Bay mouth; severe erosion
1997–98	Lincoln and Tillamook Counties	El Niño winter (second strongest on record); erosion: considerable
Jan–Mar. 1999	coastwide	five storms; coastal erosion extensive, including: • significant erosion (Neskowin, Netarts Spit, Oceanside, Rockaway beach) • overtopping and flooding (Cape Meares) • significant erosion along barrier beach (Garrison Lake) • overtopping 27-ft-high barrier
Dec. 2007	Tillamook and Clatsop Counties	wind storm

Sources: Schlicker et al. (1972, 1973); Stembridge (1975); Komar and McKinney (1977); Komar (1986, 1987, 1997, 1998); Allan et al. (2003, 2009), and many others.

Table 2-77 lists historic landslides at the Oregon Coast. Landsliding in these areas will almost certainly continue due to the combination of steep terrain, local geology (seaward dipping tertiary sediments), and high precipitation.

Table 2-77. Historic Coastal Landslide Hazards in Region 1

Date	Location	Description
Ongoing	Clatsop County (Cannon Beach)	several large landslides exist along the Clatsop County coastline, particularly in the vicinity of Cannon Beach; these include: • large landslide block failure at Ecola State Park occurred in 1961 • Silver Point landslide in 1974 damaged several homes and affected US-101 • Slow-moving S-Curves landslide (1995) • landslide/rockfall at the south end of Falcon Cove about 2003
Ongoing	Tillamook County	several large landslides exist along the Tillamook County coastline; these include: • The Capes development on the north side of Netarts Bay and south of Oceanside • a large active landslide exists on the north side of Cape Meares and affects the southern portion of the community of Cape Meares • the Three Capes landslide, located to the south of Tierra del Mar, occurred during the 1997-98 El Niño and affected the Three Capes Scenic byway road; this landslide has been remediated • a small landslide failure developed on Aug. 21, 2011, above Happy Camp in Netarts; this landslide has been remediated
Ongoing	Lincoln County (Newport area)	Several large translational landslide blocks exist throughout Lincoln County. The majority of these are in the Newport/Beverly Beach area and include: • Cape Foulweather landslide failed in Dec. 1999 (since remediated) • Johnson Creek • Carmel Knoll • Moolack Shores • NW 73rd St landslide • Schooner Creek • landslide block failed immediately adjacent to the Jump-Off Joe headland destroying multiple homes over a period in 1942-1943 • Mark St
Jan. 2000	Lane County	Cape Cove landslide (immediately adjacent to the tunnel located between the Heceta Head lighthouse and the Sea Lion caves)
Ongoing	Curry County	Multiple large active landslide block failures exist along US-101 along the Curry County coastline; these include: • Gregory Point landslide 2.2 miles south of Port Orford occurred in Jan. 2006 • multiple landslides between Gregory Point and Humbug Mountain • Arizona landslide south of Humbug Mountain, north of Ophir

Sources: Schlicker et al. (1961, 1972, 1973); Komar (1997); Allan and Hart (2009); Witter et al. (2009); SLIDO web database (http://www.oregongeology.org/slido/index.html)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience coastal erosion is shown in **Table 2-78**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—).

Table 2-78. Local Probability Assessment of Coastal Erosion in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	—	H	—	—	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The erosion of the Oregon coast is exceedingly complex, reflecting processes operating over both short and long time scales, and over large spatial scales. However, the most significant erosion effects are largely controlled by high-magnitude (relatively infrequent) events that occur over the winter (the months of October to March), when wave heights and ocean water levels tend to be at their highest.

Previous analyses of extreme waves for the Oregon coast estimated the "100-year" (1%) storm wave to be around 33 feet. In response to a series of large wave events that occurred during the latter half of the 1990s, the wave climate was subsequently re-examined and an updated projection of the 1% storm wave height was determined, which is now estimated to reach approximately 47 to 52 feet (**Table 2-79**), depending on which buoy is used. These estimates are of considerable importance to the design of coastal engineering structures and in terms of defining future coastal erosion hazard zones.

Table 2-79. Projection of Extreme Wave Heights for Various Recurrence Intervals: Each Wave Height Is Expected to Occur on Average Once during the Recurrence Interval

	Extreme Wave Heights (feet)	
Recurrence Interval (years)	**NDBC buoy #46002* (Oregon)**	**NDBC buoy #46005+ (Washington)**
10	42.5	41.7
25	46.2	44.0
50	48.8	—
75	50.1	45.7
100	51.2	47.1

Sources: *DOGAMI analyses; +Ruggiero et al. (2010)

In order to understand the potential extent of erosion for different communities, DOGAMI has completed coastal erosion hazard maps for Lincoln, Tillamook, and Clatsop Counties, as well in the Nesika Beach area in Curry County. Maps were undertaken for these areas mainly because they contain the largest concentration of people living along the coastal strip, and in the case of Nesika Beach in response to a specific request by the Oregon Department of Land Conservation and Development. In all cases, the maps depict erosion hazard zones that fall into four categories: Active, High, Medium, and Low. The High and Medium hazard zones reflect erosion associated with a 2% and 1% storm, respectively. The Low hazard zone includes a 1% storm coupled with a Cascadia subduction zone earthquake and has a much lower probability of occurrence. The erosion scenarios were defined using a combination of probabilistic (waves) and deterministic (water levels) approaches.

In July 2014, DOGAMI completed new updated maps for the dune-backed beaches in Tillamook County using a fully probabilistic approach of the waves and water levels to map the erosion hazard zones. The revised modeling used three total water level scenarios (10%, 2% and 1% events) produced by the combined effect of extreme wave runup (R) plus the measured tidal elevation (T), and erosion due to sea level rise (low/mean/maximum estimates) at 2030, 2050, and 2100. In total 81 scenarios of coastal erosion were modeled; an additional two scenarios were also modeled that considered the effects of a Cascadia subduction zone earthquake, and the effects of a single (1%) storm, where the storm's duration was taken into account. The completed study ultimately recommended five hazard zones for consideration. A sixth hazard zone was also proposed. This latter zone was defined using a more sophisticated dune erosion model that accounted for the effect of the duration of a storm. Table 2-80 provides the calculated erosion associated with an extreme (1%) storm for Tillamook County, after accounting for the storms duration. The results indicate that the storm induced erosion ranges from about 47 to 73 ft. When the duration of the storm is removed from consideration the amount of beach and dune erosion increases substantially to about 70 to 260 ft. Finally, modeling coastal change by nature is fraught with large uncertainty that is a function of variations in the morphology of the beach and the beach sediment budget.

Table 2-80. Storm-Induced Erosion Defined for Selected Sites in Tillamook County after Having Accounted for the Duration of the Event

	Maximum 1% Erosion Distance	
	(meters)	(feet)
Neskowin	20.6	67.6
Nestucca Spit	14.5	47.6
Sand Lake	18.7	61.4
Netarts Spit	22.2	72.8
Bayocean Spit	17.6	57.7
Rockaway	19.9	65.3
Nehalem Spit	19.3	63.3

Modeled erosion is for a 1% storm.

Although some coastal landslide failures have been remediated, the majority are considered active and hence will continue to move and fail. Without detailed knowledge of every slide, it is impossible to assign probabilities of failure. However, it is a high probability that all of these existing landslide sites would be activated following a Cascadia earthquake, and more new landslides would occur.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to coastal erosion is shown in Table 2-81. In some cases, counties either did not rank a particular hazard or did not find it to be significant, noted with a dash (—).

Table 2-81. Local Vulnerability Assessment of Coastal Erosion in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	—	L	—	—	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Department of Geology and Mineral Industries is the agency with primary oversight of coastal hazards. Based on agency staff review of the available hazard data, DOGAMI ranks Tillamook, Lincoln, Clatsop, and Curry Counties one through four respectively as the counties most vulnerable to coastal hazards in the state.

Coastal hazards in Coos, Lane, and Douglas Counties are considered to be generally negligible. This is because the bulk of these coastlines have little population base and hence are largely unmodified. In Coos County, coastal hazards can be found in a few discrete communities such as adjacent to the Coquille jetty in Bandon and along Lighthouse Beach near Cape Arago. Similarly, coastal hazards in Lane County are confined almost entirely to the Heceta Beach community and adjacent to the Siuslaw River mouth, particularly within the lower estuary mouth where development lines coastal bluffs that is gradually being eroded by riverine processes.

The counties and communities most vulnerable to coastal hazards on the Oregon Coast include:

Tillamook County (ranked #1) —

- Neskowin (erosion and flooding),
- Pacific City (erosion),
- Tierra del Mar (erosion and flooding),
- Cape Meares (flooding),
- Twin Rocks (erosion and flooding), and
- Rockaway Beach(erosion and flooding);

Lincoln County (ranked #2) —

- Yachats to Alsea Spit (erosion),
- Waldport (erosion and flooding),
- Alsea Spit (erosion),
- Seal Rock (erosion and landsliding),
- Ona Beach to Southbeach (erosion and landsliding),
- Newport (landsliding),
- Beverly Beach (erosion and landsliding),
- Gleneden Beach to Siletz Spit (erosion, landsliding, and flooding), and
- Lincoln City (erosion and landsliding);

Clatsop County (ranked #3) —

- Falcon Cove (erosion and landsliding),
- Arch Cape (erosion and flooding),
- Tolovana to Cannon Beach (erosion and flooding), and
- Seaside (Flooding);

Curry County (ranked #4) —

- Nesika Beach (erosion and landsliding), and
- Port Orford (flooding at Garrison Lake).

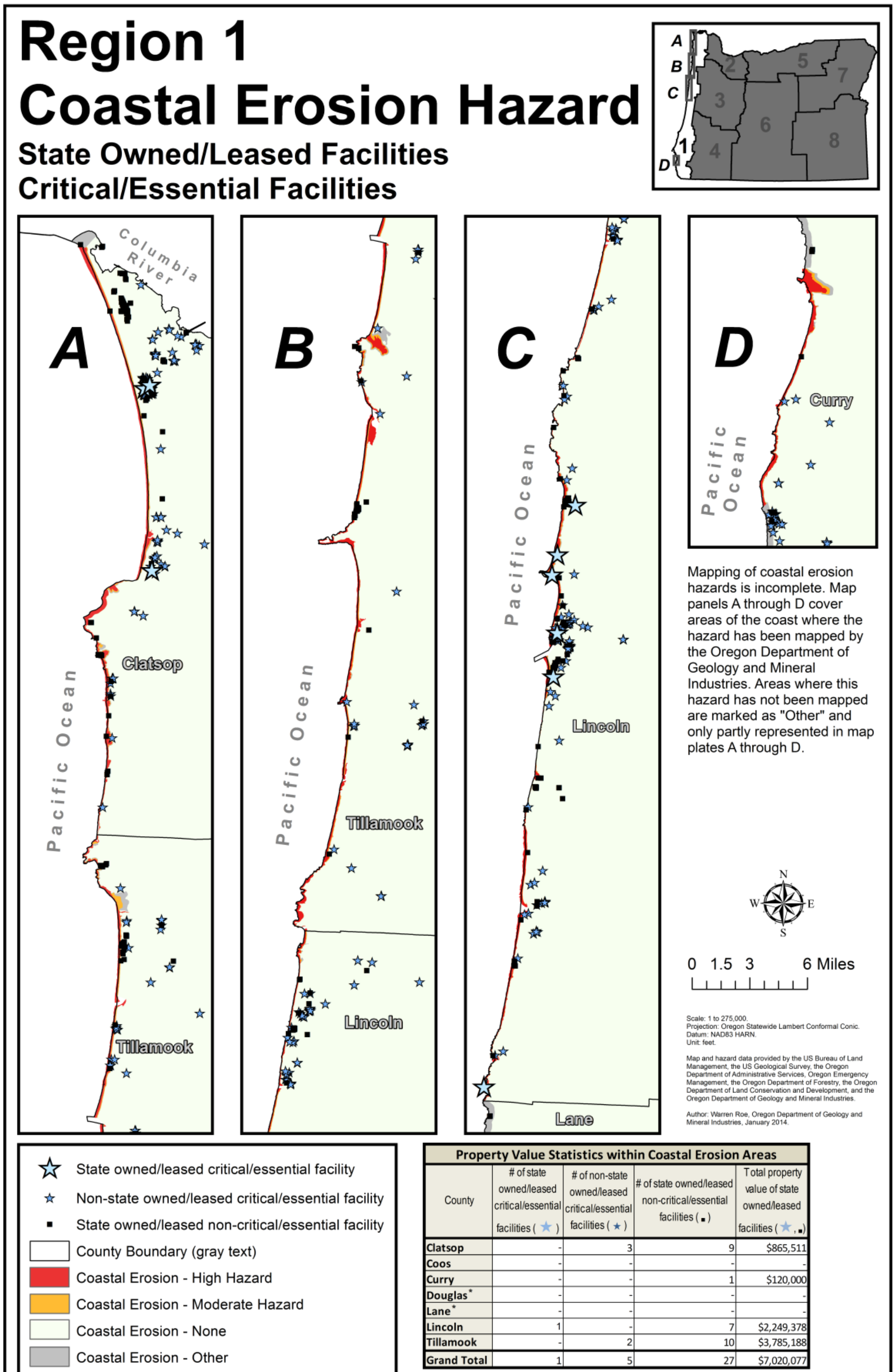
Coastal hazards in Lane and Douglas Counties are considered to be negligible.

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a State facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.)

Of the 5,693 state facilities evaluated, 28 are currently located within a coastal erosion zone in Region 1, representing a value of approximately $7 million in property value (**Figure 2-92**). One of these (ODOT Cape Perpetua Radio building) is identified as a critical or essential facility. Five additional critical/essential facilities, not state owned/leased, are also located in a Region 1 coastal erosion zone.

Figure 2-92. State-Owned/Leased Facilities and Critical/Essential Facilities in a Coastal Erosion Zone in Region 1



Property Value Statistics within Coastal Erosion Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	-	3	9	$865,511
Coos	-	-	-	-
Curry	-	-	1	$120,000
Douglas*	-	-	-	-
Lane*	-	-	-	-
Lincoln	1	-	7	$2,249,378
Tillamook	-	2	10	$3,785,188
Grand Total	1	5	27	$7,020,077

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Droughts

Characteristics

Drought is not a common occurrence in Region 1. Since 1995, the Governor has declared drought only once, in Coos and Curry Counties during 2002 when much of the state was facing drought conditions. Although Region 1 is less vulnerable to drought impacts than most of Oregon, droughts can still be problematic, especially given that they often precede major wildfires. Severe drought conditions resulted in the four disastrous Tillamook fires (1933, 1939, 1945, 1951), collectively known as the Tillamook Burn.

Historic Drought Events

Table 2-82. Historic Droughts in Region 1

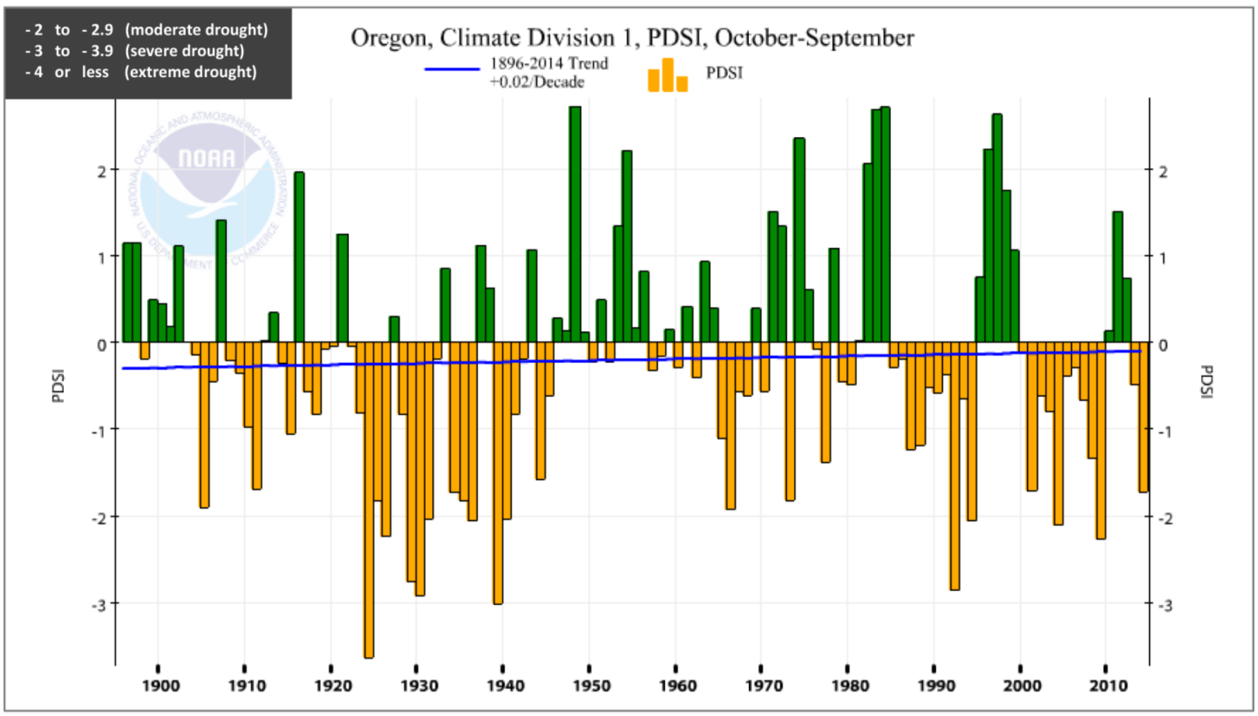
Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1930	Regions 1, 2, 3, 5, 6, & 7	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state
1939	statewide	Water Year 1939 was one of the more significant drought years in Region 1 during that period; the second of the three Tillamook Burns started in 1939
1992	statewide, especially Regions 1, 2, 3, 4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1; the winter of 1991-1992 was a moderate El Niño event, which can manifest itself in warmer and drier winters in Oregon; Governor declared a drought for all 36 counties in September 1992
2001-02	affected all regions, except Regions 2 & 3	the second most intense drought in Oregon's history; 18 counties with state drought declaration (2001); 23 counties state-declared drought (2002); some of the 2001 and 2002 drought declarations were in effect through June or December 2003; Coos and Curry Counties in Region 1 were not under a drought declaration until December of 2002

Sources: Taylor and Hatton (1999); NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker, http://www.wrcc.dri.edu/wwdt; personal communication, Kathie Dello, Oregon Climate Service, Oregon State University

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. **Figure 2-93** shows years where drought or dry conditions affected the coastal areas of Oregon (Climate Division 1). Based on this index, Water Years 1924 and 1939 were severe drought years for the coastal region.

U.S Climate Divisions

Figure 2-93. Palmer Drought Severity Index for Region 1



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience drought is shown in **Table 2-83**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-83. Local Probability Assessment of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	M	H	—	—	—	H	L

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis should be completed statewide in order to analyze and compare the risk of drought across the state.

Based on limited data, there is a low probability of drought occurring in Region 1.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-84**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-84. Local Vulnerability Assessment of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	M	M	—	—	—	L	L

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor-declared drought declarations since 1992, Region 1 could be considered less vulnerable to drought impacts than many other parts of the state. Regardless, even short term droughts can be problematic. Potential impacts to community water supplies are the greatest threat. Long-term drought periods of more than a year can impact forest conditions and set the stage for potentially devastating wildfires.

Earthquakes

Characteristics

The geographic position of Region 1 makes it susceptible to earthquakes from three sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) shallow crustal events within the North America Plate. All have some tie to the subducting or diving of the dense, oceanic Juan de Fuca Plate under the lighter, continental North America Plate. Stresses occur because of this movement.

There is no historic record of major damaging crustal earthquakes centered in Region 1 in the past 156 years, although the region has experienced small crustal earthquakes and crustal earthquakes that originated outside the region. The geologic record shows that movement has occurred along numerous offshore faults as well as a few onshore faults in Coos and Tillamook Counties. The faulting has occurred over the last 20,000 years. Intraplate earthquakes are very rare in Oregon, although such earthquakes originating outside of the state have been felt in Region 1. It is believed that the M7.3 near Brookings in 1873 was an intraplate quake.

In Region 1, geologic earthquake hazards include severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding from local and distant tsunamis. The severity of these effects depends on several factors, including the distance from earthquake source, the ability of soil and rock to conduct seismic energy composition of materials, and ground and ground water conditions.

Historic Earthquake Events

Table 2-85. Significant Earthquakes Affecting Region 1

Date	Location	Magnitude (M)	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area, Oregon	7.3	intraplate event; origin probably Gorda block of the Juan de Fuca plate; chimneys fell (Port Orford, Grants Pass, and Jacksonville); no aftershocks
Nov. 1962	Portland, Oregon	5.2 to 5.5	crustal event; damage to many homes (chimneys, windows, etc.)
Mar. 1993	Scotts Mills, Oregon	5.6	crustal event; FEMA-985-DR-OR; damage: $28 million (homes, schools, businesses, state buildings [Salem])
Sep. 1993	Klamath Falls, Oregon	5.9 to 6.0	crustal event; FEMA-1004-DR-OR; two earthquakes; fatalities: two; damage $7.5 million (homes, commercial, and government buildings)

*BCE: Before Common Era.

Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience earthquakes is shown in **Table 2-86**.

Table 2-86. Local Probability Assessment of Earthquake in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	M	M	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

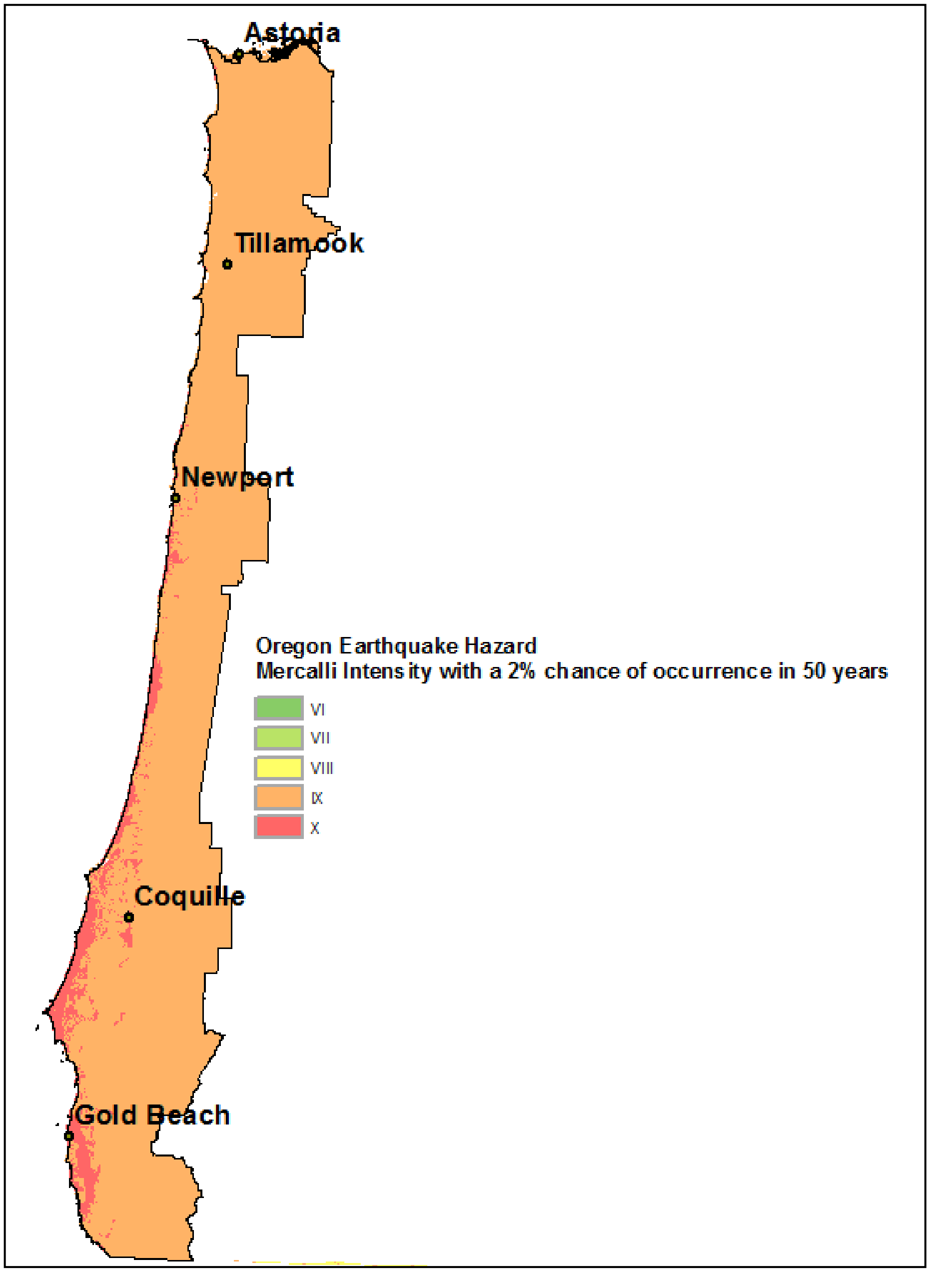
The probability of damaging earthquakes varies widely across the state. In Region 1, the hazard is dominated by Cascadia Subduction Zone (CSZ) earthquakes originating from a single fault with a well-understood recurrence history.

Figure 2-94 shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-94**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about

240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-94. Probabilistic Earthquake Hazard in Region 1



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-87**.

Table 2-87. Local Vulnerability Assessment of Earthquakes in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Of the 15 counties in Oregon with the highest expected damages and losses based on the 500-year model CSZ earthquake the following counties are located in in Region 1:

- Lane,
- Coos,
- Lincoln,
- Clatsop, and
- Douglas.

Region 1 is especially vulnerable to earthquake hazards. This is because of the built environment's proximity to the CSZ, regional seismicity, topography, bedrock geology, and local soil profiles. For example, a large number of buildings are constructed of unreinforced masonry (URM) or are constructed on soils that are subject to liquefaction during severe ground shaking. Also, some principal roads and highways are susceptible to earthquake-induced landslides. Bridges and tunnels need to be retrofitted to withstand ground shaking and the dams should be able to withstand earthquake forces to prevent uncontrolled releases. This is especially important as 12 dams in Region 1 have been designated as "high hazard." Problem areas within the region are readily identifiable online at Oregon's hazard viewer at http://www.oregongeology.org/sub/hazvu/index.htm and on earthquake hazard maps prepared by DOGAMI (available at website: http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm).

Table 2-88 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-88. Region 1 School and Emergency Response Building Collapse

	Level of Collapse Potential			
County	**Low (< 1%)**	**Moderate (>1%)**	**High (>10%)**	**Very High (100%)**
Clatsop	24	19	20	1
Tillamook	19	9	23	5
Lincoln	30	18	12	3
Lane*	8	4	5	—
Douglas**	3	2	10	—
Coos	41	11	48	7
Curry	15	10	10	2

*Includes only the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome.

**Includes only the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007), available at http://www.oregongeology.org/sub/projects/rvs/default.htm

Other useful resources for planning for earthquakes include the following:

- **Maps of earthquake hazard areas:** DOGAMI has mapped all of the Region 1 counties and has statewide GIS earthquake hazard layers available through Open-File Report O-13-06 (Madin & Burns, 2013).
- **Map of coastal critical facilities vulnerable to hazards:** DOGAMI has developed these maps for all Region 1 counties. For more information about critical facilities in Region 1 see State-Owned/Leased Facilities and Critical/Essential Facilities.
- **Environmental geology maps:** DOGAMI has developed these maps for all Region 1 counties (DOGAMI Bulletins 74, 79, 81, 84, 85, and 87).
- Nuclear energy and hazardous waste sites inventories: No Region 1 counties have nuclear facilities.

DOGAMI also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

Table 2-89 shows the projected dollar losses based on both models. Please note that the losses are in 1999 dollars. Since that time, additional growth and inflation has occurred, thus the values are too low. However, the relative rankings are between the counties likely remains the same. For example, the economic base (column 2) for Clatsop County remains lower than Coos County, and the expected losses from a magnitude 8.5 Cascadia earthquake (column 3) in Clatsop County remain lower than Coos County.

Table 2-89. Projected Dollar Losses in Region 1, Based on an M8.5 Subduction Event and a 500-Year Model

Region 1 Counties	Economic Base in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from an M8.5 CSZ Event[1]	Greatest Absolute Loss in Thousands (1999) from a 500-Year Model[2]
Clatsop	$2,198,000	$549,000	$760,000
Coos	$3,263,000	$1,339,000	$1,429,000
Curry	$1,093,000	$371,000	$388,000
Douglas[3]	$4,631,000	$275,000	$546,000
Lane[3]	$15,418,000	$1,614,000	$3,044,000
Lincoln	$2,668,000	$624,000	$793,000
Tillamook	$1,539,000	$226,000	$364,000

Notes:

[1] "…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[2]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[3]Entire county.

Source: Wang and Clark (1999)

Table 2-90 shows the projected dollar losses associated with the magnitude 8.5 Cascadia model.

Table 2-90. Estimated Losses in Region 1 Associated with a M8.5 Subduction Zone Event

	Region 1 Counties						
	Clatsop	**Coos**	**Curry**	**Douglas**[1]	**Lane**[1]	**Lincoln**	**Tillamook**
Injuries	298	854	221	151	1,036	358	132
Deaths	6	16	3	2	19	7	3
Displaced Households	788	2,069	430	255	2,345	592	158
Operational the "day after" the event[2]:							
Fire stations	16%	10%	9%	66%	49%	26%	31%
Police stations	15%	6%	5%	57%	42%	22%	44%
Schools	16%	8%	6%	44%	46%	19%	32%
Bridges	58%	44%	34%	74%	76%	51%	58%
Economic losses to[2]:							
Highways	$18 mil	$44 mil	$48 mil	$43 mil	$39 mil	$16 mil	$25 mil
Airports	$5 mil	$20 mil	$11 mil	$5 mil	$11 mil	$9 mil	$7 mil
Communications	$6 mil	$25 mil	$18 mil	$7 mil	$11 mil	$9 mil	$5 mil
Debris Generated (thousands of tons)	383	853	267	222	1,341	446	158

Remarks:

The Cascadia Subduction Zone (CSZ) is the most dangerous fault in Oregon. The entire coastline is essentially the epicenter. The earthquake could be M8.5 (or M9.0). The event might last as long as 4 minutes. Within a few minutes a tsunami would follow. (Tsunami damages are not included in the estimates for this earthquake but would dramatically increase losses for coastal counties.) A CSZ earthquake could affect a very large area. If the entire fault ruptures, destruction could occur from northern California to Canada. The number of deaths and injuries depends on the time of day, building type, occupancy class, and traffic pattern. (DOGAMI Special Paper 29 [Wang and Clark, 1999], p. 4).

[1]Entire county.

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

Source: Wang and Clark (1999)

Table 2-91 shows the estimated losses associated with the 500-year model.

Table 2-91. Estimated Losses in Region 1 Associated with a 500-Year Model

	Clatsop	Coos	Curry	Douglas[1]	Lane[1]	Lincoln	Tillamook
Injuries	397	845	212	294	2,254	436	181
Deaths	8	16	3	4	45	9	4
Displaced households	1,182	2,521	486	534	4,543	847	275
Economic losses for buildings[2]	$760 mil	$1.4 bil	$328 mil	$546 mil	$3 bil	$792 mil	$364 mil
Operational the "day after" the event[3]:							
Fire stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Police Stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schools	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Economic losses to[2]:							
Highways	$33 mil	$49 mil	$44 mil	$69 mil	$74 mil	$22 mil	$39 mil
Airports	$7 mil	$20 mil	$12 mil	$9 mil	$20 mil	$12 mil	$8 mil
Communications	$8 mil	$2 mil	$15 mil	$12 mil	$20 mil	$10 mil	$6 mil
Debris generated (thousands of tons)	474	864	261	411	2,424	525	224

Note: Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[1]Entire county.

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated.

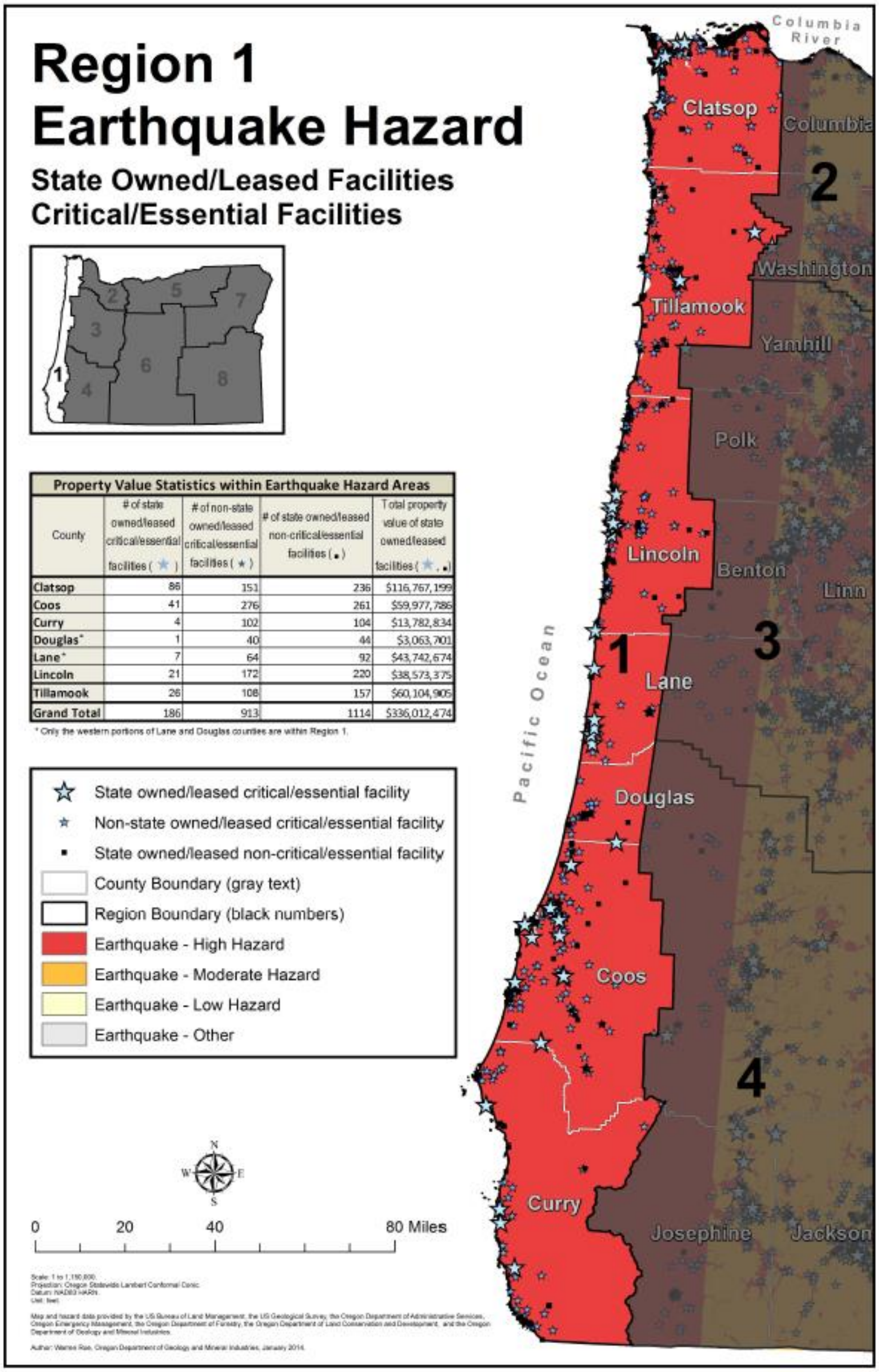
Source: Wang and Clark (1999)

STATE-OWNED/LEASED FACILITIES AND CRITICAL/ESSENTIAL FACILITIES

The following information is based on a state facility and facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of 5,693 state facilities evaluated, 1,300 totaling over $336 million worth of property are located in an earthquake hazard zone in Region 1 (**Figure 2-95**). Among the 1,141 state-owned/leased critical/essential facilities, 186 are in an earthquake hazard zone in Region 1. Additionally, 913 non-state-owned/leased critical/essential facilities in Region 1 are located in an earthquake hazard zone.

Figure 2-95. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 1



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	86	151	236	$116,767,199
Coos	41	276	261	$59,977,786
Curry	4	102	104	$13,782,834
Douglas*	1	40	44	$3,063,701
Lane*	7	64	92	$43,742,674
Lincoln	21	172	220	$38,573,375
Tillamook	26	108	157	$60,104,905
Grand Total	186	913	1114	$336,012,474

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification*. According to that report, seismic lifelines in Region 1 have the following vulnerabilities.

Region 1 has the most seismically vulnerable highway system of all the geographic zones and is the most difficult to access due to multiple geographic constraints. While it could be argued that the region's critical post-earthquake needs should dictate that all coastal area routes be Tier 1 (first priority roadways), the reality is that — to make the entire lifeline system resilient — the vulnerabilities in Region 1 are so extensive that the majority of the cost would be incurred for repairs done within this region. Furthermore, because of the high vulnerability of the region, it is paramount that emergency services and recovery resources are able to reach this region from other regions. Consequently, all needs are best served with a conservative Tier 1 backbone system, selected according to the criteria described earlier in this Plan.

The Tier 1 (first roadway priority) system in Region 1 consists of three access corridors:

- OR-30 from Portland to Astoria,
- OR-18 from the Willamette Valley to US-101 and north and south on US-101 between Tillamook and Newport, and
- OR-38 from I-5 to US-101 and north and south on US-101 from Florence to Coos Bay.

The Tier 2 (second roadway priority) system in Region 1 consists of three access corridors:

- US-26 from OR-217 in Portland to US-101 and north and south on US-101 from Seaside to Nehalem,
- OR-126 from the Valley to US-101 at Florence, and
- US-101 from Coos Bay to the California border.

The Tier 3 (third roadway priority) system in Region 1 would complete an integrated coastal lifeline system and consists of the following corridors:

- US-101 from Astoria to Seaside,
- US-101 from Nehalem to Tillamook,
- OR-22 from its junction with OR-18 to the Valley,
- OR-20 from Corvallis to Newport,
- OR-42 from I-5 to US-101, and
- US-199 from I-5 to the California border.

REGIONAL IMPACT. Coastal highways, most importantly US-101, will be fragmented in many areas. In some areas there are possible detours inland from US-101, but many of those routes are also vulnerable to ground shaking, landslides, and other hazards.

- Ground shaking: In Region 1 ground shaking will be intense and prolonged. Most unreinforced structures and many unreinforced roadbeds and bridges will be damaged to varying extents, and it is likely that many damaged areas will become impassable without major repairs.

- Landslides and Rockfall: Many areas along the coast highway, US-101, are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews on long stretches of the highway. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Tsunami: Some reaches of US-101 and connecting and parallel routes will be inundated by tsunami. Tsunami debris may block large areas of the street and highway network.
- Liquefaction: Structures in wetland, estuarine, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. The vulnerabilities studied in the OSLR project are geographic rather than jurisdictional. Other research suggests that the risks of a subduction zone seismic event are somewhat higher along the Southern Oregon Coast, but the risks assessed in this study pertain to the vulnerability of highway facilities in the case of a CSZ event and the higher vulnerabilities are generally low lying areas, active and ancient landslide and rockfall areas, and where critical bridges may not be easily repaired or detoured around. Vulnerability also relates to a current conditions context — high groundwater and saturated soils, high tides, and time of day as it relates to where people are relative to the highway system and other vulnerable facilities. Coos, Curry, Douglas, Lane, Lincoln, Tillamook, and Clatsop Counties are all highly vulnerable to a CSZ event.

Floods

Characteristics

In general, three types of flooding occur in Region 1: (a) riverine, (b) ocean flooding from high tides and wind-driven waves, and (c) flooding associated with a tsunami event. Tsunami flooding is not addressed in this section.

Riverine

There are two distinct periods of riverine flooding in Region 1 — winter and late spring — with the most serious occurring December through February. The situation is especially severe when riverine flooding, caused by prolonged rain and melting snow, coincides with high tides and coastal storm surges. In short, the rivers back up and flood the lowlands. This type of flooding is especially troublesome in the Tillamook Bay area where homes and livestock can be isolated for several days. Several northern coastal rivers carry heavy silt loads that originated in areas burned during the "Tillamook Burn" fires (1933 to 1951) or from areas covered with volcanic ash during the Mount St. Helens eruption (1980). Consequently, some rivers actually may be elevated above local floodplains, which increases flood hazards. The costs and long-term benefits of dredging these rivers have not been determined. **Table 2-92** lists the principal riverine flood sources in Region 1.

Ocean Flooding and Wave Action

Flooding from wind-driven waves is common during the winter, during El Niño events, and when spring and perigean tides occur. The Federal Emergency Management Agency has identified and mapped coastal areas subject to direct wave action (V zones) and sand dune over-topping (AH and AO zones). Direct wave action was especially severe during the winter storm events of 1972 (Siletz Spit), 1978 (Nestucca Spit), and the El Niño events of 1982-83 and 1997-98. Significant beach and cliff erosion occurred during these periods and a number of homes were destroyed. The following lessons were learned (and often forgotten between damaging events):

- Oregon coastal processes are complex and dynamic, sometimes eroding, sometimes aggrading;
- Some sections of the Oregon coast are rising in relation to ocean levels, others remain fairly constant or are becoming lower (Komar 1992, 40-41);
- Primary frontal dunes provide protection from ocean storms;
- Sand spits are not permanent features; and
- Erosion rates vary and are dependent on several factors including storm duration and intensity, composition of sea cliff, time of year, and impact of human activities (e.g., altering the base of sea cliffs, interfering with the natural movement of beach sand).

Historic Flood Events

Table 2-92. Historic Floods in Region 1

Date	Location	Description	Type of Flood
1813	NW Oregon	said to exceed "Great Flood" of 1861 (source: Native Americans)	unknown
Dec. 1861	coastal rivers	the "Great Flood"; largest flood of known magnitude on the Rogue	rain on snow
Feb. 1890	coastal rivers	widespread flooding; Siuslaw River dammed by a large debris flow	rain on snow
Jan. 1923	Lower Columbia	mild temperatures; large amount of rain; flooded roads and railroads	rain on snow
Mar. 1931	western Oregon	extremely wet and mild; saturated ground	rain on snow
Dec. 1933	northern Oregon	intense warm rains; Clatskanie River set record	rain on snow
Dec. 1937	western Oregon	heavy coastal rain; large number of debris flows	rain on snow
Oct. 1950	SW Oregon coast	heavy October rain	rain on snow
Dec. 1953	western Oregon	heavy rain accompanied major windstorm; serious log hazards on Columbia	rain on snow
Dec. 1955	Columbia and coastal streams	series of storms; heavy, wet snow; many homes and roads damaged	rain on snow
Dec. 1962	SW Oregon	severe flooding, especially the Rogue River	rain on snow
Mar. 1964	coast and Columbia River estuary	Ocean flooding	tsunami
Dec. 1964	entire state	two storms; intense rain on frozen ground	rain on snow
Jan. 1972	northern coast	severe flooding and mudslides; 104 evacuated from Tillamook	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt; rapid runoff	rain on snow
Dec. 1978	coastal streams	Intense warm rain; two fatalities on Yaquina River; widespread flooding	rain on snow
Feb. 1986	entire state	warm rain and melting snow; numerous homes evacuated	rain on snow
Feb. 1987	western Oregon	heavy rain; mudslides; flooded highways; damaged homes	rain on snow
Dec. 1989	Clatsop, Tillamook and Lincoln	warm Pacific storm system; high winds; fatalities; mudslides	rain on snow
Jan. 1990	W. Oregon	significant damage in Tillamook County; many streams had all-time records	rain on snow
Apr. 1991	Tillamook County	48-hour rainstorm. Wilson River 5 ft. above flood stage; businesses closed	rain on snow
Feb. 1996	NW Oregon	deep snow pack; warm temperatures; record-breaking rains	rain on snow
Nov. 1996	W. Oregon	record-breaking precipitation; flooding; landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 2005	Coos, Curry, and Douglas Counties	$2,840,000.00 in property damage (includes Jackson and Josephine Counties)	riverine
Nov. 2006	Tillamook County	heavy rains caused major flooding in Nehalem and Tillamook, causing $1 million in damage in Nehalem and $15 million in Tillamook	riverine

Date	Location	Description	Type of Flood
Nov. 2006	Lincoln County	Siletz River crested at 7 feet above flood stage	riverine
Dec. 2006	Coos County	two floods in Coos County on the Coquille River inundated several roads, including OR-42 and OR-42S	riverine
Dec. 2007	Clatsop County	storm total of 7.3 inches of rain, causing many rivers to overflow their banks. $9.15 million in damages	riverine
Dec. 2007	Columbia County	Nehalem (Vernonia)	riverine
Dec. 2007	Tillamook County	heavy rains led to flooding in Tillamook along the Wilson River damaging businesses, homes, the railroad to the Port; county-wide damages total 26 million	riverine
Dec. 2007	Lincoln County	Siletz River had moderate flooding, causing flood damage near Siletz and Lincoln City; total county-wide damages include $124,000 in damages inland and $31,000 damages for coastal property	riverine
Dec. 2007	Lane County	flooding along coast, $31,000 in property damage	riverine
Dec. 2007	Curry County	Rogue river exceeds flood stage, but no known damages	riverine
Dec. 2008	Tillamook County	heavy rainfall caused flooding in downtown Tillamook; estimate of $3.8 million in damages throughout Tillamook County	riverine
Jan. 2012	Coos, Curry, Lincoln, and Tillamook Counties	a severe winter storm including flooding, landslides, and mudslides affected mostly the southern Oregon coastal counties	riverine
Nov. 2012	Curry and Josephine Counties	heavy precipitation caused over $4 million in damages to public infrastructure	riverine, sheet flow
Sep. 2013	Tillamook County	heavy rain caused flooding at the Wilson River	riverine

Source: Taylor and Hannan (1999), Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://hvri.geog.sc.edu/SHELDUS/index.cfm?page=faq. National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms.

Table 2-93. Principal Riverine Flood Sources by County in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Lewis and Clark R	Coquille R	Chetco R	Umpqua R	Siuslaw R	Alsea R	Kilchis R
Little Walluski R	Willicoma R	Elk R	Smith R	Munsel Cr	Salmon R	Miami R
Necanicum R	Ten Mile Cr	Pistol R	Scholfield Cr		Siletz R	Nehalem R
Nehalem R	Palouse Cr	Rogue R			Yachats R	Nestucca R
Bear Cr	Larson Cr	Sixes R			Yaquina R	Three Rivers
Beerman Cr	Kentuck Sl	Winchuck R			Drift Cr	Tillamook R
Big Cr	Willanch Sl	Hunter Cr			Depot Cr	Trask R
Cow Cr	Pony Cr				Ollala Cr	Wilson R
Fishhawk Cr					Schooner Cr	Dogherty Sl
Humbug Cr						Hoquarten Sl
Little Cr						
Neacoxi Cr						
Neawanna Cr						
Northrup Cr						
Plymton Cr						

Note: R = river, Cr = creek, Sl = slough.

Sources: Federal Emergency Management Agency (FEMA), Clatsop County Flood Insurance Study (FIS), July 17, 2001, FEMA, Coos County FIS, May 15, 1984, FEMA, Curry County FIS, Feb. 04, 1998, FEMA, Douglas County FIS, Apr. 21, 1999, FEMA, Lane County FIS, June 02, 1999, FEMA, Lincoln County FIS, Mar. 1, 1980, FEMA, Tillamook County FIS, Aug. 20, 2002.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience flooding is shown in **Table 2-94**.

Table 2-94. Local Probability Assessment of Flood in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores.

State Assessment

Riverine

FEMA has mapped the streams listed in **Table 2-93** for 10, 50, 100, and 500-year flood events, with the probability of flooding in a year being 10%, 2%, 1%, and 0.2%, respectively. Areas subject to the 1% annual flood are depicted on FEMA Flood Insurance Rate Maps (FIRMs). Recurrence intervals can differ between reaches of the same stream during the same flood event. For example, certain reaches of the Wilson River may experience a 100-year (1%) flood while other sections of the river may be having a 50-year (2%) or perhaps a 500-year (0.2%) flood event.

Flood Insurance Rate Maps (FIRM) show flood conditions; however, many maps are based on old flood models. The following is a list of Region 1 counties and the date of their most recent FIRM:

- Clatsop, September 17, 2010;
- Coos, September 25, 2009;
- Curry, September 25, 2009;
- Douglas, Feb. 17, 2010;
- Lane, June 2, 1999;
- Lincoln, Dec. 18, 2009; and
- Tillamook, Aug. 20, 2002.

Ocean Flooding / Wave Action

Ocean storms can be expected every year. El Niño effects, which tend to raise ocean levels, occur about every 3 to 5 years (Taylor & Hannan, 1999). V (wave velocity) zones, depicted on FEMA's Flood Insurance Rate Maps, are areas subject to 100-year events (i.e., 1% chance in any given year). The Flood Insurance Rate Maps show areas vulnerable to wave action (V zones), ponding and sheet-flow from waves over-topping dunes (AO and AH zones). All of the counties in Region 1 have hazardous areas identified on the maps. DOGAMI and FEMA also provide information about wave action.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-95**.

Table 2-95. Local Vulnerability Assessment of Flood in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	M	H	L	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-96**.

Table 2-96. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Low-lying coastal areas in Region 1 are particularly vulnerable to flood hazards that can be exacerbated by high tides. Region 1 received the highest flood vulnerability index score (83) partly because seven counties (all or partial) are included in this region, but also because four of the highest scoring counties are located in Region 1. The lower Siletz and Siuslaw rivers in Lincoln and Lane Counties respectively and the rivers that feed Tillamook Bay in Tillamook County have all experienced significant flood losses. In fact, the meaning of the term "100-year flood" was lost when repetitive flood events impacting the City of Tillamook and adjacent portions of Tillamook County exceeded the base flood elevation numerous times, including major flood events in 1996, 1998 and 1999, 2007, and 2011. Many pre- and post-FIRM buildings experienced repetitive flood losses along US-101 north of the City of Tillamook, many of which have been mitigated using HMGP grants.

In general, the northern half of Region 1 is more vulnerable to riverine flood damage than the southern half because it is more densely populated and consequently contains much of the region's infrastructure. Physical location also makes a difference. For example, five rivers empty into Tillamook Bay, thereby increasing risk from riverine flooding on the relatively flat valley floor.

Fortunately, unlike the East and Gulf coasts, only a few of Oregon's coastal developments are within FEMA-designated Velocity (V) zones. Region 1 counties have not inventoried all buildings that are vulnerable to wave action (i.e., in V zones); however pertinent information from the National Flood Insurance Program (NFIP) indicates that Lincoln and Tillamook Counties and their coastal cities account for nearly all of the V-zone flood policies (275 of 277) and losses (18 out of 20) in Region 1.

While the exact number of buildings, parks, infrastructure, and critical facilities in Region 1 vulnerable to ocean storms is unknown, the low-lying areas adjacent to bays or the ocean are known to be at risk. Bayocean, Salishan Spit, Jumpoff Joe, Rogue Shores, and The Capes are examples of development in such areas whose buildings and infrastructure have been destroyed by wave attack. A number of local governments in Region 1 have initiated and accomplished building elevation and/or buy-out programs. Also, dairy farmers and other businesses have made considerable progress in protecting their investments.

Coastal highways have always been problematic. In Region 1, much of the problem is linked to the local geology. Bedrock conditions change abruptly within very short distances resulting in inconsistent highway foundation; some sections are more susceptible to wave action than others and require continuous maintenance. There is no practical solution outside of relocation of the highway; this option is not financially feasible at this point in time. Flood vulnerability scores for Region 1 are listed in **Table 2-97**.

Table 2-97. Flood Vulnerability Scores, by County in Region 1

County	Flood Vulnerability Score
Clatsop	6
Coos	7
Curry	7
Douglas*	6
Lane *	6
Lincoln	6
Tillamook	11

*Only coastal sections of Douglas and Lane Counties.

Source: DLCD

FEMA has identified 138 Repetitive Loss (RL) properties in Region 1, three of which are Severe Repetitive Loss (SRL) properties. This region has the most repetitive flood losses of any of the Oregon NHMP Natural Hazard Regions, reflecting the high rainfall amounts characteristic of the coastal region and the high density of watercourses. The coast is also subject to flooding from the Pacific Ocean.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Douglas and Lane Counties participate in CRS, as do the cities of Cannon Beach, Nehalem, and Tillamook.

Table 2-98. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 1

County	RL	SRL	# of CRS Communities per County
Clatsop	6	1	1
Coos	12	—	0
Curry	3	—	0
*Douglas	0	—	0
*Lane	16	—	0
Lincoln	45	2	0
Tillamook	56	—	2
Total	**138**	**3**	**3**

*Includes only coastal sections of Douglas and Lane Counties.

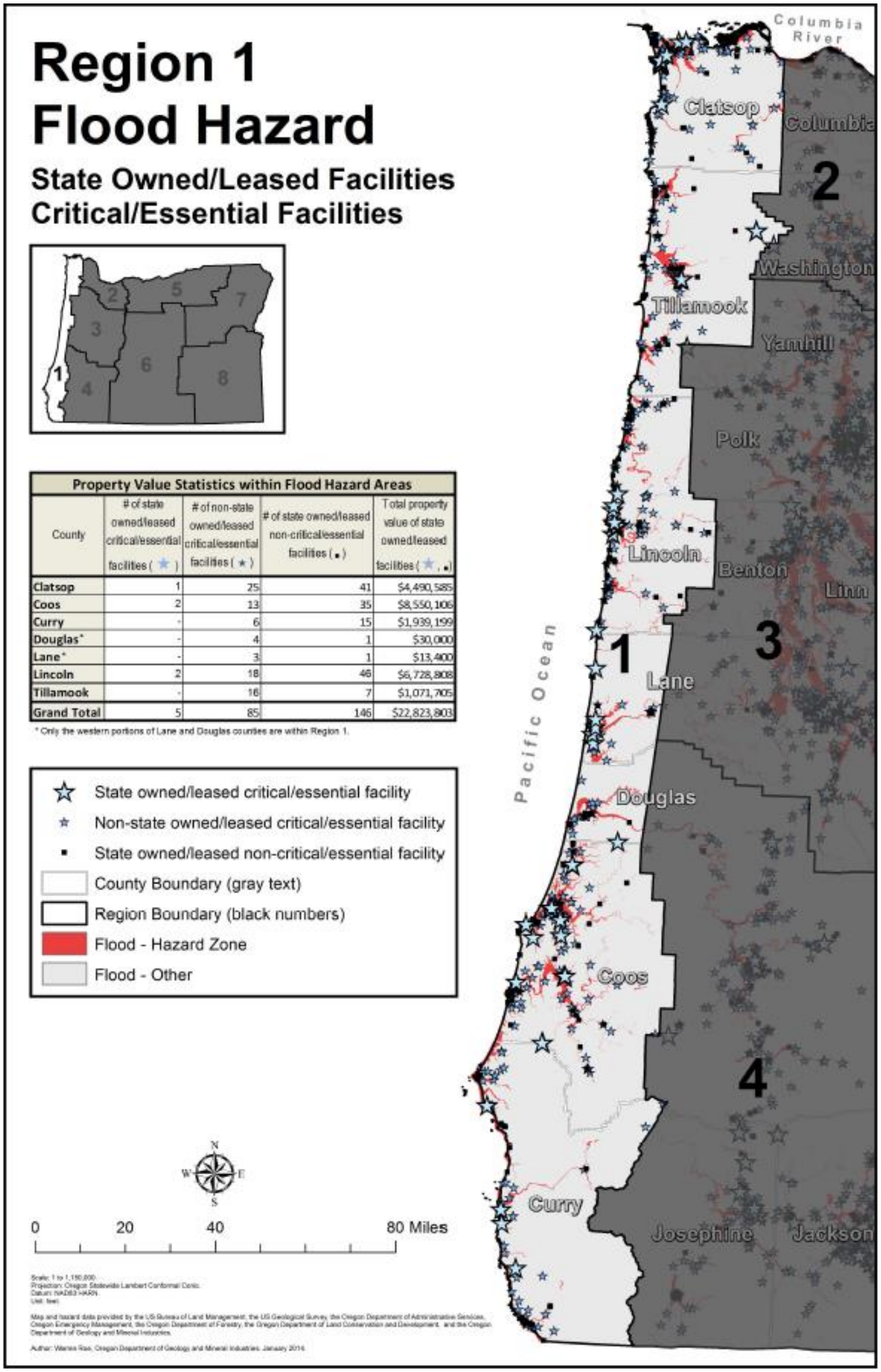
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed Dec. 1, 2014

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 151 are currently located within a flood hazard zone in Region 1 and have an estimated total value of nearly $23 million (**Figure 2-96**). Of these, five are identified as a critical or essential facility. An additional 85 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 1.

Figure 2-96. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 1



Property Value Statistics within Flood Hazard Areas				
County	# of state owned/leased critical/essential facilities (☆)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (☆ , ▪)
Clatsop	1	25	41	$4,490,585
Coos	2	13	35	$8,550,106
Curry	-	6	15	$1,939,199
Douglas*	-	4	1	$30,000
Lane*	-	3	1	$13,400
Lincoln	2	18	46	$6,728,808
Tillamook	-	16	7	$1,071,705
Grand Total	5	85	146	$22,823,803

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the coast and Coast Range Mountains have a very high incidence of landslides. On occasion, major landslides occur on U.S. or state highways and sever these major transportation routes (including rail lines), causing temporary but significant economic damage to the state. Less commonly, landslides and debris flows in this area cause loss of life.

Historic Landslide Events

Table 2-99. Historic Landslides in Region 1

Date	Location	Description
Feb. 1926	between Coos Bay and Coquille, Oregon	damages: $25,000; closed Roosevelt Highway
Feb. 1961		large section of Ecola State Park slid into the Pacific Ocean
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides and debris flows across the state, many on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); five fatalities; several injuries (Douglas County)
Feb. 1999	south of Florence, Oregon	two timber workers killed in a mud and rockslide (south of Florence)
Jan. 2000	north of Florence, Oregon	a landslide (north of Florence) closed US-101 for 3 months, resulting in major social and economic disruption to nearby communities
Dec. 2004	Lane, Polk, and Lincoln Counties	property damage: $12,500
Dec. 2007	Clatsop and Tillamook	property damage: $300,000

Sources: Taylor and Hatton (1999); and FEMA After-Action Report, 1996 events; and interviews, Oregon Department of Transportation representatives.

Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from: http://www.sheldus.org.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience landslides is shown in **Table 2-100**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-100. Local Probability Assessment of Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-101**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-101. Local Vulnerability Assessment of Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	L	M	M	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Rain-induced landslides and debris flows can potentially occur during any winter in this region. This area is also subject to future very large earthquakes, which will trigger landslides. Many of the communities in Region 1 have a high exposure to the landslide hazard, for example Astoria. A new study of the landslide hazard and risk of Astoria found 121 landslides within the city limits and losses in a major earthquake are likely to be 50% greater than somewhere with low or no landslide hazards (Burns and Mickelson, 2013).

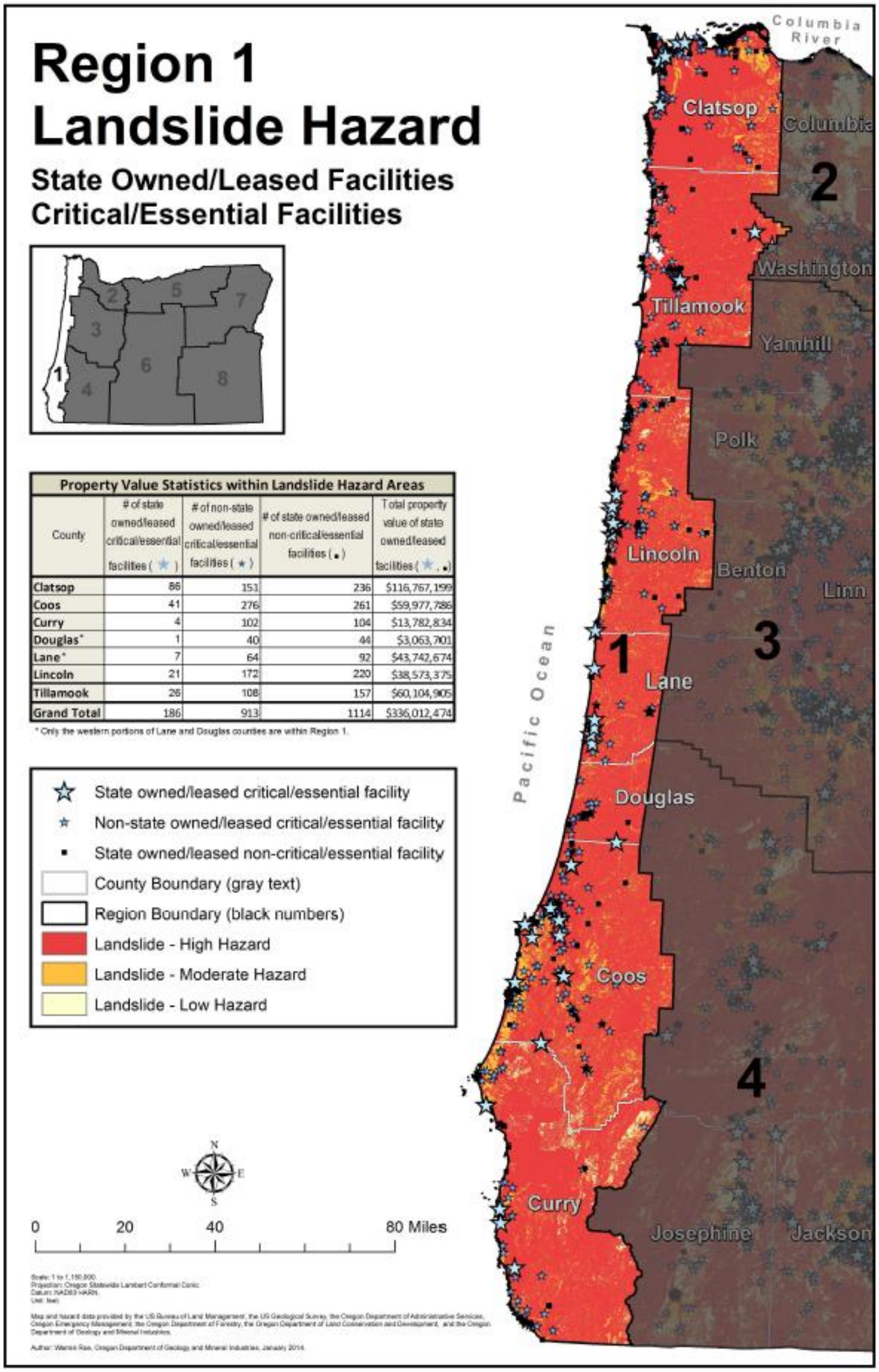
Some of the greatest exposure in Region 1 is the east-west roadways that carry traffic to and from the coast, with the potential for injuries and loss of life from rapidly moving landslide events.

STATE-OWNED/LEASED FACILITIES AND CRITICAL/ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 1,300 are located within landslide hazard areas in Region 1, totaling roughly $336 million (**Figure 2-97**). This includes 186 critical or essential facilities; 913 additional critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 1.

Figure 2-97. State-Owned/Leased Facilities and Critical/Essential Facilities in a Tsunami Hazard Zone in Region 1



Property Value Statistics within Landslide Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Clatsop	86	151	236	$116,767,199
Coos	41	276	261	$59,977,786
Curry	4	102	104	$13,782,834
Douglas*	1	40	44	$3,063,701
Lane*	7	64	92	$43,742,674
Lincoln	21	172	220	$38,573,375
Tillamook	26	108	157	$60,104,905
Grand Total	186	913	1114	$336,012,474

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Tsunamis

Characteristics

Tsunami waves are infrequent events, but can be extremely destructive. They may be generated by earthquakes, submarine volcanoes, or landslides, and travel hundreds of miles before striking land. Hardly discernible at sea, tsunami waves travel as fast as 500 mph across open water until, at landfall, they slow down significantly and can reach heights from 20 to about 100 feet. Seward, Alaska, experienced tsunami waves as high as 25 feet during the 1964 earthquake-tsunami event.

Most tsunami waves have been described as an onrushing, rapidly rising tide, which can be seen in the few motion pictures that have captured the tsunami phenomenon. The size and behavior of tsunamis depend on a number of factors, including distance traveled, submarine topography and the shape and orientation of the coastline. Much of the damage results from water-borne debris, which can act as battering rams against on-shore development. Wave-borne fuel drums are especially hazardous because of their propensity to cause or exacerbate fires.

All Region 1 counties are susceptible to tsunami hazards. Oregon's coastal communities have experienced, to various degrees, tsunamis that have originated in the oceanic regions near Russia's Kamchatka Peninsula, Japan, Chile, Hawaii, the Gulf of Alaska, and northern California. Additionally, the geologic record implies that over the last 10,000 years approximately 42 tsunamis have been generated locally off the Oregon Coast along the Cascadia Subduction Zone (CSZ). Nineteen of these tsunamis were from full-margin ruptures of the CSZ and arrived in all parts of the coast about 15–20 minutes after the earthquake; the others arrived this quickly on parts of the south coast adjacent to each of the segment ruptures. Any locally generated tsunamis would cause significant damage to coastal ports and pose a threat to those near waterfront areas. This is the region's greatest concern. See **Earthquake** section.

Historic Tsunami Events

Table 2-102 describes some of the tsunami history of Region 1.

Table 2-102. Historic tsunamis affecting Region 1

Date	Origin of Event	Affected Community	Damage	Remarks
04/1868	Hawaii	Astoria, Oregon		observed
08/1868	N. Chile	Astoria, Oregon		observed
08/1872	Aleutian Is	Astoria, Oregon		observed
11/1873	N. California	Port Orford, Oregon		debris at high tide line
04/1946	Aleutian Is	Bandon, Oregon		barely perceptible
04/1946		Clatsop Spit, Oregon		water 3.7 m above MLLW
04/1946		Depoe Bay, Oregon		bay drained; water returned as a wall
04/1946		Seaside, Oregon		wall of water swept up Necanicum River
11/1952	Kamchatka	Astoria, Oregon		observed
11/1952		Bandon, Oregon	log decks broke loose	
05/1960	S. Cent. Chile	Astoria, Oregon		observed
05/1960		Seaside, Oregon	bore on Necanicum River damaged boat docks	
05/1960		Gold Beach, Oregon		observed
05/1960		Newport, Oregon		observed for about four hours
05/1960		Netarts, Oregon	some damage observed	
Mar. 1964	Gulf of Alaska	Cannon Beach, Oregon	bridge and motel unit moved inland; $230,000 damage	
Mar. 1964		Coos Bay, Oregon	$20,000 damage	
Mar. 1964		Depoe Bay, Oregon	$5,000 damage; four children drowned at Beverly Beach	
Mar. 1964		Florence, Oregon	$50,000 damage	
Mar. 1964		Gold Beach, Oregon	$30,000 damage	
Mar. 1964		Seaside, Oregon	one fatality (heart attack); damage to city: $41,000; private: $235,000; four trailers, 10-12 houses, two bridges damaged	
05/1968	Japan	Newport, Oregon		observed
04/1992	N. California	Port Orford, Oregon		observed
10/1994	Japan	Oregon Coast		tsunami warning issued, but no tsunami observed
3/2011	Japan	Oregon Coast	$6.7 million; extensive damage to the Port of Brookings	tsunami warning issued, observed ocean waves

Sources: NOAA, 1993, Tsunamis Affecting the West Coast of the United States: 1806-1992; FEMA, 2011, Federal Disaster Declaration

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience a tsunami is shown in **Table 2-103**.

Table 2-103. Local Probability Assessment of Tsunami in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	M	H	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on the Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the CSZ happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

With respect to distant sources, Oregon has experienced 25 tsunamis in the last 145 years with only 3 causing measurable damage. Thus, the average recurrence interval for tsunamis on the Oregon coast from distant sources would be about 6 years. However, the time interval between events has been as little as one year and as much as 73 years. The two most destructive tsunamis occurred only 4 years apart (1960 and 1964) and originated from two different source areas (south central Chile and the Gulf of Alaska). Because only a few tsunamis caused measurable damage, a recurrence interval for distant tsunamis does not have much meaning for this region with respect to losses. However, every time NOAA issues a distant tsunami warning for the coast, evacuation plans are triggered at significant cost to local government and business.

Geologists predict a 10% chance that a CSZ tsunami will be triggered by a shallow, undersea earthquake offshore Oregon in the next 30 years, causing a tsunami that will strike all parts of the Oregon coast about 15–20 minutes after the earthquake. This forecast comes from the 10,000-year geologic record of 19 CSZ fault ruptures extending the entire length of the Oregon coast (i.e., recurrence of approximately 500 years) (DOGAMI, 2009). As previously mentioned, the southern Oregon coast has a higher chance of experiencing a local tsunami and earthquake, the probability increasing progressively southward. The last CSZ event occurred approximately 300 years ago (Satake et al., 1996).

Owing to much faster arrival and generally larger size, tsunamis originating from the CSZ will cause much larger life and property losses than most distant tsunamis and are at least as frequent as the largest distant tsunamis. Inundation from the largest distant tsunamis approximates inundation from the “Small” Cascadia tsunami on Oregon Tsunami Inundation Maps (TIMs).

Vulnerability

Local Assessment

Based on an OEM hazard analysis conducted by county emergency program managers, the region’s vulnerability to tsunami is shown in **Table 2-104**.

Table 2-104. Local Vulnerability Assessment of Tsunami in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

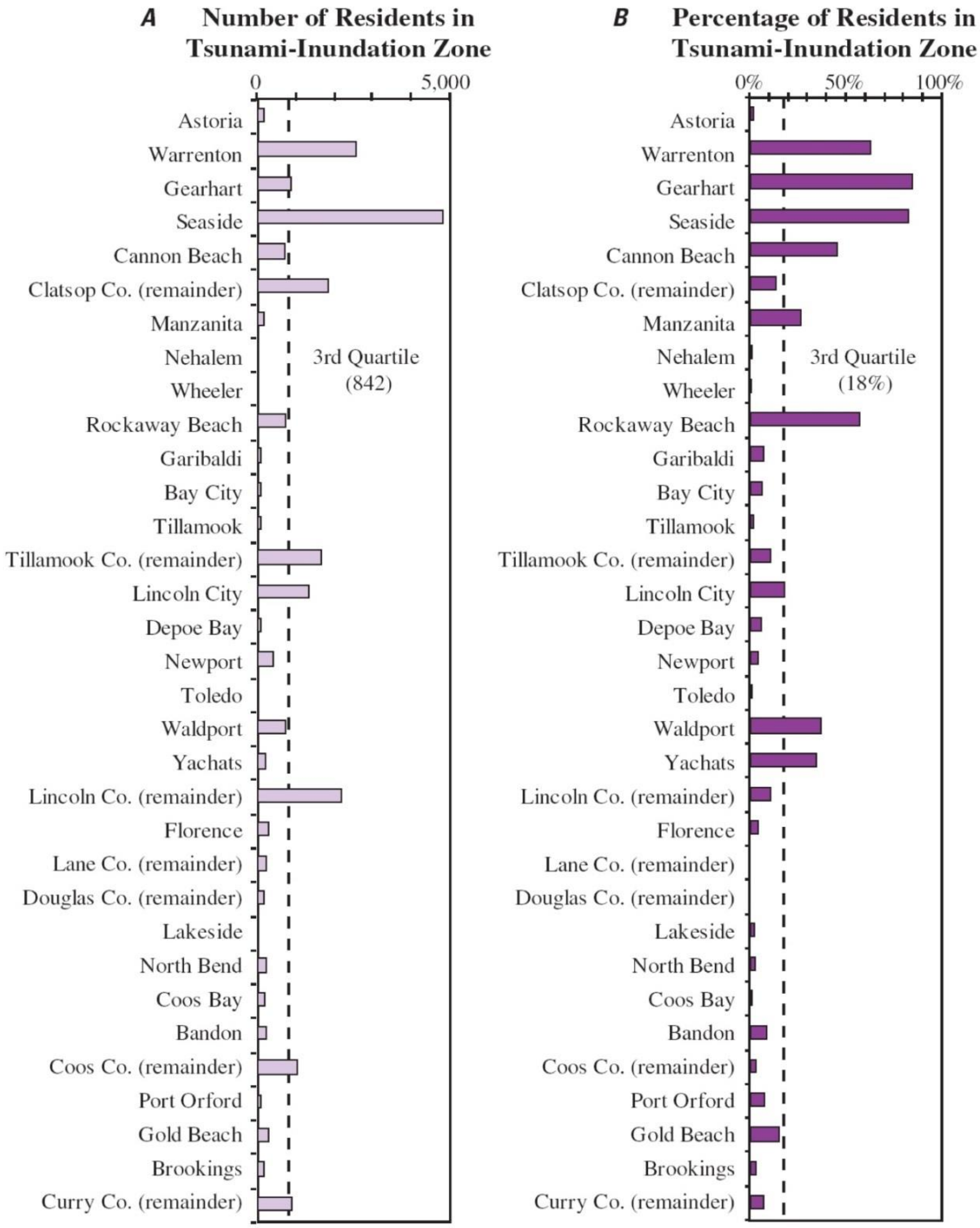
The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

All communities in Region 1 are especially vulnerable to tsunamis because of their coastal settings and locations in low-lying areas. Seaside is the most vulnerable city due to its low elevation and high resident and tourist populations, and its county, Clatsop, is the most vulnerable county, having the largest exposed population (**Figure 2-98**) (Wood, 2007). Although many communities have evacuation maps and evacuation plans, many casualties are expected. The built environment in the inundation zone will be especially hard hit.

The United States Geological Survey (USGS) completed a comprehensive study (Wood, 2007) of coastal cities’ exposure and sensitivity to a CSZ tsunami similar to the most likely “Medium” scenario depicted in the 2010–2013 DOGAMI Tsunami Inundation Map series. The tsunami zone of the USGS study is the 1995 regulatory inundation zone used by the Oregon Building Code to limit new construction of critical/essential, hazardous, and high-occupancy facilities. Results indicate that the regulatory inundation zone contains approximately 22,201 residents (4% of the total population in the seven coastal counties), 14,857 employees (6% of the total labor force), and 53,714 day-use visitors on average every day to coastal Oregon State Parks within the tsunami-inundation zone. The zone also contains 1,829 businesses that generate approximately $1.9 billion in annual sales volume (7% and 5% of study-area totals, respectively) and tax parcels with a combined total value of $8.2 billion (12% of the study-area total). Although occupancy values are not known for each facility, the tsunami-inundation zone also contains numerous dependent-population facilities (for example, adult-residential-care facilities, child-day-care facilities, and schools), public venues (for example, religious organizations and libraries), and critical facilities (for example, police stations).

Additionally, results indicate that vulnerability, described in the study by exposure (the amount of assets in tsunami-prone areas) and sensitivity (the relative percentage of assets in tsunami-prone areas) varies considerably among 26 incorporated cities in Region 1 (Wood, 2007). City exposure and sensitivity to tsunami hazards is highest in the northern portion of the coast. The City of Seaside in Clatsop County has the highest exposure, the highest sensitivity, and the highest combined relative exposure and sensitivity to tsunamis. Results also indicate that the amount of city assets in tsunami-prone areas is weakly related to the amount of a community's land in this zone; the percentage of a city's assets, however, is strongly related to the percentage of its land that is in the tsunami-prone areas.

Figure 2-98. Number (A) and Percentage (B) of Residents in the Oregon Regulatory Tsunami Inundation Zone



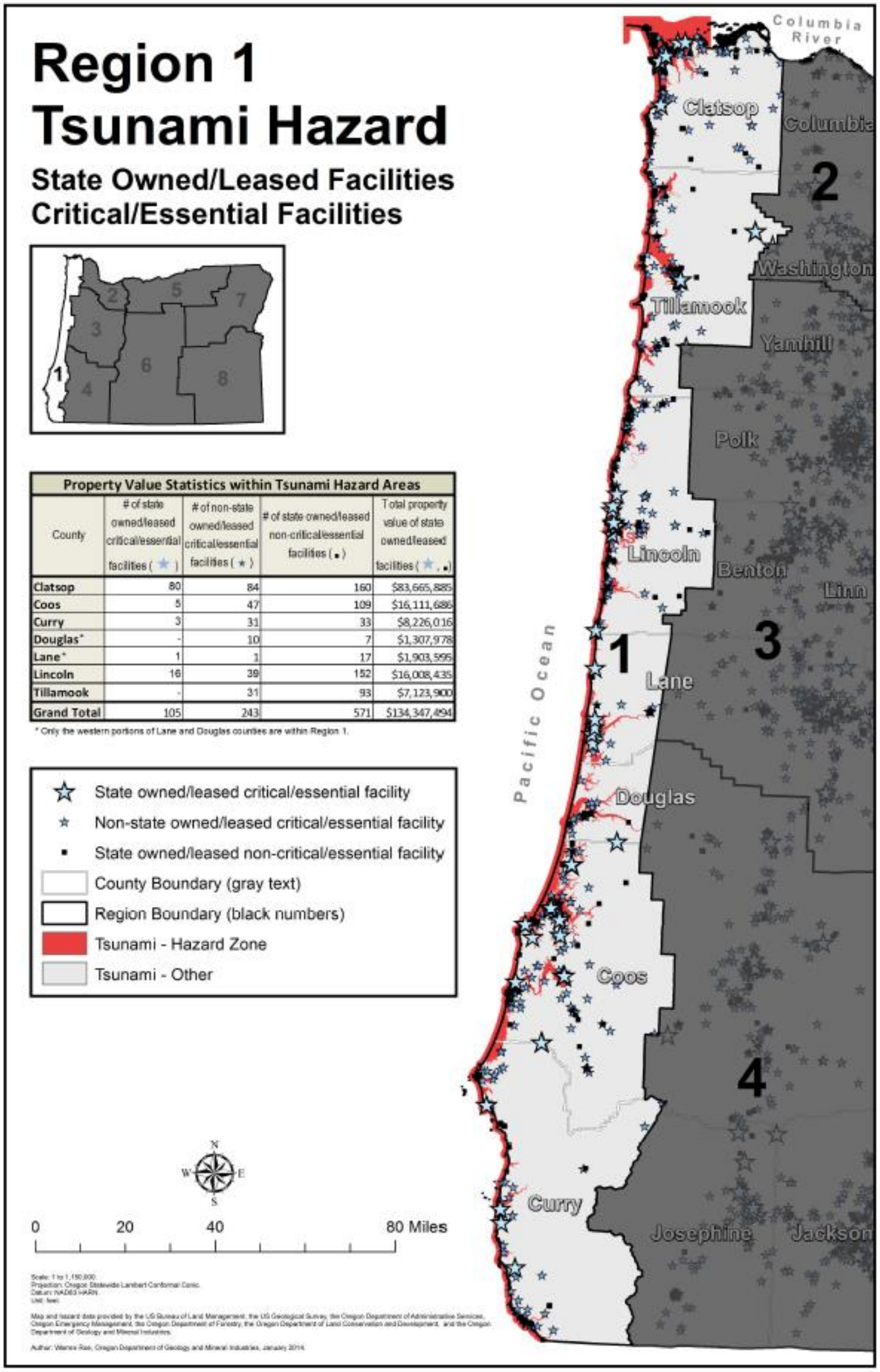
Source: Wood (2007)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the state 5,693 facilities evaluated, 676 are currently located within the tsunami hazard zone and have an estimated total value of $134 million (**Figure 2-99**). Of these, 105 are identified as state-owned/leased critical/essential facilities. An additional 243 non-state critical/essential facilities are also located with a tsunami hazard zone in Region 1.

Figure 2-99. State-Owned/Leased Facilities and Critical/Essential Facilities in a Tsunami Hazard Zone in Region 1



County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	80	84	160	$83,665,885
Coos	5	47	109	$16,111,686
Curry	3	31	33	$8,226,016
Douglas*	-	10	7	$1,307,978
Lane*	1	1	17	$1,903,595
Lincoln	16	39	152	$16,008,435
Tillamook	-	31	93	$7,123,900
Grand Total	105	243	571	$134,347,494

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Mountain Range is not within Region 1 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is not a priority consideration to Coastal Oregon. However, there is some risk from volcanic ashfall. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, the cities of Yakima (80 miles) and Spokane (150 miles), Washington, were inundated with ash during the May 1980, Mount St. Helens eruption. Ashfall can reduce visibility to zero, and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery. It would be prudent for communities that may be exposed to ashfall to identify disposal areas for large quantities of ash. Part of Clatsop County borders the Columbia River, which in theory makes it vulnerable to lahars or mudflows carried by the river. Although unlikely, such an event cannot be dismissed out of hand. A lahar or mudflow that traveled down Washington's Cowlitz River following the eruption of Mount St. Helens, filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements in the vicinity of the Cowlitz for months (Wolfe and Pierson, 1995).

Historic Volcanic Events

There are no significant volcanoes within Region 1 and no historic volcano-related events.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience volcanic hazards is shown in **Table 2-105**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-105. Local Probability Assessment of Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	M	M	L	—	—	L	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Mount St. Helens is a probable source of ashfall and lahars that can reach the Columbia River. The probability of coastal counties receiving ashfall is about 1 in 10,000 — with a large portion of Curry County being even less (Sherrod et al., 1997). A lahar mudflow that traveled down Washington's Cowlitz River following the 1980 eruption of Mount St. Helens filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements for months.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-106**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-106. Local Vulnerability Assessment of Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	M	M	H	—	—	L	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

None of the communities identified by DOGAMI as being most vulnerable to volcano hazards are located in Region 1. However, as noted earlier, there is some risk of ashfall that can be especially damaging to machinery. Although remote, the threat of lahars or volcanic related mudflows could impact the shipping industry on the Columbia River in Region 1.

Wildfires

Characteristics

Existing development near wildland areas combined with the spread of gorse and other flammable plant species throughout the region is increasing the level of wildfire risk. Wildfires in the wildland-urban interface (WUI) pose serious threats to life and endanger property, critical infrastructure, water resources, and valued commercial and ecological forest resources. While the region is characterized as moist and regarded as lower than normal fire danger, some the largest fire events have occurred in this area. The historic Tillamook Burn, comprising devastating wildfires every 6 years between 1933 and 1951, burned a total of 355,000 acres. Much of the burn was attributed to powerful east wind events and heavy fuels.

Historically, lighting has been the primary ignition source of wildfires in the region. Weather patterns from May through October are characterized by periods of drought separated by storms that produce dry forest fuels followed by frequent lightning strikes, a common source of ignitions. During the past two decades, fires caused by human activities were more frequent than those ignited by natural processes.

Long periods of drought are common during the summer and electrical storms are a common cause of wildfire. These types of storms are most frequent from May through October. Long periods of drought during the summer months also create challenges for wildfire responders. Many small rural communities lack the type of water systems that make water accessible for fire suppression. Instead fire fighters in these areas are often dependent on water from ponds, creeks, and rivers. Often in the mid- to late summer months, these sources are low or completely dry.

Wind direction changes to an easterly flow in early fall when landscapes are at their driest. These “east wind events” resemble the well-known Santa Anna winds of southern California that produce large, destructive wildfires.

Wildfires have played a significant role in shaping the species composition and forest structure in the region. Intensive fire suppression has resulted in forest fuel buildup and changes in species composition and structure in the past 60 years.

Coastal and Lower Columbia River counties are heavily timbered and have a long history of devastating forest fires. Some of the history is derived from Native Americans who recall extensive forest fires before the arrival of Euro-Americans. Fires involving the wildland interface occur in portions of the state where urbanization and natural vegetation fuels allow a fire to spread rapidly from natural fuels to structures and vice versa. Especially in the early stage of such fires, structural fire suppression resources can be quickly overwhelmed increasing the number of structures destroyed. Such fires are known for the large number of structures that are simultaneously exposed to fire, increasing the total losses per structure ignited. Nationally, wildland interface fires commonly produce widespread, extreme losses. Thus far, Oregon has escaped the level of property losses experienced by neighboring states.

Gorse, a spiny evergreen shrub, was introduced in south coastal Oregon from Europe. It has become an established invasive weed that displaces native vegetation, significantly altering the native vegetation patterns. Because Gorse is highly flammable, it increases wildfire risk wherever it spreads. Infestations of Gorse are particularly common along the coastal area; these areas are a major concern for wildfire managers.

Wildfire managers in the southern part of the region are also concerned with the spread of Port-Orford-Cedar root disease and Sudden Oak Death. Trees infected by these pathogens are at increased risk to wildfire and vegetation management activities need to be conducted in a way that minimizes the spread of disease pathogens. The Rogue River-Siskiyou National Forest, Bureau of Land Management, Oregon Department of Forestry, and Oregon State Parks have implemented actions to manage the spread of these pathogens.

Historic Wildfire Events

Table 2-107. Historic Wildfires in Region 1

Date	Name of Fire	Location	Characteristics	Remarks
1846	Yaquina	Lincoln and Lane Counties	> 450,000 acres	event related by Native American hunters
1853	Nestucca		> 320,000 acres	
1868	Coos Bay	Coos	296,000 acres	
1922	Astoria	downtown City of Astoria	many buildings (32 city blocks burned!)	early December structural fire most likely not related to wildfire
1933	Tillamook		240,000 acres	the Tillamook Forest burned every 6 years between 1933 and 1951; total acreage burned was over 350,000 acres; together, the four events are called the Tillamook Burn; dry forest conditions seems to have been a major factor (Taylor)
1936	Bandon		143,000 acres	
1939	Saddle Mountain	Clatsop County	207,000 acres	
1945	Wilson River / Salmonberry	Tillamook County	173,000 acres	
1951	North Fork / Elkhorn	Tillamook County	33,000 acres	
2002	Florence / Biscuit	Curry County	almost 500,000 acres (perimeter)	largest forest fire in Oregon since arrival of Euro-Americans; the perimeter contained many unburned islands within the overall acreage

Source: Brian Ballou, 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; unknown sources from previous versions of the Oregon NHMP

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience wildfire is shown in **Table 2-108**.

Table 2-108. Local Probability Assessment of Wildfire in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	M	H	M	L	H	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The potential that wildland fires, both small and large, will threaten life, property and natural resources is a reality. Fire statistics show that fire incident rates, and therefore risks, are prevalent in the WUI areas. Population growth and development continue to encroach into and fragment forests. The natural ignition of forest fires is largely a function of weather and fuel; human-caused fires add another dimension to the probability. Dry and diseased forests can be mapped accurately and some statement can be made about the probability of lightning strikes. Each forest is different and consequently has different probability/recurrence estimates.

The probability of significant fire activity occurring in Region 1 is most likely during the late summer and early fall months when temperatures remain high, vegetation has had the entire summer to dry out and east winds are more prevalent coming out of the Columbia Gorge in the north and Chetco drainages in the south portions of the region.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-109**.

Table 2-109. Local Vulnerability Assessment of Wildfire in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	M	H	M	L	M	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Most counties within Region 1 have low to moderate risk from wildfire based primarily on cool, moist weather conditions. However, this region has had some of the largest wildfires that posed threats to communities when they occurred. The 1936 Bandon Fire is a prime example of a fire that, when combined with heavy fuels (gorse) and powerful dry east winds, an entire city was destroyed killing 13 people.

Gorse, brush, and timber still make up much of the landscape in Region 1. Given the right conditions, this region's vulnerability to wildfire exists. However, due to infrequent fire activity, the level of vulnerability can be categorized as moderate. A large wildfire in this region would affect local economies that rely on tourism and recreation dollars.

The economic stability of the region is dependent on a major state highway (US-101) that runs along the Oregon Coast. Should a major wildfire or other natural event (such as a tsunami) threaten or impact this major thoroughfare, coastal tourism and recreational economies would come to a halt.

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 1, Douglas County has a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, and Fire Effects, making it especially vulnerable. Note: WWRA data does not differentiate between coastal and non-coastal Douglas County. Therefore, all of Douglas County is considered most vulnerable to wildfire.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface), thereby increasing wildfire hazards. These communities have been designated “Wildland-Urban Interface Communities” and are listed in **Table 2-110**.

Table 2-110. Wildland-Urban Interface Communities in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook	
Arch Cape	Bandon	Agness	Gardiner	Dunes City	Depoe Bay	Bay City	Oceanside
Astoria	Charleston	Brookings	Reedsport	Florence	E. Lincoln Co.	Beaver	Oretown
Brownsmead	Coos Bay	Gold Beach	Winchester Bay	Mapleton	Elk City	Blaine	Pacific City
Cannon Beach	Coquille	Langlois		Swisshome	Lincoln City	Cape Meares	Pleasant Valley
Coastal Strip	Dora	Nesika Beach		Triangle Lake	Newport	Cloverdale	Rockaway
Elsie-Vinemaple	Fairview	Port Orford			Otter Rock	Foley Creek	Sandlake
Fern Hill	Green Acres				Rose Lodge	Garibaldi	Siskeyville
Ft. Clatsop	Lakeside				Seal Rock	Hebo	Tierra del Mar
Hamlet	Millington				Siletz	Hemlock	Tillamook
Hewell	Myrtle Point				Tidewater	Jordan Creek	Winema Beach
Knappa-Svensen	North Bend				Toledo	Lees Camp	Woods
Lewis and Clark	Powers				Waldport	Nehalem Bay	
Necanicum	Saunders Lake				Yachats	Neskowin	
Olney	Sumner					Netarts	
West Port							

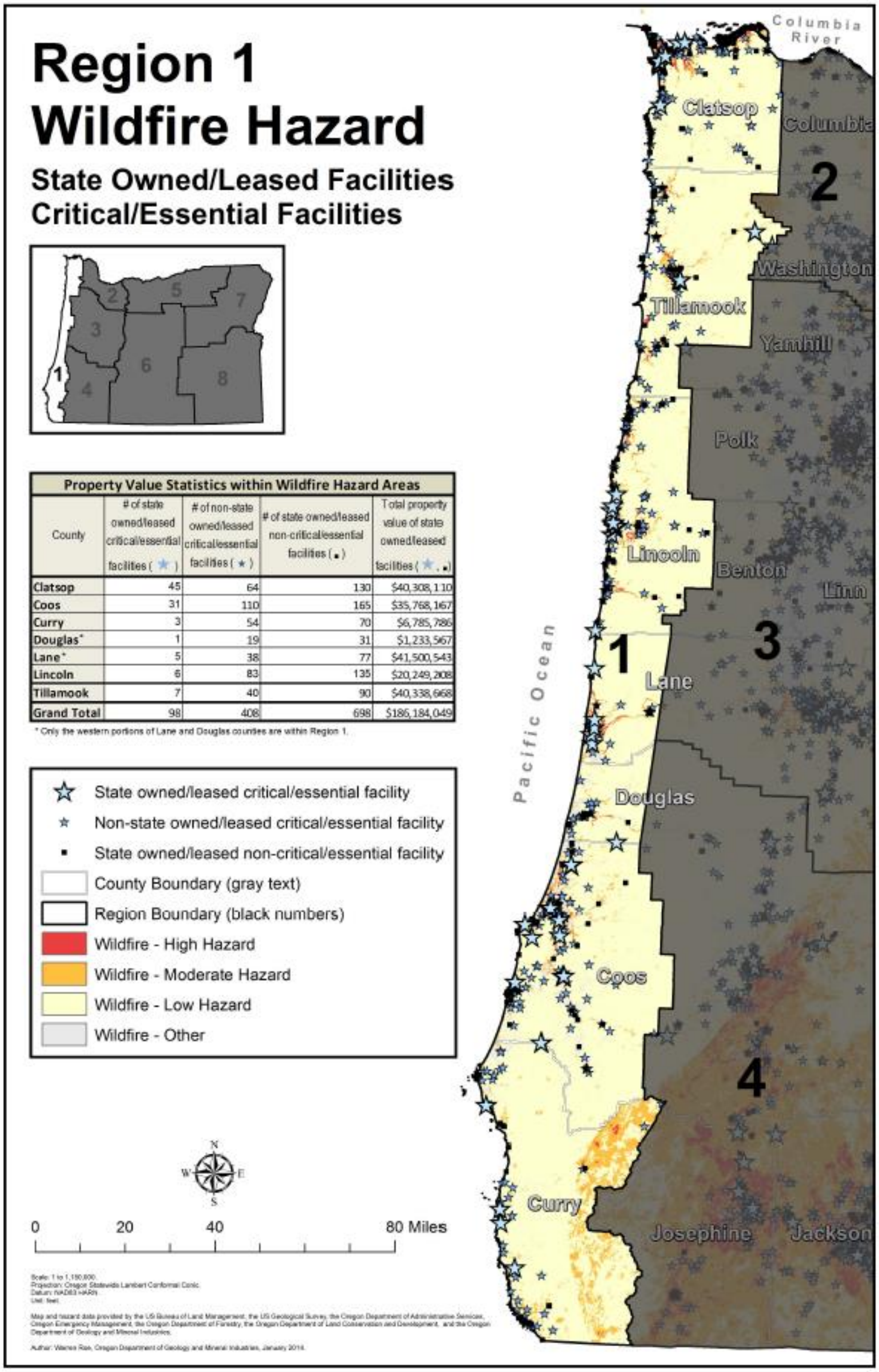
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 796 are within a wildfire hazard zone in Region 1 and total about $186 million in value (**Figure 2-100**). Among those, 98 are state critical/essential facilities. An additional 408 non-state critical/essential facilities are located in a wildfire hazard zone in Region 1.

Figure 2-100. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Zone in Region 1



Property Value Statistics within Wildfire Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clatsop	45	64	130	$40,308,110
Coos	31	110	165	$35,768,167
Curry	3	54	70	$6,785,786
Douglas*	1	19	31	$1,233,567
Lane*	5	38	77	$41,500,543
Lincoln	6	83	135	$20,249,208
Tillamook	7	40	90	$40,338,668
Grand Total	98	408	698	$186,184,049

* Only the western portions of Lane and Douglas counties are within Region 1.

Source: DOGAMI

Windstorms

Characteristics

High winds can be expected throughout Region 1, due to their coastal location. Destructive wind storms are less frequent, and their pattern is fairly well known. They form over the North Pacific during the cool months (October through March), move along the coast, and swing inland in a northeasterly direction. Wind speeds vary with the storms. Gusts exceeding 100 miles per hour have been recorded at several coastal locations (**Table 2-111**) but lessen as storms move inland. These storms, such as the Columbus Day Storm of October, 1962, can be very destructive. Less destructive storms can topple trees and power lines and cause building damage. Flooding can be an additional problem. A large percentage of Oregon's annual precipitation comes from these events (Taylor & Hatton [1999]; FEMA-1405-DR-OR, 2002YEAR, Reducing Windstorm Damage to Property and Electrical Utilities).

Tornadoes

Most people do not associate tornadoes with the State of Oregon, and certainly not in coastal areas. Nevertheless, tornadoes have occurred in Region 1. The first recorded tornado on the Oregon Coast occurred in 1897 (**Table 2-112**). They are characteristically brief and small, but also damaging.

Historic Windstorm Events

Table 2-111. Historic Windstorms in Region 1

Date	Location	Description	Remarks
Jan. 1880	western Oregon	very high winds, 65-80 mph near Portland	flying debris; fallen trees
Jan. 1921	Oregon coast / Lower Columbia	winds 113 mph at mouth of Columbia; gusts at Astoria, 130 mph	widespread damage
Apr. 1931	western Oregon	unofficial reports of wind speeds up to 78 mph	widespread damage
Nov. 1951	most of Oregon	winds 40–60 mph with 75–80 mph gusts	widespread damage, especially to transmission lines
Dec. 1951	most of Oregon	winds, 60–100 mph, strongest along coast	many damaged buildings; telephone/power lines down
Dec. 1955	western Oregon	wind gusts at North Bend 90 mph	significant damage to buildings and farms
Jan. 1956	western Oregon	heavy rains, high winds, mud slides	estimated damage: $95,000 (1956 dollars)
Nov. 1958	most of Oregon	wind gusts to 75 mph at Astoria; gusts to 131 mph at Hebo	damage to buildings and utility lines
Nov. 1962	statewide	wind speeds of 131 mph on the Oregon coast (Columbus Day Windstorm Event)	Oregon's most destructive storm: 23 fatalities; damage at $170 million
Mar. 1963	Coast and NW Oregon	100 mph gusts (unofficial)	widespread damage
Oct. 1967	western and N. Oregon	winds on Oregon Coast 100–115 mph	significant damage to buildings, agriculture, and timber
Mar. 1971	most of Oregon	notable damage in Newport	falling trees took out power lines; building damage

Date	Location	Description	Remarks
Jan. 1986	N and central Oregon coast	75 mph winds	damaged trees, buildings, power lines
Jan. 1987	Oregon coast	wind gusts to 96 mph at Cape Blanco	significant erosion (highways and beaches); several injuries
Dec. 1987	Oregon coast / NW Oregon	winds on coast 60 mph	saturated ground enabled winds to uproot trees
Mar. 1988	N. and central coast	wind gusts 55–75 mph	one fatality near Ecola State Park; uprooted trees
Jan. 1990	statewide	100 mph winds in Netarts and Oceanside	one fatality; damaged buildings; falling trees (FEMA-853-DR-Oregon)
Feb. 1990	Oregon coast	wind gusts of 53 mph at Netarts	damage to docks, piers, boats
Jan. 1991	most of Oregon	winds of 63 mph at Netarts; 57 at Seaside	75-foot trawler sank NW of Astoria
Nov. 1991	Oregon coast	slow-moving storm; 25-foot waves off shore	buildings, boats, damaged; transmission lines down
Jan. 1992	southwest Oregon	wind gusts of 110 mph at Brookings	widespread damage
Jan. 1993	Oregon coast / N. Oregon	Tillamook wind gusts at 98 mph	widespread damage, esp. Nehalem Valley
Dec. 1995	statewide	wind gusts over 100 mph; Sea Lion Caves: 119 mph; followed path of Columbus Day Storm (Dec. 1962)	four fatalities; many injuries; widespread damage (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	winds of 89 mph at Florence; 80 mph at Netarts and Newport	severe beach erosion; trees toppled
Feb. 2002	SW Oregon	75–100 mph on the SW coast (Douglas, Coos, and Curry Counties)	widespread loss of electricity and damage to public utility infrastructure (FEMA-1405-DR-Oregon)
Apr. 2004	Lane County		$5,000 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lane County		$6,250 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lincoln County		$6,250 in property damage (figure includes damages outside of Lincoln County)
Dec. 2004	Tillamook County		$6,250 in property damage (figure includes damages outside of Tillamook County)
Dec. 2004	Clatsop County		$6,250 in property damage (figure includes damages outside of Clatsop County)
Jan. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two storm events with high winds of 86 mph and 103 mph	$244,444 and $144,444 in estimated property damage among all four coastal counties; the storm also impacted 5 other counties outside Region 1; total damages equal $300,000 and $200,000, respectively
Feb. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	wind storm event with winds measured at 77 mph	$150,000 and $91,600 in estimated property damage among all four coastal counties; the storm also impacted nine other counties outside of Region 1; total damages equal $300,000 and $275,000

Date	Location	Description	Remarks
Mar. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two wind storm events with winds measured at 60 mph and 75 mph	$75,000 and $211,000 in estimated property damage among all four coastal counties; the storms also impacted 10 other counties outside of Region 1; total damages equal $75,000 and $475,000
Nov. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 70 mph.	total of $10,000 in damages
Dec. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 90 mph	total of $225,000 in estimated damages for Coos, Curry, and Douglas Counties; the storm also impacted Josephine County, leading to a total storm damage of $300,000
Dec. 2006	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Nov. 2007	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Dec. 2007	Clatsop, Tillamook Counties	series of powerful Pacific storms	resulted in Presidential Disaster Declaration; $180 million in damage in the state, power outages for several days, and five deaths attributed to the storm
Dec. 2008	Clatsop, Lane, Tillamook, Lincoln Counties	intense wind and rain events	resulted in nearly $8 million in estimated property and crop damages for Clatsop, Lane, Tillamook, and Lincoln Counties

Sources: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007); Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-112. Tornadoes Recorded in Region 1

Date	Location	Remarks
June 1897	Bay City, Oregon	observed, but no damage recorded
Oct. 1934	Clatskanie, Oregon	observed; no damage
Apr. 1960	Coquille, Oregon	accompanied by heavy rain; no damage
Nov. 1965	Rainier, Oregon	crossed Columbia River; two buildings damaged
Oct. 1966	Seaside, Oregon	windows broken, telephone lines down, outdoor signs destroyed
Oct, 1967	Near Astoria, Oregon airport	began over ocean and moved inland. Several homes and commercial buildings damaged
Dec, 1973	Newport, Oregon	some roof damage
Dec. 1975	Tillamook, Oregon	90 mph wind speed; damage to several buildings
Aug. 1978	Scappoose, Oregon	manufactured home destroyed; other damage
Mar. 1983	Brookings, Oregon	minor damage
Nov. 1984	Waldport, Oregon	damage to automobiles and roofs
Feb. 1994	Near Warrenton, Oregon	damage in local park
Nov. 2002	Curry County, Oregon	$500,000.00 in property damage
Nov. 2009	Lincoln County, Oregon	$35,000 in property damage, damage to homes and automobiles

Sources: National Weather Service, Portland; Taylor and Hatton (1999); National Climatic Data Center (2013) Storm Events Database, http://www.ncdc.noaa.gov/stormevents/; Hazards and Vulnerability Research Institute (2007); the Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center (2013); U.S. Tornado Climatology, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience windstorms is shown in **Table 2-113**.

Table 2-113. Local Probability Assessment of Windstorm in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

High winds occur yearly in Region 1. The 100-year event is considered to be a storm with 1-minute average winds of 90 miles per hour. A 50-year event has average winds of 80 mph, and a 25-year event has winds of 75 miles per hour.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-114**.

Table 2-114. Local Vulnerability Assessment of Windstorm in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	M	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 1 are vulnerable to wind damage. This is especially true in open areas, such as along the Oregon Coast, natural grasslands, or farmland. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. All the coastal counties are most vulnerable to windstorm damage.

Oregon's history of wind damage underscores the need for a comprehensive wind-hazard mitigation program. The necessity of such an action is partly supported in an after-action report focusing on western Oregon's high-wind event of February 7, 2002 (Hazard Mitigation Survey Team Report, FEMA-1405-DR-OR). Other historic events (e.g., 1962 Columbus Day Storm) provide additional insights.

Structures most vulnerable to high winds in Region 1 include insufficiently-anchored manufactured homes and older buildings in need of roof repair. Section 307 of the Oregon Building Code identifies high-wind areas along the Oregon Coast and sets anchoring standards for manufactured homes located in those areas. It is essential that coastal counties ensure that the standards are enforced. The Oregon Department of Administrative Service's inventory of state-owned and operated buildings includes an assessment of roof conditions as well as the overall condition of the structure.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines, effectively bringing local economic activity and other essential activities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Tree-lined coastal roads and highways present a special problem. This is because much of the traveling public enjoys the beauty of forested corridors and most certainly would be concerned with any sort of tree removal program. In short, any safety program involving tree removal must be convincing, minimal, and involve a variety of stakeholders.

Wind-driven waves are common along the Oregon coast and are responsible for road and highway wash-outs and the erosion of beaches and headlands. These problems are addressed in the Flood section of this regional analysis. Unlike Oregon’s Willamette Valley (Regions 2 and 3), there are no water-borne ferry systems in Region 1 whose operations would be affected by high winds. Bridges spanning bays or the lower Columbia River would be closed during high-wind periods.

Winter Storms

Characteristics

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. Snow and ice are less common in the coastal regions, but often bring flooding after snow melts. Flooding is where the problem begins. See the **Flood** section in this regional analysis for more about flooding along the Oregon Coast.

Historic Winter Storm Events

Table 2-115. Historic Winter Storms in Region 1

Date	Location	Description
Jan. 1998	Clatsop County	trees and large tree limbs were knocked down causing widespread power outages; citizens urged to stay home; 3 known fatalities
Jan. 2002	statewide	strong winter storm with high winds at coast and heavy snows to the inland areas of Northwest Oregon; Florence had 46 mph sustained winds and 36 mph gusts to 63 mph, Newport Jetty 39 mph with gusts to 53 mph, and Garibaldi 42 mph; 32 inches of snow at Timberline Lodge on Mount Hood and 30 inches at Santiam Pass
Jan. 2004	statewide	frigid arctic air mass, heavy snow, sleet and freezing rain; weight from the snow and ice buildup resulted in widespread downed trees and power lines, leaving 46,000 customers without power, and collapsed roofs; Oregon Governor Kulongoski estimated cost of damages to public property at $16 million
Dec. 2008	northern Oregon coast	third unusually cold storm system that season with heavy snow in northwest Oregon; heavy snowfall across northwest Oregon; 11–24 inches of snow in the north Oregon Coast Range

Source: National Weather Service

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 1 will experience winter storms is shown in **Table 2-116**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—).

Table 2-116. Local Probability Assessment of Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	—	H	L	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

On the basis of historical data, severe winter storms could occur about every 4 years in Region 1. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-117**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—).

Table 2-117. Local Vulnerability Assessment of Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	—	M	L	—	H

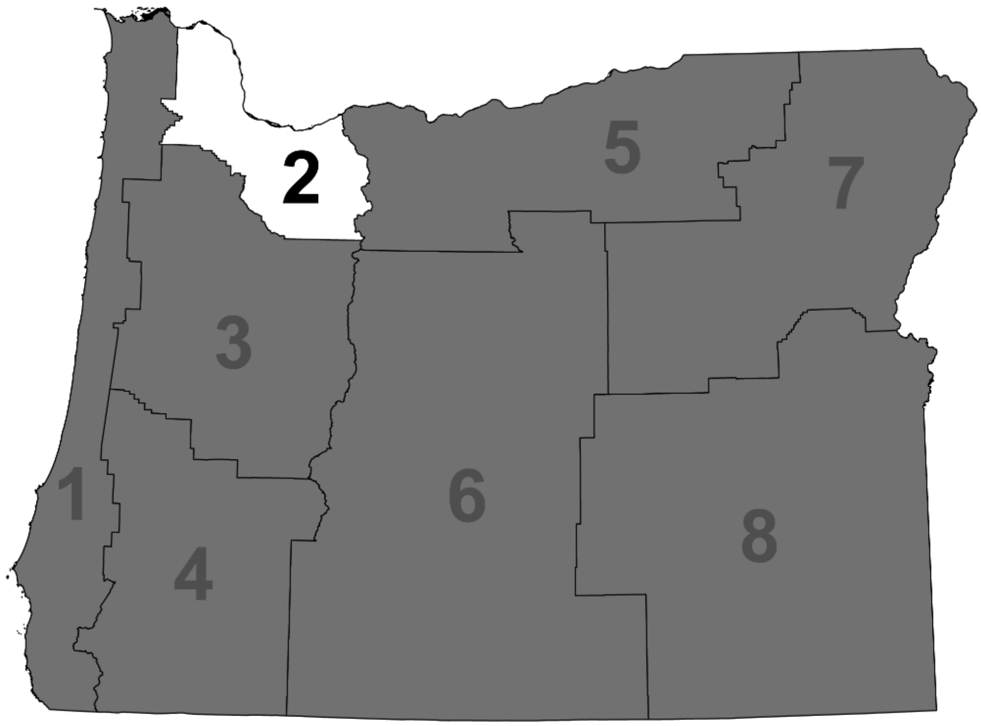
Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. These conditions bring widespread power outages and road closures due to downed trees from the heavy ice. These events close roads and isolate communities. Due to the logistics of the coastal regions many of the communities may become isolated due to winter storms. Countywide road closures can cause considerable travel delays. Communities in Region 1 that may be impacted by severe winter storms include Astoria, Cannon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay and Newport.

2.3.2 Region 2: Northern Willamette Valley / Portland Metro

Clackamas, Columbia, Multnomah, and Washington Counties



2.3.2.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Regionally, social vulnerability is driven by a high number of tourists who are likely not familiar with the hazard types and level of risk in the region. At the county level, high numbers of disabled persons in Multnomah County; a dramatic increase in the homeless population in Clackamas County; and higher numbers of renters and of persons who do not speak English "very well" in Multnomah and Washington Counties increase the level of risk to these populations. Columbia County's low incomes and high poverty rates make it especially vulnerable to heightened economic hardship that often follows a hazard event.

Compared to other areas of the state, communities around the Portland Metro area weathered the financial crisis that began in 2007 due to the diversity of key industries, employment sectors, and higher wages than the state average. The region's resilience is bolstered by strong Professional and Business Services, Health and Social Assistance, and Government sectors, which have low vulnerability to natural disasters and are key to post-disaster recovery efforts. Columbia County's economy is struggling the most, with higher unemployment and lower wages.

Transportation networks across the state are vulnerable to natural hazard events, especially seismic events. Following a Cascadia earthquake event, access across the Willamette River and along I-5 may be limited due to bridge collapse. The region has two ports with facilities, including the Portland International Airport, that are key to the statewide economy and are vulnerable to disruptions in service that can impact the transport of people, goods, and emergency services.

Older centralized water infrastructure is vulnerable to flooding and pollution. Upstream pollution in the Willamette and Columbia Rivers threaten ecosystems and public health.

Eight power-generating facilities and many dams — including Bonneville Power Administration's main dam, the Bonneville Dam — are in this region. Additionally, the site of Oregon's Critical Energy Infrastructure Hub, located in Portland, is subject to seismically induced liquefaction, making it exceptionally vulnerable to a Cascadia earthquake. Disruption or failure to these systems could be devastating to the region and state.

Region 2 is developing at a slightly faster pace than the rest of the state. The majority of growth is occurring in urban areas surrounding Portland. Over half the homes in Multnomah County were built prior to current seismic and floodplain management standards, making them particularly vulnerable to seismic and flood events.

Hazards and Vulnerability

Region 2 is affected by eight of the 11 natural hazards that affect Oregon communities. Coastal hazards, dust storms, and tsunami do not directly impact this region.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. Moderate-type drought years have occurred in Region 2 more than a dozen times between 1939 and 2001.

Earthquakes: Four types of earthquakes affect Region 2 (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for the Northern Willamette Valley. The region is particularly vulnerable to earthquakes due to the amount of area that is susceptible to earthquake-induced landslide, liquefaction, and ground shaking. Region 2 is home to the majority of the state's population, employment, and built environment. A CSZ event will dramatically impact the region's critical infrastructure, including seismic lifelines along Interstate-5 and Oregon's Critical Energy Hub in North Portland. There are 849 state-owned/leased facilities, valued at over $1 billion, in Region 2's earthquake hazard zone. Of these, 120 are critical/essential facilities. An additional 2,675 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: All counties in the Northern Willamette Valley are affected by riverine flooding. Rain-on-snow events and heavy rain events leading to tributary backups are common in this region. Clackamas and Columbia Counties are most vulnerable to flooding events. Region 2 has the second highest number of repetitive flood losses in the state (which is one third of all losses statewide), of which four are severe repetitive losses. Many of these are along the Columbia River where high rainfall impacts high population density. Following floods in 1996 and 2007, elevation and acquisition projects initiated by the City of Vernonia helped reduce flood risk in Columbia County. There are 51 state-owned/leased facilities, valued at approximately $25.4 million, located in the region's flood hazard zone. Of these, two are considered critical/essential facilities. In addition, 56 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months, and earthquakes can trigger landslides. Vulnerability is increased in populated areas such as the Portland Metro Area and in the Coast and Cascade Mountain Ranges. In general, the counties of Washington, Multnomah, and Clackamas have relatively high vulnerability. There are 848 state-owned/leased facilities, valued at over $1 billion, in Region 2's earthquake hazard zone. Of these, 120 are critical/essential facilities. An additional 2,675 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: The region can be impacted by volcanic activity, particularly within parts of eastern Clackamas and Multnomah Counties (including Portland) that coincide with the crest of the Cascade Mountain Range. Most volcanic activity is considered local. However, some activity, such as lahars and ashfall, can travel many miles and could impact the communities of Government Camp, Rhododendron, and Welches. There are 220 state-owned/leased facilities, valued at approximately $73.7 million, located in a volcanic hazard zone. Of these, 17 are identified as critical/essential facilities. In addition, 601 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: The region's vulnerability to wildfire is moderate at best. Wildfires are most common during the late summer. The areas of greatest vulnerability are within the wildland-urban interface communities. Much of the risk to wildfire in Region 2 is mitigated by large expanses of urban development and quick response times. There are 234 state-owned/leased facilities, valued at approximately $115 million, located in a wildfire hazard zone. Of these, 18 are identified as critical/essential facilities. In addition, 380 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms affect the region annually. The most frequent and strongest originate in the Pacific Ocean and travel southwest. Columbia, Multnomah, and Washington Counties are most vulnerable to these types of storms. To a lesser degree, eastern winds traveling through the Columbia River Gorge also affect Region 2 communities. Windstorms can impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Winter storms occur annually. The Columbia River Gorge can bring colder weather, higher precipitation, and high westerly winds to the region causing severe weather for short periods of time. Because these storms are infrequent and short lived, communities including the Portland Metro Area are often unprepared for them.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 2 include drought, wildfire, flooding, and landslides. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. In addition, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas of Region 2 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return interval. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger increased landslides. While winter storms and windstorms affect Region 2, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.2.2 Profile

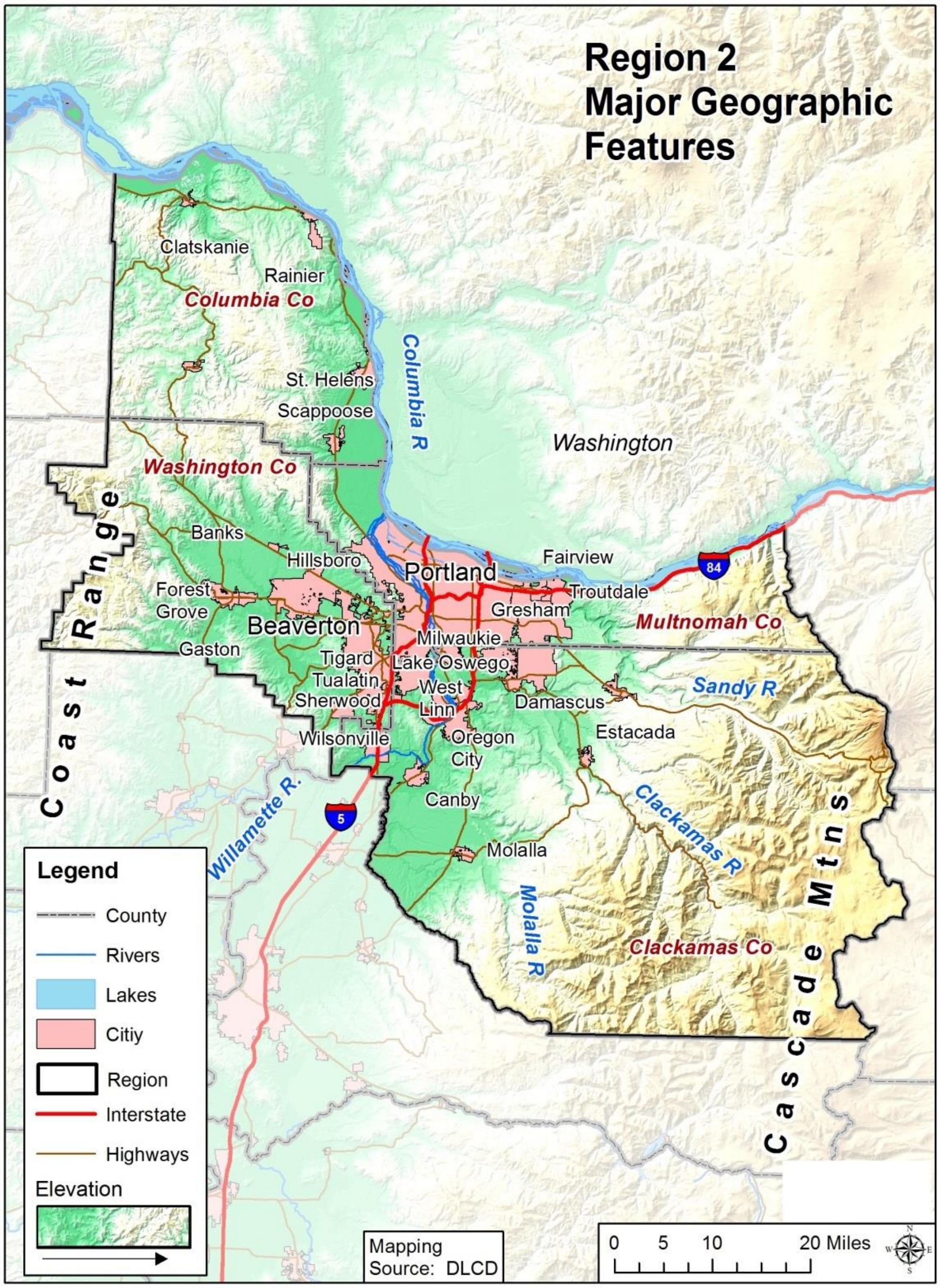
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

The Northern Willamette Valley and Portland Metro Area is approximately 3,758 square miles in size, and includes Clackamas, Columbia, Multnomah, and Washington Counties. Mountain ranges and watersheds shape the region's topography. Region 2 begins at the Cascade Mountain Range in the east and extends westward through the Willamette Valley and into the Coast Range and southward from the Columbia River in the North to the Mid-Willamette Valley. Two rivers shape the region's main watersheds, the Columbia River and the Willamette River. **Figure 2-101** shows the dominant mountain ranges, major watersheds, and political boundaries of Region 2.

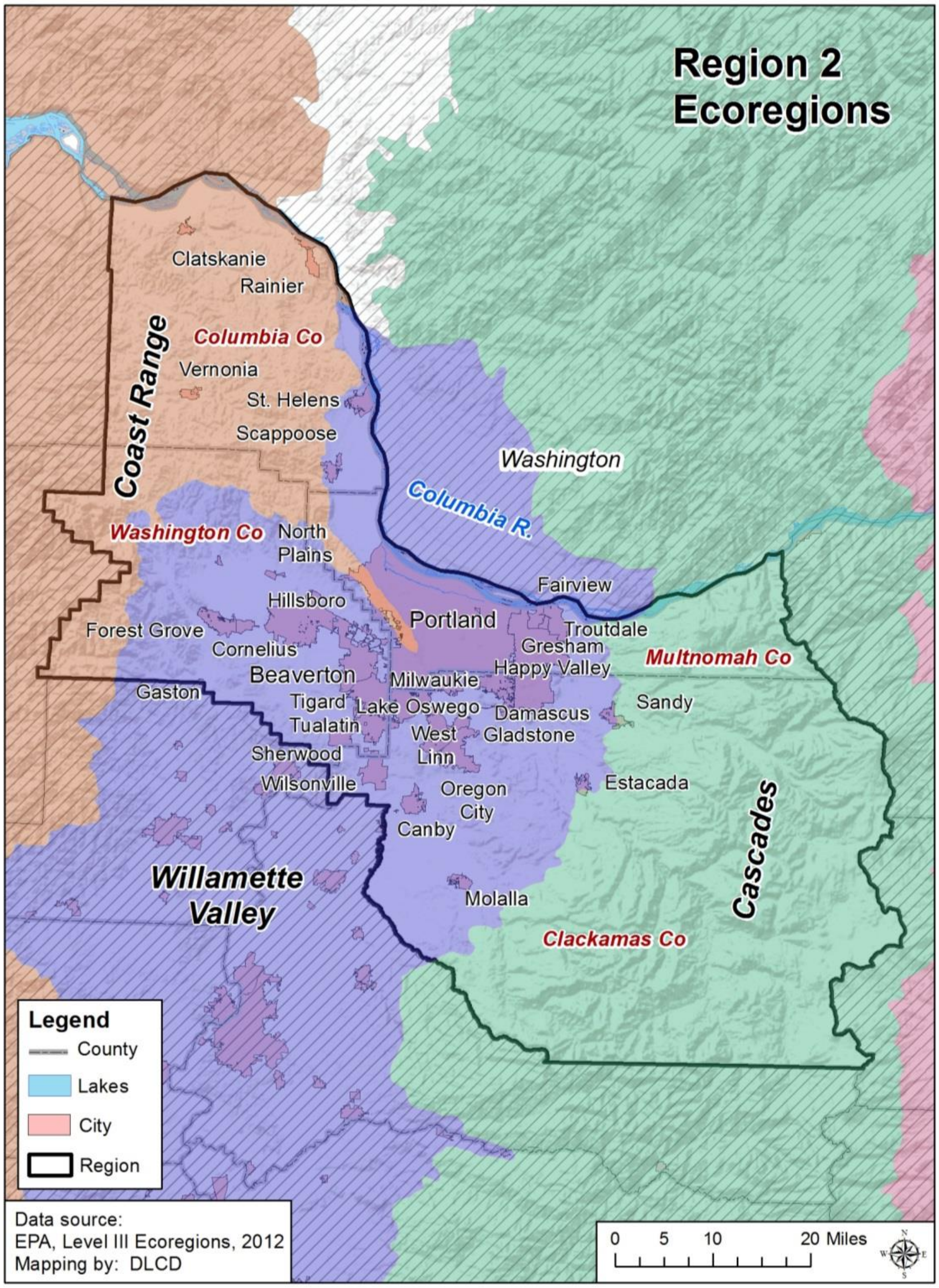
Figure 2-101. Region 2 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 2 is composed of three ecoregions: the Coast Range, the Willamette Valley, and the Cascades (**Figure 2-102**).

Figure 2-102. Region 2 Ecoregions



Cascades: Soil in this ecoregion is volcanic. Mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water (Thorson et al., 2003).

Willamette Valley: Terraces and floodplains dominate the nearly flat central Willamette Valley. The valley floor is dotted with scattered hills, buttes, and bordered by the adjacent foothills. Historically, valley waterways meandered throughout floodplains on the nearly flat valley floor, contributing to the valley's highly fertile soil and supporting the dominance of oak savannah and prairie ecosystems. Today the Willamette River and its tributaries are highly channelized, restricting the flow of these waterways, helping protect property but also threatening stream health. The productive soils and temperate climate make this ecoregion one of the most important agricultural areas in Oregon. The valley's flat terraces have made urban and suburban development possible in the valley (Thorson et al., 2003).

Coast Range: The east slope of the Coast Range is located within Region 2. Soils are a mix of sedimentary and volcanic composition. Sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Thorson et al., 2003). Volcanic soils are underlain by basaltic rocks resulting in more consistent summer stream flows. This soil composition supports runs of spring Chinook salmon and summer steelhead. On the other hand, sedimentary soils are prone to failure following clear cuts. This may be of concern as the commercial Douglas fir forests are highly productive commercial logging areas.

Climate

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment**.

Variations in temperature and precipitation vary widely by sub-ecoregion and microclimate. Precipitation generally occurs in the winter months. Wet winters and dry summers increase risk to droughts, floods, landslides, wildfires, and winter storms. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-118. Average Precipitation and Temperature Ranges in Region 2 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Willamette Valley*	37–60	32/46	50/85
Coast Range*	50–200	30/46	50/76

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 2.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised.

Overall, from 2000 to 2013, Region 2 grew at about the same rate as the state. The exception is Washington County, which grew almost most 10% more than the rest of the region. By 2020, all counties in Region 2 except Multnomah are projected to grow at a rate greater than the state.

Table 2-119. Population Estimate and Forecast for Region 2

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 2	1,487,779	1,743,450	17.2%	1,906,659	9.4%
Clackamas	338,391	386,080	14.1%	422,576	9.5%
Columbia	43,560	49,850	14.4%	54,517	9.4%
Multnomah	660,486	756,530	14.5%	807,198	6.7%
Washington	445,342	550,990	23.7%	622,368	13.0%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 2 are largely centered on special events (such as fairs, festivals or sporting events), city trips, and touring (traveling to experience scenic beauty, history and culture) (Longwoods International, 2011). Thirty percent of all overnight trips in Oregon included time in the Northern Willamette Valley/Portland Metro area. The average travel party contains 3.4 persons and 68% of these trips originate from Oregon or California. The average trip length is 3.5 nights (Longwoods International, 2011). In 2013, over 70% of visitors in Clackamas, Columbia, and Washington Counties lodged in private homes.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-120. Annual Visitor Estimates in Person Nights in Region 2

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 2	25,731	—	26,367	—	26,780	—
Clackamas	6,626	100%	6,832	100%	6,828	100%
Hotel/Motel	1,205	18.2%	1,279	18.7%	1,292	18.9%
Private Home	4,849	73.2%	4,974	72.8%	4,948	72.5%
Other	572	8.6%	579	8.5%	588	8.6%
Columbia	627	100%	622	100%	622	100%
Hotel/Motel	51	8.1%	43	6.9%	38	6.1%
Private Home	496	79.1%	493	79.3%	493	79.3%
Other	80	12.8%	86	13.8%	91	14.6%
Multnomah	10,996	100%	11,475	100%	11,686	100%
Hotel/Motel	5,440	49.5%	5,785	50.4%	5,979	51.2%
Private Home	5,127	46.6%	5,251	45.8%	5,262	45.0%
Other	429	3.9%	439	3.8%	445	3.8%
Washington	7,482	100%	7,438	100%	7,644	100%
Hotel/Motel	1,693	22.6%	1,682	22.6%	1,769	23.1%
Private Home	5,640	75.4%	5,604	75.3%	5,721	74.8%
Other	149	2.0%	152	2.0%	154	2.0%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). While somewhat fewer people in Region 2 identify as having a disability than do people throughout the state, 46% of those who consider themselves to have a disability live in Multnomah County. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-121. People with a Disability by Age Group in Region 2, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 2	1,683,829	184,388	11.0%	15,218	3.9%	68,586	36.4%
Clackamas	375,412	42,579	11.3%	3,849	4.3%	17,787	34.6%
Columbia	49,072	6,968	14.2%	546	4.7%	2,600	38.1%
Multnomah	730,762	85,534	11.7%	6222	4.1%	29,888	39.1%
Washington	528,583	49,307	9.3%	4,601	3.4%	18,311	34.3%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless people are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). This population has increased in the region by roughly 30% from 2009 to 2011. The greatest increase, roughly 163%, in homeless populations in the Northern Willamette Valley and Portland Metro Area has taken place in Clackamas County.

Extra attention is needed to care for and serve homeless communities**.** Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-122. Homeless Population Estimate for Region 2

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 2	6,440	5,132	9,439	7,004
Clackamas	168	208	2,741	1,039
Columbia	256	342	285	294
Multnomah	4,808	3,199	5,059	4,355
Washington	1,208	1,383	1,354	1,315

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 2 is similar to that of the state, roughly 50:50 (U.S. Census Bureau, 2010, American Community Survey, Table DP-1). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

The region's percentage of seniors is slightly lower than the state. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to elderly (Morrow, 1999).

The region's percentage of children is similar to the statewide percentage. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time and money when their children's childcare facilities and schools are impacted by disasters.

Table 2-123. Population by Vulnerable Age Groups in Region 2, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 2	1,695,451	386,620	22.8%	191,947	11.3%
Clackamas	377,206	88,732	23.5%	52,187	13.8%
Columbia	49,317	11,704	23.7%	6,926	14.0%
Multnomah	737,110	150,824	20.5%	78,778	10.7%
Washington	531,818	135,360	25.5%	54,056	10.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations can be harder to reach with outreach materials. They are less likely to be prepared if special attention is not given to language and culturally appropriate outreach techniques. In the region, Multnomah and Washington Counties have the highest percentages of residents who do not speak English very well. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-124. English Usage in Region 2, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 2	1,458,376	91.9%	128,981	8.1%
Clackamas	339,863	95.5%	16,163	4.5%
Columbia	46,006	98.9%	528	1.1%
Multnomah	626,678	90.7%	64,290	9.3%
Washington	445,829	90.3%	48,000	9.7%

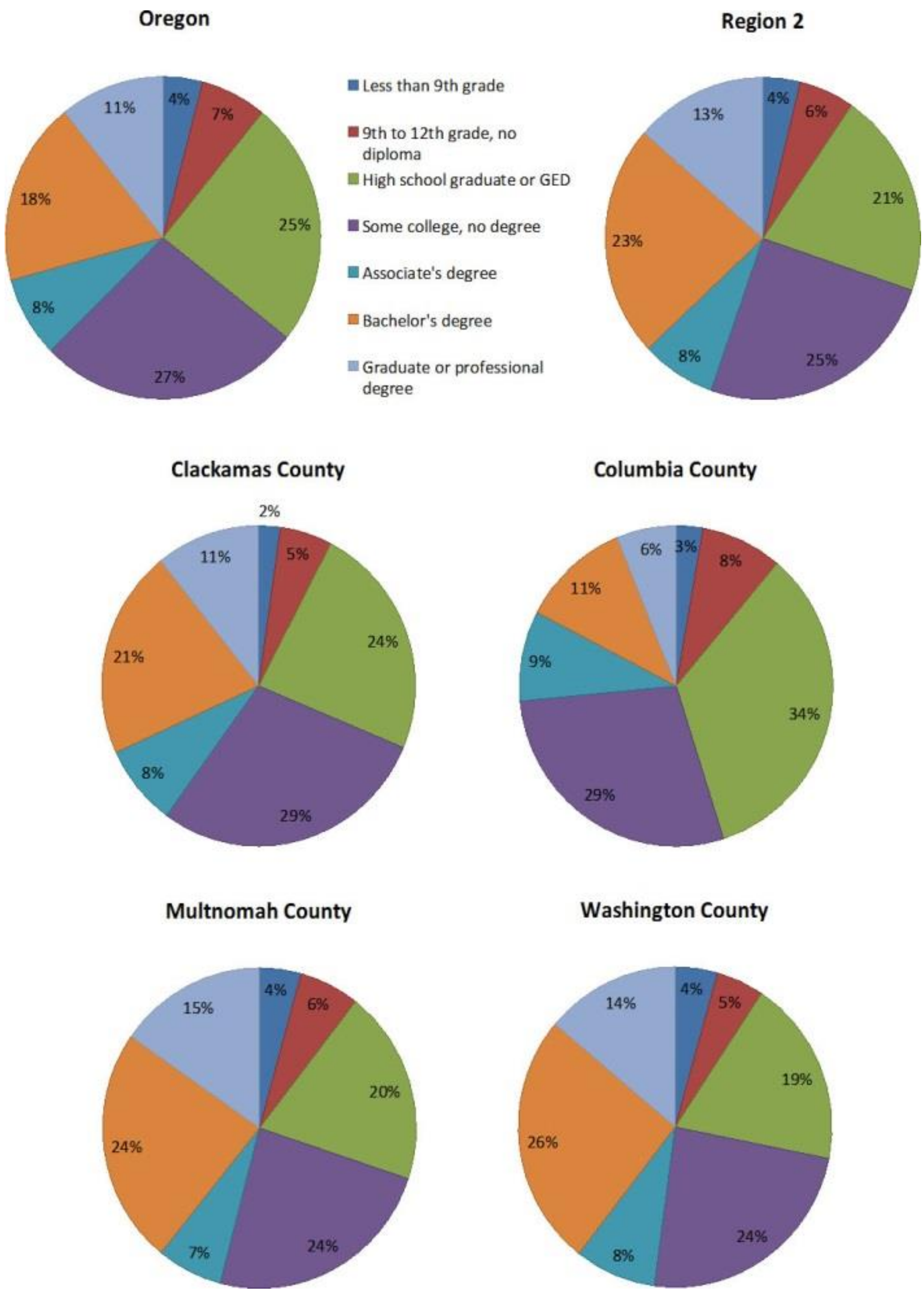
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02, http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence the ability to understand warning information (Cutter et al., 2003) and to access hazard resources.

There is a higher percentage of bachelor's and graduate or professional degrees in the Northern Willamette Valley and Portland Metro Area compared to statewide numbers (**Figure 2-103**). There is a lower percentage of people with only a high school degree or GED.

Figure 2-103. Educational Attainment in Region 2, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

The recent financial crisis that began in 2007 moderately affected Region 2. Overall, median household incomes in the region are between $5,000 and $14,000 above those for the state, except in Multnomah County where they are only about $1,000 more than statewide numbers. Between 2009 and 2012, the greatest percent decrease in median household incomes occurred in Columbia County, falling by 9% — dropping by roughly 2 times median household incomes statewide.

Table 2-125. Median Household Income in Region 2

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 2	N/A	N/A	N/A
Clackamas	$66,383	$63,951	-3.7%
Columbia	$60,897	$55,358	-9.1%
Multnomah	$52,622	$51,582	-2.0%
Washington	$66,585	$64,375	-3.3%

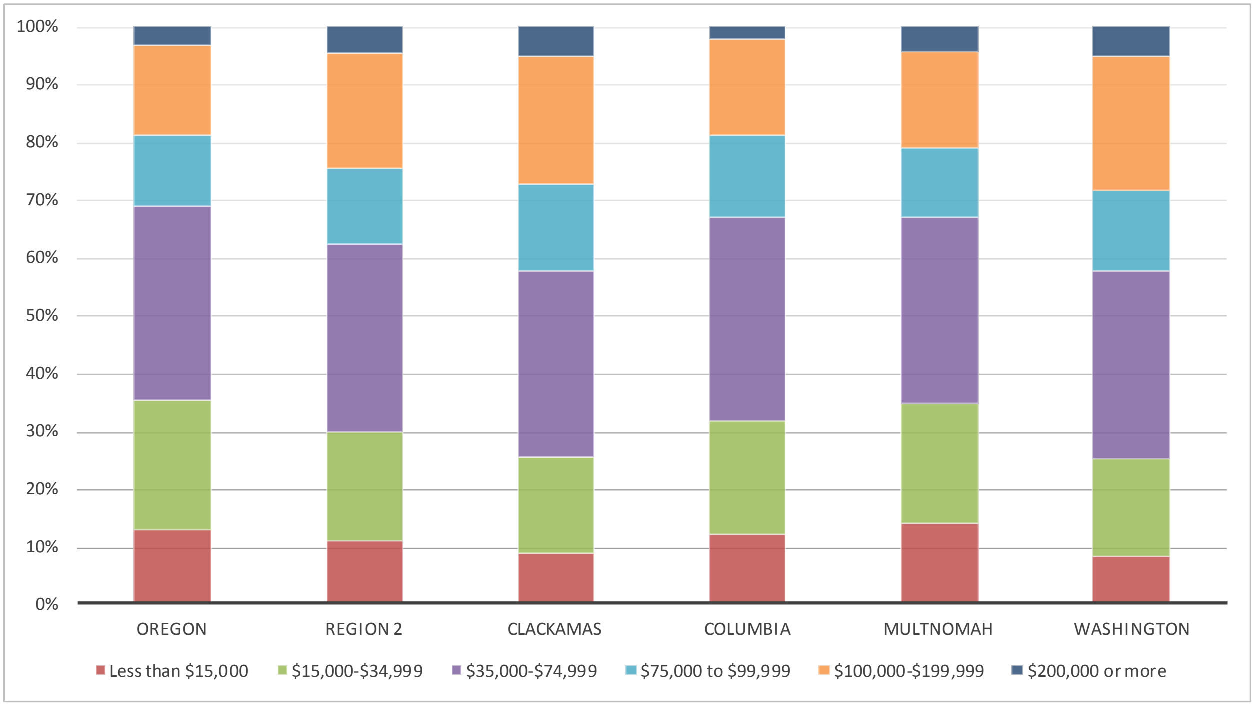
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau, 2005–2009 and 2008–2012 American Community Survey – 5-Year Estimates, Table DP03

The region has a smaller percentage of households earning less than $35,000 per year than the state as a whole. Clackamas and Washington Counties have the largest percentages of households earning more than $75,000 per year.

Figure 2-104. Median Household Income Distribution in Region 2, 2012



Source: U.S. Census Bureau; 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has 2% fewer individuals and 3% fewer children living in poverty than the statewide average. Multnomah County has the highest percentage of its population living in poverty. However, the most dramatic increase in poverty rates has been in Columbia County with an almost 59% increase in overall poverty, including an 86% increase in child poverty.

Table 2-126. Poverty Rates in Region 2, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	**Percent**	**Percent Change***	**Number**	**Percent**	**Percent Change***
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 2	223,962	13.4%	15.6%	66,738	17.5%	14.4%
Clackamas	36,265	9.7%	9.2%	11,161	12.7%	9.0%
Columbia	6,797	13.9%	58.7%	2,257	19.6%	86.2%
Multnomah	123,434	17.1%	16.3%	34,231	23.1%	13.5%
Washington	57,466	10.9%	14.7%	19,089	14.3%	14.2%

*Percent change since 2009

Source: U.S. Census Bureau, 2005–2009 and 2008–2012 American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover from a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. Further, renters are typically not in a position to be able to decide to and make substantive improvements such as seismic retrofits to their residences. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Compared to the state overall, Multnomah and Washington Counties have a higher share of rental units. Almost half of the units in Multnomah County are rented. Columbia County has the highest percentage of owner occupied households — nearly 15% more than the region's average.

Table 2-127. Housing Tenure in Region 2

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 2	667,878	404,784	60.6%	263,094	39.4%	39,156	5.5%
Clackamas	145,004	100,759	69.5%	44,245	30.5%	9,203	5.9%
Columbia	19,060	14,383	75.5%	4,677	24.5%	1,436	7.0%
Multnomah	303,654	166,200	54.7%	137,454	45.3%	17,496	5.4%
Washington	200,160	123,442	61.7%	76,718	38.3%	11,021	5.2%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households (Cutter et al., 2003). Every county in the region except Multnomah has a slightly higher share of family households with children when compared to statewide numbers. Multnomah County's share is slightly less.

Table 2-128. Family vs. Non-family Households in Region 2, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 2	667,878	413,103	61.9%	254,775	38.1%	191,979	28.7%
Clackamas	145,004	100,694	69.4%	44,310	30.6%	35,549	24.5%
Columbia	19,060	13,440	70.5%	5,620	29.5%	4,499	23.6%
Multnomah	303,654	164,793	54.3%	138,861	45.7%	101,623	33.5%
Washington	200,160	134,176	67.0%	65,984	33.0%	50,308	25.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-129. Family Households with Children by Head of Household in Region 2, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 2	192,041	28.8%	13,723	2.1%	40,615	6.1%	137,703	20.6%
Clackamas	43,804	30.2%	3,346	2.3%	8,026	5.5%	32,432	22.4%
Columbia	5,328	28.0%	424	2.2%	1,226	6.4%	3,678	19.3%
Multnomah	75,794	25.0%	5,957	2.0%	19,076	6.3%	50,761	16.7%
Washington	67,115	33.5%	3,996	2.0%	12,287	6.1%	50,832	25.4%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 1 is particularly vulnerable during a hazard event in the following categories:

- Thirty percent of all tourists in the state visited this region.
- Columbia County has a greater percentage of disabled citizens than the region overall and the state overall.
- Clackamas County has seen a drastic increase in its homeless population.
- Multnomah and Washington Counties have the greatest proportion of residents who do not speak English well.
- Columbia County has seen a drop in median household income and dramatic increase in poverty.
- The percentage of renters in Multnomah County significantly exceeds that of the region and the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). Since the end of the financial crisis that began in 2007 job recovery in Region 2 has outpaced the state's as a whole. Most major private sector industries are at or above pre-recession employment levels. Portland has regained about 90% of jobs lost, and half of these new jobs pay more than $50,000 annually.

Regional unemployment rates have been declining steadily since 2009. Unemployment rates in all counties except Columbia are generally 1% lower than the state. Columbia County has the smallest labor force in the region, the highest unemployment rate, and the lowest average salary. The majority of the region's employees are within Multnomah County. Washington County has the highest average wage, $59,481 (132% of the state average).

Winter months tend to have the lowest employment rates due to less tourism and fewer employment opportunities in outdoor industries such as construction and agriculture (Tauer, 2014). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Lower employment rates during winter months could be further exacerbated by a hazard event.

Table 2-130. Employment and Unemployment Rates in Region 2, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 2	910,110	848,951	93.3%	61,159	6.7%
Clackamas	196,081	182,673	93.2%	13,408	6.8%
Columbia	23,449	21,516	91.8%	1,933	8.2%
Multnomah	400,250	372,664	93.1%	27,586	6.9%
Washington	290,330	272,098	93.7%	18,232	6.3%

Source: Oregon Employment Department, 2014

Table 2-131. Unemployment Rates in Region 2, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 2	10.1%	9.7%	8.5%	7.7%	6.7%	-3.4%
Clackamas	10.2%	10.1%	8.9%	8.0%	6.8%	-3.4%
Columbia	13.2%	12.1%	10.7%	9.7%	8.2%	-4.9%
Multnomah	10.4%	9.9%	8.7%	7.8%	6.9%	-3.5%
Washington	9.4%	9.0%	7.8%	7.1%	6.3%	-3.1%

Source: Oregon Employment Department, 2014

Table 2-132. Employment and Payroll in Region 2, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 2	861,474	$52,136	116%
Clackamas	143,101	$45,274	100.6%
Columbia	9,797	$34,558	76.8%
Multnomah	452,060	$50,521	112.2%
Washington	256,516	$59,481	132.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 2 were: (a) Trade, Transportation, and Utilities; (b) Professional and Business Services; (c) Education and Health Services; (d) Government; and (e) Manufacturing. The following information is from the State of Oregon Employment Department (https://www.qualityinfo.org): Columbia County is within the Portland Metro area but remains a strong natural resource based economy that also has an increasing number of residents commuting to jobs in Portland and Cowlitz County, Washington. Multnomah and Washington Counties have a diverse economic base that has seen the most recovery in the state since the financial crisis that began in 2007. Industries in these counties include manufacturing, trade, and services. The high-tech industry is of particular importance to the region. Clackamas County has some of the state's most fertile farmland and is known for a strong agriculture based economy.

Table 2-133. Covered Employment by Sector in Region 2, 2013

Industry	Region 2	Clackamas Employment	Clackamas Percent	Columbia Employment	Columbia Percent
Total All Ownerships	861,474	143,101	100%	9,797	100%
Total Private Coverage	87.3%	127,251	88.9%	7,886	80.5%
Natural Resources & Mining	1.1%	4,527	3.2%	311	3.2%
Construction	4.7%	8,806	6.2%	517	5.3%
Manufacturing	11.1%	17,657	12.3%	1,336	13.6%
Trade, Transportation & Utilities	18.8%	31,903	22.3%	1,941	19.8%
Information	2.3%	1,963	1.4%	53	0.5%
Financial Activities	5.8%	7,260	5.1%	368	3.8%
Professional & Business Services	15.6%	15,952	11.1%	638	6.5%
Education & Health Services	13.7%	19,382	13.5%	1,110	11.3%
Leisure & Hospitality	10.1%	13,790	9.6%	1,075	11.0%
Other Services	3.9%	5,970	4.2%	535	5.5%
Private Non-Classified	0.0%	42	0.0%	(c)	-
Total All Government	12.7%	15,850	11.1%	1,911	19.5%
Federal Government	1.6%	1,062	0.7%	67	0.7%
State Government	1.9%	2,322	1.6%	256	2.6%
Local Government	9.2%	12,466	8.7%	1,588	16.2%

Industry	Region 2	Multnomah Employment	Multnomah Percent	Washington Employment	Washington Percent
Total All Ownerships	861,474	452,060	100%	256,516	100%
Total Private Coverage	87.3%	381,281	84.3%	235,231	91.7%
Natural Resources & Mining	1.1%	1,760	0.4%	3,228	1.3%
Construction	4.7%	18,809	4.2%	12,546	4.9%
Manufacturing	11.1%	32,874	7.3%	44,128	17.2%
Trade, Transportation & Utilities	18.8%	83,202	18.4%	45,297	17.7%
Information	2.3%	10,504	2.3%	7,307	2.8%
Financial Activities	5.8%	27,481	6.1%	14,644	5.7%
Professional & Business Services	15.6%	69,947	15.5%	47,522	18.5%
Education & Health Services	13.7%	66,568	14.7%	30,830	12.0%
Leisure & Hospitality	10.1%	51,072	11.3%	21,298	8.3%
Other Services	3.9%	19,036	4.2%	8,345	3.3%
Private Non-Classified	0.0%	30	0.0%	85	0.0%
Total All Government	12.7%	70,779	15.7%	21,286	8.3%
Federal Government	1.6%	12,271	2.7%	705	0.3%
State Government	1.9%	11,063	2.4%	2,763	1.1%
Local Government	9.2%	47,444	10.5%	17,818	6.9%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within this sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region and are most numerous in the Portland Metro area.

Professional and Business Services: This sector is composed of professional service providing industries including scientific and technical, management professionals and administrative and support services (e.g., engineering, law, headquarters, temp help, etc.). In general, this sector has low vulnerability to natural disasters. Vulnerability is increased if suppliers are affected or physical infrastructure such as buildings, roads, telecommunications, or water systems is damaged. Mitigation efforts for this sector should include preparing business continuity and recovery plans.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. The importance of the health care and social assistance sector is underscored in Region 2 because the region serves as a hub for health care. Health care is a relatively stable revenue sector with an abundant distribution of businesses primarily serving a local population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Multnomah and Washington Counties.

Revenue by Sector

Region 2 accounts for almost half of all revenue generated in Oregon. In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in the region. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $114 billion (86%) in revenue. Trade (Retail and Wholesale) is the largest grossing sector in Clackamas and Multnomah Counties. Manufacturing is the highest grossing sector in Columbia and Washington Counties.

Table 2-134. Revenue of Top Industries (in Thousands of Dollars) in Region 2, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 2	$132,790,589	47.1%	30.9%	7.9%
Clackamas	$19,898,459	52.2%	28.5%	8.6%
Columbia	$1,423,749	31.9%	58.0%	3.8%
Multnomah	$61,238,728	52.1%	17.2%	10.0%
Washington	$50,229,653	39.4%	47.9%	5.1%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2010 and 2020, the largest job growth in Region 2 is expected to occur in the following sectors: (a) Education and Health services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Professional and Business Services; (d) Leisure and Hospitality; and (e) Manufacturing (Oregon Employment Department, 2012; Employment Projections by Industry and Occupation: 2010–2020 Oregon and Regional Summary Retrieved April 10, 2014, from http://www.qualityinfo.org/olmisj/PubReader?itemid=00005720).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region (19.2%). The Other Services sector is the second most abundant and Education and Health Services sector ranks third. Leisure and Hospitality and Construction round out the top five sectors (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 40% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. This analysis shows that the economy in Region 2 is particularly strong in the following areas:

- The Portland Metro area has rebounded from the financial crisis that began in 2007 more strongly than any other area in the state and is near pre-recession employment levels.
- Much of the growth in employment within the region is spurred by the high-tech industry, which grew by 70% over the last decade (Oregon Employment Department, n.d., Region 2 data).
- Regionally, Columbia County is still struggling the most after the financial crisis that began in 2007. The unemployment rate is higher, overall educational attainment is lower, and the average salary is only 77% of state average.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

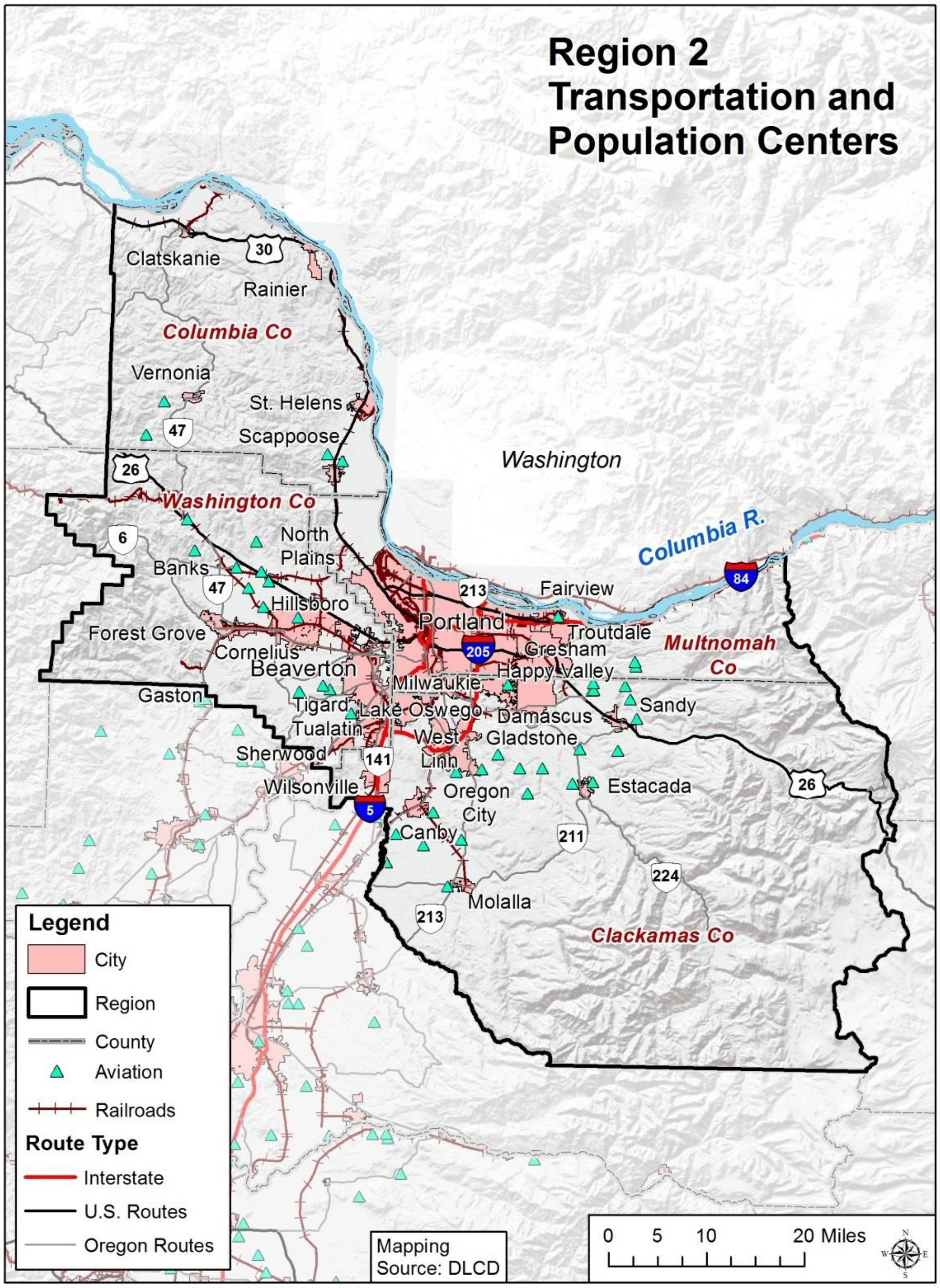
The largest population bases in Region 2 are located along the region's major freeways: I-5, I-205, and I-84. I-5 runs north-south through Region 2 and is the main passage for automobiles and trucks traveling along the West Coast. I-205 is a loop route that serves Portland and Vancouver and provides access through the eastern edge of the Portland area. I-84 runs east-west and is the main passage for automobiles and trucks traveling between Oregon and central and eastern states.

Region 2's growing population centers bring more workers, automobiles and trucks onto roads. Collectively, these create additional stresses on transportation systems through added maintenance, congestion, and oversized loads. Furthermore, a high percentage of workers driving alone to work, coupled with interstate and international freight movement on the interstate corridors, can cause added traffic congestion and accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

The region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 2, see **Seismic Lifelines**.

Figure 2-105. Region 2 Transportation and Population Centers



Source: Oregon Department of Land Conservation and Development, 2014

Bridges

As mentioned, the region's bridges are highly vulnerable to seismic activity. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-135 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency. A deficient bridge (De) is a federal performance measure used for non-ODOT bridges. These ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). 30% of region's bridges are distressed or deficient. About 28% of the region's ODOT bridges are distressed; 51% of those are in Multnomah County. Five bridges within the Portland Metro area are part of an I-5 seismic retrofit project scheduled to begin in the summer of 2014.

Table 2-135. Bridge Inventory for Region 2

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic Covered
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	ST	%D	
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 2	154	549	28%	117	429	27%	64	182	35%	11	23	48%	346	1137	30%	76
Clackamas	22	114	20%	36	154	23%	5	17	29%	1	1	100%	64	283	23%	16
Columbia	10	33	32%	14	81	17%	2	9	22%	0	2	0%	26	123	21%	8
Multnomah	95	282	38%	23	45	51%	52	122	43%	5	13	38%	175	429	41%	50
Washington	27	120	24%	44	149	30%	5	34	15%	5	7	71%	81	302	27%	2

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 2 support cargo and trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The Port of Portland is a major marine gateway for rail freight. There are six major rail yards and terminals in the region — all of which are in Portland — operated by UP or BNSF. Oregon's freight rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in the state, as well as products from other states that are shipped to and through Oregon by rail.

Amtrak provides passenger rail service throughout the region. In addition, the Portland Westside Express Service provides passenger rail options for commuters in Washington County. The area is also serviced by a regional transit system (TriMet) that provides both bus and light rail service through the greater Portland Metropolitan area.

Rails are sensitive to icing from winter storms that can occur in Region 2. Disruptions in the rail system can result in economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, especially if hazardous materials are involved.

Airports

The Portland International Airport is the only primary commercial airport in the region and is the busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated, and administered by the Port of Portland. It serves 17 passenger air carriers and seven cargo carriers with approximately 183,000 annual commercial flights, 20,300 cargo flights, and 21,000 military and general aviation annual flights (Portland International Airport, 2014). The Port of Portland also operates two relief airports, Portland-Hillsboro and Portland-Troutdale, that serve the region.

Table 2-136. Public and Private Airports in Region 2

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 2	12	33	1	24	70
Clackamas	5	19	0	6	30
Columbia	2	2	0	0	4
Multnomah	2	1	1	10	14
Washington	3	11	0	8	22

Source: FAA Airport Master Record (Form 5010), 2014

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Ports

Oregon's ports have historically been used for timber transport and for commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and river, rail, road, and air infrastructure. There are two ports within Region 2, the Port of St. Helens and the Port of Portland. The Port of St. Helens includes 93 acres of light industrial and is approximately 30 miles from Portland (Port of St. Helens, http://www.portsh.org/index.php). The Port of Portland is responsible for overseeing the Portland International Airport and other aviation and marine activities in the Portland Metro area. The Port of Portland includes four marine terminals, five industrial parks, and three airports (Port of Portland, http://www.portofportland.com).

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. Portland General Electric (PGE) is the largest investor-owned utility in the region, serving large areas of Clackamas, Multnomah, and Washington Counties. Pacific Power and Light (Pacific Power) is another investor-owned utility company serving a small portion of Multnomah County. Additionally, the Western Oregon Electric Cooperative, Inc. provides electricity for portions of Region 2. Three municipal utility districts support the region: City of Cascade Locks, City of Forest Grove, and City of Canby. In addition, the Clatskanie People's Utility District and the Columbia River PUD serve portions of the region.

The Northern Willamette Valley / Portland Metro area has eight power-generating facilities: six generate hydroelectric and two generate natural gas. In total, these facilities have the ability to produce up to 1,121 megawatts (MW) of electricity.

Table 2-137. Power Plants in Region 2

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 2	6	2	0	0	0	8
Clackamas	6	0	0	0	0	6
Columbia	0	2	0	0	0	2
Multnomah	0	0	0	0	0	0
Washington	0	0	0	0	0	0
Energy Production (MW)	203	918	0	0	0	1,121

*Other includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer owned utilities. The Bonneville Dam is BPA's major dam in the region, located on the Columbia River. Other dams in the region are located on the Willamette, Clackamas, and Sandy Rivers.

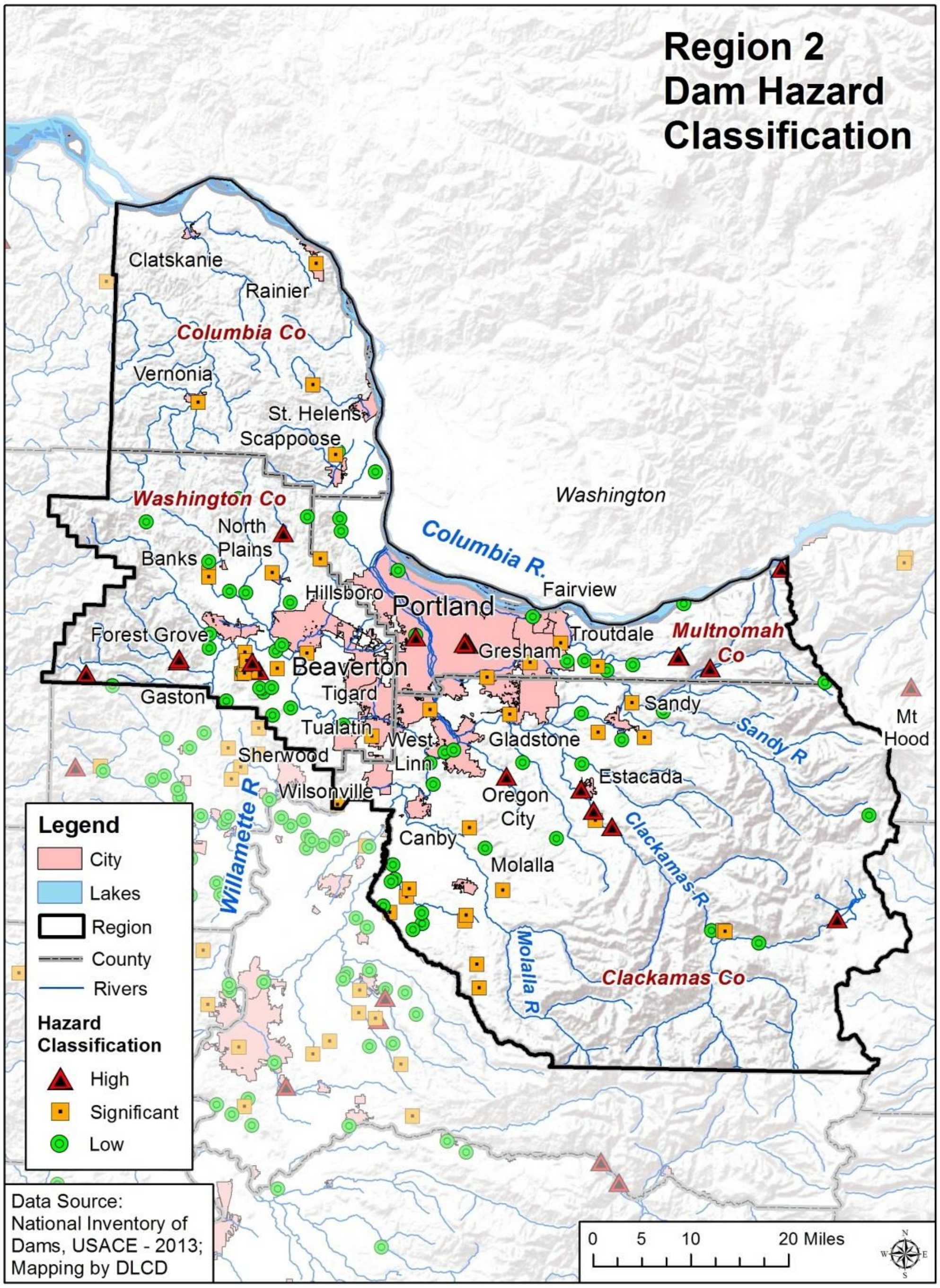
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. For example, major dam failures occurred near Hermiston in 2005, and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology and maintains an inventory of all large dams in Oregon. **Table 2-138** lists the number of dams included in the inventory. The majority of dams in the region are located in Clackamas and Washington Counties. There are 17 High Threat Potential dams and 42 Significant Threat Potential dams in the region.

Table 2-138. Threat Potential of Dams in Region 2

	Threat Potential			Total Dams
	High	Significant	Low	
Region 2	17	42	144	203
Clackamas	7	20	44	71
Columbia	0	3	9	12
Multnomah	7	5	14	26
Washington	3	14	77	94

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-106. Region 2 Dam Hazard Classification

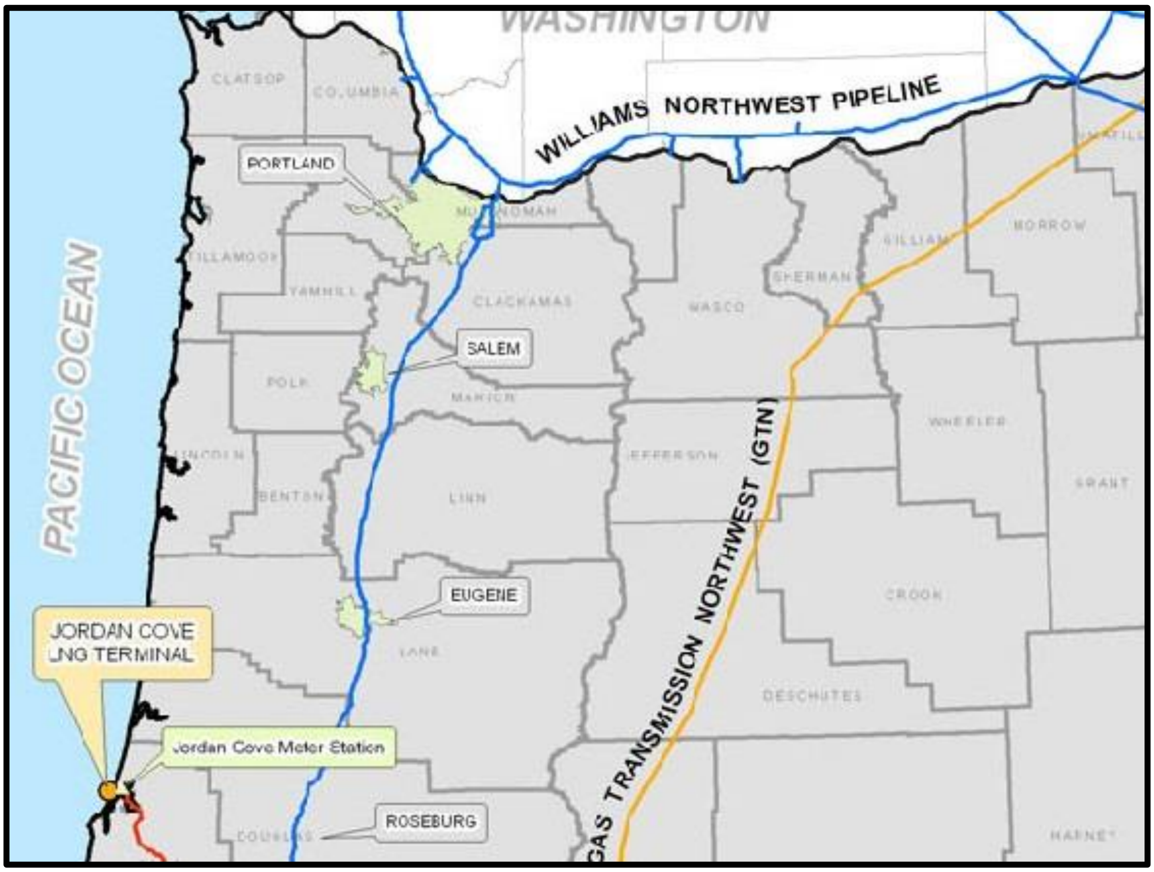


Source: USACE National Inventory of Dams, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-107** shows the Williams Northwest Pipeline, which runs through Clackamas and Multnomah Counties (in blue) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-107. Liquefied Natural Gas Pipelines in Region 2



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Oregon's Critical Energy Infrastructure Hub

Oregon's critical energy infrastructure hub (CEI Hub) is located in north Portland on the lower Willamette River between the south tip of Sauvie Island and the Fremont Bridge along US-30. Over 90% of Oregon's refined petroleum is imported to Oregon via the Puget Sound and arrives to Oregon CEI Hub via pipeline or marine vessels (Wang et al., 2013). In addition, much of Oregon's natural gas passes through the CEI Hub and a high voltage electrical transmission corridor crosses, and supplies distribution for, the area. The CEI Hub includes the following energy sector facilities (Pipelines International, 2009):

- All of Oregon's major liquid fuel port terminals,
- Liquid fuel transmission pipelines and transfer stations,
- Natural gas transmission pipelines,
- A liquefied natural gas storage facility,
- High-voltage electric substations and transmission lines, and
- Electrical substations for local distribution.

In 2013, the Oregon Department of Geology and Mineral Industries (DOGAMI) conducted a study of the CEI Hub's earthquake risk entitled Earthquake Risk Study for Oregon's Critical Energy Infrastructure Hub (DOGAMI Open-File Report O-13-09). The study determined (a) the vast majority of facilities are constructed on soils susceptible to liquefaction and (b) significant seismic risk exists within the various energy sector facilities. The CEI Hub was identified as being highly vulnerable to a Cascadia Subduction Zone (CSZ) event: "western Oregon is likely to face an electrical blackout, extended natural gas service outages, liquid fuel shortage, as well as damage and losses in the tens of billions of dollars" (Pipelines International, 2009). Significant pro-active seismic mitigation projects are recommended to be integrated into the affected energy sector companies' business practices in order to allow Oregon to adequately recover from a CSZ event within a reasonable period of time. For more information see the full report.

Utility Lifelines

The Northern Willamette Valley / Portland Metro region is an important thoroughfare for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Canada. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes. If these lines fail or are disrupted essential functions of the community can become severely impaired.

Region 2 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. Oil and gas are supplied by Northern California from a separate network. The electric, oil, and gas lifelines that run through the region are municipally and privately owned (Loy et al., 1976).

Portland General Electric and Bonneville Power Administration primarily operate the electrical transmission lines running through Region 2, and these lines produce and distribute power locally (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 2 is part of the Portland Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013), which also includes Clark County, Washington. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 2. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in eastern Multnomah County and a small area of central Columbia County (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 2 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Portland Operational Area are (Oregon Office of Emergency Management, 2013):

- KXL-FM, 10.1 MHZ, Portland;
- KGON-FM, 92.3 MHZ, Portland; and
- KOPB-FM, 91.5 MHZ, Portland.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 2 is served by ARES District 1. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 2 include (American Relay Radio League Oregon Chapter, http://www.arrloregon.org):

- Clackamas County: KA7OZO;
- Columbia County: W7OR;
- Multnomah County: N9VCU; and
- Washington County: KE7WKM.

Water

Drinking water, stormwater, and wastewater systems all possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 2 the majority of the municipal drinking water supply is obtained primarily from surface water sources such as rivers. These surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months. For many communities in Regions 2 and 3, the Willamette River is both a source of potable water and a discharge location for wastewater treatment facilities. Cities that draw water from the Willamette River face water rights disputes and issues related to water quality. The Bull Run watershed is the primary drinking source for the City of Portland and its 19 wholesale customers and does not face the same water quality issues as the Willamette River. However, Portland residents have expressed concerns about the well field that is the City's backup water source. Portlanders have complained of the water's unpleasant taste and expressed concern that water quality may be compromised due to the well field's close proximity to industrial facilities.

Rural residents in the region draw water from surface water, groundwater wells, or springs. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources. In areas where no new live-flow water rights are available, farmers and ranchers are turning to above-ground storage to help supply water for crop irrigation during dry seasons. At times, urban water districts with an abundant supply have sold water to rural areas. The City of Portland has a long history of these transactions and in recent years has faced competition from other sellers.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure such as reservoirs, treatment facilities, and pump stations can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 2, most local building codes and stormwater management plans emphasize the use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 2. Low-impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, lower speeds, and lower temperatures. The City of Portland has been recognized as a national innovator in stormwater management and code because of its progressive LID stormwater mitigation strategies in the City's building code. However, the majority of jurisdictions in the region do not require LID strategies in their building code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Roads, bridges, and rail systems in the region support Oregon's largest population centers and freight moving through the Pacific Northwest. These transportation systems and are vulnerable to a variety of natural hazards that could disrupt transportation of goods, block evacuation routes and sever lifelines. The effects of road, bridge, and rail failures on the economy and health of the region's residents could be devastating. ODOT understands this risk and began seismically upgrading five of the areas key bridges within the Portland Metro area in summer 2014.

In addition, the region has two ports with marine terminals, industrial parks and aviation facilities. The Portland International Airport is the busiest in the state, moving the majority of passengers and freight. These ports, including airports, face potential disruptions in services due to natural hazard events.

The region is an energy hub for the state. There are multiple dams and eight power-generating facilities. The Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer owned utilities. BPA's main dam, the Bonneville Dam, is located on this region on the Columbia River. Liquid Natural Gas is transported through the region via the Williams Northwest Pipeline that runs through Clackamas and Multnomah Counties. Of particular concern is Oregon's critical energy infrastructure hub, located in north Portland, which is highly vulnerable to a Cascadia event.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from Portland, especially central Columbia and eastern Multnomah Counties. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be centralized and lacking in system redundancies. Furthermore, because most drinking water is sourced from surface water, the region is vulnerable to high levels of pollutants entering waterways during high-water events. The City of Portland has been recognized as a leader in stormwater management best practices because of its decentralized Low Impact Development (LID) stormwater systems.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's land use program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD, http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Washington and Columbia Counties have experienced the region's greatest percent urban growth during the decade from 2000 to 2010, roughly 5% and 7% more than the state average respectively. Similar to the state, the region is becoming less rural. However, Columbia County, the least populated county along the coast, is the only county in the region to increase its rural population.

The region's urban housing units grew eight times those in rural areas. Multnomah County was the only county to decrease its share of rural residences, notably by 11%. Columbia County had the largest percent growth in in both urban and rural units 24.1% and 10.8% respectively.

Not surprisingly, populations tend to cluster around major road corridors and waterways. The region's largest population is clustered around the Portland Metro area.

Table 2-139. Urban and Rural Populations in Region 2

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 2	1,352,896	1,561,409	15.4%	134,883	128,978	-4.4%
Clackamas	266,367	308,018	15.6%	72,024	67,974	-5.6%
Columbia	22,769	27,828	22.2%	20,791	21,523	3.5%
Multnomah	649,010	725,464	11.8%	11,476	9,870	-14.0%
Washington	414,750	500,099	20.6%	30,592	29,611	-3.2%

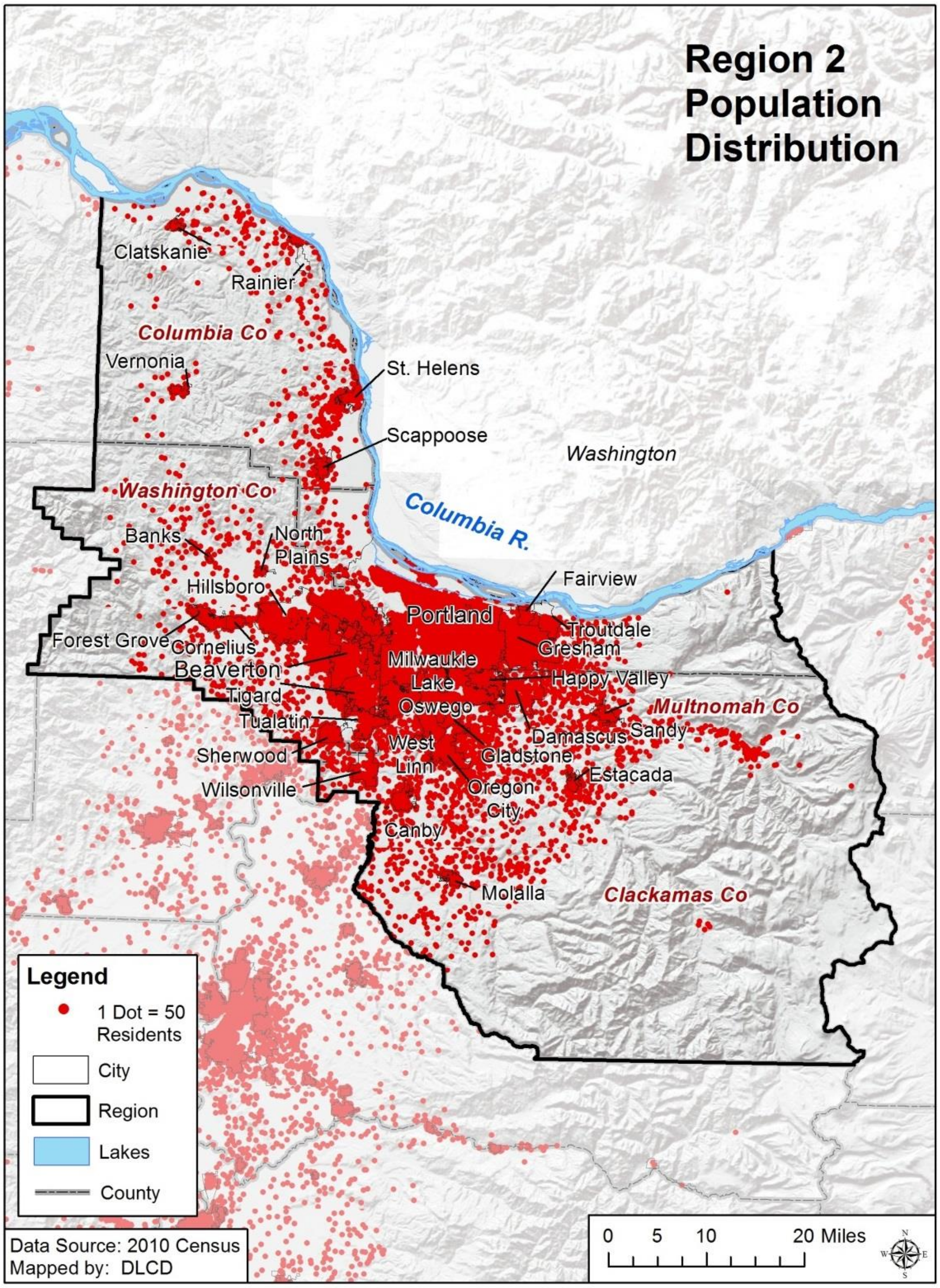
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-140. Urban and Rural Housing Units in Region 2

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 2	569,834	661,845	16.1%	52,166	53,080	1.8%
Clackamas	109,047	128,740	18.1%	27,907	28,205	1.1%
Columbia	9,247	11,474	24.1%	8,325	9,224	10.8%
Multnomah	283,957	320,735	13.0%	4,604	4,097	-11.0%
Washington	167,583	200,896	19.9%	11,330	11,554	2.0%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-108. Region 2 Population Distribution



Source: U.S. Census, 2012

Land Use

Approximately 65% of the land in Region 2 is in private ownership, followed by federal (31%), state (3%), and local government (1%). Subtracting the Cascade Mountain area leaves nearly the entire Region 2 in private holdings.

Not surprisingly, between 1974 and 2009, the Portland area, followed by the North Willamette Valley area, demonstrated the greatest rates of change in the state in the conversion of private land in resource land uses to low-density residential and urban uses. Within the Portland area, the highest rate of increase took place in Washington County, followed by Clackamas County. Both counties experienced much higher rates of conversion to low-density residential and urban uses than was the case in highly urbanized Multnomah County (Lettman, 2011).

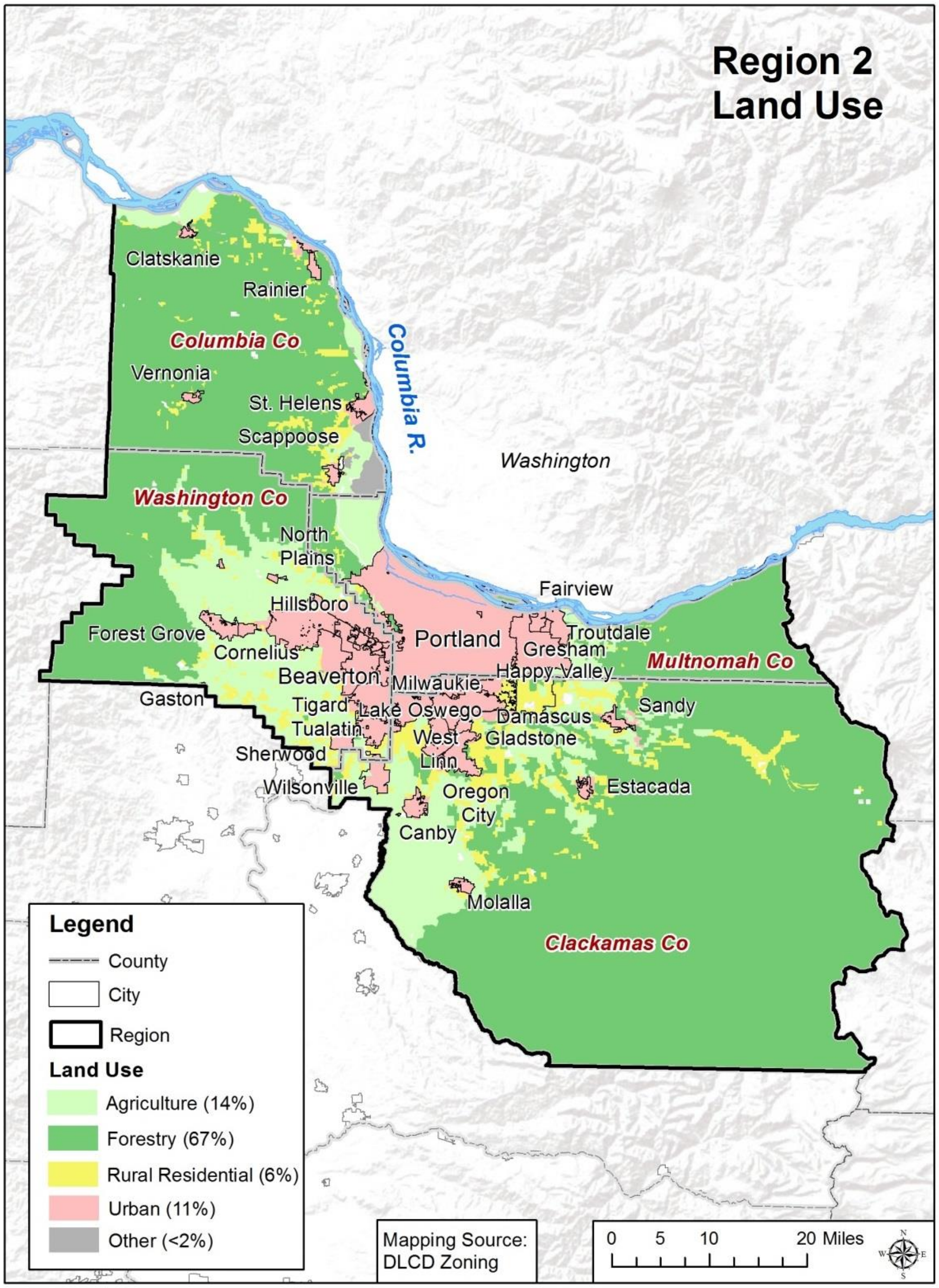
In the past few years, along with most of Western Oregon, Region 2 has experienced an upswing in residential building permits as the local and national economies rebounded. For example, in the first four months of 2014 the region saw a surge in these types of residential building permits. The City of Portland dominated the residential permit numbers, up 16% from the same period in 2013 (State of Oregon Employment Department, May 2014, Portland Economic Indicators). Since 2007, 58% of the new residential growth in the Portland area has been either infill or redevelopment. The rest of the residential construction in that time, about 42%, has been on vacant land (Lettman, 2011).

Overall, 2013 saw the strongest surge of new residents in 5 years for Region 2. According to the most recent estimates from the regional government Metro, by 2035 the Portland-Beaverton-Vancouver area (including Multnomah, Clackamas, Washington, Yamhill, Columbia, Clark, and Skamania Counties) might grow by up to 725,000 people, topping the 3 million population mark.

Under Oregon law, each of the state's cities and metropolitan areas has created around its perimeter an urban growth boundary (UGB), which is a land use planning line to control urban expansion onto farm and forest lands. The UGB is assessed every 6 years, in a process that involves various levels of government and the public. In 2013-2014 Metro will revise its UGB. Most notable will be changes in the urban and rural reserves of Washington County.

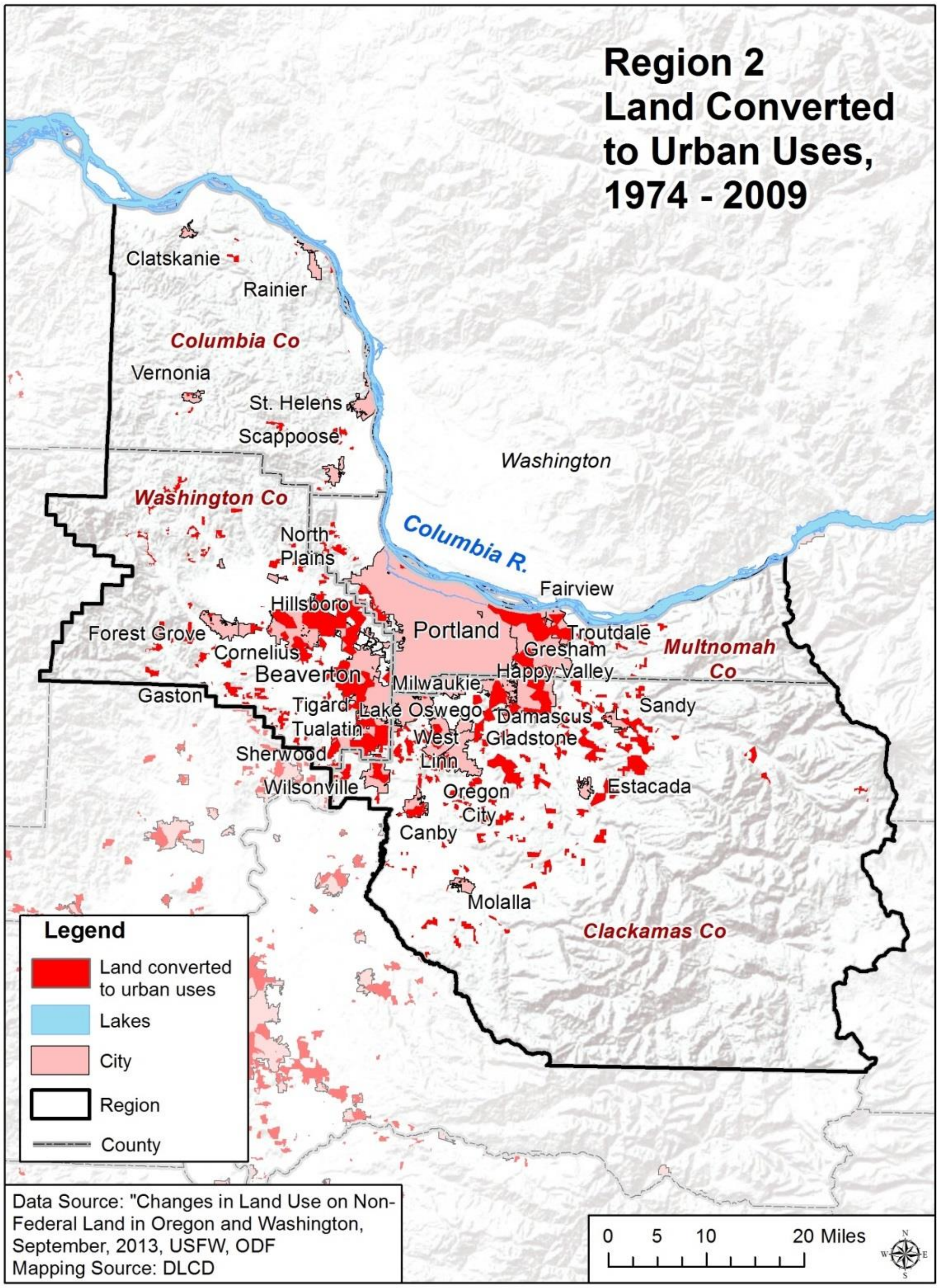
Potential upgrades to the 28 miles of levees that protect the north Portland area from the Columbia River remain a continuing land use issue for the region. As of July 2014, potential costs to the four drainage districts involved were estimated at $100 million dollars. Failure to maintain certification and FEMA accreditation may result in thousands of property owners and businesses subject to federal flood insurance regulations (DLCD, internal communication, 2014).

Figure 2-109. Region 2 Land Use



Source: DLCD, Statewide Zoning

Figure 2-110. Region 2 Land Converted to Urban Uses, 1974–2009



Source: "Changes in Land Use on Non-Federal Land in Oregon and Washington," September 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. Nearly half of the region's multi-family units are located in Multnomah County, in the Portland area in particular. Mobile residences make up only 3.5% of all housing in the region. Columbia County has the highest percentage of mobile homes (12.6%), and Clackamas County has the highest number of units (9,752). In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-141. Housing Profile for Region 2

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 2	714,150	469,018	65.7%	219,384	30.7%	24,748	3.5%
Clackamas	156,933	114,764	73.1%	32,160	20.5%	9,752	6.2%
Columbia	20,639	15,577	75.5%	2,334	11.3%	2,599	12.6%
Multnomah	324,192	196,592	60.6%	120,404	37.1%	6,657	2.1%
Washington	212,386	142,085	43.8%	64,486	19.9%	5,740	1.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25024

Aside from location and type of housing, the year a structure was built (Table 2-142) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally, 38.7% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Notably, over 55% of homes in Multnomah County were constructed before 1970. Regionally, approximately two thirds of the housing stock was built before 1990 and the codification of seismic building standards. Washington County has the highest percentage (43.5%) and largest number (92,732) of units built after 1990.

Table 2-142. Age of Housing Stock in Region 2

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 2	714,150	276,458	38.7%	208,448	29.2%	229,244	32.1%
Clackamas	156,933	45,462	29.0%	56,471	36.0%	55,000	35.0%
Columbia	20,639	7,324	35.5%	6,115	29.6%	7,200	34.9%
Multnomah	324,192	180,658	55.7%	68,862	21.2%	74,672	23.0%
Washington	212,386	43,014	20.3%	77,000	36.3%	92,372	43.5%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. **Table 2-143** shows the initial and current FIRM effective dates for Region 2 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-143. Community Flood Map History in Region 2

	Initial FIRM	Current FIRM
Clackamas County	March 1, 1978	June 17, 2008
Barlow	May 5, 1981	June 17, 2008
Canby	June 15, 1984	June 17, 2008
Damascus	July 19, 2000	June 17, 2008
Estacada	June 17, 2008	June 17, 2008
Gladstone	March 15, 1977	June 17, 2008
Happy Valley	December 4, 1979	June 17, 2008
Lake Oswego	August 4, 1987	June 17, 2008
Milwaukie	June 18, 1980	June 17, 2008
Molalla	June 17, 2008	June 17, 2008
Oregon City	December 15, 1980	June 17, 2008
Portland	see Multnomah County	see Multnomah County
Rivergrove	August 4, 1987	June 17, 2008
Sandy	December 11, 1979	June 17, 2008
Tualatin	see Washington County	see Washington County
West Linn	March 15, 1977	June 17, 2008
Wilsonville	January 6, 1982	June 17, 2008
Columbia County	August 16, 1986	November 26, 2010
Clatskanie	September 29, 1986	November 26, 2010
Columbia, City	June 5, 1985	November 26, 2010
Prescott	August 16, 1988	November 26, 2010
Rainier	August 16, 1988	November 26, 2010
St. Helens	September 29, 1986	November 26, 2010
Scappoose	December 19, 1975	November 26, 2010
Vernonia	August 16, 1988	November 26, 2010
Multnomah County	June 15, 1982	December 18, 2009
Fairview	March 18, 1986	December 18, 2009
Gresham	July 16, 1979	December 18, 2009
Lake Oswego	see Clackamas County	see Clackamas County
Milwaukie	see Clackamas County	see Clackamas County
Portland	October 15, 1980	November 26, 2010
Troutdale	September 30, 1988	December 18, 2009
Wood Village	December 18, 2009	December 18, 2009
Washington County	September 30, 1982	February 18, 2005
Beaverton	September 28, 1984	February 18, 2005
Cornelius	January 6, 1982	January 6, 1982
Durham	January 6, 1982	February 18, 2005
Forest Grove	March 15, 1982	March 15, 1982
Gaston	July 5, 1982	July 5, 1982
Hillsboro	May 17, 1982	May 17, 1982
King City	February 18, 2005	February 18, 2005
Lake Oswego	see Clackamas County	see Clackamas County
North Plains	April 1, 1982	March 16, 1989
Portland	see Multnomah County	see Multnomah County
Rivergrove	see Clackamas County	see Clackamas County
Sherwood	January 6, 1982	January 6, 1982
Tigard	March 1, 1982	February 18, 2005
Tualatin	May 2, 1978	February 19, 1987
Wilsonville	see Clackamas County	see Clackamas County

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 2 can be found in **Table 2-144**. The region contains 13.7% of the total value of state-owned/leased critical/essential facilities, valued at over $1 billion.

Table 2-144. Value of State-Owned/Leased Critical and Essential Facilities in Region 2

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 2	$1,002,513,064	13.7%
Clackamas	$233,143,765	3.2%
Columbia	$9,287,172	0.1%
Multnomah	$300,609,402	4.1%
Washington	$459,472,725	6.3%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 2 is largely an urban county with urban development focused around the Portland Metropolitan area. The region's urban areas are growing at about the same rate as the state's. Columbia and Washington Counties have the fastest urban growth rates within the region. The region's housing stock is largely single-family homes. However, the region has a slightly higher percentage of multi-family units than the state as a whole; Multnomah County has the highest percentage (37%). Conversely, the region has a lower percentage of mobile homes than the state, with the exception of Columbia County. About 55% of housing in Multnomah was built prior to 1970, prior to current seismic and floodplain management standards. In contrast, over 44% of housing in Washington County was built after 1990. With the exception of some cities within Washington County all of the region's FIRMs have been modernized or updated. The cities in Washington County may have maps that are not as up-to-date as other areas of the state and therefore may not accurately represent flood risk.

2.3.2.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are uncommon in Region 2. In 1992, the Governor declared a drought for all 36 counties in Oregon. Since 1992, no Governor-declared droughts have occurred in this region.

Historic Drought Events

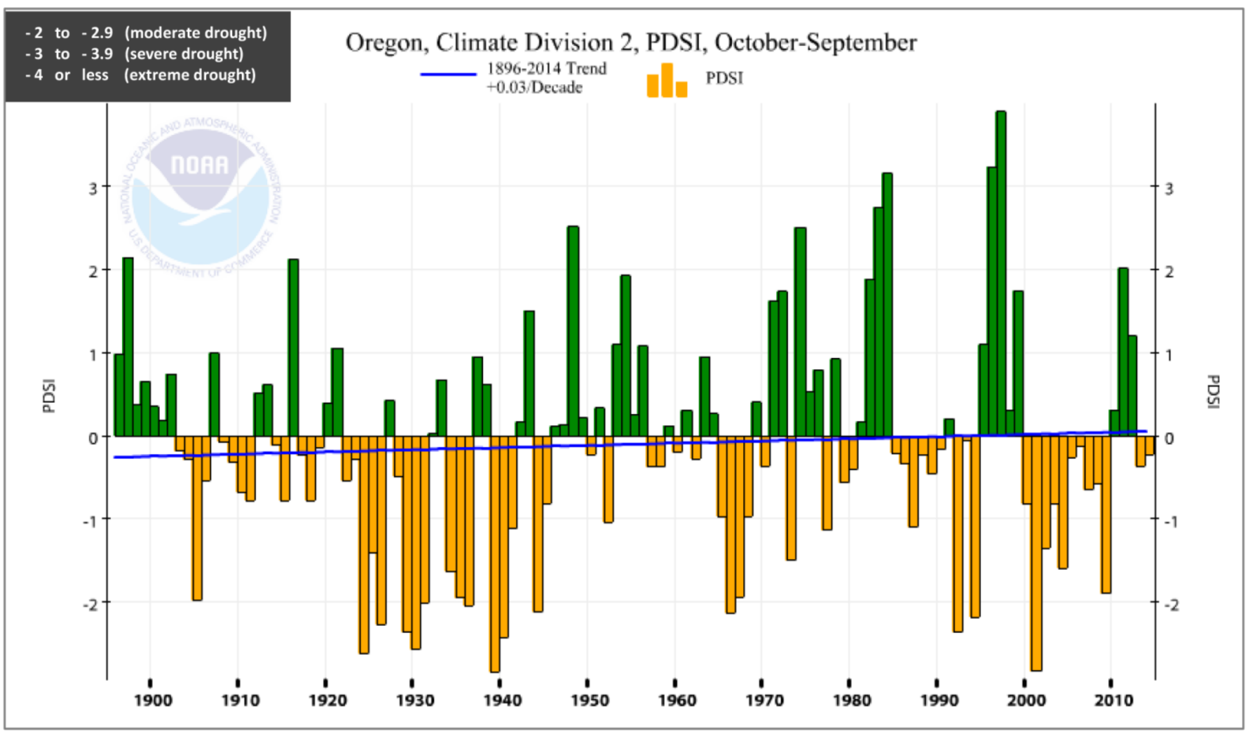
Table 2-145. Historic Droughts in Region 2

Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1930	Regions 1–3, 5–7	moderate to severe drought affected much of the state; the worst years in Region 2 were 1928–1930, which kicked off an era of many drier than normal years
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1992	statewide, especially Regions 1–4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1
2001	Regions 2–4, 6, 7	the driest water year on record in the Willamette Valley (NOAA Climate Division 2); warmer than normal temperatures combined with dry conditions

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division; NOAA's Climate at a Glance; Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt; personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. Figure 2-111 shows years where drought or dry conditions affected the Willamette Valley (Climate Division 2). Based on this index, Water Years 1939 and 2001 were the driest years with values of -2.84 and -2.83 respectively. These moderate-type drought years have occurred more than a dozen times during this record.

Figure 2-111. Palmer Drought Severity Index for Region 2



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Although not shown here, drought data from Climate Division 4, “the High Cascades,” could also be analyzed to show a broader picture of drought impacts in Hazard Regions 2 and 3.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience drought is shown in **Table 2-146**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-146. Local Probability Assessment of Drought in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis could be completed statewide to analyze and compare the risk of drought across the state.

Based on limited data, there is a low probability of drought occurring in this region. There has only been one drought declaration in this region, which occurred in 1992 when all 36 counties were affected by a drought.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-147**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-147. Local Vulnerability Assessment of Drought in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	L	L	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 2 could be considered less vulnerable to drought impacts than many other parts of the state.

Earthquakes

Characteristics

The geographic position of Region 2 makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intraplate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity. All have some tie to the subducting or diving of the dense, oceanic Juan de Fuca Plate under the lighter, continental North America Plate. Stresses occur because of this movement and there appears to be a link between the subducting plate and the formation of volcanoes some distance inland from the off-shore fault zone.

Region 2 has had at least seven crustal earthquakes of magnitude 4 or greater since 1877. The region's largest earthquakes were the 1877 M5.3 and the 1962 M5.2. In addition, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. There is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. Deep-seated intraplate events, as occurred near Olympia, Washington in 1949 and 2001, could generate magnitudes as large as M7.5, but none have been identified in the region's historical or prehistoric records.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 2, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

The City of Portland has been built on three identified crustal faults that stretch the length of Portland: the Oatfield Fault west of the northwest hills; the East Bank Fault, traversing the Willamette into Oregon City and the Portland Hills Fault which runs parallel to Forest Park into downtown Portland. Each of these crustal faults is capable of generating large earthquakes of M6.0–6.8.

Historic Earthquake Events

Table 2-148. Significant Earthquakes Affecting Region 2

Date	Location	Magnitude (M)	Description
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone (CSZ)	probably 8.0–9.0	these are the mid-points of the age ranges for these six events
Jan. 1700	CSZ	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Oct, 1877	Portland area, Oregon	5.2	two events in one day; affected area: 41,000 sq km; damage: chimney damage
Feb. 1892	Portland area, Oregon	5.0	no major damage occurred
Dec. 1941	Portland area, Oregon	4.5	felt by most Portland residents; damage: shattered windows and cracked plaster (Hillsboro and Sherwood)
Apr. 1949	Olympia, Washington	7.1	damage: in Washington and NW Oregon
Dec. 1953	Portland area, Oregon	4.5	cracked plaster and caused objects to fall (Portland)
Nov. 1961	Portland area, Oregon	5.0	principal damage: from cracked plaster
Nov. 1962	Portland area, Oregon	5.5	shaking: up to 30 seconds; damage: chimneys cracked, windows broken, furniture moved
Dec. 1963	Portland area, Oregon	4.5	damage: books and pictures fell (Plains)
Mar. 25, 1993	Scotts Mills, Oregon	5.6	FEMA-985-DR-Oregon; center: Mt. Angel-Gales Creek fault; damage: $30 million (including Oregon Capitol Building in Salem)
Feb. 2001	Nisqually, Washington	6.8	felt in the region, no damage reported

*BCE: Before Common Area.

Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section [2.2.2.4, Local and State Vulnerability Assessment Comparison]**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience an earthquake is shown in **Table 2-149**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-149. Local Probability Assessment of Earthquakes in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	L	M	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

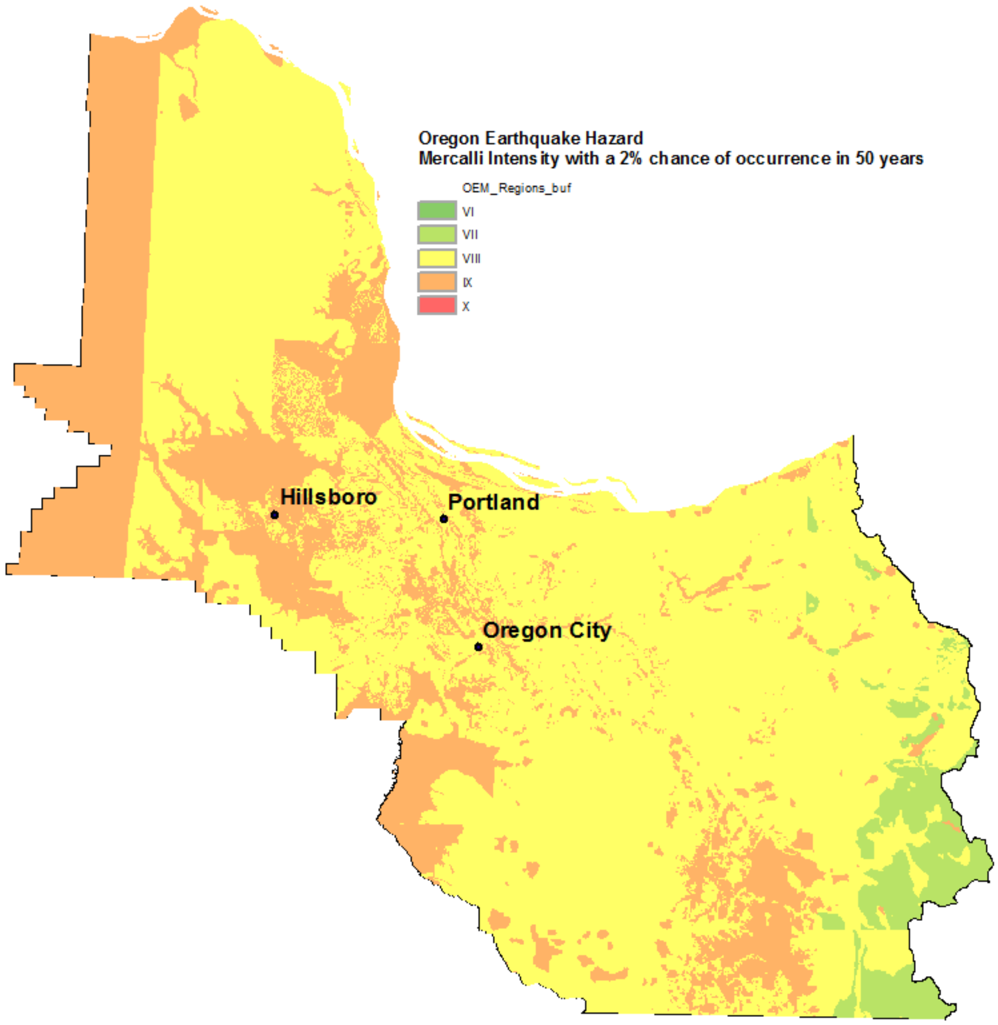
State Assessments

The probability of damaging earthquakes varies widely across the state. In Region 2 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 2 is depicted in **Figure 2-112**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone (CSZ).

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-112**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-112. Probabilistic Earthquake Hazard in Region 2



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-150**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-150. Local Vulnerability Assessment of Earthquakes in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

All of Region 2 is especially vulnerable to earthquake hazards for two reasons: (a) much of the area is susceptible to earthquake-induced landslides, liquefaction, and severe ground shaking; and (b) the region contains the bulk of Oregon's population and built environment.

Of the 15 counties in the state with the highest expected damages and losses, based on a 500-year model, the following counties are located in Region 2:

- Multnomah,
- Washington, and
- Clackamas.

Table 2-151 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-151. School and Emergency Response Building Collapse Potential in Region 2

	Level of Collapse Potential			
County	**Low (< 1%)**	**Moderate (>1%)**	**High (>10%)**	**Very High (100%)**
Clackamas	123	48	40	6
Columbia	19	13	15	3
Multnomah	68	118	116	29
Washington	81	69	80	6

Source: Lewis (2007), available at http://www.oregongeology.org/sub/projects/rvs/default.htm.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA), as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties. Results are found in **Table 2-152**.

Metro (the elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington Counties and the 24 cities in the Portland Metro area) has likewise evaluated earthquake potential and losses for its three-county area. The analysis included an inventory of over 50,000 commercial and multi-family dwellings at risk. Single-family dwellings within the Metro boundary were not evaluated because their structural similarity (Metro, 1998).

Other useful resources for planning for earthquakes include the following:

Maps of earthquake hazard areas: DOGAMI has mapped all of the Region 2 counties and has statewide GIS earthquake hazard layers available (Madin & Burns, 2013).

Map of critical facilities vulnerable to hazards: DOGAMI has developed these maps for all Region 2 counties.

Environmental geology maps: DOGAMI has developed these maps for all Region 2 counties.

Nuclear energy/hazardous waste sites inventories: No Region 2 counties have nuclear facilities.

Table 2-152. Projected Dollar Losses in Region 2, Based on an M8.5 Subduction Event and a 500-Year Model

M8.5 CSZ Event					**500-Year Model[1]**			
COUNTIES	**Multnomah**	**Washington**	**Columbia**	**Clackamas**	**Multnomah**	**Washington**	**Columbia**	**Clackamas**
Injuries	1,521	555	36	128	8,659	2,910	150	1,402
Deaths	28	10	0	2	186	62	3	29
Displaced households	2,803	2,062	94	426	13,777	7,666	326	2,525
Economic losses for buildings[2]	$1.9 b	$931 m	N/A	$316 m	$9.2 b	$3.8 b	$267 m	$2.1 b
Operational "day after" the quake								
Fire Stations	78%	66%	unknown	84%	N/A[3]	*	*	*
Police Stations	76%	64%	45%	84%	N/A	*	*	*
Schools	81%	64%	63%	84%	*	*	*	*
Bridges	94%	79%	82%	90%	*	*	*	*
Economic losses to								
Highways	$21 m	$15 m	$2 m	$6 m	$437 m	$61 m	$10 m	$74 m
Airports	$2 m	$5 m	$2 m	$3 m	$12 m	$23 m	$8 m	$32 m
Communications	$3 m	$752,000	$97,000	$232,000	$31 m	$4 m	$950,000	$4 m
Debris generated (thousands of tons)	1,598	763	57	237	6,745	2,817	184	1,588

[1]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]"…there are "numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated.

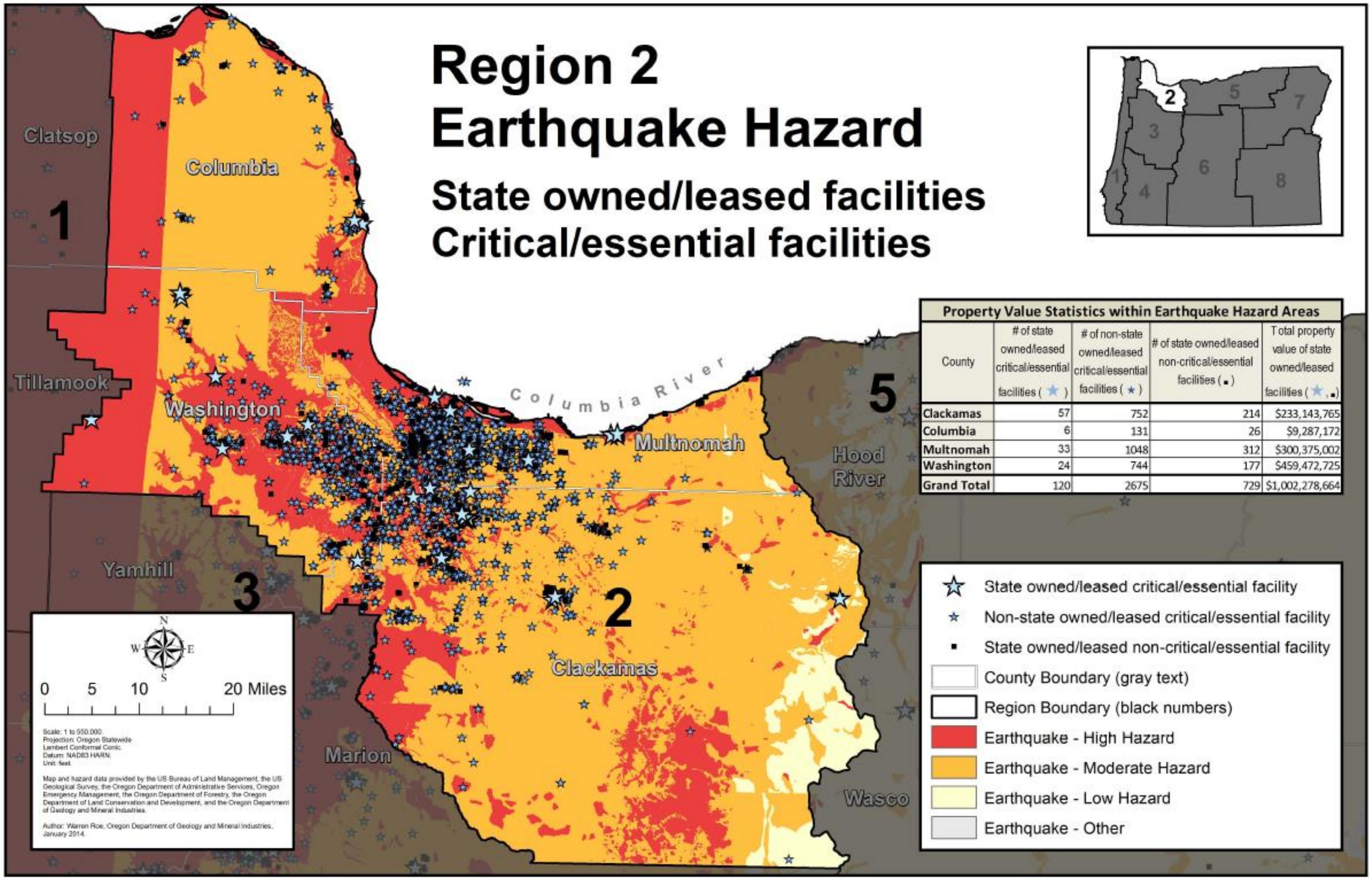
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a State facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.)

Of 5,693 state facilities evaluated, 849 totaling over $1 billion worth of property are located in an earthquake hazard zone in Region 2 (**Figure 2-113**). Among the 1,141 State critical/essential facilities, 120 are in an earthquake hazard zone in Region 2. Additionally, 2675 non-state critical/essential facilities in Region 2 are located in an earthquake hazard zone.

Figure 2-113. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 2



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Clackamas	57	752	214	$233,143,765
Columbia	6	131	26	$9,287,172
Multnomah	33	1048	312	$300,375,002
Washington	24	744	177	$459,472,725
Grand Total	120	2675	729	$1,002,278,664

Source: DOGAMI

Seismic Lifelines

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 2 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 2:

- *Portland Metro Geographic Zone:* In addition to encompassing the largest population concentration in the state, this zone contains extensive facilities (such as transportation, communication, and fuel depots) that are critical to statewide earthquake response and recovery. For these reasons, it has a higher concentration of lifeline routes than the other geographic zones and redundant Tier 1 crossings of the Willamette River.

  The Tier 1 system (highest priority roadway) in the Portland Metro Geographic Zone consists of the following corridors:

  - I-5, excluding the section between the northern and southern I-405 interchanges,
  - I-405,
  - I-205, and
  - OR-99 W from I-5 to OR-217.

  The Tier 2 system (second highest priority roadway) in the Portland Metro Geographic Zone consists of three access corridors:

  - I-84,
  - I-5 between the northern and southern I-405 interchanges, and
  - US-26 from OR-217 to I-405.

  The Tier 3 system in the Portland Metro Geographic Zone consists of the following corridors:

  - OR-217,
  - US-26 from I-5 to I-205, and
  - OR-43.

- *Cascades Geographic Zone:* This region also includes part of the OSLR Cascades Zone. The recommended seismic lifelines for this region include three crossings of the Cascades from western to central Oregon that have areas vulnerable to landslides and may be subject to damage from ground shaking. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The Tier 1 system in the Cascades Geographic Zone that serves this region is I-84. The Tier two routes in the Cascades Geographic Zone that serve this region are OR-212 and US-26. There are no corridors designated as Tier 3 in the Cascades Geographic Zone.

Regional Impact.

- Ground shaking: In the Northern Willamette Valley / Portland Metro Region, the level of damage from ground shaking levels depends upon its intensity and duration. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents, and it is expected that river crossings and areas with limited surface transportation alternatives will isolate some neighborhoods hindering rescue and recovery activities. There are also several localized faults in the region about which not much is known; it is possible that a major CSZ event could activate local faults.
- Landslides and rockfall: Many roadways in the area are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews in hilly areas and the parts of the Cascades and Coast Regions that fall within Region 2. A major CSZ event may increase landslide and rockfall activities in this region and may reactivate ancient slides that are currently inactive. In the Lower Columbia River basin, ground shaking may change the shipping channel and other features.
- Tsunamis: There may be tsunami impacts in the Lower Columbia area, with variables including the size and force of the tsunami, whether jetties hold up to the tsunami and water levels in the river. Damage to ports, shipping channels, water-dependent uses, and other low lying areas is possible.
- Liquefaction: Structures in wetland, estuarine, alluvial, and other saturated areas may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event. Bridge approaches, low lying roadways, and transportation fuel supplies are all at risk in this region.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Columbia and Multnomah Counties are the most vulnerable to water related effects, particularly liquefaction. The whole region, including Clackamas and Washington Counties, is likely to have significant impacts related to ground shaking. Landslides are likely in some hilly areas. Vulnerabilities with both regional and statewide transportation impacts in Multnomah County, Portland, and the Portland Metro area include potential loss of stored fuels and distribution infrastructure; interruption of services at Portland International Airport; interruption of intermodal freight capacity due to river channel changes; damage to onshore facilities and surface transportation facilities; and bridge or bridge approach failures across both the Willamette and Columbia Rivers.

Floods

Characteristics

The northern Willamette Valley (including the Portland Metro area) has a lengthy flood history with significant floods occurring about every 5–7 years (**Table 2-153**). The Willamette and Columbia Rivers have produced numerous floods, some of which are shown in **Table 2-153**. Most Willamette River flooding is a winter phenomenon. The common pattern includes the accumulation of heavy wet snow in higher elevations followed by a mild, rainy, weather system. The resulting snowmelt on saturated or frozen ground sometimes produces devastating flood conditions. These conditions would be worse were it not for many dams (used for, among other purposes, flood control) on the upper reaches of the Willamette and some of its tributaries.

Clackamas County is the third most populated county in the state, with nearly all development concentrated in the western half of the county, downstream from significant sources of mountain runoff.

Columbia County, smaller in area and less populated than Clackamas County, receives more annual rainfall and, as a result, has a denser stream network. The City of Vernonia (see **3.3.5.5, Mitigation Success — City of Vernonia, 2014**), suffered extensive flooding in 2007 resulting in damage to over 300 buildings. Mitigation activities in Vernonia, including relocation of the K–12 school buildings, following the 2007 flood event have significantly reduced damage potential in this small city.

The Columbia River Estuary is the second largest river in the United States and the largest river to flow into the eastern North Pacific. Columbia River floods usually occur in the early summer and are associated with seasonal runoff from melting snow. Although unusually extreme, the Vanport Flood (1948) provides an example of such an event. The 20-day flood was the greatest single disaster in the recorded history of the Columbia River Basin. The toll was 32 dead and 7 missing in the Portland area. Flooding occurred when the Columbia River broke through a dike surrounding the community of Vanport and forced 50,000 people to evacuate their homes. Economic losses reportedly exceeded $100 million. Vanport, a Vancouver-Portland suburban community and the largest public housing project ever built in the United States, was not rebuilt. Prolonged winter rain, debris dams, and breeched dikes have produced flood conditions at several Columbia County locations. Tidal influences are observed on the Columbia River inland to the Bonneville Dam and on the Willamette in Portland.

A common Willamette Valley phenomenon involves tributary stream backup during periods of high water. When tributary streams cannot enter swollen main stem rivers during periods of high water, tributary streams are forced out of their banks. During the February 1996 flood, dams controlled Columbia River flows. This allowed the Willamette River to enter the Columbia, averting flooding in downtown Portland, but other streams produced widespread flooding throughout the region. **Table 2-154** summarizes the sources of flooding for each of the major rivers in the region.

Historic Flood Events

Table 2-153. Significant Historic Floods in Region 2

Date	Location	Description	Type of Flood
Dec. 1861	coastal rivers	the "Great Flood;" largest flood of known magnitude on the Willamette River; every town on the river was flooded or washed away; widespread damage	rain on snow and snow melt
Dec. 1862	Willamette River Basin	widespread flooding	rain on snow
Feb. 1890	Willamette Basin	second largest flood of known magnitude; water levels in Portland: 22.3 ft	rain on snow
June 1894	main stem Columbia	largest flood ever observed on the river; current small in Portland; little damage	snow melt
Jan. 1923	Willamette and Columbia Rivers	rain and mild weather; widespread damage to roads and railroads	rain on snow
Dec. 1937	Willamette Basin	considerable flooding; landslides	rain on snow
Dec. 1945	Willamette Basin / NW Oregon	very warm temperatures; considerable flood damage	rain on snow
June 1948	main stem of the Columbia	Vanport near Portland completely destroyed	snow melt
Dec. 1955	Columbia River and Willamette Basin	strong winds/flooding; five fatalities	rain on snow
Dec. 1964	entire state	record-breaking December rainfall; widespread damage; warm temperatures	rain on snow
Jan. 1972	Willamette and Sandy Rivers	widespread damage; many fish buildings, etc. destroyed; five fatalities	rain on snow
Jan. 1974	western Oregon	mild storms followed heavy snow and freezing rain; nine counties declared disasters	rain on snow
Jan. 1978	Willamette River and NW Oregon	intense rain/snowmelt; widespread flooding	rain on snow
Feb. 1986	entire state	numerous homes evacuated; intense rain and melting snow	snow melt
Feb. 1987	western Oregon	Willamette and tributaries; mud slides, flooded highways, damaged homes	rain on snow
Jan. 1990	western Oregon	10 rivers in eight counties flooded; many bridges washed away	rain on snow
Feb. 1996	NW Oregon	warm temperatures / record breaking rains; widespread flooding (FEMA-1099-DR-OR. 1996)	rain on snow
Dec. 1996	western Oregon	mild subtropical moisture led to extensive flooding. 14 county disaster	rain on snow
Jan. 2006	Washington County	Tualatin River in Dilley and Farmington reached above flood stages	riverine
Nov. 2006	Clackamas County	heavy rain caused the Sandy River and Clackamas River to flood, causing damage in Estacada and Oregon City. Total county-wide damages of $3 million	riverine
Dec. 2007	Washington County	flooding of the Tualatin River following heavy rainfall from a tropical storm; old OR-47 and OR-47 closed temporarily; total of $2.3 million in damages	riverine
Dec. 2007	Columbia County	flooding of the Nehalem River caused widespread damage in Vernonia, flooding numerous homes and causing a total of $36 million in damages for Columbia County	riverine
Jan. 2009	Washington County	severe winter storm/snow event that included snow, high winds, freezing rain, ice, blizzard conditions, mudslides, and landslides	
Jan. 2011	Clackamas County	severe winter storm, flooding, mudslides, landslides, and debris flows	
Sep. 2013	Multnomah County	heavy rain resulted in damage to the Legacy Good Samaritan Medical Center and several businesses in northwest Portland	riverine

Sources: Taylor and Hatton (1999); National Climatic Data Center; KPTV_KPDX (2013)

Table 2-154. Principal Riverine Flood Sources in Region 2

Clackamas	Columbia	Multnomah	Washington
Willamette River and tributaries:	Clatskanie River	Columbia and Willamette Rivers and tributaries:	Willamette River and tributaries:
Abernethy Creek	Columbia River	Sandy River	Tualatin River
Clackamas River	Conyers Creek	Multnomah Channel	Fanno Creek
Clear Creek	McNulty Creek	Johnson Creek	Summer Creek
Dear Creek	Milton Creek	Fairview Creek	Ash Creek
Eagle Creek	Multnomah Channel	Columbia Slough	Rock Creek
Johnson Creek	Nehalem Creek	Ponding within Drainage Dist. #1	Cedar Creek
Kellogg Creek	Rock Creek	Beaver Creek	Butternut Creek
Milk Creek	Scappoose Creek	Fairview Creek	Dawson Creek
Molalla River		Kelley Creek	Beaverton Creek
Mt. Scott Creek		Mitchell Creek	Bronson Creek
Nyberg Slough			Willow Creek
Oswego Channel			Cedar Mill Creek
Phillips Creek			Johnson Creek
Pudding River			Dairy Creek
Salmon River			McKay Creek
Sandy River			Council Creek
Still Creek			Gales Creek
Tualatin River			Wapato Creek
Zig Zag River			Nyberg Slough
Tickle Creek			

Sources: FEMA, Clackamas County Flood Insurance Study (FIS), Aug. 15, 1996, FEMA, Lane County FIS, June 2, 1999, FEMA, Linn County FIS, Sept. 29, 1986, FEMA, Marion County FIS, July 13, 2001, FEMA, Polk County FIS, Dec. 19, 1995, FEMA, Yamhill County FIS, Sept. 30, 1983

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience flooding is shown in **Table 2-155**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-155. Local Probability Assessment of Flood in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

All Region 2 counties have Flood Insurance Rate Maps (FIRM) depicting the extent of the 1% flood (100 year). Most of the flood zones shown on these maps are based on old modeling and could be outdated. The FIRM maps were issued at the following times:

- Clackamas County, June 2008;
- Multnomah County, December 2009;
- Washington County, September 1982 (rural areas) and February 2005 (urban areas); and
- Columbia County, November 2010.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-156**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-156. Local Vulnerability Assessment of Flood in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-157**.

Table 2-157. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

The four counties in Region 2 received flood vulnerability scores ranging from 5 to 9: Clackamas (9), Columbia (8), Multnomah (5), and Washington (5). Clackamas County has the most repetitive losses of the group, which supports that county's higher than average vulnerability score. Washington County, on the other hand, reports a similar number of repetitive losses, but its vulnerability score is below average. The reasons for this difference have not been quantified; however, it is likely due to the very damaging flood and channel migration incidents that occurred in eastern Clackamas County on the flanks of Mount Hood. More research is needed to articulate the exact reasons why Clackamas County is the most vulnerable in the region to damaging floods. Columbia County's score is likely due to the very damaging floods in the City of Vernonia and Nehalem Valley in 1996 and 2007. After the 2007 floods, the city and county completed many mitigation projects (elevations and buy-outs) with the likely outcome that this region is actually less vulnerable now than reported here because past losses were used to calculate vulnerability scores.

FEMA has identified 98 Repetitive Loss properties in Region 2, four of which are Severe Repetitive Loss properties. This region has the second most repetitive flood losses of the Oregon NHMP Natural Hazard Regions, reflecting high rainfall amounts near the Columbia River and a high population density.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Clackamas County participates in CRS, as do the cities of Oregon City, Portland, Scappoose, and Troutdale.

Table 2-158. Severe/Repetitive Flood Losses and Community Rating System Communities by County in Region 2

County	RL	SRL	# of CRS Communities per County
Clackamas	53	3	2
Columbia	6		1
Multnomah	4		2
Washington	35	1	0
Totals:	**98**	**4**	**5**

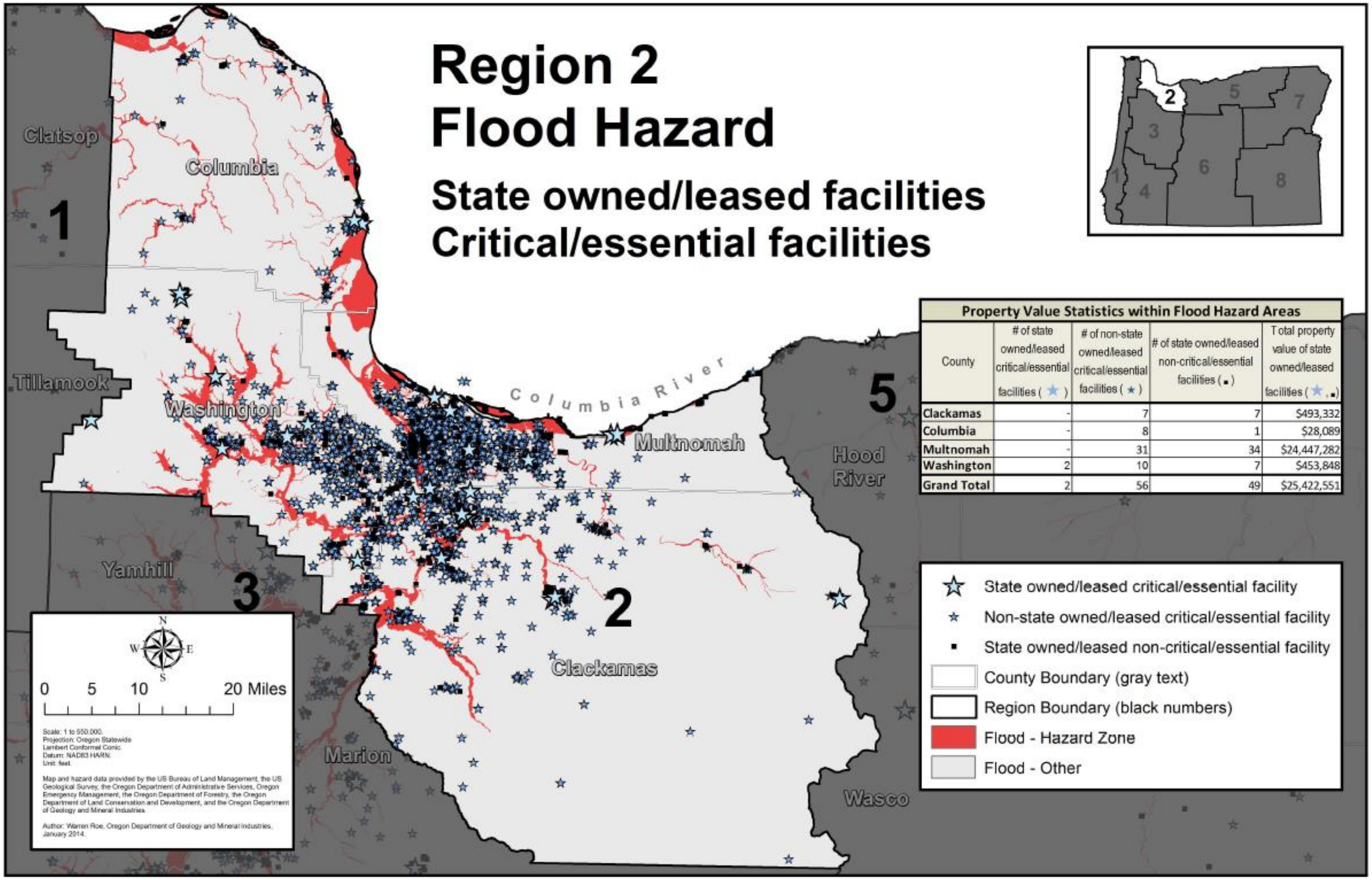
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 51 are currently located within a flood hazard zone in Region 2 and have an estimated total value of $25.4 million (**Figure 2-114**). Of these, two are identified as a critical or essential facility. An additional 56 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 2.

Figure 2-114. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 2



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Clackamas	-	7	7	$493,332
Columbia	-	8	1	$28,089
Multnomah	-	31	34	$24,447,282
Washington	2	10	7	$453,848
Grand Total	2	56	49	$25,422,551

Source: DOGAMI

Landslides

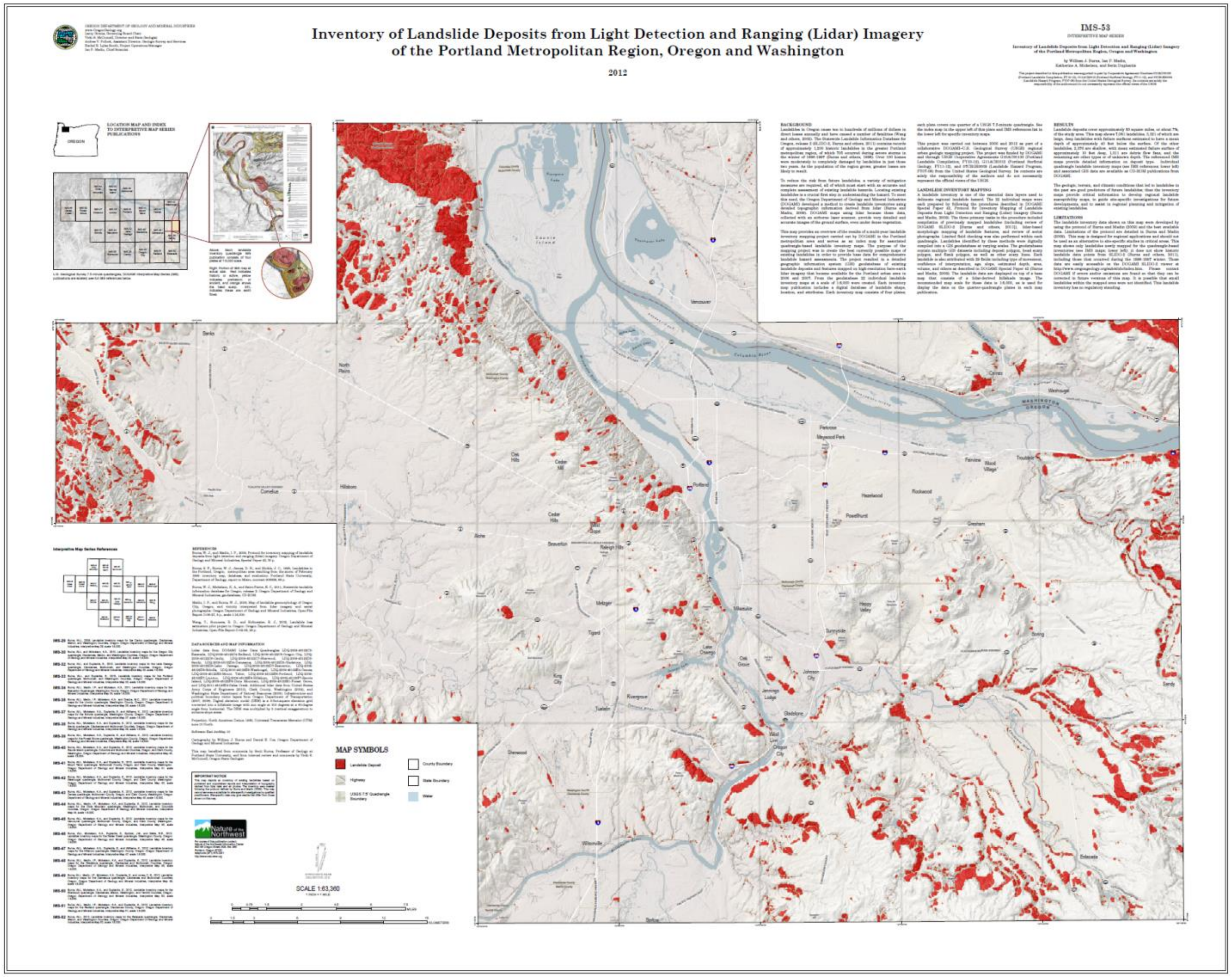
Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Coast Range and Cascade Mountains have a very high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage to the state.

In Multnomah County (including the city of Portland) landslide activity has been a recurring problem for many years. In February 1996, landslide activity that occurred in Portland and the Dodson-Warrendale area (east Multnomah County) was notable and severely impacted homeowners and transportation routes. In fact, I-84 in the Columbia River Gorge was closed for a number of days by fast moving debris flows that covered the roadway and the east-west railroad tracks.

New lidar-based landslide inventory mapping was just completed for most of the Portland Metro area (Burns et al., 2012b). Landslide deposits cover approximately 83 square miles, or about 7%, of the study area. This map shows 7,081 landslides, 3,321 of which are large, deep landslides with failure surfaces estimated to have a mean depth of approximately 40 feet below the surface. Of the other landslides, 2,376 are shallow, with mean estimated failure surface of approximately 10 feet deep; 1,311 are debris flow fans; and the remaining are other types or of unknown depth. The geologic, terrain, and climatic conditions that led to landslides in the past are good predictors of future landslides; thus the inventory maps provide critical information to develop regional landslide susceptibility maps, to guide site-specific investigations for future developments, and to assist in regional planning and mitigation of existing landslides.

Figure 2-115. Inventory of Landslide Deposits from Lidar Imagery of the Portland Metro region, Oregon and Washington



Source: Burns et al. (2012b)

Historic Landslides

In 1996-1997, 700 landslides occurred in the Portland Metro area. Over 100 homes were moderately to completely damaged by landslides in just those two years (Burns et al., 1998). As the population of the region grows, greater losses are likely to result.

Table 2-159. Historic Landslides in Region 2

Date	Location	Description
Mar. 1972	near Portland, Oregon	mud and rock slide on I-5; injured: three motorists
Oct. 1984	I-84 near Cascade Locks, Oregon	rockslide; fatalities: two children; cost of stabilizing the slide area: $4 million
Sep. 1990	near Troutdale, Oregon	landslide; injuries: four highway workers
Feb. 1996	Dodson-Warrendale, Portland Metro area, Oregon	FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to thousands of landslides and debris flows across the state; many occurred on clear cuts that damaged logging roads; I-84 closed at Dodson-Warrendale (700 in the Portland Metro area)
Dec. 2007	Clatsop, Columbia, Tillamook, Washington, and Yamhill Counties, Oregon	landslide due to heavy rains from a strong winter storm; damages: $1.5 million total (Clatsop, Columbia, Tillamook, Washington, and Yamhill Counties); $300,000 (to Columbia County alone)

Sources: ODOT Emergency Operations Plan, May, 2002; Interagency Hazard Mitigation Team Report, FEMA-1099-DR-OR, June, 1997; Interagency Hazard Mitigation Team Report, FEMA-1149-DR-OR, March, 1997; Taylor and Hatton, 1999; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience landslides is shown in **Table 2-160**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-160. Local Probability Assessment of Landslides in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	H	H	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-161**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-161. Local Vulnerability Assessment of Landslides in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	L	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

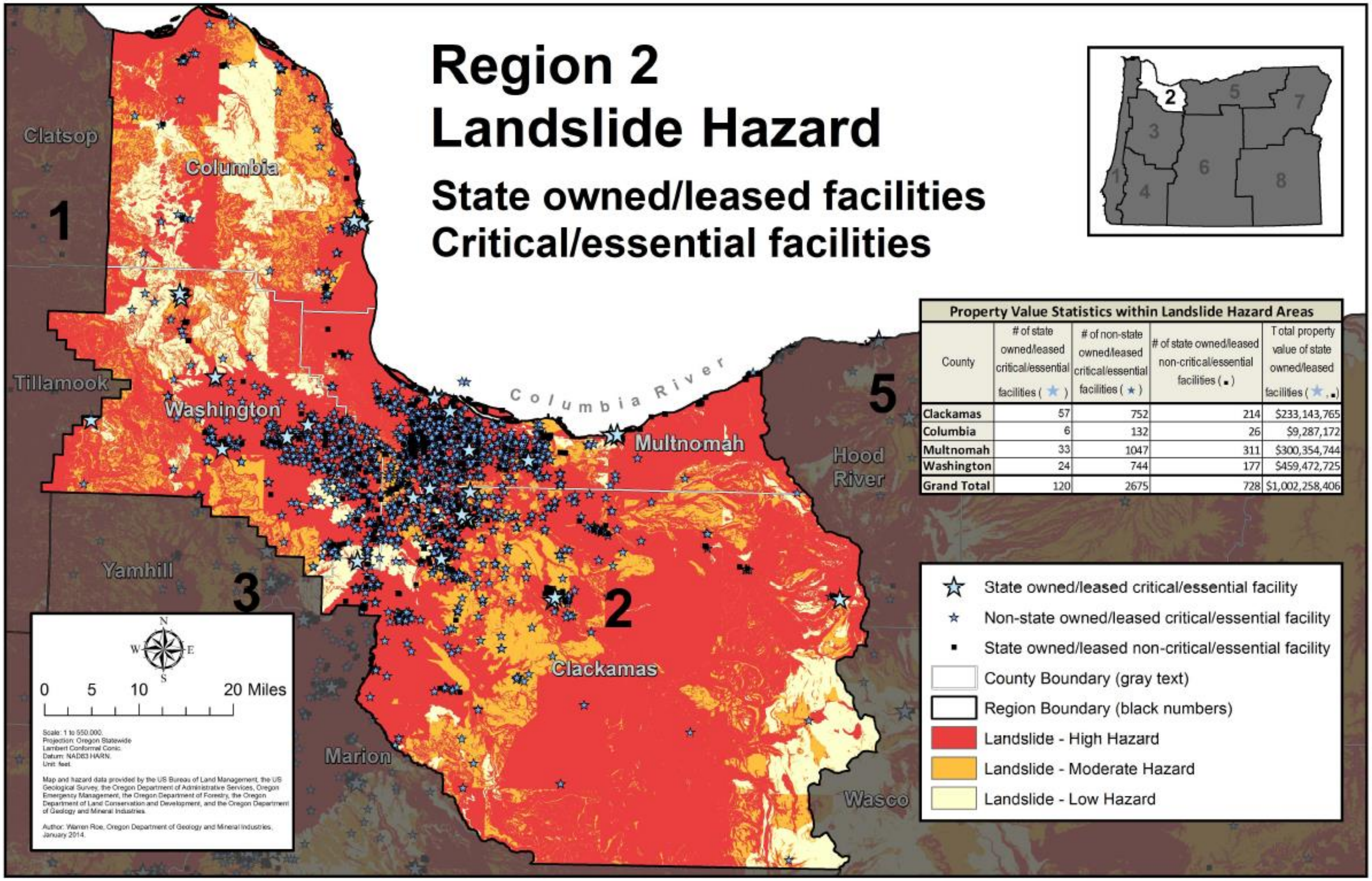
Many communities in this region are vulnerable to landslides; for example, the Portland Hills and the Oregon City area both have high exposure to landslides. In general, Washington, Multnomah, and Clackamas Counties have relatively high vulnerability.

STATE-OWNED/LEASED FACILITIES AND CRITICAL/ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.)

Of the 5,693 state facilities evaluated, 848 are located within landslide hazard areas in Region 2, totaling roughly $1 billion (**Figure 2-116**). This includes 120 state critical or essential facilities. An additional 2,675 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 2.

Figure 2-116. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Zone in Region 2



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Clackamas	57	752	214	$233,143,765
Columbia	6	132	26	$9,287,172
Multnomah	33	1047	311	$300,354,744
Washington	24	744	177	$459,472,725
Grand Total	120	2675	728	$1,002,258,406

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Clackamas and Multnomah Counties coincide with the crest of the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when remain. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances through stream valleys, and ashfall can blanket areas many miles from the source.

Historic Volcanic Events

Table 2-162. Historic Volcanic Events in Region 2

Date	Location	Description
about 20,000 to 13,000 YBP	Polallie eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859/1865	Crater Rock on Mount Hood	steam explosions/tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions
1980	Mount St. Helens (Washington)	debris avalanche, ashfall, flooding on Columbia River

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Wolfe and Pierson (1995); Scott et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience volcanic activity is shown in **Table 2-163**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-163. Local Probability Assessment of Volcanic Activity in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	L	L	H	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 2 communities are closest to Mount Hood (Clackamas County), a stratovolcano. Stratovolcanoes have wide ranging modes of eruption, making future volcanic activity difficult to predict definitively. Mount Hood's eruptive history can be traced to late Pleistocene times (15,000–30,000 years ago) and will no doubt continue. However, the central question remains: When?

The most recent series of events (1760–1907) consisted of small lahars, debris avalanches, steam explosions, and minor ashfalls. Mount Hood's recent history also includes ashfalls, dome building, lahars, pyroclastic flows, and steam explosions. These occurred approximately 200 years ago. Geoscientists have provided estimates of future activity in the vicinity of Crater Rock, a well-known feature on Mount Hood. They estimate a 1 in 300 chance that some dome activity will take place in a 30-year period (1996–2026). For comparison, the 30-year probability of a house being damaged by fire in the United States is about 1 in 90 (Scott et al., 1997).

The probability of 1 cm or more of ashfall from eruptions throughout the Cascade Range include (Sherrod et al., 1997):

- Clackamas County: between 1 in 500 and 1 in 1000;
- Multnomah County: between 1 in 500 and 1 in 1,000;
- Washington County: between 1 in 1,000 and 1 in 5,000; and
- Columbia County: between 1 in 5,000 to 1 in 10,000.

Mount St. Helens is less than 50 air miles from some Columbia County communities and is still active. Prevailing wind direction is of paramount importance. Because the prevailing winds are westerly in Columbia County, the risk of ashfall is considerably reduced.

Table 2-164 summarizes the probability of volcano-related hazards for each county. Debris from the 1980 eruption of Mount St. Helens impacted the shipping channel on the Columbia River by reducing water depth to such an extent that dredging was required.

Table 2-164. Probability of Volcano-Related Hazards in Region 2

Volcano Related Hazards	Washington	Multnomah	Clackamas	Columbia	Remarks
Volcanic ash (annual probability of 1cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000 to 1 in 10,000	1 in 1,000 to 1 in 5,000	1 in 1,000 to 1 in 5,000	1 in 5,000 to 1 in 10,000	Sherrod et al. (1997)
Lahar	no risk	Source: Mount Hood	Source: Mount Hood	no risk	Scott et al. (1997)
Lava flow	no risk	no risk	Source: Mount Hood	no risk	Scott et al. (1997)
Debris flow / avalanche	no risk	Source: Mount Hood	Source: Mount Hood	Mount St. Helens	Scott et al. (1997)
Pyroclastic flow	no risk	no risk	Source: Mount Hood	no risk	Scott et al. (1997)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-165**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-165. Local Vulnerability Assessment of Volcanic Activity in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

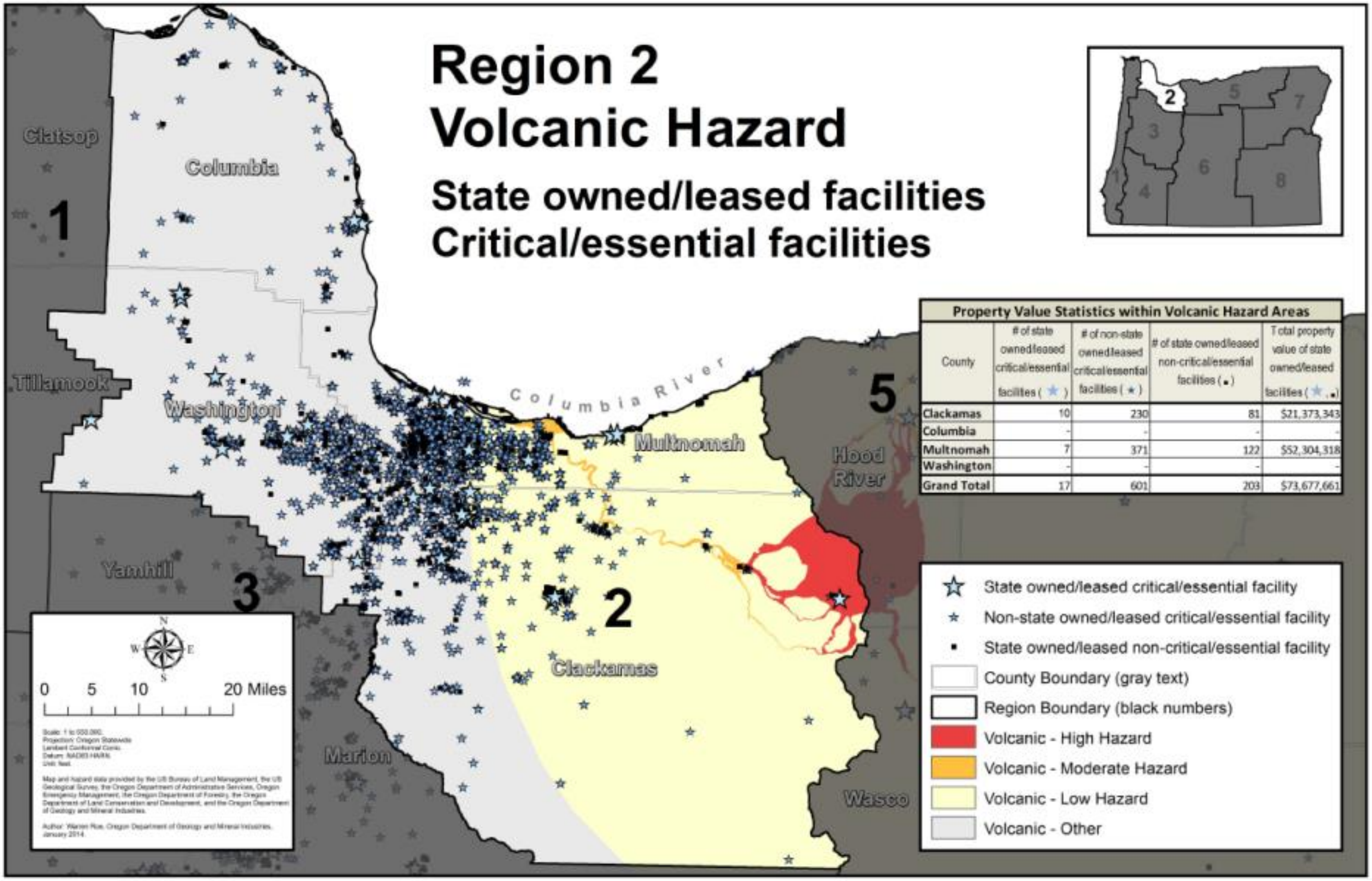
The U.S. Geological Survey has addressed volcanic hazards at Mount Hood (Scott et al., 1997) and Mount St. Helens (Wolfe and Pierson, 1995). These reports include maps depicting the areas at greatest risk. Clackamas and Multnomah Counties, including the Portland Metro area, are at risk and should consider the impact of volcano-related activity on small mountain communities, dams, reservoirs, energy-generating facilities, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation). The communities of Government Camp, Rhododendron, and Welches merit special attention. There is virtually no risk from volcanoes in Washington County, although normal prevailing winds could shift and carry ash into that area. Debris entering the Columbia River from eruptions at Mount St. Helens or Mount Hood may disrupt shipping operations based in Columbia and Multnomah Counties.

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.)

Of the 5,693 state facilities evaluated, are 220 located within a volcanic hazard in Region 2; and total roughly $73.7 million in value. Of those facilities, 17 are critical or essential facilities. In addition, there are 601 non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 2 (**Figure 2-117**).

Figure 2-117. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 2



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (■)	Total property value of state owned/leased facilities (★, ■)
Clackamas	10	230	81	$21,373,343
Columbia	-	-	-	-
Multnomah	7	371	122	$52,304,318
Washington	-	-	-	-
Grand Total	17	601	203	$73,677,661

Source: DOGAMI

Wildfires

Characteristics

There is extensive forested land in Columbia, Clackamas, Multnomah, and Washington Counties, both in undeveloped National Forest land and developing wildland-urban interface areas. All of it is at risk, but especially within the interface areas. In recent years, the cost of fire suppression has risen dramatically. A large number of homes have been threatened or burned, more firefighters have been placed at risk, and fire protection in wildland areas has been reduced. These factors have prompted communities and protection agencies to come together and use or create extensive fire prevention/mitigation programs. Community Wildfire Protection Plans lead the way for the development of Firewise Communities and fuel reduction projects throughout the region.

Residents have a high risk of experiencing a wildland fire due to the extensive forestland present in the communities and the current trend toward rural home site development. The age of the surrounding timber stands can be a factor in determining whether a non-threatening ground fire will spread to the canopy and become a dangerous crown fire. Clearings and fuel breaks will disrupt a slow moving wildfire enabling successful suppression. Agricultural and ranching activities throughout the area increase the risk of a human-caused wildfire spreading to forested areas. Large expanses of fallow fields or non-annual cash crops provide areas of continuous fuels that have potential to threaten several homes and farmsteads. Under extreme weather conditions, escaped agricultural fires could threaten individual homes or a town site; however, this type of fire is usually quickly controlled. High winds increase the rate of fire spread and intensity of fires.

Table 2-166 shows the single significant fire affecting Region 2.

Historic Wildfire Events

Table 2-166. Historic Wildfires in Region 2

Year	Name of Fire	Counties	Acres Burned	Remarks
1902	Columbia	Clackamas/Multnomah	170,000	—

Source: Brian Ballou, 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience wildfire is shown in **Table 2-167**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-167. Local Probability Assessment of Wildfire in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

This document defines wildfire as an uncontrolled burning of forest, brush, or grassland. Wildfires have always been a part of these ecosystems, sometimes with devastating effects. Wildfire may result from natural causes (e.g., lightning strikes), a mechanical failure (Oxbow Fire), or human causes (unattended campfire, debris burning, or arson). Most wildfires can be linked to human carelessness.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-168**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-168. Local Vulnerability Assessment of Wildfire in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	M	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The vulnerability in this region is mild at best. The Northern Willamette Valley / Portland Metro area is dominated by highly populated rural interface as well as metropolitan areas. Timber and agriculture land line suburban areas. A cooler climate and reduced fire danger results in fewer wildfires. In addition, response times are typically much quicker in this region due to large populations and several fire agencies nearby.

Each year a significant number of people build homes within or on the edge of the forest (wildland-urban interface), thereby increasing wildfire hazards. These communities have been designated "Wildland-Urban Interface Communities" and include those in **Table 2-169**.

Table 2-169. Wildland-Urban Interface Communities in Region 2

Clackamas	Columbia	Multnomah	Washington
Beaver Creek	Alston	Bonneville	Buxton
Bull Run	Clatskanie	Burlington	Cherry Grove
Cedarhurst Park	Columbia City	East Metro	Gales Creek
Colton	Deer Island	Holbrook	Gaston
Dickey Prairie	Goble	Lower Columbia Gorge	Glenwood
Eagle Creek	Mist Birkenfeld	Portland Metro	Stimson Mill
Estacada	Pittsburg	Shelternoon	Timber
Fallsview	Prescott	Skyline	Tualatin Valley
Firgrove	Quincy	Warrendale	
Government Camp	Rainier		
Hoodland Corridor	St. Helens		
Maple Grove	Scappoose		
Molalla	Spitzenburg		
Molino	Swedetown		
Redland	Vernonia		
Sandy	Warren		
Springwater	Yankton		
Timber Grove			

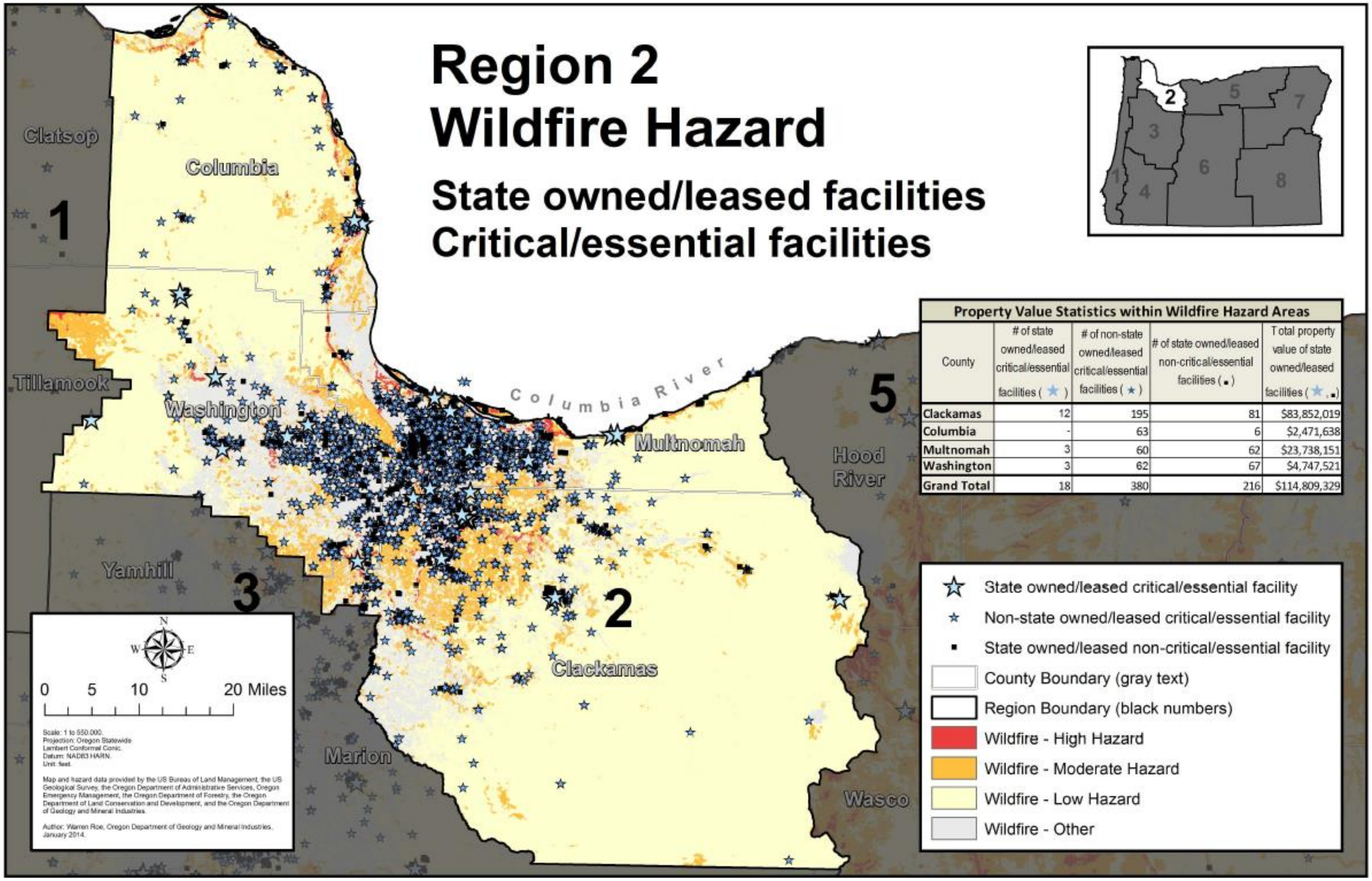
Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 234 are within a wildfire hazard zone in Region 2 and total about $ 115 million in value (**Figure 2-118**). Eighteen of these facilities are state critical/essential facilities. An additional 380 non-state critical/essential facilities are also located in a wildfire hazard zone in Region 2.

Figure 2-118. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 2



Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge; these areas have special building code standards. A majority of the destructive surface winds in Region 2 are from the southwest. Under certain conditions, very strong east winds may occur, but these usually are limited to small areas in the vicinity of the Columbia River Gorge or other low mountain passes.

The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 2.

Historic Windstorm Events

Table 2-170. Historic Windstorms in Region 2

Date	Location	Description
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40-60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec.1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71 mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million (FEMA-1405-DR-Oregon)
June 2004	Washington Count	$100 in property damage from a tornado
Dec. 2004	Clackamas County	$6,250 in property damage *damage estimate includes areas outside of Region 2
June 2005	Multnomah County	lightning causes $50,000 in damage
Dec. 2005	Clackamas, Multnomah, and Washington Counties	$9,000 in property damage
Jan. 2006	Clackamas, Columbia, Washington, and Multnomah Counties	wind storm with winds up to 58 mph caused a total of $500,000 in damages spread out over all four counties and included Yamhill, Marion, and Polk Counties as well
Feb. 2006	Columbia, Multnomah, Clackamas, Washington Counties	strong wind storm caused $167,000 in damage for all four counties; storm also impacted counties in Regions 3 and 1 for a total storm damage of $575,000
May 2007	Clackamas County	windstorm brought wind gusts up to 50 mph and produced extensive hail, causing $5000 in damages
July 2007	Multnomah and Washington Counties	heavy windstorm with 58-mph winds downed several trees, caused $5000 in damage/$1000 in damage in Beaverton
Sep. 2007	Multnomah County	severe storm that produced hail and a tornado, caused $5000 in damages
June 2008	Clackamas County	severe storms produced heavy winds and hail near the Cascades, caused $5000 in damages
Mar. 2009	Columbia County	72-mph winds caused $20,000 in property damage
Nov. 2012	Lincoln County	97-mph winds at Newport cost $1 million in property damage

Sources: Taylor and Hatton (1999; and FEMA-1405-DR-OR: February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; National Climatic Data Center, Storm Events, Database http://www.ncdc.noaa.gov/stormevents/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience windstorms is shown in **Table 2-171**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-171. Local Probability Assessment of Windstorms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	M	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in Region 2 is considered to be one-minute average winds of 80mph. A 50-year storm is 72 mph. And a 25-year storm is 65 mph in this region.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to windstorms is shown in **Table 2-172**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-172. Local Vulnerability Assessment of Windstorms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	L	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Columbia, Multnomah, and Washington Counties are listed as most vulnerable to windstorms, as determined by the staff of the Oregon Public Utilities Commission and OCCRI.

Many buildings, utilities, and transportation systems within Region 2 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods and affect emergency operations. In addition, uprooted or shattered trees can down power and other utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Additional considerations include ferry systems and bridges, which may be closed during high-wind periods.

Winter Storms

Characteristics

Winter storm events occur annually in Region 2, sometimes becoming severe. Severe winter weather in this region is characterized by extreme cold, snow, ice, and sleet. While most communities are prepared for severe winter weather, some are unprepared financially and otherwise. This is particularly true in the vicinity of Portland, where frigid air sometimes moves westward through the Columbia River Gorge. During these periods, it is not unusual for northern Willamette Valley communities to receive snow or ice storms known as “silver thaws.” Severe weather conditions do not last long in Region 2. Consequently, winter preparedness is a moderate priority.

Historic Winter Storms

Table 2-173. Historic Winter Storms in Region 2

Date	Location	Description
Dec. 1861	statewide	snowfall 1-3 ft; snow in Willamette Valley until late Feb.
1862, 1866, 1884, 1885, 1890, 1892, 1895	Portland area / Northern Willamette Valley	severe winter conditions, especially in the Portland area; record-breaking snowfalls
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Dec. 1919	Portland area	third heaviest snowfall on record; Columbia River froze, closing navigation
1927, 1936, 1937, 1943, 1949	Portland area, Western Oregon	heavy snowfalls recorded
Jan. 1950	statewide	heaviest snowfall since 1890; many highway closures; considerable property damage
1956, 1960, 1962	western Oregon	packed snow became ice; automobile accidents throughout the region
Mar. 1960	statewide	snowfall: 3-12 inches, depending on location
Jan. 1969	statewide	record-breaking snowfalls; $3 to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	western valleys received between 2-4 inches of snow; massive power failures (tree limbs broke power lines)
Dec. 1985	Willamette Valley	heavy snowfall throughout valley
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures
Feb. 1990	statewide	average snowfall from one storm about 4 inches (Willamette Valley)
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfalls
Winter 1998-1999	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 2007	Columbia County	resulted in Presidential Disaster Declaration; $180 million in damage in the state; severe flooding in Vernonia; power outages for several days; five fatalities
Dec. 2008	Columbia County	snow and freezing rain in the Portland Metro area; $300,000 in property damage
Dec. 2009	statewide	snow and freezing rain in Salem, and Portland to Hood River; I-84 closed for 22 hours
Nov. 2010	statewide	snow, freezing rain, and ice accumulation in Portland to Hood River
Jan. 2012	Multnomah County	snow and ice east of Troutdale; I- 84 closed for 9 hours

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 2 will experience winter storms is shown in **Table 2-174**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-174. Local Probability Assessment of Winters Storms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 2. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-175**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-175. Local Vulnerability Assessment of Winter Storms in Region 2

	Columbia	Clackamas	Multnomah	Washington
Vulnerability	H	M	H	H

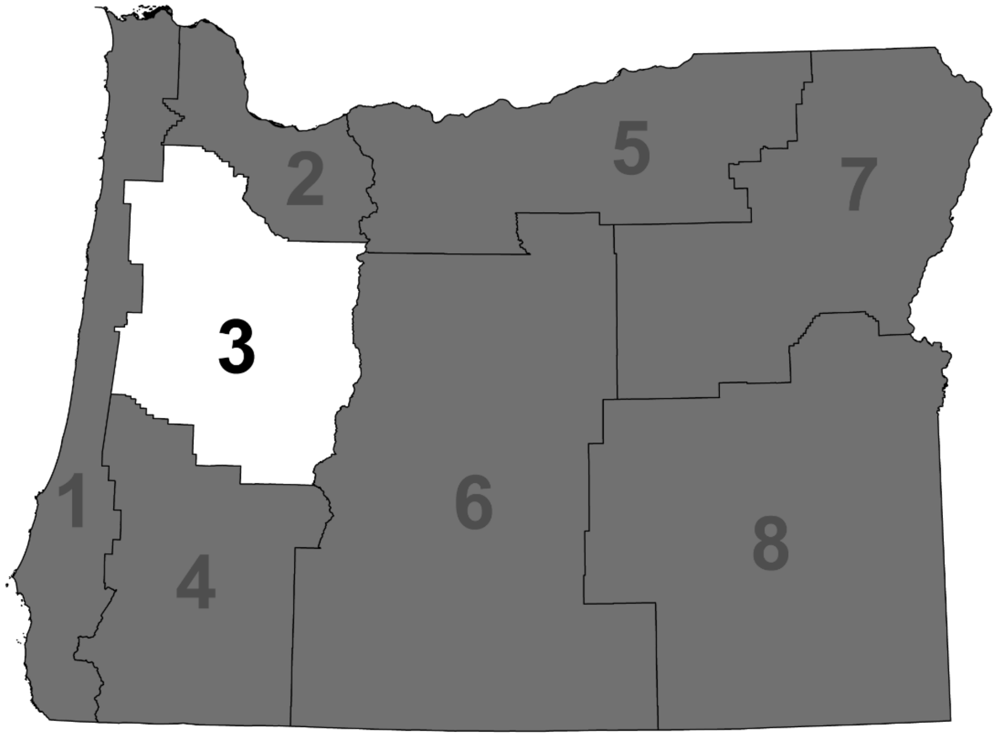
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Due to the large population and large truck commodity transport through this region, it is extremely costly when the roads are closed due to severe winter storms.

2.3.3 Region 3: Mid/Southern Willamette Valley

Benton, *Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties



Note: The coastal portion of Lane County is within Region 1. Where data are available for the coastal areas of Lane County, the data are provided within the Region 1 profile; otherwise, countywide datasets are reported in this profile.

2.3.3.1 Summary

Regional Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

The region's social vulnerability is particularly challenged in Lane, Marion, Benton, and Linn Counties. The following vulnerability indicators have been identified for one or more of those counties: high numbers of tourists, persons with disabilities, renters, people living in poverty, people who do not speak English very well, children, and seniors. Median household incomes have fallen in Marion and Lane Counties. Homeless populations have dramatically increased in Lane and Yamhill Counties.

The region has a number of key industries and employment sectors providing economic stability for the region. The exceptions are Linn and Yamhill Counties, which rely heavily on fewer key industries. Except for in Benton County, wages are lower in Region 3 than statewide.

Transportation networks across the region are vulnerable to natural hazard events, especially seismic events. Following a Cascadia earthquake event, access across the Willamette River and along I-5 may be limited due to bridge collapse. Lane County has a particularly high number of state-owned bridges that are distressed or deficient. The Eugene Airport, the state's second largest airport, could become a staging ground after a natural disaster, but is also vulnerable to a catastrophic seismic event.

Energy facilities and conveyance system infrastructure in the region support the regional economy and are vulnerable to natural hazard events. The region is a key provider of hydroelectricity for the state. Roughly 14% (53) of all dams in the region have either Significant or High Threat Potential. The majority of dams in the region are in Marion and Yamhill Counties. Liquid Natural Gas is transmitted via pipelines that run through Marion, Linn, and Lane Counties.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, lacking in system redundancies and sourced from surface water. Combined sewer overflow (CSO) during high-water events is one such threat. Low impact development (LID) stormwater systems, such as those employed by the City of Eugene, can help communities better manage high-precipitation events.

Urban growth in Region 3 is 4 times rural growth. The majority of growth is occurring in urban areas along I-5, in the region's major cities: Eugene, Albany, Corvallis, Salem, and the Portland Metro Area. Linn County has the highest percentage of mobile homes, which are inherently more vulnerable to natural hazards events. Almost two thirds of all homes in the region were built before 1990 and seismic building standards. Over one third of all homes in Polk and Yamhill Counties were built before floodplain management standards.

Hazards and Vulnerability

Region 3 is affected by eight of the 11 natural hazards that affect Oregon communities. Coastal hazards, dust storms, and tsunamis do not directly impact this region.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. Though not common in Region 3, a dry winter or spring could reduce community water supplies, impacting recreation, agriculture and the regional economy.

Earthquakes: Four types of earthquakes affect Region 3: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for the Mid/Southern Willamette Valley. This area is particularly vulnerable due to the large area susceptible to earthquake-induced landslide, liquefaction, and ground shaking. In a 500-year model for a CSZ event or combined crustal events, five of the 15 counties with highest expected damages and losses are in this region: Lane, Marion, Benton, Linn, and Yamhill. Seismic lifelines will be affected by prolonged ground shaking with several roadways susceptible to landslide, rockfall, or liquefaction. There are 2,134 state-owned/leased facilities in this region's earthquake hazard zone, valued at over $4.2 billion. Of these, 455 are critical/essential facilities. An additional 2,413 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: The most common types of flooding events affecting the Mid/Southern Willamette Valley are riverine and sheet flooding. The most damaging floods are rain-on-snow events and the backing up of tributaries that takes place in December and January in association with La Niña events. While all of the region's counties are considered moderately vulnerable to flooding, the coastal portion of Lane County and the cities of Eugene-Springfield, Salem, Scio, and Sheridan are considered the most vulnerable. This region has the third most repetitive flood loss properties (46) of which four are Severe Repetitive Loss (SRL) properties. There are 28 state-owned/leased facilities, valued at approximately $13 million, located in the region's flood hazard zone. Of these, one is considered a critical/essential facility. An additional 90 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can also trigger landslides. Vulnerability is increased in highly populated areas, such as in the Cities of Corvallis, Eugene, and Salem, and in the Coast and Cascade Mountains. There are 2,134 state-owned/leased facilities, valued at over $4.2 billion, within this hazard zone in Region 3. Of these, 455 are critical/essential facilities. An additional 2,413 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Volcanic activity may occur within the eastern areas of Lane, Linn, and Marion Counties that coincide with the crest of the Cascade mountain range. Most volcanic activity is considered local; however, lahars and ashfall can travel many miles. As such, small mountain communities, dams, reservoirs, energy-generating facilities, and highways in the region may be vulnerable to volcanic activity. There are 28 state-owned/leased facilities located in the volcanic hazard zone in this region, with an approximate value of $13 million. Of these, one is identified as a critical/essential facility. An additional 90 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: Wildfire risk is low to moderate in the Mid/Southern Willamette Valley. Wildfires that do occur usually happen in the late summer. The areas of greatest vulnerability are wildland-urban interface communities. There are 610 state-owned/leased facilities located in a wildfire hazard zone with a value of approximately $315 million. Of these, 70 are identified as critical/essential facilities. An additional 587 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms can occur when winds generated in the Pacific Ocean travel inland in a northeasterly direction. Strong winds from the south are also possible in this region and often cause the most damage. Windstorms affect the region annually. These storms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Colder weather and higher precipitation and can occur in the region annually. More severe winter storms occur about every 4 years. Due to the infrequent nature of severe storms in Region3, winter storm preparedness is not a priority of most communities.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 3 include drought, wildfire, flooding, and landslides. Climate models project warmer, drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by increased incidences of drought and wildfire. In addition, an increase in extreme precipitation is projected for some areas in Region 3 and can result in a greater risk of flooding in certain basins, including an increased incidence of magnitude and return intervals. While winter storms and windstorms affect Region 3, there is little research on how climate change influences these hazards in the Pacific Northwest. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**

2.3.3.2 Profile

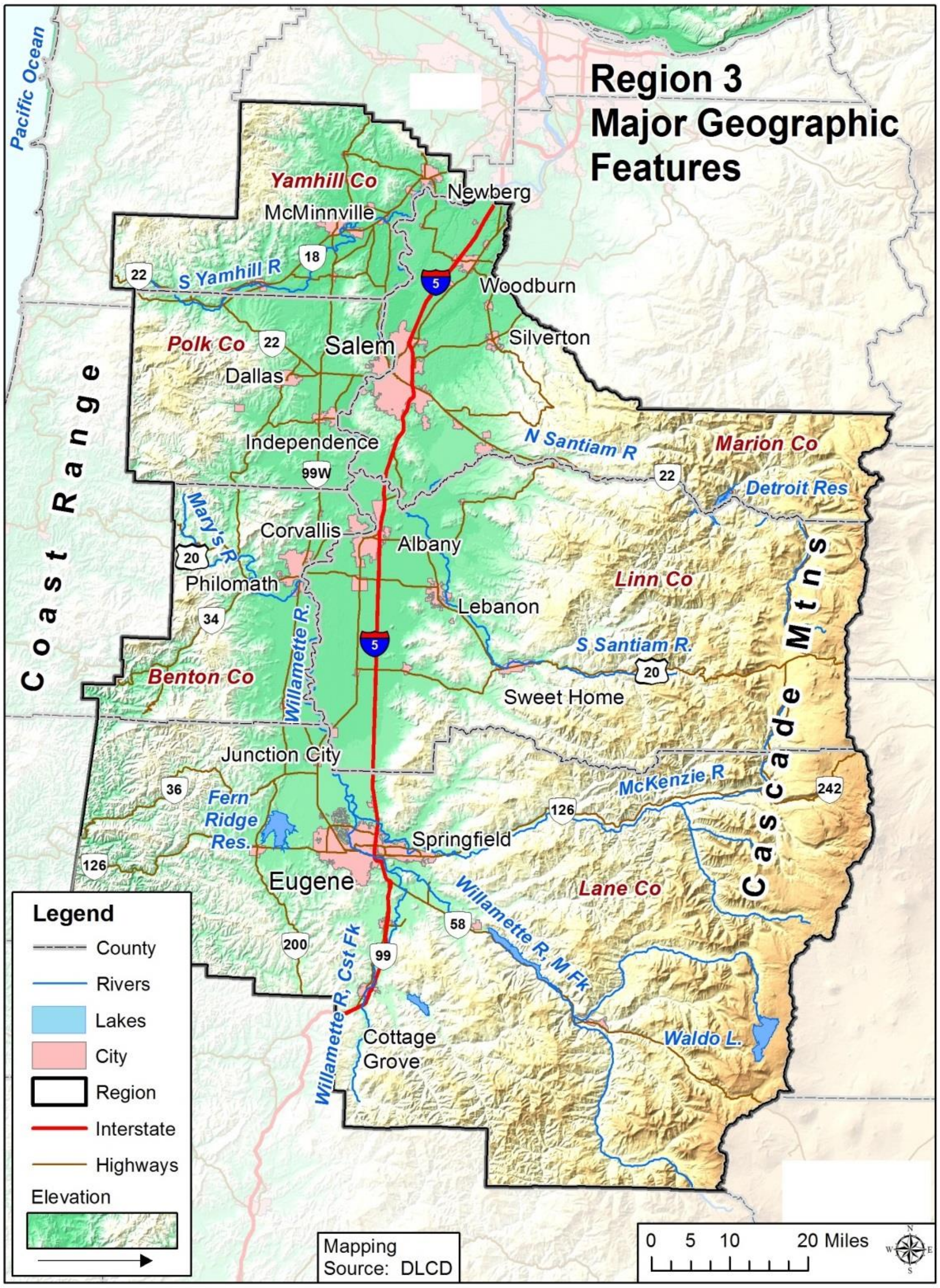
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

The Mid/Southern Willamette Valley is approximately 10,163 square miles in size, and includes Benton, Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties. Mountain ranges and watersheds shape the region's topography. Region 3 begins at the Cascades crest in the east, and extends to the Coast Range in the west. It extends from the base of the Calapooya Mountains in the south to the Portland suburbs in the north. The major watershed is the Willamette River with smaller water bodies feeding it as it flows north into the Columbia River. The original Oregon Trail settlers sought out the fertile soil and ample rainfall of the Willamette Valley for their homesteads. The region is still an agriculturally vital area.

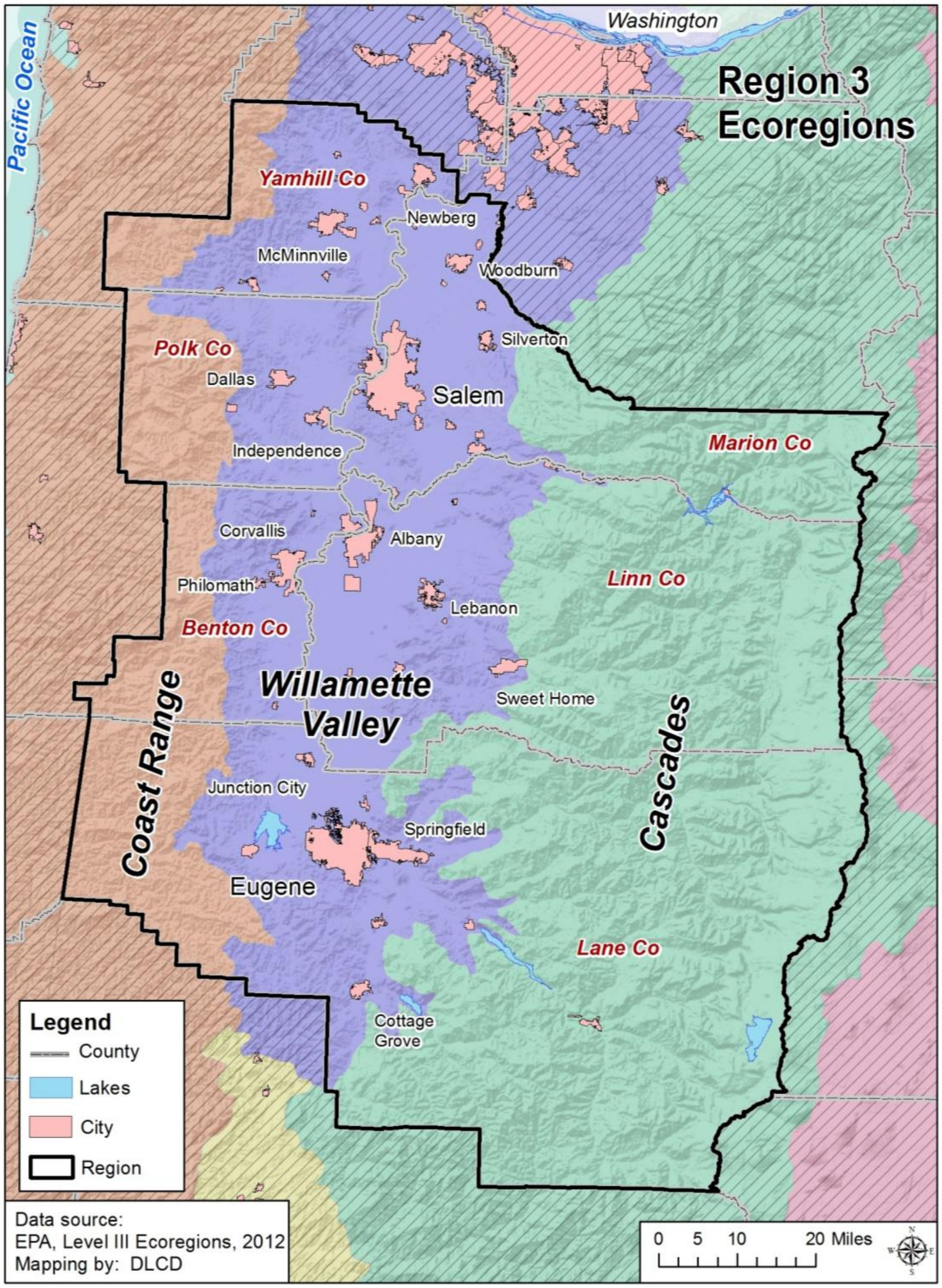
Figure 2-119. Region 3 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 3 is composed of three ecoregions: the Cascades, the Willamette Valley, and the Coast Range.

Figure 2-120. Region 3 Ecoregions



Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers, and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Coast Range: The eastern slope of the Coast Range is located within Region 3. Soils in this ecoregion are a mixture of sedimentary and volcanic composition. Volcanic soils are underlain by basaltic rocks resulting in more consistent summer streamflows and supporting runs of spring Chinook salmon and summer steelhead. Sedimentary soils in this ecoregion are prone to failure following clearcuts, which may be of concern as the commercial Douglas fir forests located here are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. The ecoregion's sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Thorson et al., 2003).

Willamette Valley: Terraces and floodplains dominate the nearly flat central Willamette Valley. The valley floor is dotted with scattered hills and buttes and is bordered by the adjacent foothills. Historically, valley waterways meandered throughout floodplains on the nearly flat valley floor, contributing to the valley's highly fertile soil and supporting the dominance of oak savannah and prairie ecosystems. Today the Willamette River and its tributaries are highly channelized, helping to protect property, but also restricting the flow of these waterways and threatening stream health. Productive soils and temperate climate make this ecoregion one of the most important agricultural areas in Oregon. The valley's flat terraces have made urban and suburban development possible (Thorson et al., 2003).

Climate

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment**.

Region 3 has diverse ecoregions with varying climatic conditions. Precipitation generally occurs in the winter months. Wet winters and dry summers influence drought, floods, landslides, wildfires, and winter storms. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-176. Average Precipitation and Temperature Ranges in Region 3 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Willamette Valley*	40–60	32/46	50/85
Coast Range*	60–200	30/48	48/78

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 3.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Polk and Yamhill Counties experienced the most growth in the region during the decade from 2000 to 2010. By 2020, Marion, Polk, and Yamhill Counties are expected to grow at a higher rate than the state as a whole. Conversely, Lane County is expecting to grow at half the rate of the state as a whole.

Table 2-177. Population Estimate and Forecast for Region 3

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 3	936,387	1,063,860	13.6%	1,155,049	8.6%
Benton	78,153	87,725	12.2%	91,379	4.2%
Lane	322,959	356,125	10.3%	378,335	6.2%
Linn	103,069	118,665	15.1%	128,454	8.2%
Marion	284,834	322,880	13.4%	355,189	10.0%
Polk	62,380	77,065	23.5%	88,081	14.3%
Yamhill	84,992	101,400	19.3%	113,611	12.0%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 3 are largely centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods Travel USA, 2011c). The average travel party contains 3.1 persons, and 76% of their trips originate from Oregon or Washington. In this region, the average trip length is 3.5 nights (Longwoods Travel USA, 2011c). The majority of tourists visit Lane County. In 2013, more than 20% of Region 3's visitors lodged in hotels, motels and other venues.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-178. Annual Visitor Estimates in Person Nights in Region 3

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 3	16,784	—	17,280	—	17,463	—
Benton	1,334	100%	1,382	100%	1,399	100%
Hotel/Motel	395	29.6%	424	30.7%	443	31.7%
Private Home	860	64.5%	878	63.5%	874	62.5%
Other	79	5.9%	80	5.8%	82	5.9%
Lane	7,348	100%	7,484	100%	7,550	100%
Hotel/Motel	1,599	21.8%	1,669	22.3%	1,727	22.9%
Private Home	4,498	61.2%	4,550	60.8%	4,539	60.1%
Other	1,251	17.0%	1,265	16.9%	1,284	17.0%
Linn	1,775	100%	1,836	100%	1,860	100%
Hotel/Motel	287	16.2%	316	17.2%	336	18.1%
Private Home	1,184	66.7%	1,211	66.0%	1,206	64.8%
Other	304	17.1%	309	16.8%	318	17.1%
Marion	4,794	100%	4,973	100%	5,103	100%
Hotel/Motel	882	18.4%	932	18.7%	1,007	19.7%
Private Home	3,418	71.3%	3,535	71.1%	3,572	70.0%
Other	494	10.3%	506	10.2%	524	10.3%
Polk	N/A	N/A	N/A	N/A	N/A	N/A
Hotel/Motel	N/A	N/A	N/A	N/A	N/A	N/A
Private Home	N/A	N/A	N/A	N/A	N/A	N/A
Other	N/A	N/A	N/A	N/A	N/A	N/A
Yamhill	1,533	100%	1,605	100%	1,551	100%
Hotel/Motel	437	28.5%	492	30.7%	475	30.6%
Private Home	1,010	65.9%	1,025	63.9%	987	63.6%
Other	86	5.6%	88	5.5%	89	5.7%

N/A = data were not available for Polk County

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). A similar percentage of the people in Region 3 identify as having a disability as do people throughout the state. In Region 3, residents of Lane and Marion Counties together account for 65% of all persons with disabilities. Two thirds (67%) of these counties' children (under 18) and almost two thirds (63%) of their seniors (65 and older) are reported to have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-179. People with a Disability by Age Groups in Region 3, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 3	1,032,370	145,668	14.1%	11,829	5.0%	55,210	38.0%
Benton	85,132	8,606	10.1%	555	3.7%	3,483	33.9%
Lane	349,806	51,391	14.7%	3,575	5.2%	19,826	37.7%
Linn	115,996	18,982	16.4%	1578	5.6%	7,523	42.2%
Marion	309,462	43,319	14.0%	4403	5.3%	14,814	37.1%
Polk	75,054	10,428	13.9%	732	4.0%	4,456	39.3%
Yamhill	96,920	12,942	13.4%	986	4.0%	5,108	38.7%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). Over the 3-year period between 2009 and 2011, the most notable shifts in homeless populations included a 155% increase in Lane County and a 206% increase in Yamhill County. This was followed by a reduction in homeless people in all counties by 2011, to less than 2009 numbers. In Yamhill County that reduction was exceptional, 101% below 2009 numbers.

Extra attention is needed to care for and serve homeless communities**.** Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events**.** Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-180. Homeless Population Estimate for Region 3

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 3	4,268	5,795	3,480	4,514
Benton	154	154	107	138
Lane	2,232	3,467	2,136	2,612
Linn	269	245	135	216
Marion	1,195	1,152	943	1,097
Polk	52	23	122	66
Yamhill	366	754	37	386

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services.
http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 3 is similar to that of the state, almost 50:50 (U.S. Census Bureau, American Community Survey, 2010 Demographic Profile Data, Table DP-1). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

Lane County has the most seniors but about the same proportion of senior population as the other counties in Region 3. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to elderly (Morrow, 1999).

Marion County has the highest number and greatest percentage of children in the region. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter, 2003).

Table 2-181. Population by Vulnerable Age Groups, in Region 3, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 3	1,044,124	238,590	22.9%	148,032	14.2%
Benton	85,501	14,995	17.5%	10,411	12.2%
Lane	351,794	69,322	19.7%	53,449	15.2%
Linn	116,871	28,296	24.2%	18,142	15.5%
Marion	315,391	83,103	26.3%	41,047	13.0%
Polk	75,448	18,201	24.1%	11,447	15.2%
Yamhill	99,119	24,673	24.9%	13,536	13.7%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Special consideration should be given to populations who do not speak English as their primary language. These populations can be harder to reach with hazard outreach materials. They are less likely to be prepared if special attention is not given to language and culturally appropriate outreach techniques. Similar to the state, almost 94% of the region's population speaks English very well. Notably, 11% of the people in Marion County speak English less than very well. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-182. English Usage in Region 3, 2012

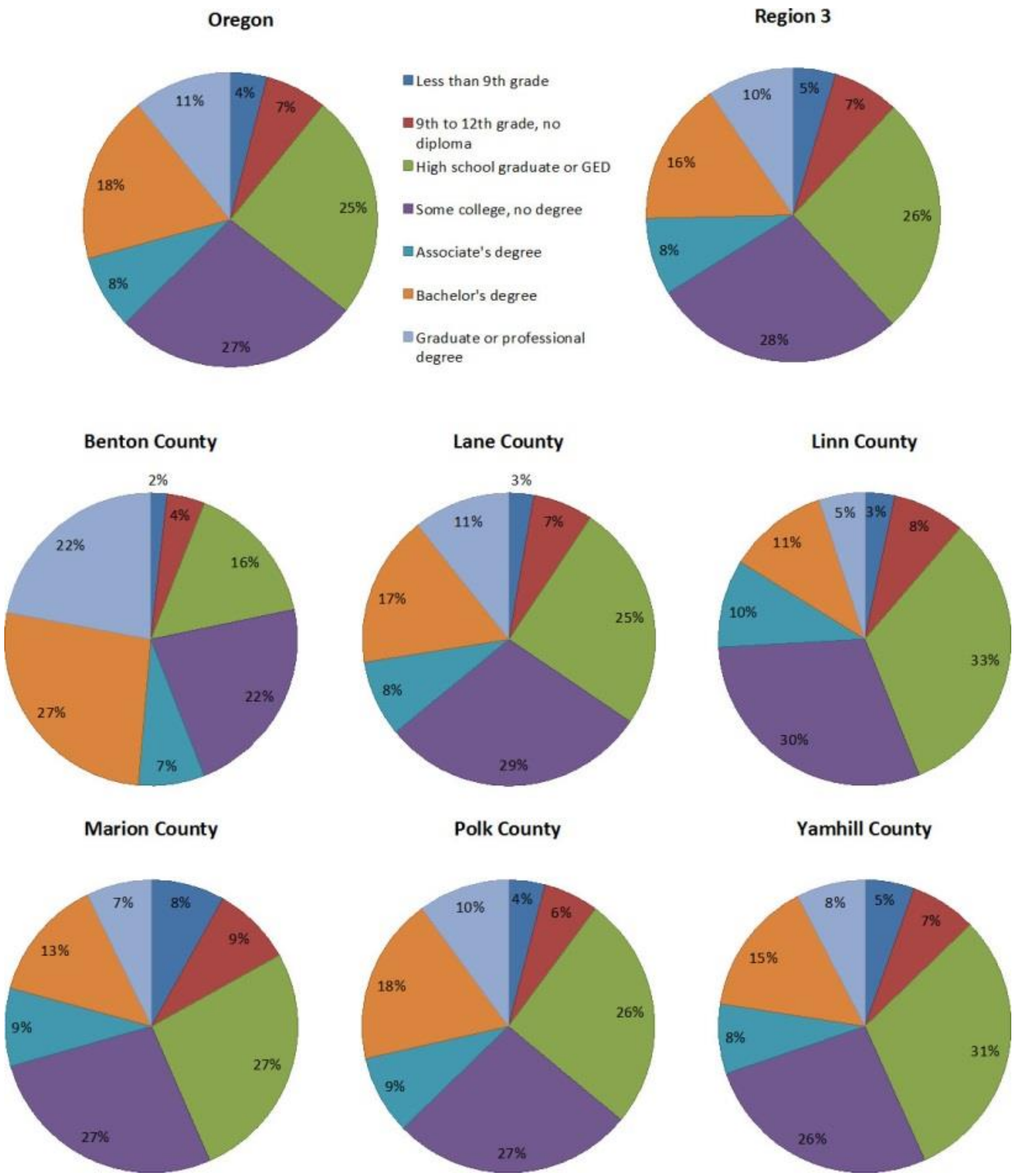
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 3	922,262	94.1%	57,814	5.9%
Benton	78,954	96.6%	2,738	3.4%
Lane	323,424	96.9%	10,235	3.1%
Linn	106,495	97.5%	2,762	2.5%
Marion	259,286	88.8%	32,727	11.2%
Polk	67,542	95.5%	3,216	4.5%
Yamhill	86,561	93.4%	6,136	6.6%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person's and community's ability to understand warning information and to access resources before and after a natural disaster. With the exception of Benton County, the populations in all counties in the region have the following education attainment breakdown: 35–44% with no college, 26–30% with some college; 26–36% with a college degree. OSU's presence in Benton County likely contributes to the facts that more than half of the county's population has a college degree and the county has the lowest percentage of population with no college experience.

Figure 2-121. Educational Attainment in Region 3, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event” (Cutter, 2006, p.76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 significantly affected Mid/Southern Willamette Valley communities. Between 2009 and 2012, median household incomes dropped most significantly in Lane and Marion Counties. Conversely, median incomes in Polk and Yamhill Counties were higher than median incomes statewide.

Table 2-183. Median Household Income in Region 3

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 3	N/A	N/A	N/A
Benton	$49,926	$48,635	-2.6%
Lane	$45,860	$42,628	-7.0%
Linn	$48,907	$47,129	-3.6%
Marion	$49,713	$46,654	-6.2%
Polk	$54,312	$52,365	-3.6%
Yamhill	$54,784	$53,950	-1.5%

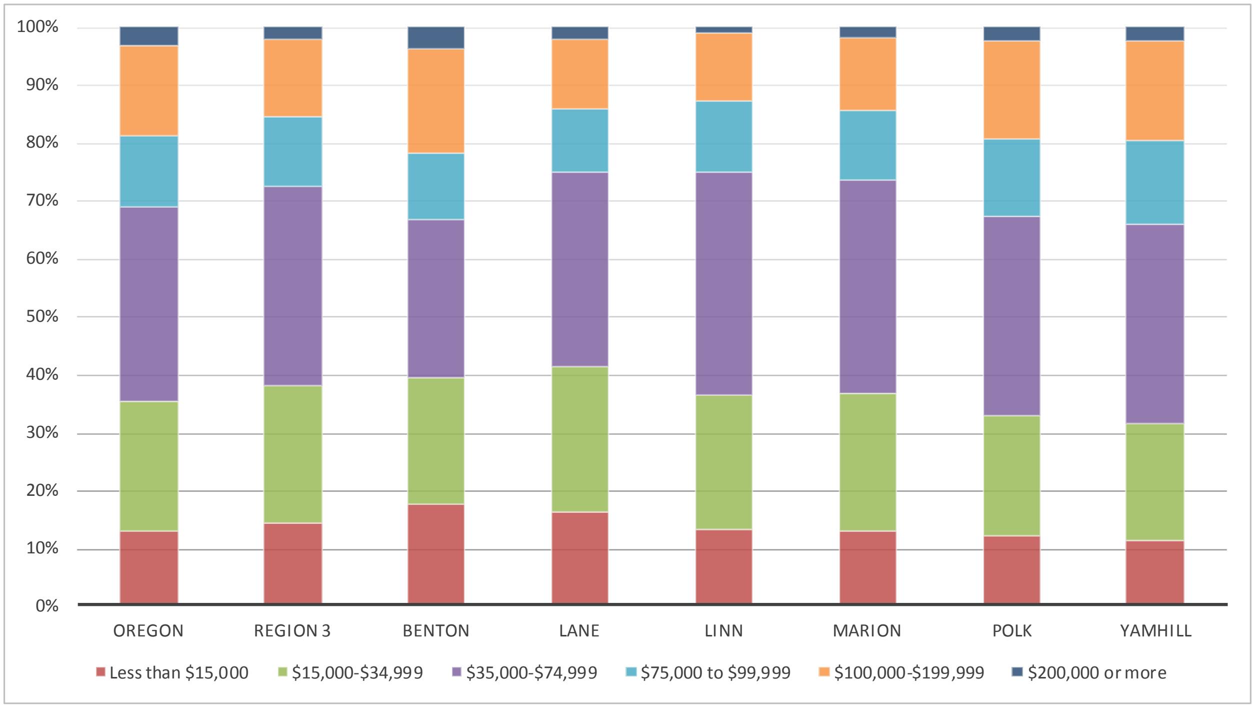
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03

The region has a larger share of its households earning less than $35,000 per year than the state as a whole. Benton, Polk, and Yamhill Counties have a higher percentage of households earning more than $75,000 per year than the state.

Figure 2-122. Median Household Income Distribution in Region 3, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Benton, Lane, and Marion Counties have had the greatest increase in poverty rates in Region 3. Over a quarter of the children in Marion and Linn Counties live in poverty.

Table 2-184. Poverty Rates in Region 3, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 3	180,439	17.8%	18.3%	53,096	22.7%	20.3%
Benton	17,418	21.6%	20.4%	2,413	16.4%	23.4%
Lane	64,705	18.8%	19.3%	13,754	20.3%	24.4%
Linn	19,237	16.7%	16.2%	6,934	25.2%	23.4%
Marion	55,223	18.0%	19.8%	22,046	27.1%	21.4%
Polk	10,788	14.6%	14.1%	3,400	18.9%	11.8%
Yamhill	13,068	13.9%	11.7%	4,549	18.8%	6.1%

*Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

The percentage of homeownership exceeds that of the state in Linn, Polk, and Yamhill Counties. Benton County has a higher rate of renter occupied units than other counties in the region. This number is likely driven by rental demand for off campus housing for students attending Oregon State University in Corvallis. The region has a lower vacancy rate than the state as a whole. Lane County has a high rate of seasonal, or recreational, housing units contributing approximately two thirds of the region’s total (U.S. Census Bureau, 2008–2012, American Community Survey, Table DP04 and Table B25004).

Table 2-185. Housing Tenure in Region 3, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 3	398,662	246,901	61.9%	151,761	38.1%	20,389	5.2%
Benton	33,502	19,342	57.7%	14,160	42.3%	2,428	6.7%
Lane	145,474	86,739	59.6%	58,735	40.4%	7,464	4.8%
Linn	44,566	29,735	66.7%	14,831	33.3%	1,738	3.6%
Marion	113,227	68,766	60.7%	44,461	39.3%	6,748	5.6%
Polk	27,973	18,681	66.8%	9,292	33.2%	2,011	6.7%
Yamhill	33,920	23,638	69.7%	10,282	30.3%	2,760	7.4%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 3 is predominantly composed of family households. Roughly 70% of households in Marion and Yamhill Counties are households with children, including both married and single-parent (male or female) households. Benton and Lane Counties have the highest percentages of one-person households and the lowest percentages of family households. These numbers are likely influenced by the presence of

Oregon State University (OSU) in Corvallis (Benton County) and the University of Oregon in Eugene (Lane County).

Table 2-186. Family vs. Non-family Households in Region 3, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 3	398,662	258,374	64.8%	140,288	35.2%	105,894	26.6%
Benton	33,502	18,825	56.2%	14,677	43.8%	9,910	29.6%
Lane	145,474	86,939	59.8%	58,535	40.2%	41,652	28.6%
Linn	44,566	30,389	68.2%	14,177	31.8%	11,027	24.7%
Marion	113,227	78,115	69.0%	35,112	31.0%	29,184	25.8%
Polk	27,973	19,244	68.8%	8,729	31.2%	6,853	24.5%
Yamhill	33,920	24,862	73.3%	9,058	26.7%	7,268	21.4%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-187. Family Households with Children by Head of Household in Region 3, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 3	111,129	27.9%	10,297	2.6%	26,455	6.6%	74,377	18.7%
Benton	7,375	22.0%	493	1.5%	1,403	4.2%	5,479	16.4%
Lane	35,308	24.3%	4,045	2.8%	8,648	5.9%	22,615	15.5%
Linn	12,316	27.6%	1,068	2.4%	3,083	6.9%	8,165	18.3%
Marion	36,724	32.4%	3,205	2.8%	9,546	8.4%	23,973	21.2%
Polk	8,263	29.5%	541	1.9%	1,611	5.8%	6,111	21.8%
Yamhill	11,143	32.9%	945	2.8%	2,164	6.4%	8,034	23.7%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 3 is particularly vulnerable during a hazard event in the following categories:

- Many more tourists visit Lane County than visit other counties In Region 3.
- Land and Yamhill Counties has seen dramatic increases in their homeless populations.
- Marion County has a high percentage of people in who do not speak English "very well."
- Marion and Lane Counties have experienced the highest percentage drop in median household incomes.
- Benton County has a greater percentage of renters than other counties in Region 3.
- Benton, Lane, and Marion Counties have had the greatest increases in poverty in Region 3 and significantly greater increases than the state overall.
- Marion and Yamhill Counties are home to more households with children than the region and the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). In 2009, Yamhill, Linn, and Lane Counties had the highest unemployment percentages in the region, above 10%. Since then all counties have experienced job growth; job growth in Lane, Linn, and Yamhill Counties has been 4% or higher. From 2009 to 2012, Benton County has consistently had the lowest unemployment rate in the region and Linn County has had the highest. Across the region, average salaries are lower than the state as a whole except in Benton County.

Table 2-188. Unemployment Rates in Region 3, 2009–2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 3	11.3%	10.8%	9.8%	9.0%	7.9%	-3.4%
Benton	7.8%	7.4%	6.7%	6.2%	5.8%	-2.0%
Lane	12.1%	11.1%	9.7%	8.7%	7.6%	-4.5%
Linn	13.8%	13.3%	11.8%	11.0%	9.7%	-4.1%
Marion	11.0%	11.1%	10.4%	9.7%	8.4%	-2.6%
Polk	9.3%	9.3%	9.0%	8.5%	7.6%	-1.8%
Yamhill	11.5%	10.7%	9.5%	8.6%	7.4%	-4.0%

Source: Oregon Employment Department, 2014

Table 2-189. Employment and Unemployment Rates in Region 3, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 3	505,807	465,842	92.1%	39,965	7.9%
Benton	43,092	40,588	94.2%	2,504	5.8%
Lane	172,339	159,176	92.4%	13,163	7.6%
Linn	53,237	48,068	90.3%	5,169	9.7%
Marion	151,876	139,126	91.6%	12,750	8.4%
Polk	37,856	34,996	92.4%	2,860	7.6%
Yamhill	47,407	43,888	92.6%	3,519	7.4%

Source: Oregon Employment Department, 2013

Table 2-190. Employment and Payroll in Region 3, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 3	398,005	$38,636	85.8%
Benton	34,291	$45,491	101.1%
Lane	138,712	$38,349	85.2%
Linn	40,668	$37,384	83.1%
Marion	134,979	$38,919	86.5%
Polk	17,191	$32,095	71.3%
Yamhill	32,164	$36,463	81.0%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 3 were: (a) Government; (b) Trade, Transportation and Utilities; (c) Education and Health Services; (d) Manufacturing; and (e) Leisure and Hospitality. Although wood products have historically been the main industry within the manufacturing sector in Lane County, this industry declined by 35% between 2001 and 2013. The region has had an increase in food products, health care, and call centers. Other key players that provide economic stability within the Government sector for the region include the University of Oregon and the Federal Courthouse (Oregon Employment Department, n.d., Region 5 data, retrieved May 5, 2014). Benton County has a strong economic base in higher education and high-tech manufacturing. The Linn County economy is primarily manufacturing based (Oregon Employment Department, n.d., Region 5 data, retrieved May 5, 2014). The counties of Marion, Polk, and Yamhill are key agricultural producers, producing nearly 30% of the state's farm sales (Oregon Employment Department, n.d., Region 3 data, retrieved May 5, 2014).

Table 2-191. Covered Employment by Sector in Region 3

		Benton County		Lane County		Linn County	
Industry	**Region 3**	**Employment**	**%**	**Employment**	**%**	**Employment**	**%**
Total All Ownerships	398,005	34,291	100%	138,712	100%	40,668	100%
Total Private Coverage	79.2%	25,212	73.5%	114,667	82.7%	33,914	83.4%
Natural Resources & Mining	5.1%	1,103	3.2%	2,205	1.6%	2,285	5.6%
Construction	4.0%	830	2.4%	5,223	3.8%	2,044	5.0%
Manufacturing	10.2%	3,003	8.8%	12,579	9.1%	6,831	16.8%
Trade, Transportation & Utilities	17.3%	4,207	12.3%	27,617	19.9%	8,546	21.0%
Information	1.4%	646	1.9%	3,365	2.4%	363	0.9%
Financial Activities	3.8%	1,011	2.9%	6,109	4.4%	1,147	2.8%
Professional & Business Services	8.9%	3,878	11.3%	14,796	10.7%	3,121	7.7%
Education & Health Services	15.2%	5,549	16.2%	22,425	16.2%	4,953	12.2%
Leisure & Hospitality	9.5%	3,565	10.4%	15,050	10.8%	3,106	7.6%
Other Services	3.8%	1,414	4.1%	5,292	3.8%	1,514	3.7%
Private Non-Classified	0.0%	7	0.0%	6	0.0%	7	0.0%
Total All Government	20.8%	9,079	26.5%	24,045	17.3%	6,754	16.6%
Federal Government	1.1%	527	1.5%	1,593	1.1%	306	0.8%
State Government	9.0%	6,031	17.6%	7,791	5.6%	1,227	3.0%
Local Government	10.7%	2,521	7.4%	14,662	10.6%	5,221	12.8%

		Marion County		Polk County		Yamhill County	
Industry	**Region 3**	**Employment**	**%**	**Employment**	**%**	**Employment**	**%**
Total All Ownerships	398,005	134,979	100%	17,191	100%	32,164	100%
Total Private Coverage	79.2%	101,487	75.2%	12,170	70.8%	27,830	86.5%
Natural Resources & Mining	5.1%	10,072	7.5%	1,537	8.9%	3,103	9.6%
Construction	4.0%	6,038	4.5%	673	3.9%	1,170	3.6%
Manufacturing	10.2%	9,792	7.3%	1,892	11.0%	6,408	19.9%
Trade, Transportation & Utilities	17.3%	21,963	16.3%	2,023	11.8%	4,433	13.8%
Information	1.4%	973	0.7%	52	0.3%	168	0.5%
Financial Activities	3.8%	5,627	4.2%	440	2.6%	959	3.0%
Professional & Business Services	8.9%	10,983	8.1%	865	5.0%	1,711	5.3%
Education & Health Services	15.2%	19,453	14.4%	2,501	14.5%	5,538	17.2%
Leisure & Hospitality	9.5%	11,582	8.6%	1,411	8.2%	3,092	9.6%
Other Services	3.8%	4,970	3.7%	771	4.5%	1,236	3.8%
Private Non-Classified	0.0%	34	0.0%	(c)	—	12	0.0%
Total All Government	20.8%	33,492	24.8%	5,021	29.2%	4,333	13.5%
Federal Government	1.1%	1,296	1.0%	72	0.4%	466	1.4%
State Government	9.0%	18,862	14.0%	1,484	8.6%	422	1.3%
Local Government	10.7%	13,334	9.9%	3,465	20.2%	3,445	10.7%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. The timber manufacturing industry is particularly vulnerable to droughts, landslides, and wildfires.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 3. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $39.2 billion in revenue for the region (88% of total).

Table 2-192. Revenue of Top Industries (in Thousands of Dollars) in Region 3, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 3	$44,717,701	44.3%	32.9%	10.5%
Benton	$2,885,212	37.2%	20.5%	17.5%
Lane	$18,119,991	40.5%	34.3%	10.7%
Linn	$5,593,199	37.8%	48.9%	5.7%
Marion	$13,087,937	57.1%	21.7%	11.1%
Polk	$1,192,318	37.4%	34.9%	10.7%
Yamhill	$3,839,044	35.1%	49.1%	8.9%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022 the largest job growth in Region 3 is expected to occur in the following sectors: (a) Education and Health Services (primarily health care); (b) Government; (c) Professional and Business Services; (d) Trade, Transportation, and Utilities (including retail trade); and (e) Leisure and Hospitality (Oregon Employment Department, 2012).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses units, 17.5% of all businesses in the region. The Other Services sector is the second most abundant. The Professional and Business Services sector, Education and Health Services sector, and Construction sector round out the top five sectors in the Mid/Southern Willamette Valley (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 66% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 3 is particularly vulnerable during a hazard event due to the following:

- The region is rebounding from the financial crisis that began in 2007. Linn and Polk have fewer key industries, and may therefore experience greater difficulty recovering after a disaster than counties with a more diverse economic base, such as Benton and Marion.
- Average salaries are 71% to 85% the state average. The exception is in Benton County where average salaries are just over the state average.

Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

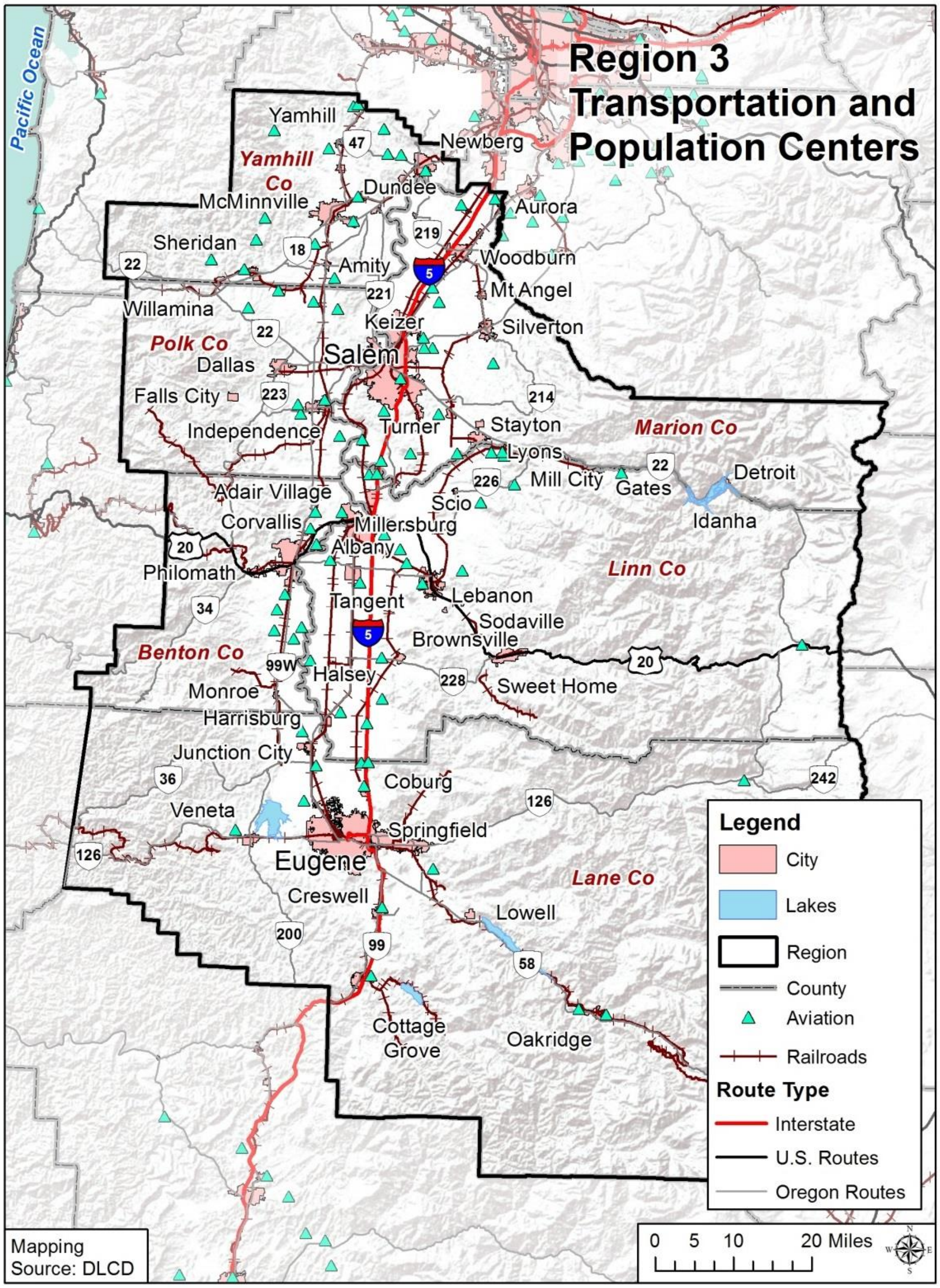
The highway system in the Region 3 centers on I-5 and the major east-west highways that intersect it. Recent population growth in the region has increased the number of vehicles on the roads. Many trips through the region originate outside the region in the Portland Metropolitan Area. Portland drivers commonly enter the region to reach Salem, The Spirit Mountain Casino, and coastal destinations. Many new residents of Yamhill County commute to Portland for work. **Figure 2-123** shows Region 3's highways and population centers.

Region 3's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 3, see **Seismic Lifelines**.

Figure 2-123. Region 3 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 3, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-193 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. These ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). 21% of state-owned bridges in the region have been identified as distressed or deficient. 44% of those bridges are located in Lane County.

Table 2-193. Bridge Inventory for Region 3

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	**ST**	**%D***	**De**	**ST**	**%D**	**De**	**ST**	**%D**	**De**	**ST**	**%D**	**D**	**T**	**%D**	**Covered**
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 3	118	610	19%	194	942	21%	44	208	21%	6	24	25%	362	1741	21%	71
Benton	11	44	27%	14	95	15%	3	28	11%	0	2	0%	28	166	17%	12
Lane	70	289	25%	44	408	11%	13	71	18%	3	12	25%	130	770	17%	32
Linn	13	142	10%	88	299	29%	7	39	18%	2	4	50%	110	474	23%	11
Marion	24	135	21%	48	140	34%	21	70	30%	1	6	17%	94	331	28%	8
Polk	14	51	28%	11	88	13%	4	13	31%	1	2	50%	30	153	20%	6
Yamhill	16	41	40%	33	89	37%	0	0	—	0	1	0%	49	130	38%	2

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads are major providers of regional and national cargo and trade flows. Railroads that run through the Mid/Southern Willamette region primarily run in a north-south direction. The Union Pacific Railroad (UP) is the major freight railroad. An Amtrak passenger train also runs on the UP line. It runs north to Spokane and south to Southern California where the tracks turn east and continue to Texas. Other freight railroads in the region include the Central Oregon and Pacific, the Albany and Eastern, the Portland and Western, the Hampton Railway, the Willamette and Pacific, and the Willamette Valley Railway.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in the Mid/Southern Willamette Valley. Disruptions to the rail system can result in economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Fifteen public airports, 73 private airports, two public helipads, and 16 private helipads serve Region 3. The Eugene Airport is the largest public airport in the region and the second busiest in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated, and administered by the City of Eugene. It serves 10 hubs and six air carriers with approximately 56 arriving and departing flights daily (Eugene, Oregon website, Visitors page, https://www.eugene-or.gov/index.aspx?NID=1715).

Table 2-194. Public and Private Airports in Region 3

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 3	15	73	2	16	106
Benton	1	9	0	1	11
Lane	7	9	1	5	22
Linn	3	20	0	2	25
Marion	2	13	1	6	22
Polk	1	7	0	0	8
Yamhill	1	15	0	2	18

Source: FAA Airport Master Record (Form 5010), 2014

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving primarily Linn, Polk, and Marion Counties. Portland General Electric is another investor-owned utility and serves Marion and Yamhill Counties. The Blachly-Lane Electric Cooperative, Lane County Electric Cooperative, and Western Oregon Electric Cooperative each serve a portion of Region 3. Four municipal utility districts serve the region: Eugene Water and Electric Board, Monmouth, McMinnville, and Springfield Utility Board. In addition, the Central Lincoln People's Utility District, Consumer's Power, Inc., Emerald People's Utility District, and Salem serve portions of the region.

The Mid/Southern Willamette Valley has a total of 16 power-generating facilities: 11 hydroelectric power facilities, one natural gas power facility, and four "other" facilities (primarily biomass and solar photovoltaic). In total, the power-generating facilities have the ability to produce up to 668 megawatts (MW) of electricity.

Table 2-195. Power Plants in Region 3

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 3	11	1	0	0	4	16
Benton	0	0	0	0	0	0
Lane	7	1	0	0	1	9
Linn	4	0	0	0	1	5
Marion	0	0	0	0	0	0
Polk	0	0	0	0	0	0
Yamhill	0	0	0	0	2	2
Energy Production (MW)	585	51	0	0	32	668

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The majority of electrical power in Region 3 is generated hydroelectrically. The Detroit, Carmen-Smith, and Lookout Point dams generate the most power for the region. They are each capable of generating over 100 MW. There are also several power plants that use biomass as their energy source (Loy, 2001). Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer-owned utilities. BPA's major dams in Region 3 are located on the following rivers: North Santiam River (Big Cliff and Detroit), South Santiam River (Foster and Green Peter), McKenzie River (Cougar), and Middle Fork of the Willamette River (Dexter, Lookout Point and Hills Creek).

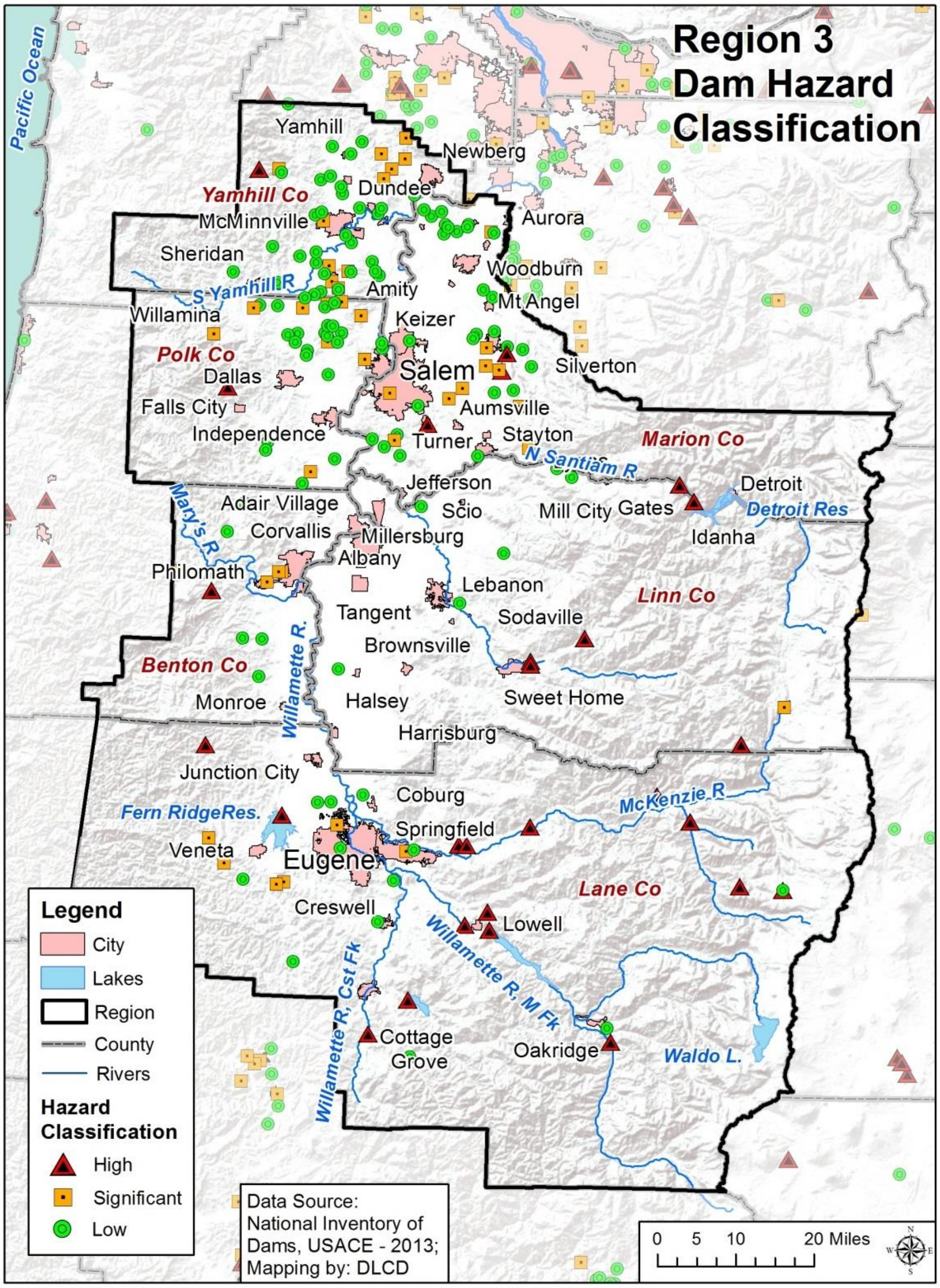
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. For example, major dam failures occurred near Hermiston in 2005 and in Klamath Lake in 2006 (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department uses the National Inventory of Dams (NID) threat potential methodology and maintains an inventory of all large dams in Oregon. **Table 2-196** lists the number of dams included in the inventory. The majority of dams in the region are located in Marion and Yamhill Counties. There are 26 High Threat Potential dams and 27 Significant Threat Potential dams in the region.

Table 2-196. Threat Potential of Dams in Region 3

	Threat Potential			Total Dams
	High	Significant	Low	
Region 3	26	27	312	365
Benton	1	2	19	22
Lane	12	6	37	55
Linn	7	1	19	27
Marion	2	11	79	92
Polk	2	7	70	79
Yamhill	2	0	88	90

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-124. Region 3 Dam Hazard Classification

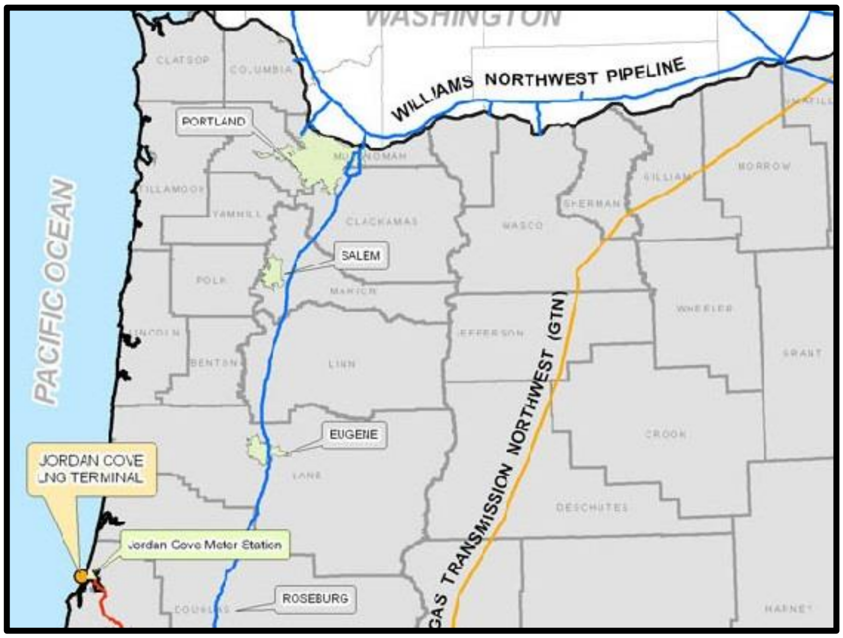


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to Pacific Power's portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-125** shows the Williams Northwest Pipeline, which runs through Marion, Linn, and Lane Counties (in blue) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-125. Liquefied Natural Gas Pipelines in Region 3



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

The Mid/Southern Willamette Valley is an important thoroughfare for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Canada. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

The electric, oil, and gas lines that run through the Mid/Southern Willamette region are both municipally and privately owned. A network of electrical transmission lines running through the region allows Oregon utility companies to exchange electricity with other states and Canada. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas owns one main natural gas transmission pipeline. An oil pipeline originating in the Puget Sound runs through the region and terminates in Eugene.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio) under the Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013). Marion, Yamhill, and Polk Counties are part of the Capitol Operational Area. Lane, Benton, Linn, and coastal Douglas Counties are part of the South Valley Operational Area. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary station identified as the emergency messengers by the Oregon State Emergency Alert System Plan in Region 3 is KWVT-TV Channel 17 in Salem.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 3. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors (I-5, OR-99, etc.). The majority of areas that lack access to broadband service are in Coast Range and the Cascades mountains (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 3 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Capitol Operational Area are:

- KOPB-FM, 91.5 MHZ, Salem; and
- WXL-96.475 MHZ, Salem.

Radio transmitters for the South Valley Operational Area are (Oregon Office of Emergency Management, 2013):

- KWAX-FM, 91.1 MHZ, Eugene; 91.6 MHZ, Florence; 101.9 MHZ, Cottage Grove;
- KKNU-FM, 93.3 MHZ Eugene; 100.9 MHZ, Florence; 101.9 MHZ, Cottage Grove; and

- KOAC-AM, 550 KHZ, Albany, 103.1 MHZ, Corvallis.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 3 is served by ARES District 4. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 3 include (American Relay Radio League Oregon Chapter, www.arrloregon.org) include:

- Benton County: W7DMR;
- Lane County: K7BHB, N7NFS;
- Linn County: W7ACW;
- Marion County: KE70LU, KD7MGF, KC7BRZ, WA7ABU, KE7EXX, W7SDP;
- Polk County: KG7G; and
- Yamhill County: W7IG.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 3 the majority of the municipal drinking water supply is obtained primarily from surface water sources. Surface water is drawn from rivers and smaller tributaries. These surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months

Rural residents draw water from surface water, groundwater wells, or springs. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources. In Polk County, saltwater naturally occurs in some aquifers, which presents a challenge during water shortages when aquifers are relied upon for backup water supply. In areas where no new live-flow water rights are available, farmers and ranchers are turning to above-ground storage to help supply water for crop irrigation during dry seasons.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and liquefaction from earthquakes can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 3, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 3. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. Most cities in Region 3 use the State of Oregon Residential Specialty Code, which does not address the issue of stormwater mitigation on new or existing construction. However, some cities, such as Eugene, require LID stormwater mitigation strategies in their building code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Roads, bridges, railroads, and airports are vulnerable to natural hazards. Failures of this infrastructure can be devastating to the economy and health of the region's residents. Bridges are particularly vulnerable to seismic events. Forty-four percent of all state-owned bridges in the region that have been identified as distressed or deficient are within Lane County. Railroads are sensitive to icing from winter storms. The second largest airport in the Oregon is in Region 3, along with several smaller airports and helipads.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. The majority of power in the region is generated hydroelectrically and there are 16 power-generating facilities in the Mid/Southern Willamette Valley. The majority of dams are in Marion and Yamhill Counties. The three major dams are Detroit, Carmen-Smith, and Lookout Point. Roughly 14% (53) of all dams in the region are either Significant or High Threat Potential. Liquid Natural Gas is transported through the region via the Williams Northwest Pipeline that runs through Marion, Linn, and Lane Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from major transportation corridors. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be centralized and lacking in system redundancies. Furthermore, because most drinking water is sourced from surface water, the region is at risk of high levels of pollutants entering waterways such as through combined sewers that overflow during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. The City of Eugene employs decentralized, low-impact development (LID) stormwater systems to better manage high-precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website, http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Regionally, between 2000 and 2010, urban areas in the Mid/Southern Willamette Valley have grown comparably to other urban areas statewide, with the greatest increases in population occurring in Linn, Polk, and Yamhill Counties. Benton is the only county in the region to experience a more even distribution of population growth in both urban and rural areas, roughly 9%. The most extreme shifts between urban and rural areas occurred in Yamhill County — 28% increase in urban populations and a 10.8% decrease in rural populations.

The percent growth of housing units in urban areas between 2000 and 2010 is almost 4 times that in rural areas. Linn, Polk, and Yamhill Counties have had the greatest increases in urban housing. Rural housing has increased by almost 16% in Benton County.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Eugene, Albany, Corvallis, and Salem and for the cities of Portland Metro area.

Table 2-197. Urban and Rural Populations in Region 3

	Urban			Rural		
	2000	**2010**	**% Change**	**2000**	**2010**	**% Change**
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 3	738,040	850,560	15.2%	198,347	193,337	-2.5%
Benton	63,378	69,521	9.7%	14,775	16,058	8.7%
Lane	260,514	290,084	11.4%	62,445	61,631	-1.3%
Linn	65,349	79,759	22.1%	37,720	36,913	-2.1%
Marion	241,260	274,046	13.6%	43,574	41,289	-5.2%
Polk	47,672	60,378	26.7%	14,708	15,025	2.2%
Yamhill	59,867	76,772	28.2%	25,125	22,421	-10.8%

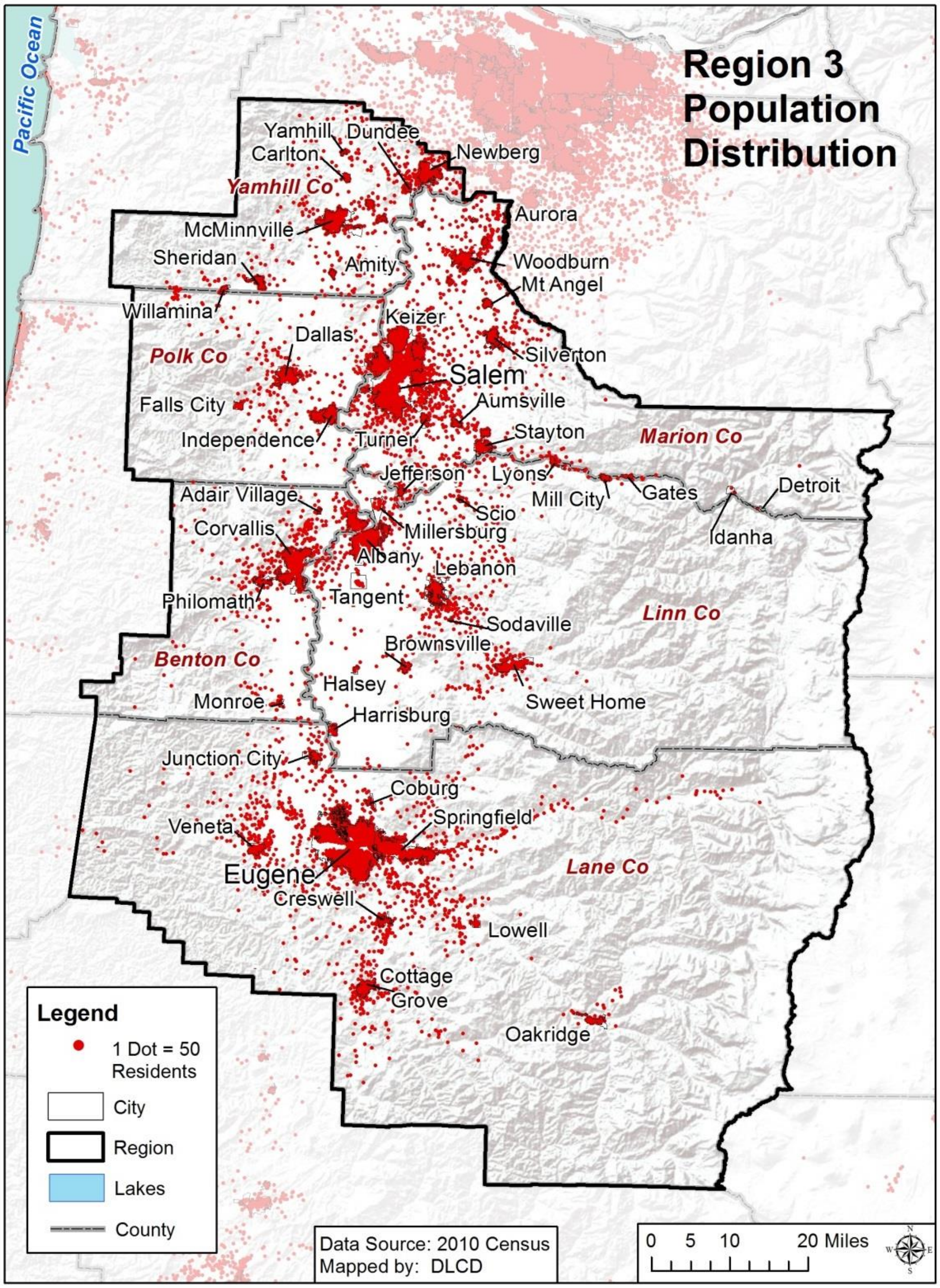
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-198. Urban and Rural Housing Units in Region 3

	Urban			Rural		
	2000	**2010**	**% Change**	**2000**	**2010**	**% Change**
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 3	298,306	348,148	16.7%	78,046	81,390	4.3%
Benton	26,115	29,459	12.8%	5,865	6,786	15.7%
Lane	112,750	128,267	13.8%	26,196	27,845	6.3%
Linn	27,712	33,467	20.8%	14,809	15,354	3.7%
Marion	91,846	104,590	13.9%	16,328	16,358	0.2%
Polk	18,851	24,204	28.4%	5,610	6,098	8.7%
Yamhill	21,032	28,161	33.9%	9,238	8,949	-3.1%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-126. Region 3 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns (Lettman, 2011)

Similar to Region 2, Region 3 overall has a larger percentage of private land (58%) than federal land (40%), with most of the federal holdings ranging up the slopes of the Cascades. However, the northern portion is dominated by agricultural activities, while the southern end has a much larger share of BLM and Forest Service timberland. As a result, Polk County, for example, is mostly privately owned, while just 42% of Lane County (minus the coastal portion) is in private hands.

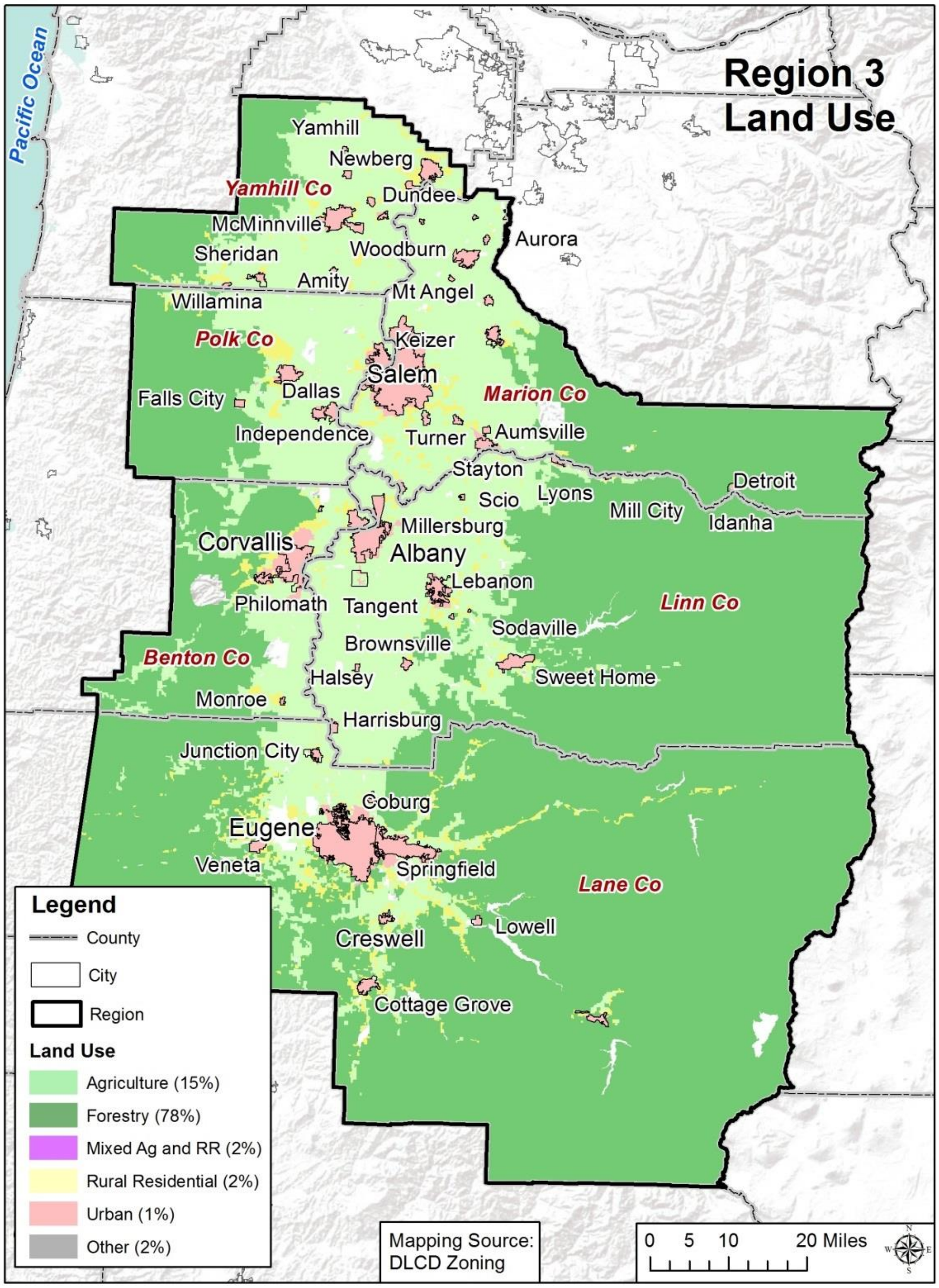
The South Willamette Region is a land of contrasts, with urban areas nestled within productive farmland, bordered by the Cascade and Coast Range timberlands. I-5 runs the length of the region, and this area's economy is shaped by the transportation system. With 61 incorporated communities in the region, there is continued pressure on area ecosystems from population growth, land use conversion, and altered habitat, fire regimes, and floodplain development.

Oregon Department of Forestry data shows that in the 25-year period between 1984 and 2009, approximately 147,000 acres of farm and range land in the state transitioned from land use classes more conducive to commercial farm or forest practices into more developed land classes. Almost half of all farm land conversion occurred in central Oregon, while nearly one quarter took place in the Metro area and one quarter in the general area of Region 3 (Lettman, 2011).

This region of the state is often subject to major flooding events, and communities have experienced major floods in 1861, 1890, 1945, 1956, 1964, 1996, and 2011. Generally, they have responded by keeping their flood ordinances current as well as going beyond minimum standards. For example, Corvallis, Albany, and Benton County integrate natural hazard information into their Comprehensive Plan, assuring that proper planning, such as determining if enough buildable land is available for future growth, and policies that regulate and prohibit development in natural hazard areas, will help minimize the extent of damage from future hazard events.

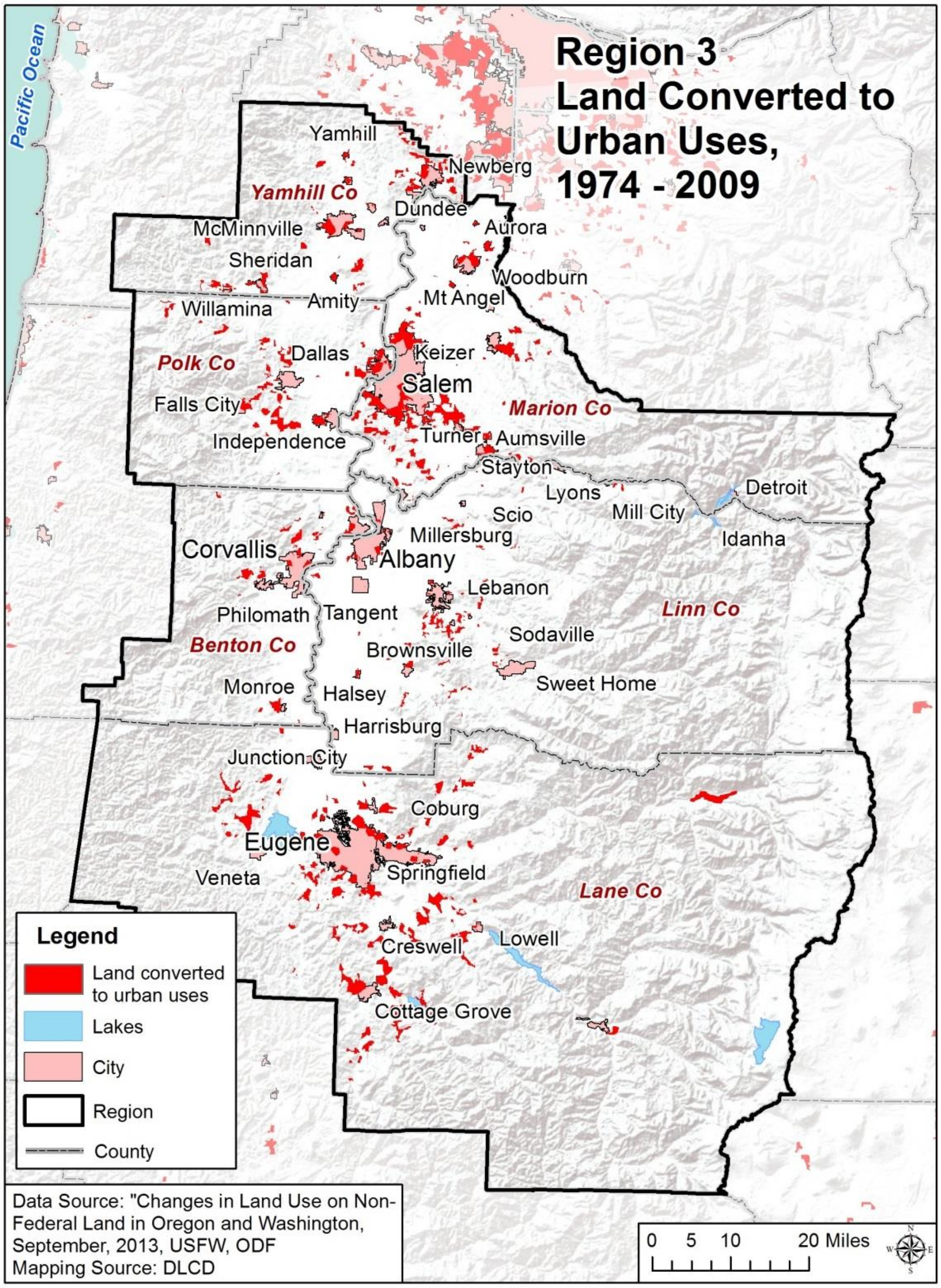
The Eugene-Springfield area is the second largest metropolitan area in Oregon, but expansion options are restricted by potential landslide and flood hazard areas. These communities are doing what they can to accommodate growth inside existing UGBs while minimizing encroachment into known hazard areas. One strategy they are using is to allow increased intensity of development outside of hazard areas, reducing the need to develop within them. For example, Eugene minimizes residential development on steep slopes by requiring larger lot sizes, and using floodplain areas as parks and open spaces. Overall, Eugene's average density has increased, and the mix of housing types is shifting toward more multi-family (DLCD, internal communication, 2014).

Figure 2-127. Region 3 Land Use



Source: DLCD, Statewide Zoning

Figure 2-128. Region 3 Land Use Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. Mobile residences make up 9.0% of Region 3's housing overall, but Linn and Yamhill Counties have a higher share of mobile homes. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-199. Housing Profile for Region 3, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 3	429,137	293,734	68.4%	95,559	22.3%	38,706	9.0%
Benton	36,301	22,684	62.5%	11,150	30.7%	2,425	6.7%
Lane	155,815	105,847	67.9%	35,331	22.7%	14,024	9.0%
Linn	48,718	34,022	69.8%	8,375	17.2%	6,170	12.7%
Marion	121,057	82,176	67.9%	28,506	23.5%	10,213	8.4%
Polk	30,190	21,922	72.6%	6,004	19.9%	2,198	7.3%
Yamhill	37,056	27,083	73.1%	6,193	16.7%	3,676	9.9%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (**Table 2-200**) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally 35.6% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Just under one third of the region's housing stock was built after 1990 and the codification of seismic building standards. Only 10% of homes in Polk and Yamhill Counties were built after 1990 and current seismic building standards.

Table 2-200. Age of Housing Stock in Region 3, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 3	429,137	152,697	35.6%	140,380	32.7%	136,060	31.7%
Benton	36,301	12,887	35.5%	11,830	32.6%	11,584	31.9%
Lane	155,815	60,365	38.7%	51,825	33.3%	43,625	28.0%
Linn	48,718	18,207	37.4%	15,542	31.9%	14,969	30.7%
Marion	121,057	40,769	33.7%	42,155	34.8%	38,133	31.5%
Polk	30,190	9,365	31.0%	8,401	27.8%	12,424	41.2%
Yamhill	37,056	11,104	30.0%	10,627	28.7%	15,325	41.4%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized.

Table 2-201 shows the initial and current FIRM effective dates for Region 3 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-201. Community Flood Map History in Region 3

	Initial FIRM	Current FIRM
Benton County	August 5, 1986	June 2, 2011
Albany	*see Linn County*	*see Linn County*
Corvallis	Jan. 3, 1985	June 2, 2011
Monroe	Sep. 26, 1975	June 2, 2011
Philomath	June 15, 1982	June 2, 2011
Lane County	Dec. 18, 1985	June 2, 1999
Coburg	Jan. 6, 1985	June 2, 1999 (M)
Cottage Grove	Nov. 15, 1985	June 2, 1999
Creswell	Sep. 18, 1985	June 2, 1999
Dunes City	Mar. 24, 1981	June 2, 1999 (M)
Eugene	Sep. 29, 1986	June 2, 1999
Florence	May 17, 1982	June 2, 1999
Junction City	June 15, 1982	June 2, 1999
Lowell	June 2, 1999	June 2, 1999 (M)
Oakridge	June 3, 1986	June 2, 1999
Springfield	Sep. 27, 1985	June 2, 1999
Veneta	Feb. 1, 1984	June 2, 1999
Westfir	Aug. 19, 1985	June 2, 1999
Linn County	Sep. 29, 1986	Sep. 29, 2010
Albany	April 3, 1985	Sep. 29, 2010
Brownsville	Aug. 17, 1981	Sep. 29, 2010
Halsey	Sep. 29, 2010	Sep. 29, 2010
Harrisburg	Feb. 3, 1982	Sep. 29, 2010
Idanha	Mar. 1, 1979	Sep. 29, 2010
Lebanon	July 2, 1981	Sep. 29, 2010
Lyons	Dec. 15, 1981	Sep. 29, 2010
Mill City	Mar. 1, 1979	Sep. 29, 2010
Millersburg	June 15, 1982	Sep. 29, 2010
Scio	Aug. 1, 1984	Sep. 29, 2010
Sweet Home	Mar. 1, 1982	Sep. 29, 2010
Tangent	May 17, 1982	Sep. 29, 2010
Waterloo	Sep. 29, 2010	Sep. 29, 2010

	Initial FIRM	Current FIRM
Marion County	Aug. 15, 1979	Jan. 2, 2003
Aumsville	Mar. 1, 1979	Jan. 19, 2000
Aurora	June 5, 1979	**Jan.** 19, 2000
Detroit	June 30, 1976	Jan. 19, 2000
Gates	Dec. 4, 1979	Jan. 19, 2000
Gervais	June 30, 1976	June 30, 1976
Hubbard	Feb. 5, 1986	Jan. 19, 2000
Jefferson	Mar. 1, 1979	Jan. 19, 2000
Keizer	May 1, 1985	Jan. 19, 2000
Mt. Angel	Jan.19, 2000	Jan. 19, 2000
Salem	June 15, 1979	Jan. 2, 2003
Scotts Mills	Mar. 1, 1979	Jan. 19, 2000
Silverton	Mar. 1, 1979	Jan. 19, 2000
St. Paul	Jan. 19, 2000	Jan. 19, 2000
Stayton	Mar. 1, 1979	Jan. 19, 2000
Turner	Apr. 2, 1979	Jan. 19, 2000
Woodburn	Mar. 1, 1979	Jan. 19, 2000
Polk County	Feb. 15, 1978	Dec. 19, 2006
Dallas	Apr. 5, 1988	Dec. 19, 2006
Falls City	July 7, 1981	Dec. 19, 2006
Independence	Apr. 5, 1988	Dec. 19, 2006
Monmouth	Apr. 5, 1988	Dec. 19, 2006
Salem	*see Marion County*	*see Marion County*
Yamhill County	Sep. 30, 1983	Mar. 2, 2010
Amity	Dec. 1, 1981	Mar. 2, 2010
Carlton	June 30, 1976	Mar. 2, 2010
Dayton	June 1, 1982	Mar. 2, 2010
Dundee	Mar. 1, 1982	Mar. 2, 2010
Lafayette	June 15, 1982	Mar. 2, 2010
McMinnville	Dec. 1, 1982	Mar. 2, 2010
Newberg	Mar. 1, 1982	Mar. 2, 2010
Sheridan	Aug. 1, 1990	Mar. 2, 2010
Willamina	Mar. 15, 1982	Mar. 2, 2010
Yamhill, City	Mar. 1, 1982	Mar. 2, 2010

(M) = no elevation determined; all Zone A, C, and X.
Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 3 can be found in **Table 2-202**. The region contains 58.3% of the total value of state-owned/leased critical/essential facilities. Many of the facilities are associated with the universities in Eugene and Corvallis and with state offices in Salem.

Table 2-202. Value of State-Owned/Leased Critical and Essential Facilities in Region 3

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 3	$4,277,900,069	58.3%
Benton	$1,093,373,557	14.9%
Lane	$283,280,825	3.9%
Linn	$75,555,783	1.0%
Marion	$2,771,586,104	37.8%
Polk	$37,996,619	0.5%
Yamhill	$16,107,182	0.2%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 3 is largely an urban county with urban development focused around the major cities along I-5. Urban areas in Linn, Polk, and Yamhill are growing at a higher rate than the state, while Benton County’s rural population is growing at a higher rate. The region has a slightly higher percentage of mobile homes than the state — the highest percentage being in Linn County 12.7%. Over one third of all homes in Polk and Yamhill Counties were built before 1970 and floodplain management standards. Furthermore, almost two thirds of the region’s homes were built before 1990 and seismic building standards. All of the region’s FIRMs have been modernized or updated.

2.3.3.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are not common in Region 3. In 1992, the Governor declared a drought for all 36 counties in Oregon. However, since 1992, no Governor-declared droughts have occurred in this region. Nonetheless, a dry winter or spring can have an effect on water supplies within the Mid/Southern Willamette Valley. In March 2014, the Natural Resources Conservation Service's (NRCS) data showed snowpack for the Willamette Basin at 47% of average, and noted that water users should expect below normal stream flows during the summer months. NRCS data shows snowpack peaked at 30–60% of typical peak levels and melted out up to four weeks early. Precipitation in May helped boost water conditions. By June, the major reservoirs in the basin were storing at their average volumes. Although conditions were dry for much of the summer in Region 3, there was no state drought declaration, unlike many parts of Oregon in 2014.

Historic Drought Events

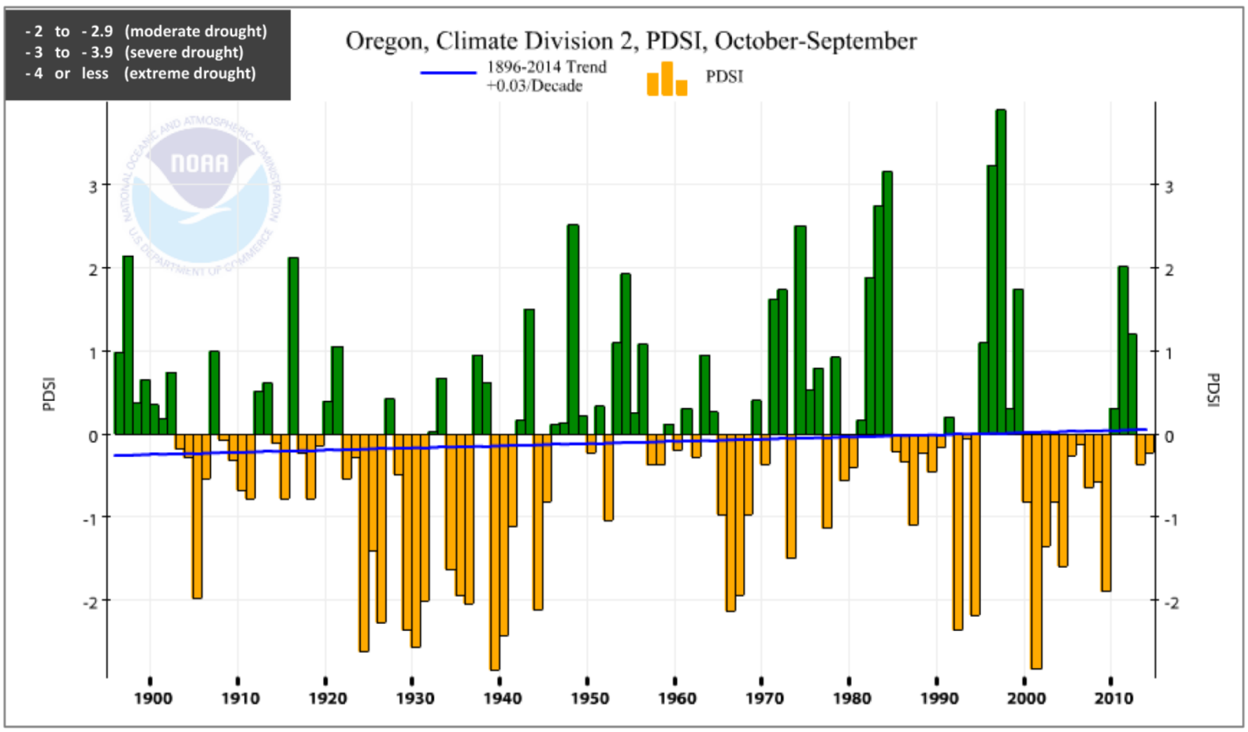
Table 2-203. Historic Droughts in Region 3

Date	Location	Description
1923-1924	statewide	prolonged statewide drought that caused major problems for agriculture
1928-1930	Regions 1–3, 5–7	moderate to severe drought affected much of the state; the worst years in Region 2 were 1928–1930, which initiated an era of many drier than normal years
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; Water Year 1939 was one of the more significant drought years in during that period
1991-1992	statewide, especially Regions 1–4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1
2000-2001	Regions 2–4, 6, 7	the driest water year on record in the Willamette Valley (NOAA Climate Division 2); warmer than normal temperatures combined with dry conditions

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. Figure 2-129 shows years where drought or dry conditions affected the Willamette Valley (Climate Division 2). Based on this index, Water Years 1939 and 2001 were the driest years with values of -2.84 and -2.83, respectively. These moderate-type drought years have occurred more than a dozen times during this record.

Figure 2-129. Palmer Drought Severity Index for Region 3



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Although not shown here, drought data from Climate Division 4, “the High Cascades,” could also be analyzed to show a broader picture of drought impacts in Hazard Regions 2 and 3.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience drought is shown in **Table 2-204**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-204. Local Probability Assessment of Drought in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	H	—	—	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

Based on limited data, there is a low probability of drought occurring in this region.

A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis could be completed statewide to analyze and compare the risk of drought across the state.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-205**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-205. Local Probability Assessment of Drought in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	—	—	—	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor-declared drought declarations since 1992, Region 3 could be considered less vulnerable to drought impacts than many other parts of the state.

Although long-term drought conditions are uncommon in the mid-Willamette Valley, a dry winter or spring could affect many communities and water users throughout the Basin. Recreation, particularly at the reservoirs owned and operated by the U.S. Army Corps of Engineers, contributes greatly to the valley's economy. Communities, such as Detroit in Marion County, can be economically impacted by low reservoir levels. The Willamette Valley is also home to one of the most productive and diverse agricultural regions in the United States.

Earthquakes

Characteristics

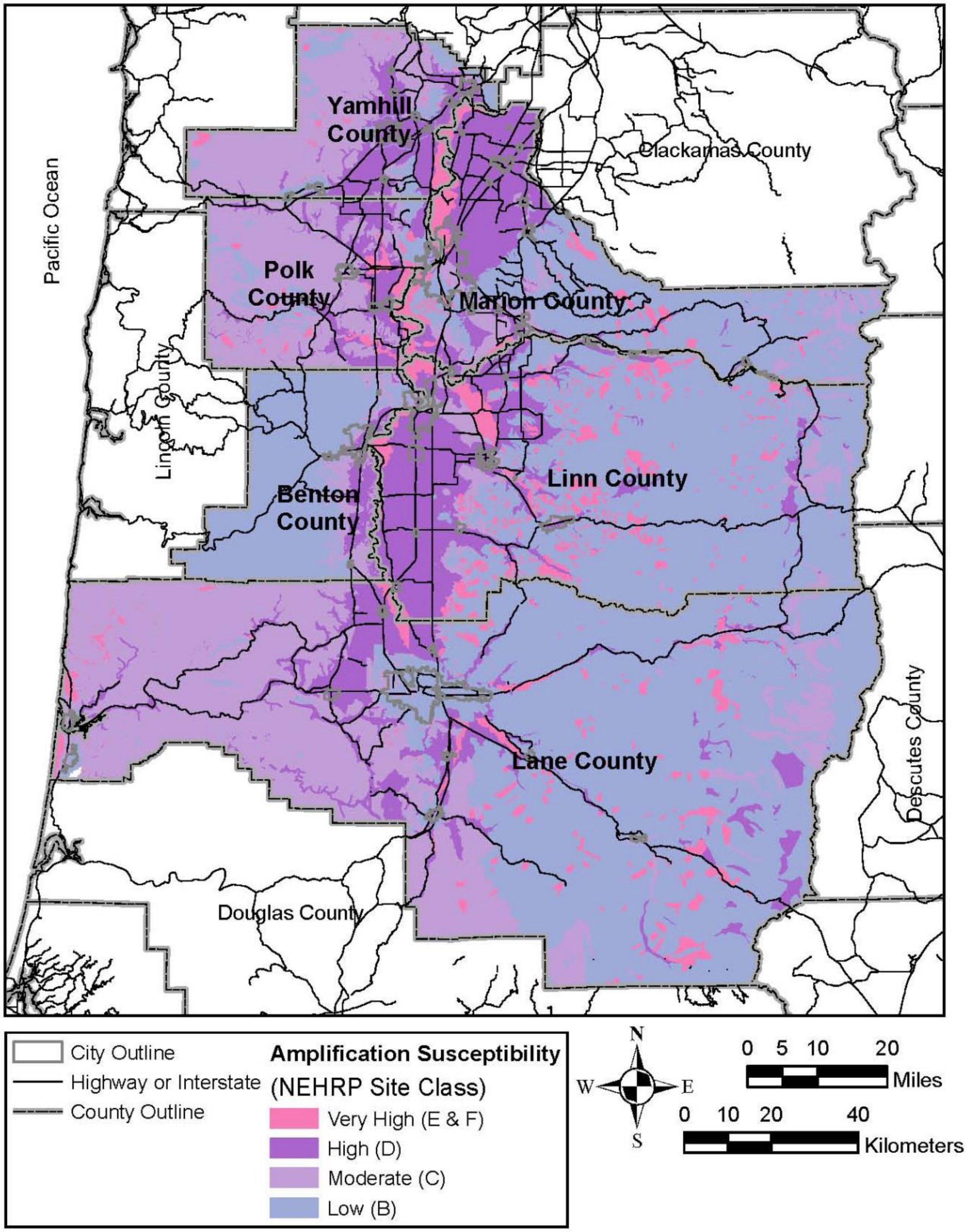
The geographic position of Region 3 makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

Region 3 has experienced a few historic earthquakes centered in the region. In addition, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. Deep-seated intra-plate events have been discovered by scientists in the region's historic and pre-historic record, as occurred near Olympia, Washington in 1949 and 2001, could generate magnitudes as large as M7.5.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 3, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Earthquake-associated hazards include severe ground shaking, liquefaction of fine-grained soils, and landsliding. The severity of these effects depend on several factors, including the distance from the earthquake source, the ability of soil and rock to conduct seismic energy, and the degree and composition of slope materials. As seismic waves travel through bedrock, some energy propagates through surface soils to the ground surface. Soil deposits can either deamplify or amplify the shaking based on the characteristics of the deposit. This phenomenon is generally referred to as ground shaking amplification (GSA). **Figure 2-130** displays the areas in Region 3 with greater and lesser ground shaking amplification hazard.

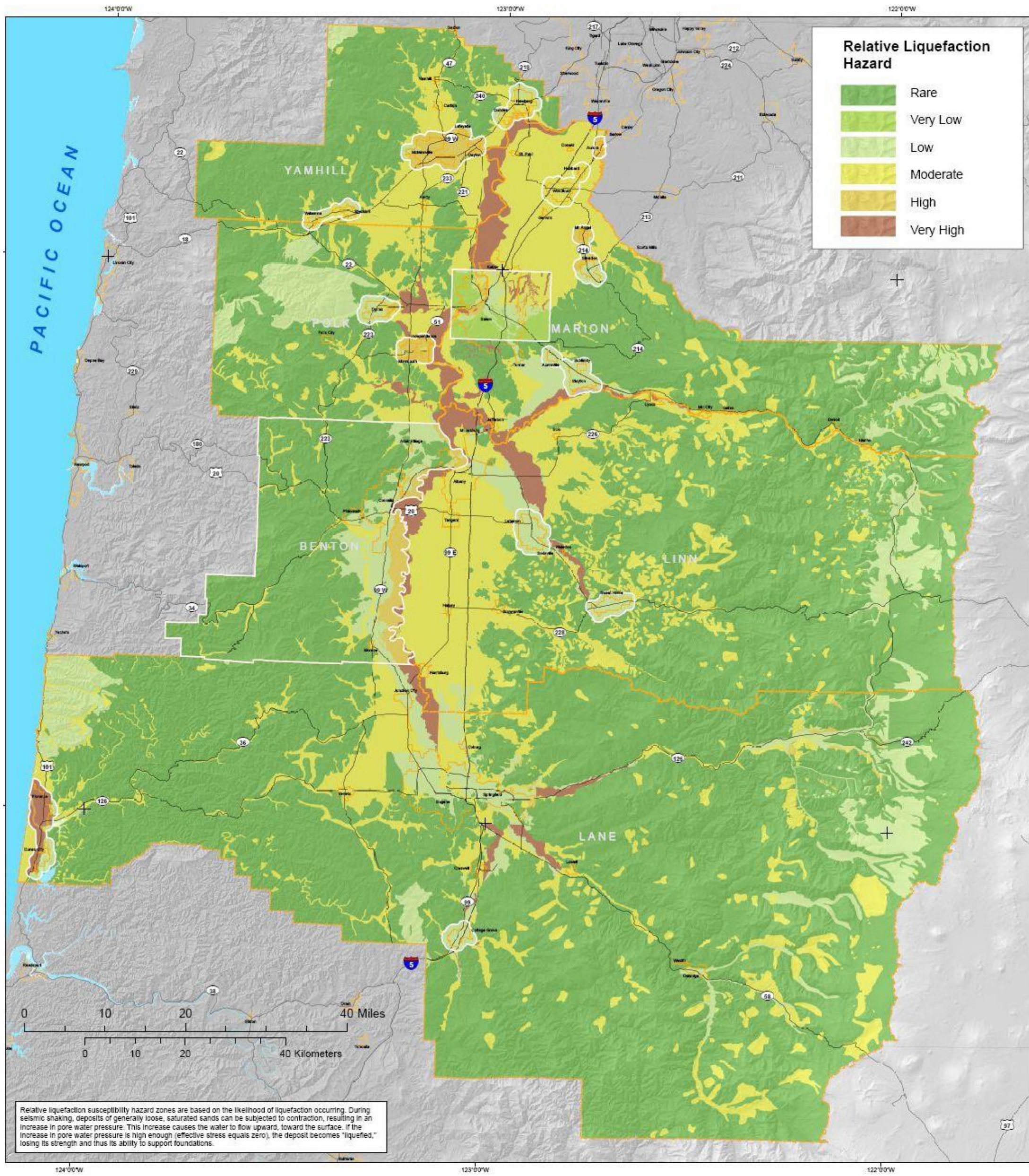
Figure 2-130. Amplification Susceptibility for Region 3



Source: Burns et al. (2008)

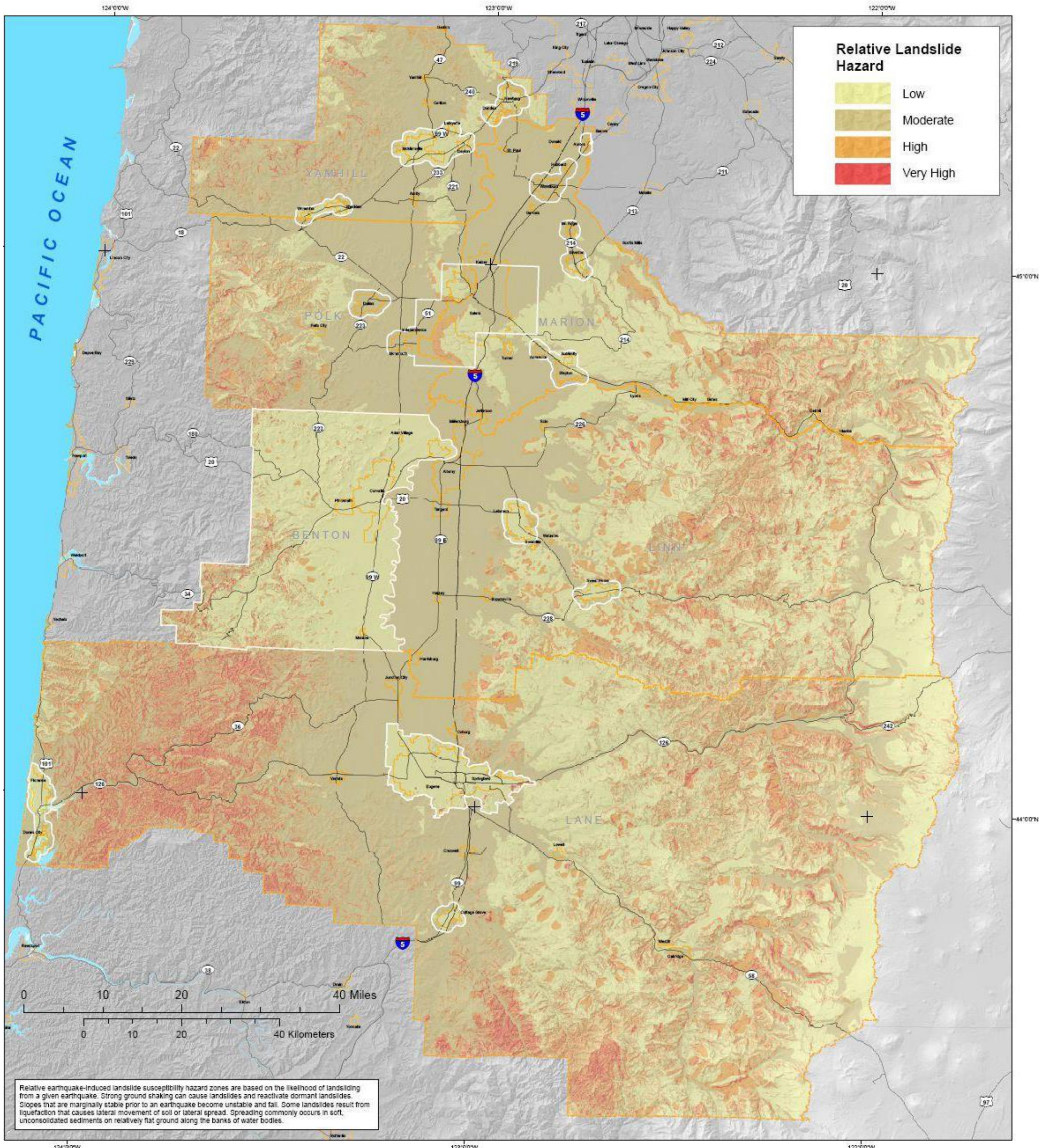
During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and thus its ability to hold and support loads. [Figure 2-131](#) displays the areas in the region with greater and lesser liquefaction hazard.

Figure 2-131. Relative Liquefaction Hazard for Region 3



Source: Burns et al. (2008)

Figure 2-132. Earthquake Induced Landslide Hazards for Region 3



Source: Burns et al. (2008)

Historic Earthquake Events

Table 2-206. Significant Earthquakes Affecting Region 3

Date	Location	Magnitude (M)	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Apr. 1896	McMinnville, Oregon	4	also felt in Portland
July 1930	Perrydale, Oregon	4	cracked plaster
Apr. 1949	Olympia, Washington	7.1	Intraplate event. Damage: significant (Washington); minor (NW Oregon)
Aug. 1961	Albany, Oregon	4.5	damage: minor (Albany)
Nov. 1962	Portland area, Oregon	5.5	shaking up to 30 seconds; chimneys cracked; windows broken; furniture moved
Mar. 1963	Salem, Oregon	4.6	damage: minor (Salem)
Mar. 1993	Scotts Mills, Oregon	5.6	FEMA-985-DR-Oregon; center: Mt. Angel-Gales Creek fault; damage: $30 million (including Oregon State Capitol in Salem)
Feb. 2001	Nisqually, Washington	6.8	felt in the region; damage: none reported

*BCE: Before Common Era.

Sources: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience earthquakes is shown in **Table 2-207**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-207. Local Probability Assessment of Earthquakes in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	L	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

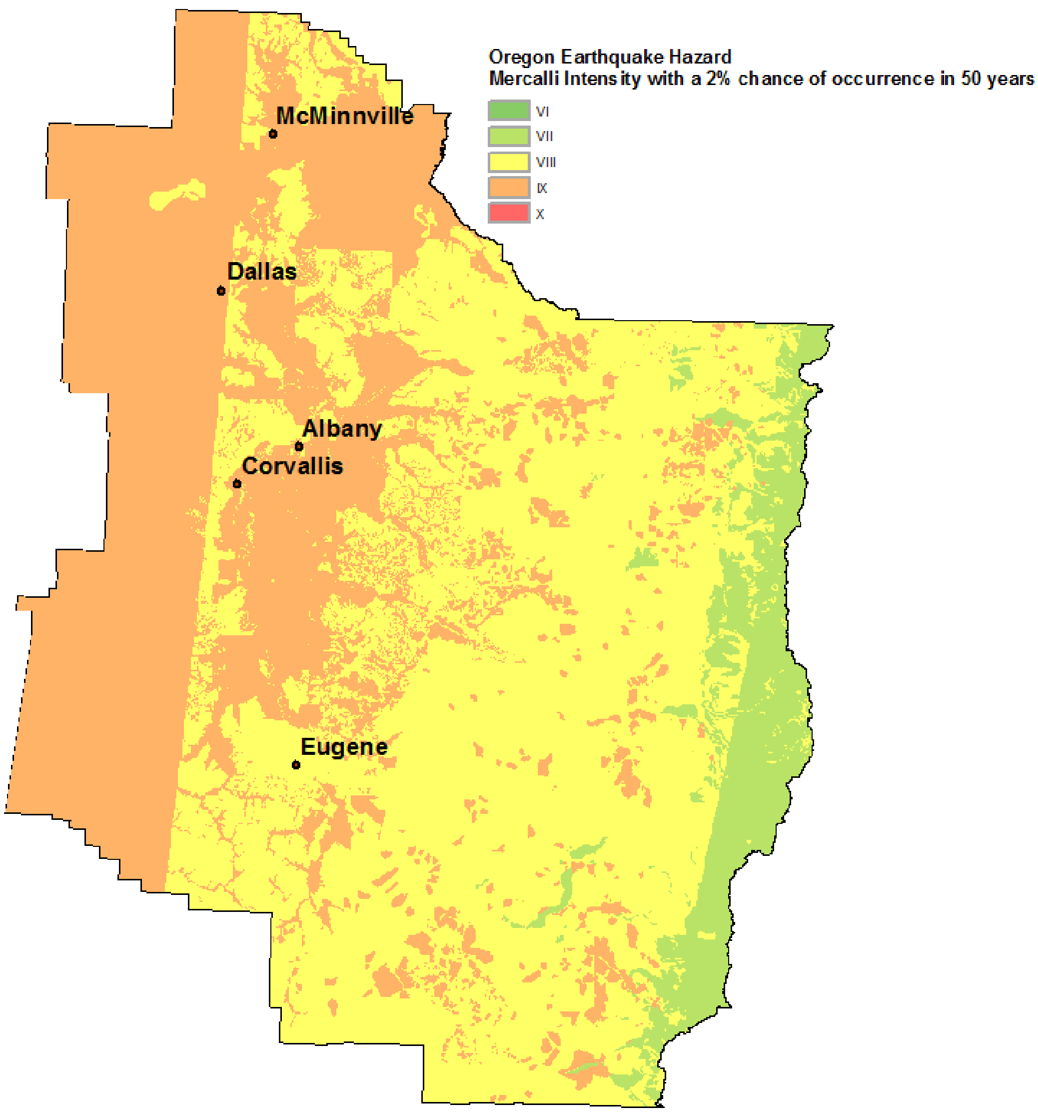
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 3 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 3 is depicted in **Figure 2-133**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-133**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-133. Probabilistic Earthquake Hazard in Region 3



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in Table 2-208. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-208. Local Vulnerability Assessment of Earthquakes in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	H	M	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 3 is especially vulnerable to earthquake hazards because much of the area is susceptible to earthquake-induced landslides, liquefaction, and strong ground shaking.

Of the 15 counties in the state with the highest expected damages and losses based on the 500 year model, the following counties are located in Region 3:

- Lane,
- Marion,
- Benton,
- Linn, and
- Yamhill.

DOGAMI also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

Table 2-209, Table 2-210, Table 2-211, and Table 2-212 show estimated losses in each county, including building collapse potential and damages based on three model scenarios.

Table 2-209. Building Collapse Potential in Region 3

County	Level of Collapse Potential: Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Benton	13	5	22	3
Lane*	126	69	68	8
Linn	74	15	30	23
Marion	94	34	88	30
Polk	13	11	17	4
Yamhill	30	20	22	5

*Does not include the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome, which are addressed in the Region 1 Profile.

Source: Lewis (2007)

Table 2-210. Estimated Losses in Region 3 from a M9 CSZ and Local Crustal Event

County	Building Value (Billions)	Total Building Related Losses from an M9.0 CSZ Event (Billions)	Total Building Related Losses from a Crustal Earthquake (Billions)
Benton	$4.85	$1.1	$0.8
Lane	$21.055	$5.0	$3.4
Linn	$5.669	$1.2	$1.3
Marion	$15.86	$2.6	$3.9
Polk	$3.467	$0.6	$0.4
Yamhill	$4.597	$1.2	$1.5

Source: Burns et al. (2008)

Table 2-211. Estimated Losses in Region 3 Associated with an M8.5-9.0 Subduction Event

Category	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	1,356	3,945	1,049	2,492	678	1190
Deaths (5 pm time period)	96	264	67	157	43	74
Displaced Households	2,375	7,633	2,563	5,787	1,822	3,082
Economic losses for buildings	$1,049.51 m	$4,652 m	$1,150.68 m	$2,604.95m	$624.43 m	$1198.48 m
Operational after Day 1						
Fire station	100%	100%	100%	100%	100%	100%
Police Station	100%	100%	100%	100%	100%	100%
Schools	91%	100%	100%	99%	100%	98%
Bridges	91%	84%	100%	89%	82%	85%
Economic loss to infrastructure						
Highways	$ 33.5 m	$211 m	$4.4 m	$127.7 m	$59.4 m	$60.2 m
Airports	$0 m	$13.3 m	$23.10 m	$13 m	$14 m	$21.4 m
Communications	$0 m	$0.33 m	$0.07 m	$0.03 m	$0.05 m	$0.03 m
Debris generated (thousands of tons)	0	2,000	0	1,000	0	0

Source: Burns et al. (2008)

Table 2-212. Estimated Losses in Region 3 Associated with an Arbitrary M6.5-6.9 Crustal Event

Mitigation Factors	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	557	1,821	993	3,249	321	1,178
Deaths (5 pm time period)	33	96	59	189	18	67
Displaced households	1,755	7,716	3,683	10,701	1,412	4,256
Economic losses from buildings	$762.25 m	$3,351.03 m	$1,315.72 m	$3979.57 m	$409.43 m	$1,525.35 m
Operational the day after the event:						
Fire station	75%	100%	77%	61%	100%	50%
Police Station	75%	91%	40%	65%	100%	64%
Schools	91%	99%	70%	74%	100%	68%
Bridges	100%	97%	91%	86%	93%	89%
Economic losses to infrastructure:						
Highways	$18.7 m	$106 m	$129.70 m	$271.5 m	$35.7 m	$71.3 m
Airports	$19.3 m	$16 m	$38.3 m	$38 m	$11 m	$43.9 m
Communications	$ 0.24 m	$0.63 m	$0.11 m	$0.18 m	$0.05 m	$0.10 m
Debris generated (in thousands of tons)	0	1,000	0	1,000	0	0

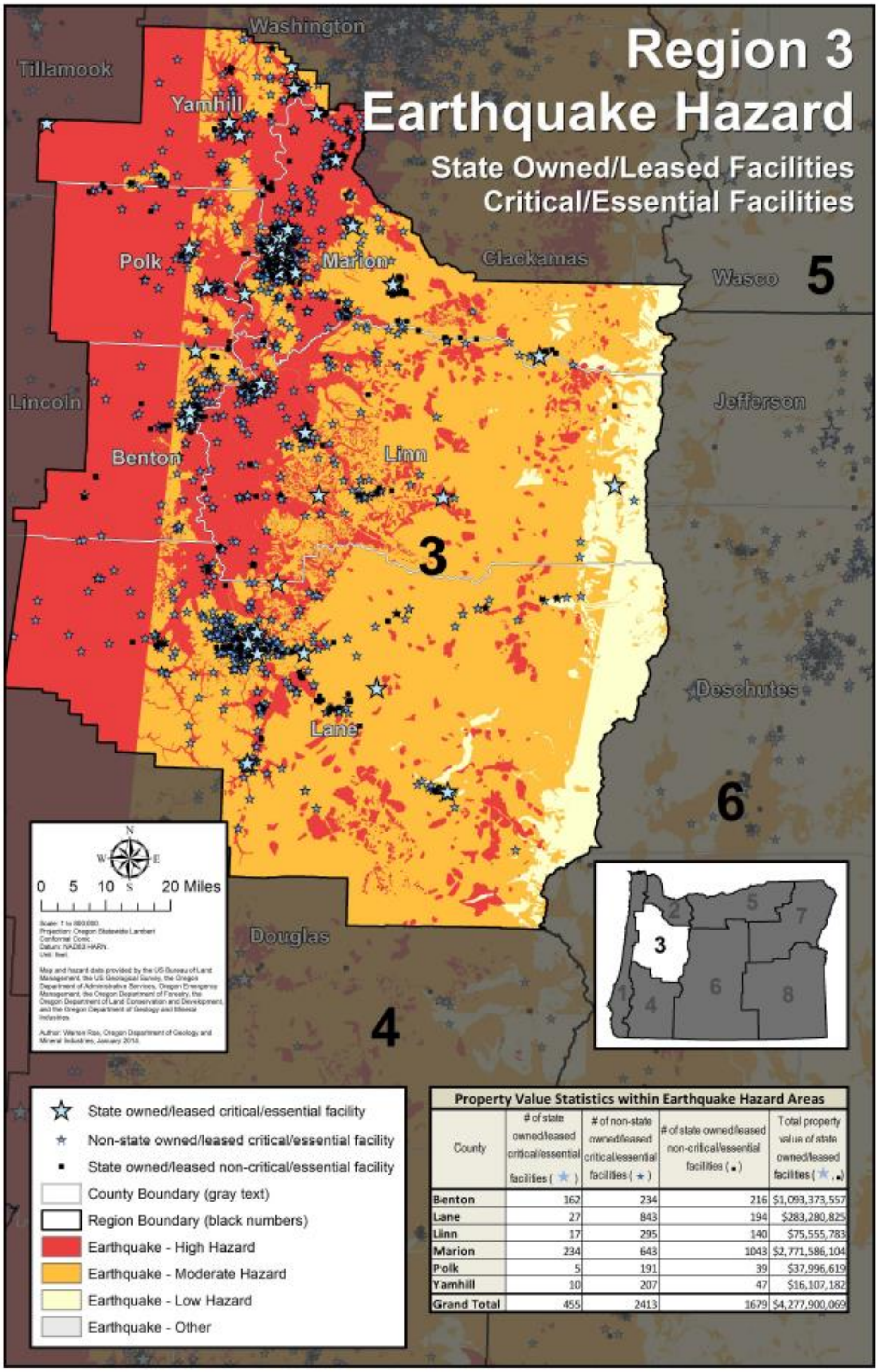
Source: Burns et al. (2008)

State-Owned/Leased Facilities and Critical/Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 2,134 totaling roughly $4.3 billion worth of property are located in an earthquake hazard zone in Region 3 (**Figure 2-134**). Among the 1,141 state critical/essential facilities, 455 are in an earthquake hazard zone in Region 2. Additionally, 2,413 non-state critical/essential facilities in Region 2 are located in an earthquake hazard zone.

Figure 2-134. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 3



County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Benton	162	234	216	$1,093,373,557
Lane	27	843	194	$283,280,825
Linn	17	295	140	$75,555,783
Marion	234	643	1043	$2,771,586,104
Polk	5	191	39	$37,996,619
Yamhill	10	207	47	$16,107,182
Grand Total	455	2413	1679	$4,277,900,069

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 3 have the following vulnerabilities.

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 3 include sections of the Valley and Cascades Geographic Zones.

VALLEY GEOGRAPHIC ZONE (OLSR). The Valley Geographic Zone generally consists of two or three north-south routes through the Willamette Valley and a variety of east-west connectors between those routes. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. Seismic lifeline routes that provide redundant north-south movement were designated.

The Tier 1 system in the Valley Geographic Zone consists of the following corridors:

- I-5,
- OR-99W from I-5 to OR-18 near Dayton,
- OR-18 from OR-99W near Dayton to McMinnville, and
- OR-22 from I-5 to OR-99E in Salem.

The Tier 2 system in the Valley Geographic Zone consists of the following corridors:

- US-26 from OR-47 to OR-217,
- OR-99W from McMinnville to Junction City,
- OR-99 from Junction City to I-5 in Eugene,
- OR-99E from Oregon City to I-5 in Salem, and
- OR-214 in Woodburn from I-5 to OR-99E.

The Tier 3 system in the Valley Geographic Zone consists of the following corridors:

- OR-219 from Newberg to Woodburn,
- OR-99E in Salem from I-5 to OR-22,
- OR-22 from OR-99W to Salem, and
- OR-34 from Corvallis to I-5.

Region 3 includes the central area of the Cascades Geographic Zone. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The Tier 1 system in this region consists of OR-58. The Tier 2 system in the Cascades Geographic Zone in Region 3 consists of OR-22 from Salem to Santiam Junction and US-20 from Santiam Junction to Bend. There are no corridors designated as Tier 3 in the Region 3 Cascades Geographic Zone.

Regional Impact.

- Ground shaking: In Region 3, ground shaking will be of a magnitude and duration to cause property damage, possibly severe. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents, and there will be damaged areas on lifelines that will be impassable without at least temporary repairs.
- Landslides and rockfall: Many rural and some developed area roadways in Region 3 are cut into or along landslide-prone features. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Liquefaction: Structures in wetland, alluvial and other saturated areas may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Benton, Lane, Linn, Marion, Polk, and Yamhill Counties are generally equally vulnerable to ground shaking from a CSZ event. Each county has some steep roads in rural and developed areas that may experience landslides. All three have some transportation facilities along river beds or crossing rivers that may be vulnerable to liquefaction.

Floods

Characteristics

Region 3 has a lengthy flood history. Notable floods affecting Region 3 are shown in **Table 2-213**. **Table 2-214** describes flood sources for each of the counties in the region. Additionally, sheet flooding occurs on agricultural land. Because this occurs far from a source river or stream, however, such flood areas are not depicted on federal Flood Insurance Rate Maps.

Most of the serious flooding experienced in Region 3 occurs in December and January. These events are usually associated with La Niña conditions, which result in prolonged rain and rapid snowmelt on saturated or frozen ground. This sudden influx of water causes rivers to swell, forcing tributary streams to back up and flood communities.

Region 3 is protected by several flood control dams.

A very large 1964 flood was a result of unusually intense precipitation on frozen topsoil, augmented by snowmelt in the mountains and valley. Without upstream regulation, the 1964 flood would have been the largest flood of the 20th century, with a peak discharge of 320,000 cubic feet per second (cfs) at the Albany gage. However, upstream regulation reduced the peak discharge to 186,000 cfs.

The unincorporated areas of Region 3 are nearly all agricultural lands or timberlands. Flood damage in those areas would be limited to farm crops, farm buildings and residences, and erosion of croplands.

Historic Flood Events

Table 2-213. Significant Historic Floods Affecting Region 3

Date	Location	Characteristics	Type of Flood
Dec. 1861	Willamette Basin and coastal rivers	preceded by two weeks of heavy rain; every town on the Willamette was flooded or washed away; 635,000 cfs at Portland	rain on snow; snow melt
Feb. 1890	Willamette Basin and coastal rivers	second largest known flood in the Willamette Basin; almost every large bridge washed downstream	rain on snow
Dec. 1937	western Oregon	flooding followed heavy rains; considerable highway flooding; landslides	rain on snow
Jan. 1953	western Oregon	widespread flooding in western Oregon accompanied by windstorm	rain on snow
Dec. 1964-Jan. 1965	Willamette Basin	record flooding throughout Willamette Basin; two intense storms; near-record early season snow depths; largest flood in Oregon since dam construction on upper Willamette (1940s–50s; $34 million in damages	rain on snow
Jan. 1974	western Oregon	flooding followed heavy wet snow and freezing rain; nine counties received Disaster Declaration	rain on snow
Dec. 1978	western Oregon	intense heavy rain, snowmelt, saturated ground; one fatality in Region 3 (Benton County)	rain on snow
Feb. 1986	entire state	severe statewide flooding; rain and melting snow; numerous homes flooded and highways closed	snow melt
Feb. 1987	western Oregon	Willamette River and tributaries; mudslides; damaged highways and homes	rain on snow
Feb. 1996	entire state	deep snow pack, warm temperatures, record-breaking rains; flooding, landslides, power-outages (FEMA-1099-DR-Oregon)	rain on snow
Nov. 1996	entire state	record-breaking precipitation; local flooding/landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 2005	Polk, Marion, Linn, Lane and Benton Counties	heavy rains causing rivers to crest above flood stage in Polk, Marion, Linn, Lane, and Benton Counties, as well as other counties in the Willamette Valley	riverine
Jan. 2006	Willamette Valley	heavy rains caused many rivers to crest above flood stage in the Willamette Valley, causing road closures and damage to agricultural lands	riverine
Dec. 2007	Yamhill	South Yamhill River flooded near McMinnville, causing damage to roads and bridges, 120 homes in Sheridan along with a few businesses and churches, and causing minor damage in Willamina; total county-wide damage estimates at $9.6 million	riverine
Dec. 2007	Polk	major flooding in Suver and other areas in Polk County; total losses equal $1 million for entire county	riverine
Jan. 2012	Polk, Marion, Yamhill, Lincoln, Benton, Linn and Lane Counties	heavy rain and wind; ice (DR-4055); flooding in the Willamette Valley; 130 homes and seven businesses were damaged in the City of Turner; 29 streets were closed in the City of Salem; the state motor pool lost 150 vehicles and thousands of gallons of fuel; Thomas Creek in the City of Scio overtopped, damaging several buildings	

Sources: Taylor and Hatton (1999); National Climatic Data Center Storm Events, located at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Table 2-214. Principal Riverine Flood Sources by County in Region 3

Benton	Lane	Linn	Marion	Polk	Yamhill
Willamette River, N. Fork Alsea, and tributaries, especially: Marys River Newton Creek Mill Race Frazier Creek Soap Creek Oak Creek Jackson Creek	Willamette River and tributaries, especially: Amazon Creek Berkshire Slough Blue River Cedar Creek Coast Fork Dedrick Slough Fall Creek Long Tom River McKenzie River Mohawk River Oxley Slough Row River Salmon Creek Silk Creek	Willamette River and tributaries, especially: Calapooia River Santiam (N and S) Thomas Creek Ames Creek Oak Creek Peters Ditch Truax Creek	Willamette River and tributaries, especially: Santiam River Pudding River Battle Creek Butte Creek Beaver Creek Claggett Creek Croisan Creek Gibson Creek Lake Labish Creek Mill Creek Pringle Creek Senecal Creek Silver Creek Shelton Ditch	Willamette River and tributaries, especially: S. Yamhill River Ash Creek (all forks) Agency Creek Ellendale Creek Gibson Creek Rickreall Creek Rock Creek Rowell Creek	Willamette River and tributaries, especially: Yamhill River Yamhill Creek Baker Creek Chehalem Creek Cozine Creek Hess Creek Palmer Creek

Sources: FEMA, Benton County Flood Insurance Study (FIS), Aug. 15, 1996; FEMA, Lane County FIS, June 2, 1999; FEMA, Linn County FIS, Sept. 29, 1986; FEMA, Marion County FIS, July 13, 2001; FEMA, Polk County FIS, Dec. 19, 1995; FEMA, Yamhill County FIS, Sept. 30, 1983

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 3 will experience flooding is shown in **Table 2-215**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-215. Local Probability Assessment of Flood in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 2 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are based on old modeling and could be outdated. The FIRM maps were issued at the following times:

- Benton, June 6, 2011;
- Lane, June 2, 1999;
- Linn, September 29, 2010;
- Marion, January 19, 2000;
- Polk, December 19, 2006; and
- Yamhill, March 2, 2010.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to flooding is shown in **Table 2-216**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-216. Local Vulnerability Assessment of Flood in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to Table 2-217.

Table 2-217. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

All of the Counties in Region 3 received the same flood vulnerability score of 5, with the exception of Lane County which received a score of 6. Lane County's higher score is because a portion of Lane County is in Region 1, which is the region most vulnerable to flood. Many of the losses that caused Lane County's higher score are in Region 1. A score of 5 indicates that overall the counties in this region are moderately vulnerable to damaging floods. Nevertheless, the State is aware of several particularly vulnerable areas within these counties, including the cities of Sheridan and Scio, and parts of Salem and Eugene-Springfield (the most populous cities in Region 3).

FEMA has identified 46 Repetitive Loss properties in Region 3, four of which are Severe Repetitive Loss properties. This region has the third most repetitive flood losses of the Oregon NHMP Natural Hazard Regions, reflecting its downstream location in or near the Willamette Valley, often flat topography, and population density.

Table 2-218. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 3

County	RL	SRL	Number of CRS Communities per County
Benton	6		1
*Lane	14	1	2
** Linn	8	1	1
Marion	12	2	3
Polk	2		1
Yamhill	4		1
Totals	**46**	**4**	**9**

*Includes non-coastal sections of Lane County.

**Albany is a CRS community located in both Benton and Linn Counties. For the purposes of this table, Albany is counted as being in Linn County.

Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

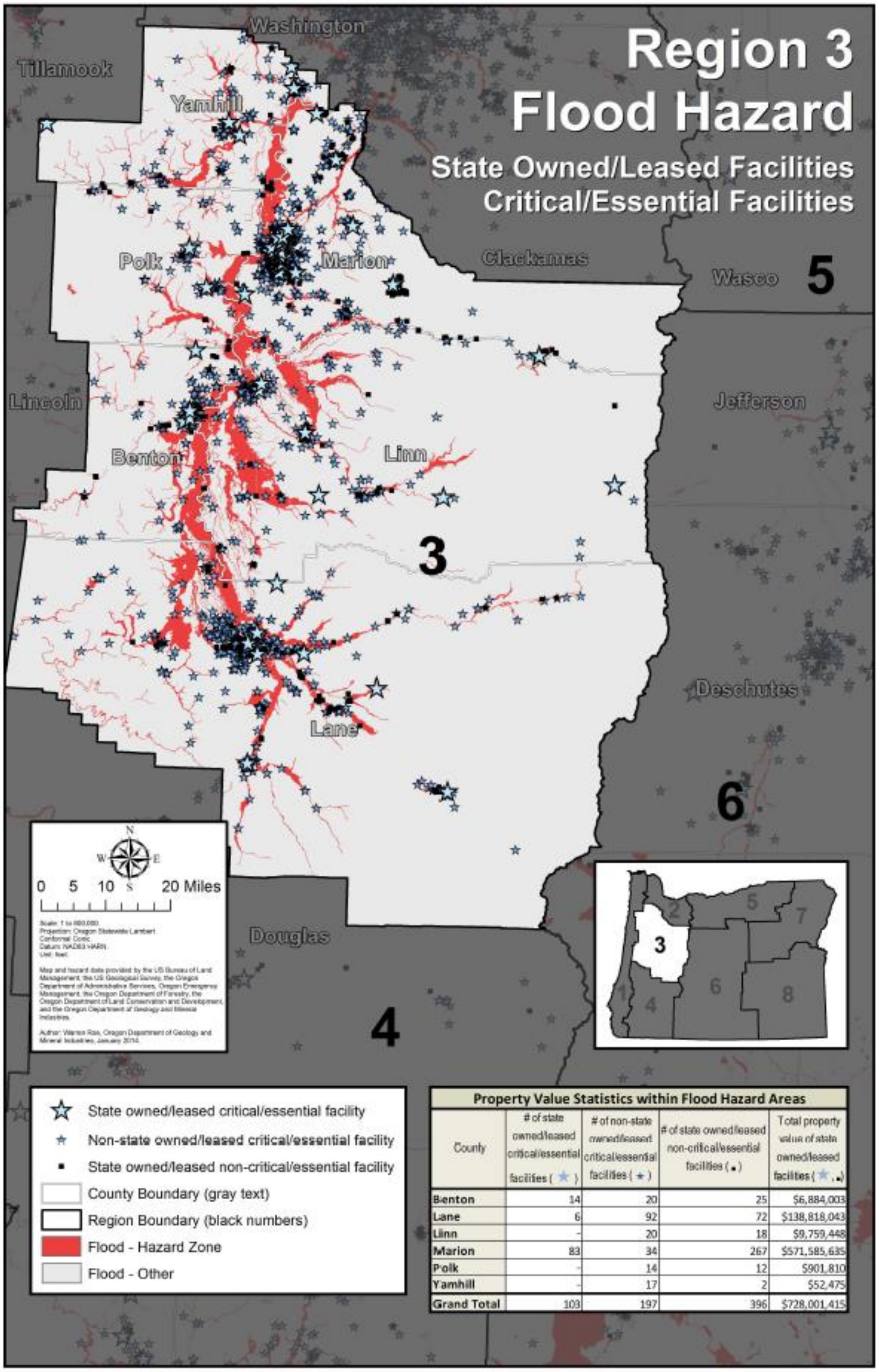
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Benton, Lane, Marion, and Polk Counties participate in CRS, as do the cities of Albany, Corvallis, Eugene, Salem, and Sheridan.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 28 are currently located within a flood hazard zone in Region 3 and have an estimated total value of $13 million (**Figure 2-135**). Of these, one is identified as a critical or essential facility. An additional 90 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 3.

Figure 2-135. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 3



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Benton	14	20	25	$6,884,003
Lane	6	92	72	$138,818,043
Linn	-	20	18	$9,759,448
Marion	83	34	267	$571,585,635
Polk	-	14	12	$901,810
Yamhill	-	17	2	$52,475
Grand Total	103	197	396	$728,001,415

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Coast Range and Cascade Mountains have a very high incidence of landslides. For example, the Vineyard Mountain area near Corvallis, which is in the Coast Range foothills, experienced at least half a dozen landslides during the January 2009 storm. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Historic Landslide Events

Table 2-219. Historic Landslides in Region 3

Date	Location	Incident
Aug. 1957	near Westfir, Oregon	rock slide; fatalities: two workers
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides/debris flows across the state; many on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); fatalities: eight; injuries: several (Douglas County)

Sources: Taylor and Hatton (1999); Oregon Department of Transportation Emergency Operations Plan, October 7, 2002

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience landslides is shown in **Table 2-220**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-220. Local Probability Assessment of Landslides in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	M	—	—	—	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-221**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-221. Local Vulnerability Assessment of Landslides in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	L	—	—	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

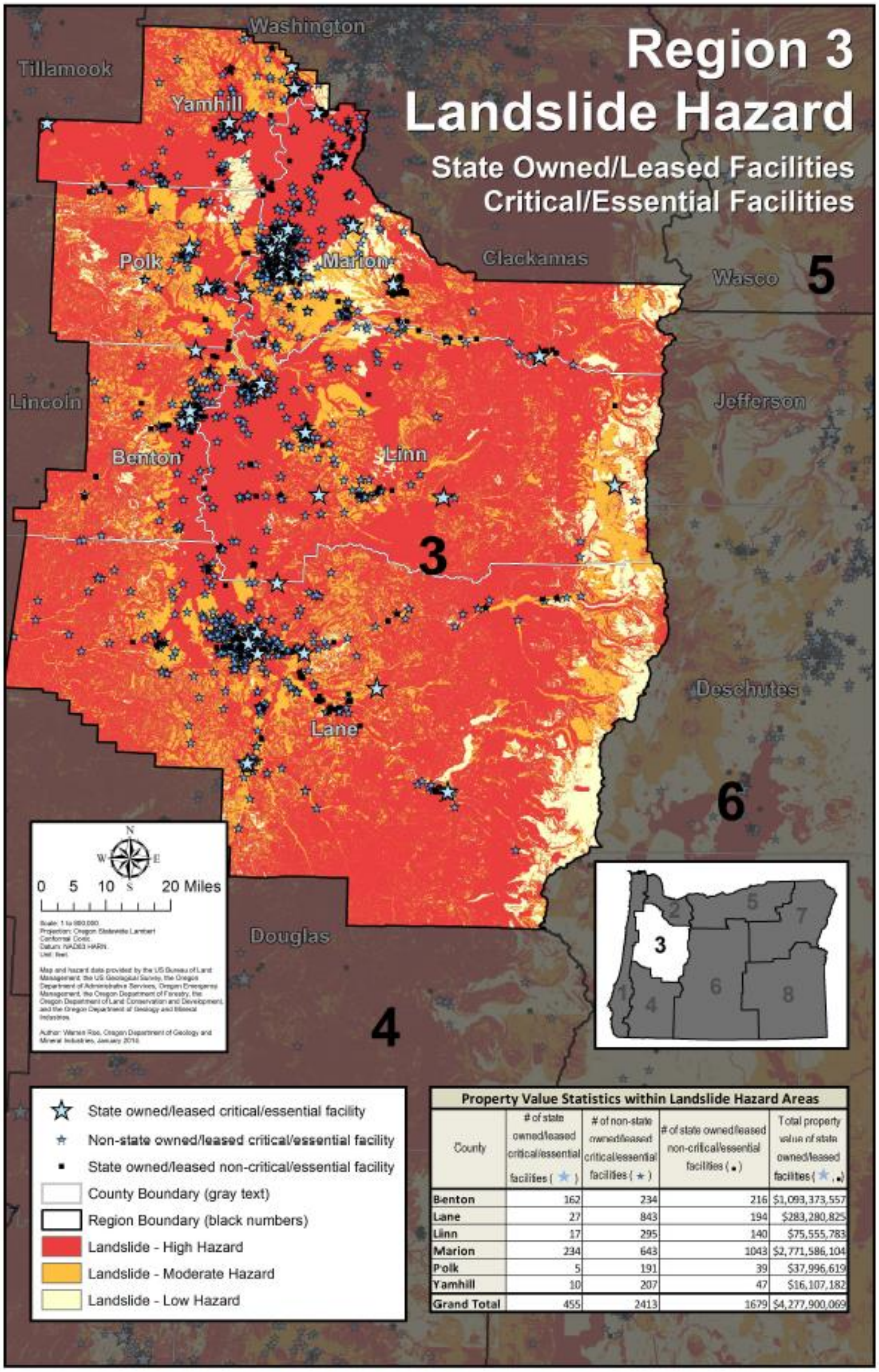
Many of the communities in this region are vulnerable to landslides; for example, the cities of Salem, Corvallis, and Eugene all have moderate exposure to landslides. As previously mentioned, the Vineyard Mountain area near Corvallis had landslides during the January 2009 storm. Many of these landslides caused significant damage to homes, roads, and the environment.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 2,134 are located within a landslide hazard zone in Region 3, totaling roughly $4.2 billion (**Figure 2-136**). This includes 455 critical or essential facilities. An additional 2,413 non-state-owned critical or essential facilities are located within a landslide hazard zone in Region 4.

Figure 2-136. State-Owned/Leased Facilities and Critical/essential facilities in a Landslide Zone in Region 3



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Benton	162	234	216	$1,093,373,557
Lane	27	843	194	$283,280,825
Linn	17	295	140	$75,555,783
Marion	234	643	1043	$2,771,586,104
Polk	5	191	39	$37,996,619
Yamhill	10	207	47	$16,107,182
Grand Total	455	2413	1679	$4,277,900,069

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Lane, Linn, and Marion Counties coincide with the crest of the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when remain unanswered. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances downstream, and wind-borne ash can blanket areas many miles from the source.

Historic Volcanic Events

Table 2-222. Historic Volcanic Events Affecting Region 3

Date	Location	Description
about 10,000 to <7,700 YBP	cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 4,000 to 3,000 YBP	Sand Mountain, central Cascades	lava flows and cinder cones in Sand Mountain field
about 3,000 to 1,500 YBP	Belknap Volcano, central Cascades	lava flows, tephra
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra

Note: YBP is years before present.

Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/
Scott et al. (2001); Walder et al. (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience volcanic activity is shown in **Table 2-223**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-223. Local Probability Assessment of Volcanic Activity in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	L	H	L	L	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 3 communities are closest to the Three Sisters and Mount Jefferson. Middle and South Sisters are the most active of the group. Because geologic history is fragmentary for these volcanoes, the probability of future explosive eruptions is difficult to estimate. Only two explosive episodes have occurred at the South Sister since the end of the ice age (about 12,000 years ago). Given the fragmentary record, the annual probability of the South and Middle Sister entering a new period of eruptive activity has been estimated from 1 in several thousand to 1 in 10,000 (Schilling et al., 1997). Similar difficulties complicate predictions of future eruptions at Mount Jefferson. There have been four episodes of lava flow eruptions around Mount Jefferson since the end of the Ice Age (about 12,000 years ago). Such a frequency suggests an annual probability of lava flow eruptions of 1 in 4,000 to 1 in 3,000 (Walder et al., 1999).

Table 2-224 provides further information about probability of volcanic eruptions in Region 3.

Table 2-224. Probability of Volcano-Related Hazards in Region 3

Volcano-Related Hazards	Benton	Lane	Linn	Marion	Polk	Yamhill	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 1,000 to 1 in 5,000	1 in 1,000	1 in 1,000	1 in 1,000	1 in 1,000 to 1 in 5,000	1 in 1,000 to 1 in 5,000	Sherrod et al. (1997)
Lahar	no risk	source: Three Sisters McKenzie River: 3 scenarios: source to Thurston	Source: Mt. Jefferson S. Santiam R. from Mt. Jefferson to Detroit	source: Mt. Jefferson, N. and S. Santiam rivers from Mt. Jefferson to Detroit	no risk	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County: Walder et al. (1999) (maps); Lane County: Scott et al. (2001) (map)
Lava flow	no risk	source: Three Sisters immediate vicinity	Source: Mt. Jefferson Immediate vicinity	source: Mt. Jefferson immediate vicinity	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)
Debris flow / avalanche	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Proximity	source: Mt. Jefferson proximity	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)
Pyroclastic flow	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Pamelia and Minto Creeks	source: Mt. Jefferson Whitewater Cr and S. Fork Santiam	no risk	no risk	Mt. Jefferson: Walder et al. (1999) (maps); Three Sisters: Scott et al. (2001) (maps)

Sources: Sherrod et al. (1997), Walder et al. (1999), Scott et al. (2001)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-225**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-225. Local Vulnerability Assessment of Volcanic Activity in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	H	M	M	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

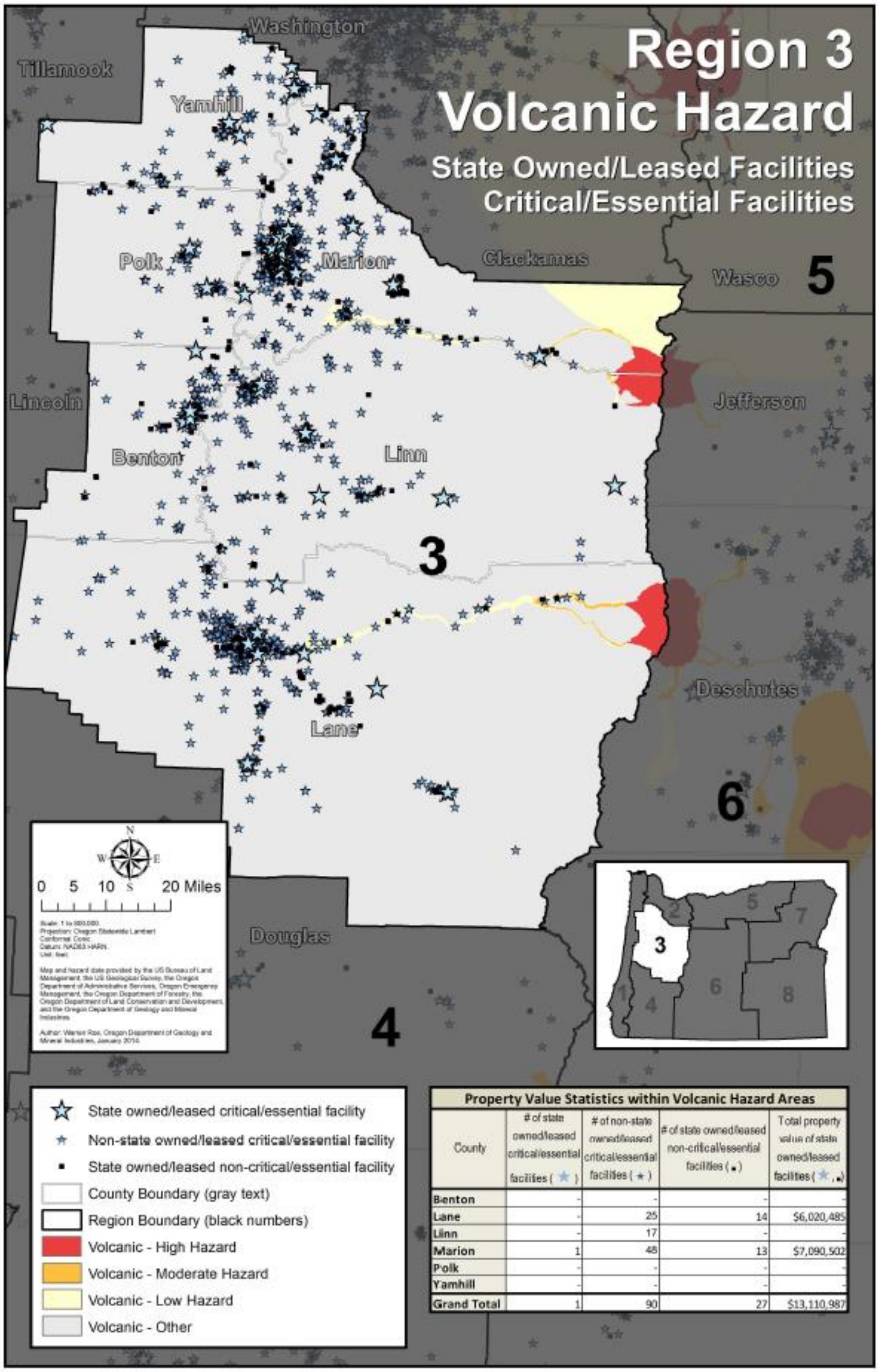
The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 1999) and the Three Sisters (Scott et al., 2001). These reports include maps depicting the areas at greatest risk. Lane, Linn, and Marion Counties are at risk and should consider the impact of volcano-related activity, such as lahars, on small mountain communities, dams, reservoirs, energy-generating facilities, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation). There is virtually no risk from volcanoes in Benton, Polk, and Yamhill Counties, although normal prevailing winds could shift and carry ash into those areas.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 28 are located within a volcanic hazard area in Region 3, totaling over $13 million in property value. Of those, one is a critical or essential facility. There are 90 non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 3 (**Figure 2-137**).

Figure 2-137. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 3



Property Value Statistics within Volcanic Hazard Areas				
County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilites
Benton	-	-	-	-
Lane	-	25	14	$6,020,485
Linn	-	17	-	-
Marion	1	48	13	$7,090,502
Polk	-	-	-	-
Yamhill	-	-	-	-
Grand Total	1	90	27	$13,110,987

Source: DOGAMI

Wildfires

Characteristics

Forests in this region are quite productive due to the mild temperatures, amount of precipitation, and deep, rich, fertile soils. Historically, this landscape was dominated by oak woodland and savanna with an understory consisting of grasses and forbs. These landscapes tended to burn on a regular basis with low intensity surface fires. This area was also heavily influenced by the Kalapuya Indians. The Kalapuyas frequently burned this area to make the landscape more favorable to elk and deer, which they hunted for food. As Euro-Americans moved in, native tribes moved on. Without prescribed burns, conifer trees have established and have overtopped the oak trees. The understory has changed from grasses and forbs to an understory with more woody shrubs and dead and downed wood. These forests are similar to those of the Oregon Coast Range and have historic fire return intervals of 150-300 years. These fires also tend to be large, stand-replacing fires, rather than the low-intensity, frequent fires of the oak woodland forest type.

Because wildland fires are being effectively suppressed, the patterns and characteristics of fires are changing. Vegetation that historically would have been minimized by frequent fires has become more dominant. Over time, some species have also become more susceptible to disease and insect damage, which leads to an increase in mortality. The resulting accumulation of dead wood and debris creates the types of fuels that promote intense, rapidly spreading fires.

Historic Wildfire Events

Table 2-226. Historic Wildfires Affecting Region 3

Year	Name of Fire	Counties	Acres Burned	Remarks
1853	Nestucca	Tillamook/Yamhill	320,000	
1849	Siletz	Lincoln/Polk	800,000	
1865	Silverton	Marion	988,000	
1933	Tillamook	Tillamook, Yamhill	240,000	Human caused. Between 1933 and 1951, the Tillamook forest burned every 6 years. Fires followed drought conditions. Total Tillamook Burn: 350,000 acres (George Taylor, *The Oregon Weather Book*, p.202)
1966	Oxbow	Lane	44,000	
1972	Yamhill	Yamhill		
1977		Yamhill		west of Carlton
1987	Shady Lane	Polk		
2002		Lane		four people were injured

Note: This list is representative of a lengthy wildfire history. There have been many fires, named and unnamed. Statistics differ, depending on the source.

Source: Brian Ballou, August 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-227**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-227. Local Probability Assessment of Wildfire in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	M	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Wildfire always has been a part of the ecosystems in Oregon, sometimes with devastating effects. Some of the state's most devastating wildfires have been in counties within Region 3 (e.g., Marion, Polk, and Yamhill). Wildfire results from natural causes (e.g., lightning strikes), mechanical failure (Oxbow Fire), or human activity (unattended campfire, debris burning, or arson).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-228**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-228. Local Vulnerability Assessment of Wildfire in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	M	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Wildfire risk is generally low to moderate in Region 3. Jurisdictions most vulnerable to wildfire are the result of a dispersed population in close proximity to abundant vegetative fuels. These forestlands contain extensive fuels composed of flammable grasses, brush, slash and timber.

Table 2-229. Wildland-Urban Interface Communities in Region 3

Benton	Lane (Non-Coastal)	Linn	Marion	Polk	Yamhill
Adair Village	Bohemia City	Albany	Breitenbush	Airlie	Grand Ronde Agency
Alpine	Coburg	Brownsville	Detroit	Buell	McMinnville
Alsea	Cottage Grove	Clear Lake Resort	Gates	Dallas	Midway
Bellfountain	Creswell	Harrisburg	Idanha	Falls City	Orchard View
Blodgett	Dexter	Lebanon	Jefferson	Fort Hill	Willamina
Corvallis	Dorena	Marion Forks	Lyons	Grand Ronde	
Dawson	Eugene	Mill City	Marion	Pedee	
Glenbrook	London Springs	New Idanha	Mehama		
Kings Valley	Lorane	Scio	Salem		
Lewisburg	Lower McKenzie	Sweet Home East	Scotts Mills		
Monroe	Lower Willamette	Sweet Home West	Silverton		
Philomath	Marcola		Stayton		
Summit	Pleasant Hill				
Wren	Springfield				
	Upper McKenzie				
	Upper Willamette				
	Waldon				
	West Valley				

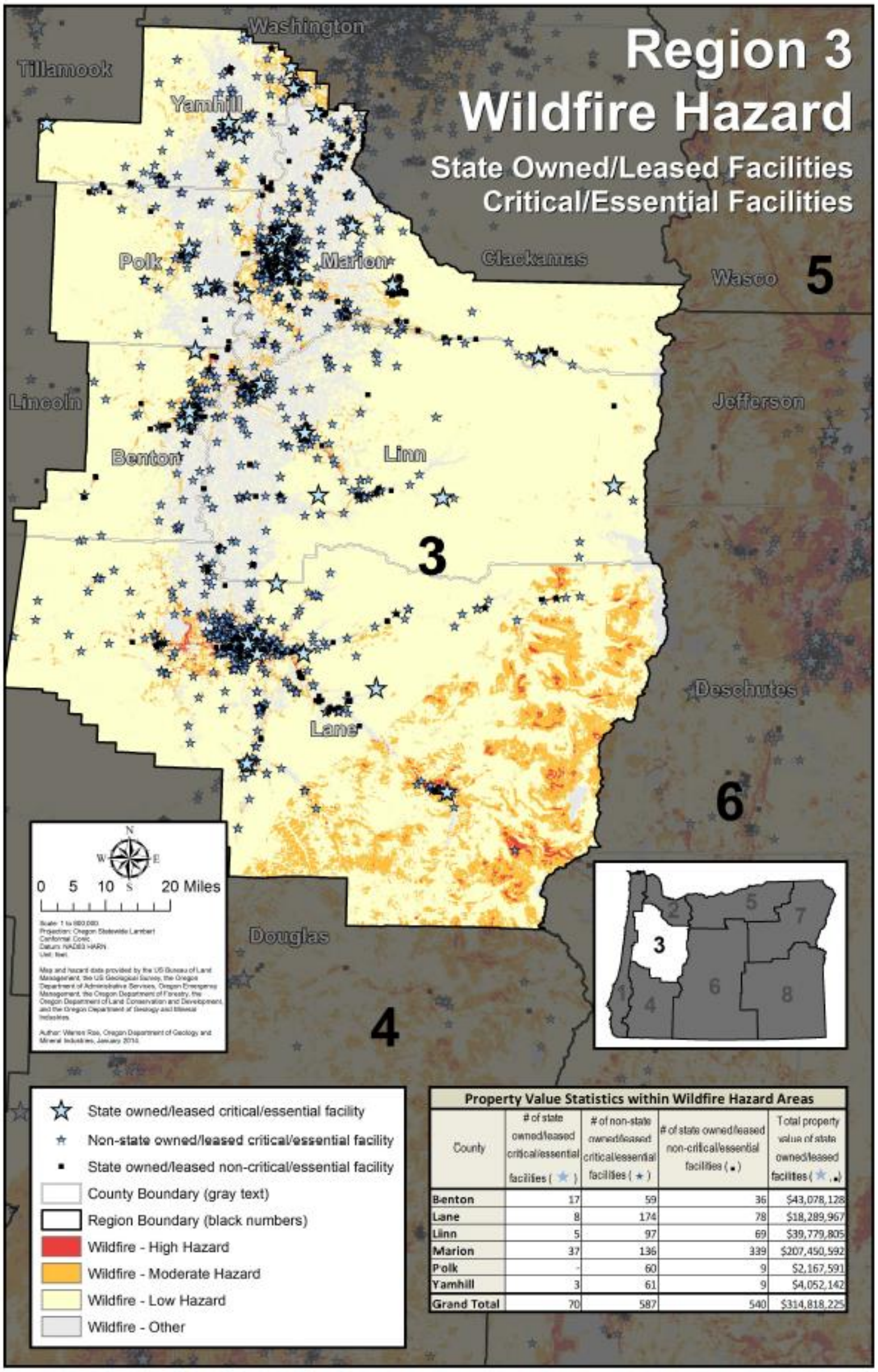
Source: Oregon Dept. of Forestry Statewide Forest Assessment, September 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 610 are within a wildfire hazard zone in Region 3 and total roughly $315 million in value (**Figure 2-138**). Among state-owned/leased critical or essential facilities, 70 are located in a wildfire hazard zone in Region 3. An additional 587 non-state-owned/leased critical or essential facilities are also located in a wildfire hazard zone in Region 3.

Figure 2-138. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 3



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilites (★, ▪)
Benton	17	59	36	$43,078,128
Lane	8	174	78	$18,289,967
Linn	5	97	69	$39,779,805
Marion	37	136	339	$207,450,592
Polk	-	60	9	$2,167,591
Yamhill	3	61	9	$4,052,142
Grand Total	70	587	540	$314,818,225

Source: DOGAMI

Windstorms

Characteristics

High winds are not uncommon in the Willamette Valley. A majority of the destructive surface winds in the region are from the southwest, similar to Region 2. The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 3.

In addition to windstorms, tornadoes have been recorded in Region 3 since 1887. The storms have occurred during all seasons, as described in **Table 2-230**. Fortunately, damage has been slight, and has mostly affected individual farm buildings, orchards, telephone poles and trees.

Historic Windstorm Events

Table 2-230. Historic Windstorms Affecting Region 3

Date	Location	Description
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; Wind speed 40-60 mph; gusts 75-80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55-65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71 mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million (FEMA-1405-DR-Oregon)
July 2003	Marion County	$15,000 in property damage
Dec. 2004	Marion, Lane, and Polk Counties	$6,250 in property damage — property damage estimate includes counties outside of Region 3
Dec. 2005	Mario and Linn Counties	$3,000 in property damage
Apr. 2004	Lane County	$5,000 in property damage
Jan. 2005	Linn and Marion Counties	windstorms cause $6,000 of damage in Linn and Marion Counties; a storm total of $15,000 in damages spread out among, Linn, Marion, Clackamas, Multnomah, and Washington Counties
Jan. 2006	Yamhill, Marion, and Polk Counties	wind storm with winds up to 58 mph causes a total of $500,000 in damages spread out over all four counties and includes Clackamas, Columbia, Washington, and Multnomah Counties as well
Feb. 2006	Linn, Marion, Lane, Benton, Polk, and Yamhill Counties	wind storms with gusts up to 77 mph cause $227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties; storm causes damages in region 2 and region 1 as well for a total storm damage of $575,000
May 2006	Lane County	$5,000 in property damage in Eugene, approximately 13,000 customers out of power
May 2007	Marion County	hail storm causes $5,000 in damages
Mar. 2008	Marion County	heavy winds measured at 40 mph cause $15,000 in damage near Woodburn

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR: February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [online database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-231. Recorded Tornadoes in Region 3

Date	County	Damage Description
Jan. 1887	Lane	fences damaged; livestock losses; trees uprooted
Nov. 1925	Polk	buildings, barns, and fruit trees damaged
Feb. 1926	Polk	house and trees damaged
Sep. 1938	Linn	observed in Brownsville; no damage
Dec. 1951	Lane	barn destroyed
Jan. 1953	Benton	observed; no damage
Mar. 1960	Marion	several farms damaged near Aumsville; trees uprooted
May 1971	Yamhill	house and barn damaged near McMinnville
Aug. 1975	Lane	metal building destroyed near Eugene
Aug. 1978	Yamhill	minor damage near Amity
Apr. 1984	Yamhill	barn roof destroyed
May 1984	Lane	barn and shelter damaged near Junction City
Nov. 1989	Lane	telephone poles and trees uprooted near Eugene
Nov. 1991	Marion	barn damaged near Silverton
Sep. 2007	Linn	a tornado rated at F0 near Albany and Lebanon causes $20,000 in damage to buildings and $22,000 to crops
Dec. 2010	Marion	a tornado rated at F2 damaged 50 buildings in the community of Aumsville, causing a total of $1.2 million in property damage
June 2013	Yamhill	tornado took ¼ mile path through town, some structural damage

Sources: Taylor and Hatton (1999, pp. 130-137); U.S. Department of Commerce. National Climatic Data Center. Available from http://www.ncdc.noaa.gov/stormevents/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience windstorms is shown in **Table 2-232**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-232. Local Probability Assessment of Windstorms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year event for a windstorm in Region 3 is 1-minute average winds of 75 mph. A 50-year event has average winds of 68 mph. A 25-year event has average winds speeds of 60 mph.

Vulnerability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the region's vulnerability that to windstorms is shown in **Table 2-233**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-233. Local Vulnerability Assessment of Windstorms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	H	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 3 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair. Benton, Lane, Marion, and Polk Counties are listed by PUC as being most vulnerable to wind damage in this region.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and other utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Bridges, which may be closed during periods of high wind, are an additional consideration.

Winter Storms

Characteristics

Severe winter weather in Region 3 is characterized by extreme cold, snow, ice, and sleet. Although such conditions may be expected in the Cascade Mountains and eastern Oregon, they are considered to be unusual in the Willamette Valley. Some Region 3 communities are unprepared, financially and otherwise, to handle severe winter storms. There are more moderate annual winter storms in the region; severe winter storms occur approximately every 4 years in the Valley. Severe weather conditions do not last long in Region 3, and winter-preparedness is a moderate priority.

Historic Winter Storm Events

Table 2-234. Severe Winter Storms in Region 3

Date	Location	Description
Dec. 1861	statewide	snowfall varied between 1 and 3 feet; did not leave Willamette Valley floor until late February
Dec. 1864	Willamette Valley and Columbia Basin	heavy snowfall; Albany (Linn County) received 16 inches in one day
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Dec. 1919	Corvallis (Benton County	Corvallis received 22 inches of snow and set an all-time low temperature record of 14 °F
Jan.- Feb. 1937	statewide	heavy snow throughout the Willamette Valley; Dallas (Polk County) had 24 inches; Salem (Marion County) had 25 inches
Jan. 1950	statewide	heaviest snowfall since 1890; many highway closures; considerable property damage
Jan. 1956	western Oregon	packed snow became ice; many automobile accidents throughout the region
Mar. 1960	statewide	snowfall: 3–12 inches, depending on location; more than 100 snow-related accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; Eugene (Lane County) had a total snow depth of 47 inches; three to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	western valleys received 2–4 inches of snow; massive power failures (tree limbs broke power lines)
Dec. 1985	Willamette Valley	heavy snowfall throughout valley
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures; Salem (Marion County) received 9 inches
Feb. 1990	statewide	average snowfall from one storm about 4 inches (Willamette Valley)
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-99	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 2003 -Jan. 2004	statewide	wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple; Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees; Presidential disaster declaration for 30 of Oregon's 36 counties
Jan.-Feb. 2008	Marion County	a series of vigorous winter storms brought record setting snow accumulation to Detroit, Oregon; three dozen Oregon National Guard personnel were called in to help with snow removal in Detroit and Idanha; the towns received over 12 feet of snow in several weeks

Source: Taylor and Hatton (1999); unknown sources

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 3 will experience winter storms is shown in **Table 2-235**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-235. Local Probability Assessment of Winter Storms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	—	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 3. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-236**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-236. Local Vulnerability Assessment of Winter Storms in Region 3

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	H	—	H

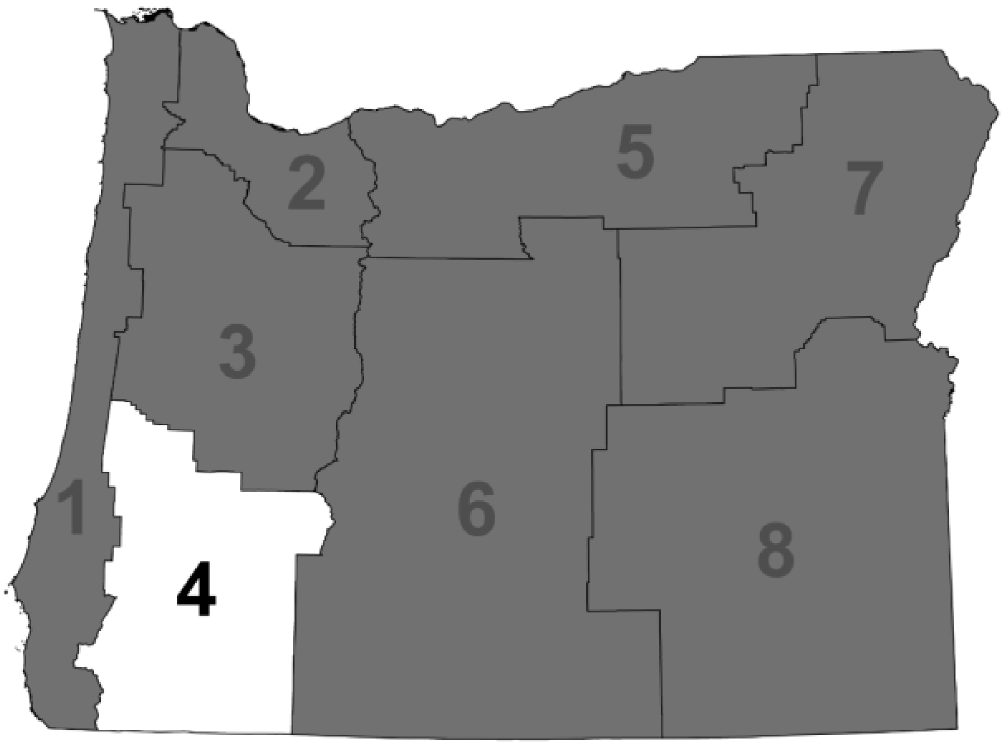
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The I-5 corridor through this region is key to intermodal transportation; severe winter storms can have an adverse impact on the economy if the interstate has to be closed for any extended period of time.

2.3.4 Region 4: Southwest Oregon

*Douglas (non-coastal), Jackson, and Josephine Counties



*Note: The coastal portion of Douglas County is within Region 1. Where data are available for the coastal areas of Douglas County, the data are provided within the Region 1 profile; otherwise, countywide datasets are reported in this profile.

2.3.4.1 Summary

Regional Profile

The region's demographic, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability across the region is driven by low median household incomes and a high proportion of senior citizens. There are several indicators of vulnerability at the county level, including: high numbers of tourists in Jackson County; a large share of seniors with disabilities in Douglas County; homelessness on the rise in Jackson and Josephine Counties; fewer college degrees in Douglas and Josephine Counties; and increases in poverty in Douglas and Jackson Counties.

Region 4 was hit particularly hard by the financial crisis that began in 2007 and continues to suffer from significantly low job recovery rates and below average wages. There are few key industries and employment sectors in Southwest Oregon. The area is particularly vulnerable during winter months when there are fewer employment opportunities.

Transportation networks across the state are vulnerable to seismic events. Following a CSZ earthquake, access along I-5 may be limited due to bridge collapse. Roughly 18% of the state-owned bridges in Southwest Oregon are distressed.

Energy facilities and conveyance systems in the region help support the regional economy and are vulnerable to damage and service disruptions due to natural hazard events. The region has multiple dams, hydroelectric and biomass power-generation facilities that service the state. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential. Natural gas pipelines run through Josephine and Douglas Counties and are vulnerable to seismic activity.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for public health and water quality. During high-water events, the region's drinking water is vulnerable to high levels of pollutants entering waterways through combined sewer overflows (CSOs). Medford is the only city in the region that requires low impact development (LID) stormwater mitigation strategies in its development code.

Region 4 is developing at about half the rate of the state. The majority of growth is occurring in cities along I-5, particularly within Jackson County. Mobile homes comprise significant share of housing units and are inherently vulnerable to natural hazards. Roughly two thirds of homes in this region were built prior to current seismic building standards, making them especially vulnerable.

Hazards and Vulnerability

Region 4 is affected by eight of the state's 11 natural hazards. Coastal hazards, dust storms, and tsunamis do not directly impact this region.

Droughts: Droughts can affect commerce, agriculture, fisheries, and overall quality of life in all three counties. Jackson and Josephine Counties were declared federal primary natural disaster areas by the U.S. Department of Agriculture in 2013.

Earthquakes: Four types of earthquakes affect Region 4 (a)shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for Southwest Oregon. The region is particularly vulnerable due to the large area susceptible to earthquake-induced landslide, liquefaction, and ground shaking. In a 500-year model for a CSZ event or combined crustal events, all three of the region's counties rank among the top 15 counties with the highest expected earthquake damages and losses. The state's seismic lifelines along Interstate-5 and east-west routes that connect the region to the rest of the state are highly vulnerable to seismic events. There are 434 state-owned/leased facilities, valued at over $164.4 million, within this region's earthquake hazard zone. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Floods affect Southwest Oregon in the form of riverine flooding often preceded by rapid snow melt and heavy rain. All of the region's counties are considered moderately vulnerable to flooding. There are 18 repetitive flood loss properties in Region 4. There are 102 state-owned/leased facilities, valued at approximately $45.4 million, located in the region's flood hazard zone. Of these, four are considered critical/essential facilities. An additional 80 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides in the region. Vulnerability is increased in populated areas – such as in the Cities of Ashland and Medford – and in the Klamath Mountains. There are 434 state-owned/leased facilities, valued at over $164.4 million, located in this hazard zone in Region 4. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Volcanic activity may occur within the eastern areas of the region's counties that coincide with the crest of the Cascade mountain range. Particular areas of vulnerability include Crater Lake, upper reaches of the Umpqua and Clearwater Rivers, and the OR-62 corridor. Most volcanic activity is considered local. However, lahars and ashfall can travel many miles and small mountain communities, dams, reservoirs, energy-generating facilities, and highways may be vulnerable. There are no state-owned/leased facilities and no critical/essential facilities located in a volcanic hazard zone within Region 4.

Wildfires: In Southwest Oregon the combination of proximity of communities to wildland areas; high summer temperatures; rugged terrain; and likelihood of summer thunderstorm activity contribute to the region's vulnerability to wildfire. Wildfires are most common during the late summer. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 4 Douglas and Jackson Counties have a high percentage of wildland acres in the Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat categories, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 198 state-owned/leased facilities located in this region's wildfire hazard zone, with a value of approximately $44 million. Of these, 11 are identified as critical/essential facilities. An additional 408 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms can occur when Pacific Ocean winds travel inland in a northeasterly direction. These storms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Cold weather and high precipitation impact the region annually. Severe winter storms can shut down the I-5 corridor passage through the Siskiyou Mountains, which can adversely impact the economy regionally and statewide.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 4 include drought, wildfire, flooding, and landslides. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by increased incidences of drought and wildfire. In addition, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas in Region 4 and could result in a greater risk of flooding characterized by increased magnitude and shorter return intervals in certain basins. Landslides in Oregon are strongly correlated with rainfall, so increased rainfall — particularly extreme events — will likely trigger more landslides. While winter storms and windstorms affect Region 4, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.4.2 Profile

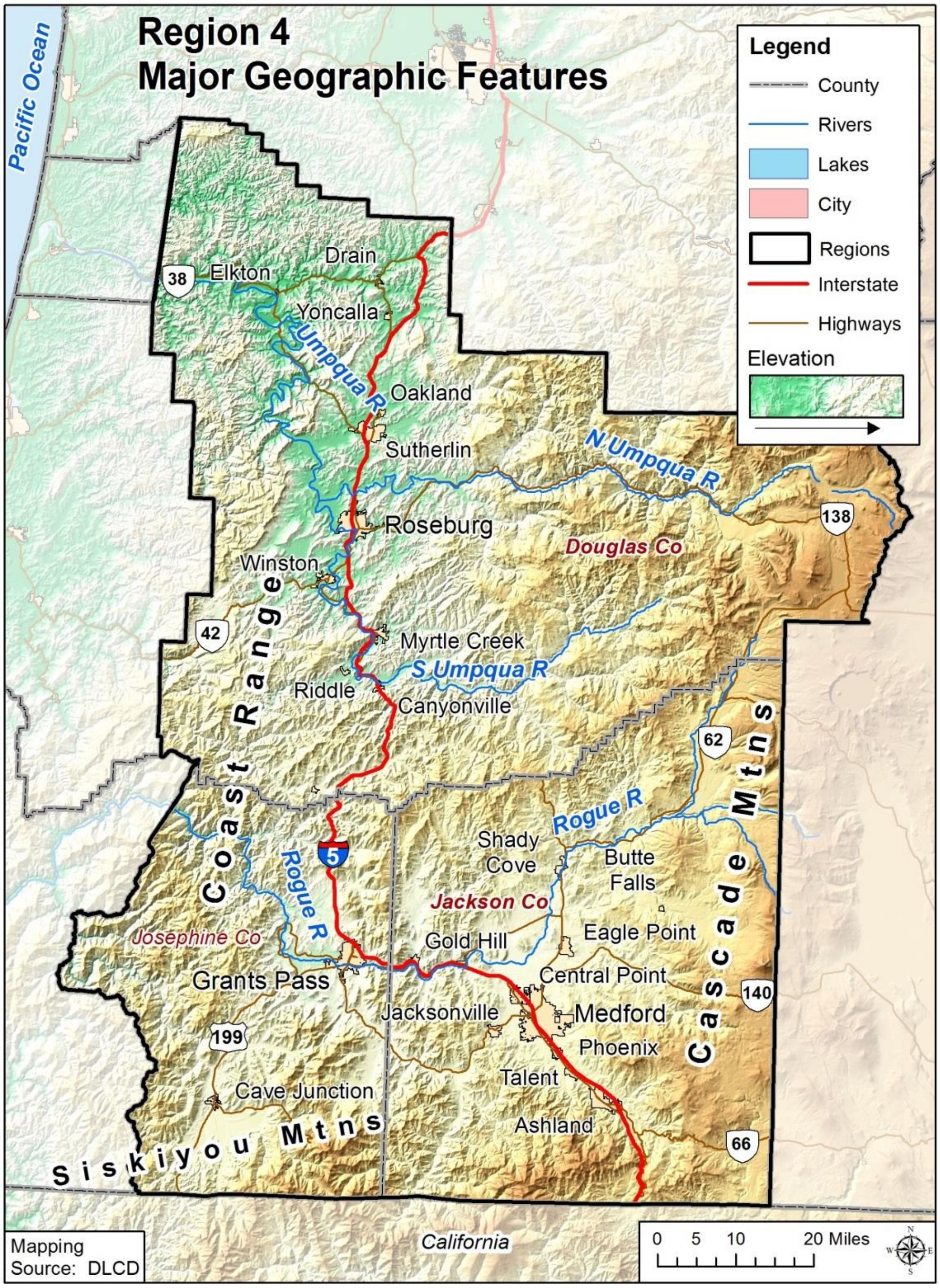
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Southwestern Oregon is approximately 9,461 square miles in size, and includes Douglas (non-coastal), Jackson, and Josephine Counties. Mountain ranges and watersheds shape the region's topography. Region 4 begins at the Cascades in the east, and extends to the Klamath Mountains and Coast Range in the west. It extends from the Rogue-Umpqua Divide in the North to the Siskiyou Mountains at the California border in the south. Three rivers shape the region's main watersheds: the Umpqua River, the Rogue River, and the Illinois River (Downing, 2012).

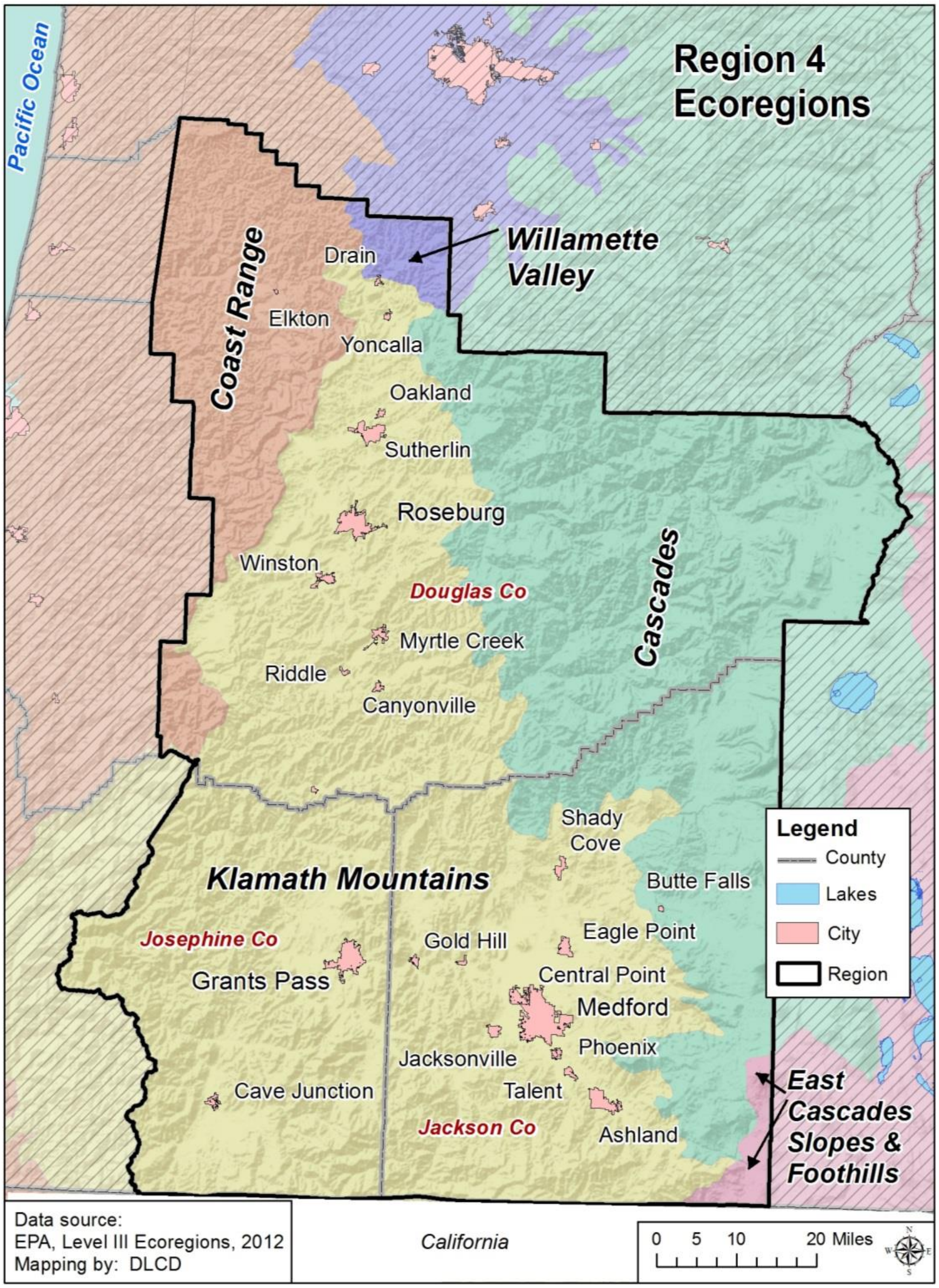
Figure 2-139. Region 4 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 4 is composed of three ecoregions: the Cascades, the Klamath Mountains, and the Coast Range (**Figure 2-140**).

Figure 2-140. Region 4 Ecoregions



Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Ecoregions of Oregon, http://www.epa.gov/wed). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water (Ecoregions of Oregon, http://www.epa.gov/wed).

Coast Range: The east slope of the Coast Range is located within Region 4. Sedimentary soils in this ecoregion are prone to failure following clearcuts, which may be of concern as the commercial Douglas fir forests located here are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. The ecoregion's sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Ecoregions of Oregon, http://www.epa.gov/wed).

Klamath Mountains: A mixture of conifer and hardwood forests covers the Klamath Mountains ecoregion. A mosaic of soil types including sedimentary, granitic, metamorphic, and extrusive rocks underlies these forests. More extensive areas of hardwood and broadleaf evergreen canopies are evident in this ecoregion than in the Cascade Mountains ecoregion. Oregon white oak savannahs and woodlands, both habitat types that have been threatened by Douglas fir encroachment and human development, are present in foothills areas. This ecoregion has a dry, Mediterranean climate, which is prone to long summer droughts. The ecoregion's water quality and habitat continue to be negatively impacted by mine tailings (Ecoregions of Oregon, http://www.epa.gov/wed).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 4's diverse ecoregions have varying climatic conditions. Precipitation generally occurs in the winter months. Wet winters and dry summers influence risk to droughts, floods, landslides, wildfires, and winter storms. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-237** shows mean annual precipitation and temperatures for the three ecoregions in Region 4 (Ecoregions of Oregon, http://www.epa.gov/wed). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-237. Average Precipitation and Temperature Ranges in Region 4 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	45–140	16/45	38/85
Klamath Mountains*	20–130	24/50	49/89
Coast Range	60–130	32/48	48/78
Willamette Valley	45–60	32/46	50/80
Eastern Cascades slopes and foothills	25–40	20/34	47/82

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 4.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

From 2000 to 2013 Region 4 as a whole has grown 3.1% less than the state overall. Jackson County has grown the most. By 2020, counties in Region 4 are projected to grow at about the same rate as the state overall.

Table 2-238. Population Estimate and Forecast for Region 4

Ecoregion	Mean Annual Rainfall (inches)	Mean Temperature (°F) January min/max	Mean Temperature (°F) July min/max
Cascades*	45-120	26/45	44/85
Klamath Mountains*	25-70	28/49	50/87
Coast Range	60-130	32/48	48/78

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. Tourism activities in Region 4 are largely centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods Travel USA, 2011b). The average travel party contains 3.1 persons and 68% of their trips originate from Oregon or California. In this region, the average trip length is 4.2 nights (Longwoods Travel USA, 2011b). More than half the tourists in this region visit Jackson County. In 2013, most visitors in Region 4 lodged in private homes.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-239. Annual Visitor Estimates in Person Nights in Region 4

	2011		2012		2013	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Region 4	8,860	—	9,088	—	9,348	—
Douglas	2,321	100%	2,341	100%	2,394	100%
Hotel/Motel	534	23.0%	533	22.8%	553	23.1%
Private Home	1,083	46.7%	1,091	46.6%	1,112	46.4%
Other	704	30.3%	717	30.6%	729	30.5%
Jackson	4,788	100%	4,952	100%	5,102	100%
Hotel/Motel	1,449	30.3%	1,517	30.6%	1,613	31.6%
Private Home	2,580	53.9%	2,665	53.8%	2,706	53.0%
Other	759	15.9%	770	15.5%	783	15.3%
Josephine	1,751	100%	1,795	100%	1,852	100%
Hotel/Motel	435	24.8%	448	25.0%	483	26.1%
Private Home	1,041	59.5%	1,066	59.4%	1,084	58.5%
Other	275	15.7%	281	15.7%	285	15.4%

Source: Dean Runyan Associates (2014)

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). About 4% more people in Region 4 identify as having a disability than do people throughout the state. Most people reporting a disability in Region 4 reside in Douglas County — over 20% of its population. About 43% of Douglas County's seniors (65 and older) are disabled. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-240. People with a Disability by Age Groups in Region 4, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	**Estimate**	**Percent**	**Estimate**	**Percent****	**Estimate**	**Percent****
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 4	390,890	68,927	17.6%	4,429	5.3%	30,069	39.5%
Douglas	106,680	22,852	21.4%	1,531	7.0%	9,710	43.3%
Jackson	202,450	32,259	15.9%	2,333	5.3%	13,651	38.2%
Josephine	81,760	13,816	16.9%	565	3.4%	6,708	37.2%

*Total population does not include institutionalized population.

**Percent of age group.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-5, tend to have higher concentrations of homeless people (Thomas et al., 2008). Over the 3-year period between 2009 and 2011 the homeless population has been gradually increasing in Jackson and Josephine Counties.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-241. Homeless Population Estimate for Region 4

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 4	357,394	397,975	11.4%	430,346	8.1%
Douglas	100,399	108,850	8.4%	116,113	6.7%
Jackson	181,269	206,310	13.8%	223,458	8.3%
Josephine	75,726	82,815	9.4%	90,776	9.6%

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services
http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender breakdown in Region 4 (roughly 50:50) is similar to that of the state (U.S. Census Bureau, n.d.). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

Region 4 has a 5.5% greater share of seniors than the state average. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The percentage of children is slightly lower than the statewide average. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-242. Population by Vulnerable Age Groups, in Region 4, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 4	393,640	83,166	21.1%	77,314	19.6%
Douglas	107,391	21,870	20.4%	22,733	21.2%
Jackson	203,613	44,437	21.8%	36,177	17.8%
Josephine	82,636	16,859	20.4%	18,404	22.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A majority of the region’s population speaks English very well. Conversely, compared to state numbers, roughly 3–5% more of the region’s population does not speak English very well. Hazard mitigation outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-243. English Usage in Region 4, 2012

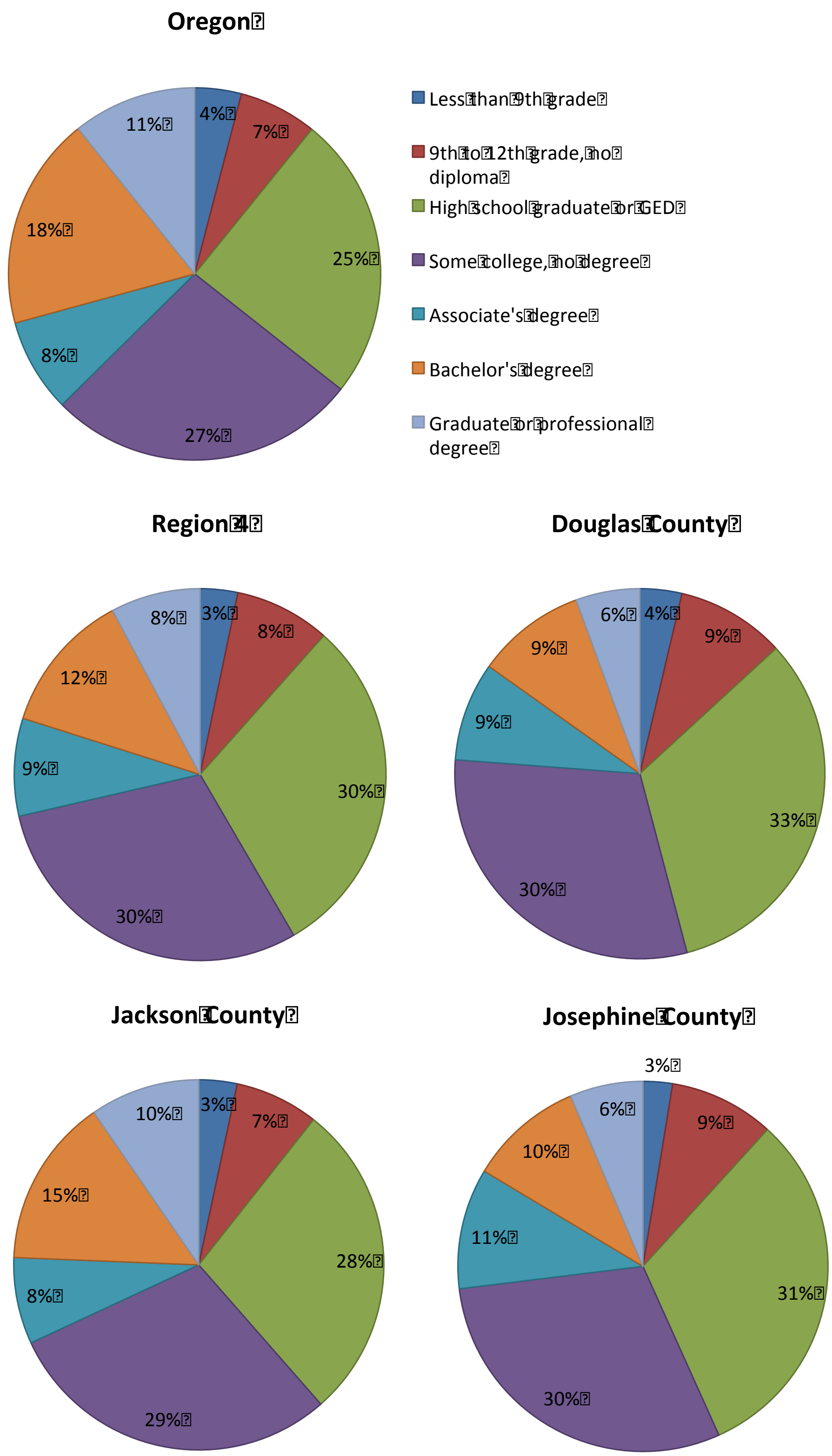
	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 4	362,946	97.6%	9,058	2.4%
Douglas	100,869	99.0%	1,037	1.0%
Jackson	184,577	96.3%	7,095	3.7%
Josephine	77,500	98.8%	926	1.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Furthermore, education can influence a person’s and community’s ability to understand warning information and to access resources before and after a natural disaster. In Southwestern Oregon, 5% more of the population has a high school degree or GED compared to state percentages. In Josephine and Douglas Counties, the share of bachelor’s degrees is roughly 8% lower than the state average. Five percent fewer persons have a graduate or professional degree than the state average.

Figure 2-141. Educational Attainment in Region 4, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 significantly affected Region 4. Across the region, median household incomes were below statewide numbers in 2009 and dropped roughly 8% by 2012. About 7% of households in Southwest Oregon earn less than $35,000 per year. Jackson County has the highest percent of its households earning more than $75,000 per year.

Table 2-244. Median Household Income in Region 4

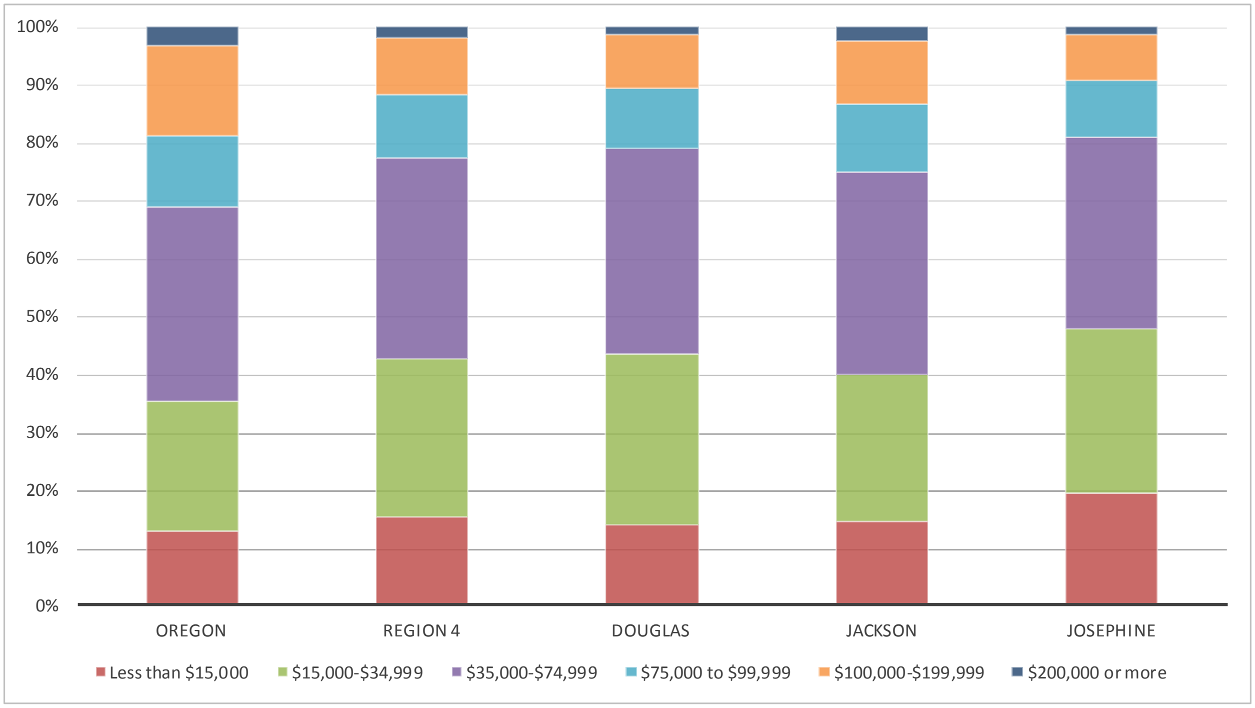
	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 4	N/A	N/A	N/A
Douglas	$43,154	$40,096	-7.1%
Jackson	$47,773	$43,664	-8.6%
Josephine	$40,085	$36,699	-8.4%

Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Figure 2-142. Median Household Income Distribution in Region 4, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Since 2009, about 7% more of the region's population has entered into poverty. Josephine County has the highest percentage of its population living in poverty — 20% of individuals and close to 31% of its children. Notably, Douglas County saw an increase in overall poverty of roughly 35%, and an almost 40% increase among its children.

Table 2-245. Poverty Rates in Region 4, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 4	68,524	17.6%	24.4%	21,063	25.7%	23.9%
Douglas	18,877	17.8%	34.5%	5,956	27.7%	39.5%
Jackson	33,346	16.6%	22.5%	10,032	22.9%	22.0%
Josephine	16,301	20.0%	18.0%	5,075	30.8%	12.6%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Collectively, counties in Region 4 have a slightly greater home-ownership rate compared to the state overall. Douglas County has the highest share of its households being owner occupied. Jackson County has the greatest percent of its population renting. Douglas County has the greatest percentage of vacant properties. Compared to the state overall, there is a smaller share of seasonal and recreational homes in Southwest Oregon (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-246. Housing Tenure in Region 4, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 4	161,421	104,869	65.0%	56,552	35.0%	12,416	7.0%
Douglas	43,678	30,362	69.5%	13,316	30.5%	4,258	8.7%
Jackson	83,370	51,646	61.9%	31,724	38.1%	5,534	6.1%
Josephine	34,373	22,861	66.5%	11,512	33.5%	2,624	6.9%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey, 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 4 is predominantly composed of family households. All three counties have a lower share of family households with children compared to the state.

Table 2-247. Family vs. Non-family Households in Region 4, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 4	161,421	105,456	65.3%	55,965	34.7%	45,352	28.1%
Douglas	43,678	29,279	67.0%	14,399	33.0%	11,609	26.6%
Jackson	83,370	53,966	64.7%	29,404	35.3%	23,426	28.1%
Josephine	34,373	22,211	64.6%	12,162	35.4%	10,317	30.0%

Source: U.S. Census Bureau, 2008–2012 American Community Survey, 5-Year Estimates, Table DP04

Table 2-248. Family Households with Children by Head of Household in Region 4, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 4	38,994	24.2%	4,285	2.7%	10,089	6.3%	24,620	15.3%
Douglas	9,556	21.9%	939	2.1%	2,619	6.0%	5,998	13.7%
Jackson	21,617	25.9%	2,241	2.7%	5,579	6.7%	13,797	16.5%
Josephine	7,821	22.8%	1,105	3.2%	1,891	5.5%	4,825	14.0%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 4 is particularly vulnerable during a hazard event in the following categories:

- High numbers of tourists visit Jackson County.
- A high percentage of the senior population in Douglas County has a disability.
- The homeless population in Jackson and Josephine Counties is increasing.
- The region has a higher share of seniors than the state overall.
- In each county 3–5% more of the population does not speak English very well.
- A smaller share of the population has a college degree, especially in Douglas and Josephine Counties.
- Median household incomes are significantly lower than the state's.
- There has been a greater increase in the share of population living in poverty, including children, in Douglas and Jackson Counties, than in the state overall.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate for natural hazards (Cutter et al., 2003). Since the end of the financial crisis that began in 2007, job recovery in Region 4 has lagged behind state's average. As of May 2013 Douglas County has recovered only 17% of jobs lost in the recession while 65% of jobs statewide have been recovered. Similarly, job recovery in Jackson County has occurred disproportionately in low-wage jobs. Regionally, unemployment rates have been declining steadily since 2009, but remain 2.4% higher than statewide averages. Jackson County has the largest labor force in the region and the lowest unemployment rate. Notably, average salaries in Southwest Oregon are 18% to 29% lower than the statewide average.

Table 2-249. Unemployment Rates in Region 4 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 4	13.7%	13.4%	12.4%	11.5%	10.1%	-3.6%
Douglas	15.5%	14.7%	13.4%	12.3%	10.8%	-4.6%
Jackson	12.6%	12.6%	11.8%	11.0%	9.5%	-3.1%
Josephine	14.3%	14.2%	12.8%	12.1%	10.9%	-3.4%

Source: Oregon Employment Department, 2014

"The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Retail trade and tourism employment ebb and flow seasonally. The winter months tend to see the lowest employment rates due to less tourism and fewer employment opportunities in outdoor industries such as construction and agriculture (Tauer, 2014). Therefore, during winter months the region's economic vulnerability to a hazard event is heightened.

Table 2-250. Employment and Unemployment Rates in Region 4, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 4	173,595	156,059	89.9%	17,536	10.1%
Douglas	43,207	38,531	89.2%	4,676	10.8%
Jackson	97,698	88,405	90.5%	9,293	9.5%
Josephine	32,690	29,123	89.1%	3,567	10.9%

Source: Oregon Employment Department, 2014

Table 2-251. Employment and Payroll in Region 4, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 4	135,543	$35,647	79.2%
Douglas	34,651	$35,382	78.6%
Jackson	78,171	$36,873	81.9%
Josephine	22,721	$31,831	70.7%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2012 the five major employment sectors in Region 4 were: (a) Trade, Transportation, and Utilities; (b) Government; (c) Education and Health Services; (d) Leisure and Hospitality; and (e) Manufacturing. **Table 2-252** shows the distribution of total employment across all sectors. Wood products have historically been the main industry within the manufacturing sector in Region 4. In recent years, however, employment in wood products manufacturing has declined, and there has been an increase in food products manufacturing in Jackson and Josephine Counties (Oregon Employment Department, 2012; Employment Projections by Industry and Occupation: 2010–2020 Oregon and Regional Summary, retrieved Feb 19, 2014 from http://www.qualityinfo.org). Lumber and wood products continue to be one of the largest employment sectors in Douglas County, employing 10% of the private sector. Douglas County contains nearly 2.8 million acres in commercial forestland and is the second largest producer of timber in the state (Oregon Employment Department, n.d., Region 6 overview, retrieved Feb. 19, 2014, from http://www.qualityinfo.org/).

Table 2-252. Covered Employment by Sector in Region 4, 2013

		Douglas County		Jackson County		Josephine County	
Industry	**Region 4**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	135,546	34,651	100%	78,171	100%	22,724	100%
Total Private Coverage	113,739	26,920	77.7%	67,111	85.9%	19,708	86.7%
Natural Resources & Mining	4,309	1,635	4.7%	2,257	2.9%	417	1.8%
Construction	4,855	1,026	3.0%	3,092	4.0%	737	3.2%
Manufacturing	13,866	4,401	12.7%	7,052	9.0%	2,413	10.6%
Trade, Transportation & Utilities	28,735	6,289	18.1%	17,505	22.4%	4,941	21.7%
Information	2,001	266	0.8%	1,473	1.9%	262	1.2%
Financial Activities	5,152	1,068	3.1%	3,078	3.9%	1,006	4.4%
Professional & Business Services	11,716	3,281	9.5%	6,515	8.3%	1,920	8.4%
Education & Health Services	22,388	4,495	13.0%	13,681	17.5%	4,212	18.5%
Leisure & Hospitality	15,341	3,159	9.1%	9,505	12.2%	2,677	11.8%
Other Services	5,351	1,297	3.7%	2,935	3.8%	1,119	4.9%
Private Non-Classified	22	(c)	—	18	0.0%	(c)	—
Total All Government	21,807	7,731	22.3%	11,060	14.1%	3,016	13.3%
Federal Government	3,292	1,363	3.9%	1,681	2.2%	248	1.1%
State Government	4,101	1,021	2.9%	2,321	3.0%	759	3.3%
Local Government	14,414	5,347	15.4%	7,058	9.0%	2,009	8.8%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region and are most numerous in Jackson County.

Education and Health Services: The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. The importance of the health care and social assistance sector is underscored in Region 4 because of the region's increasing numbers of retirees. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector. Within the region, manufacturers are primarily based in Douglas and Jackson counties. The timber manufacturing industry is particularly vulnerable to droughts, landslides, and wildfires.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 4. (Note that revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $12.7 billion (86% of total revenue) for the region (Table 2-253).

Table 2-253. Revenue of Top Industries (in Thousands of Dollars) in Region 4, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 4	$14,823,762	44.9%	27.1%	13.8%
Douglas	$3,708,424	31.5%	40.6%	13.8%
Jackson	$8,949,774	49.9%	22.8%	13.1%
Josephine	$2,165,564	47.3%	21.8%	16.5%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so workforces and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 4 is expected to occur in the following sectors: (a) Education and Health Services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Professional and Business Services; (d) Leisure and Hospitality; and (e) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in the region. The Other Services sector has the second most businesses. The Professional and Business Services sector, Education and Health Services sector, Leisure and Hospitality sector round out the top five sectors in Southwestern Oregon (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent 68% of the business units in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 4 is particularly vulnerable during a hazard event due to the following characteristics:

- Significantly high unemployment rates in Douglas and Josephine Counties;
- Lower regional wages — 71% to 82% of state average salaries; and
- An economy heavily dependent on a few key industries.

Considering the high regional unemployment and an economy heavily dependent on a few key industries, Region 4 may experience greater difficulty recovering after a disaster than a region with a more diverse economic base. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, could help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

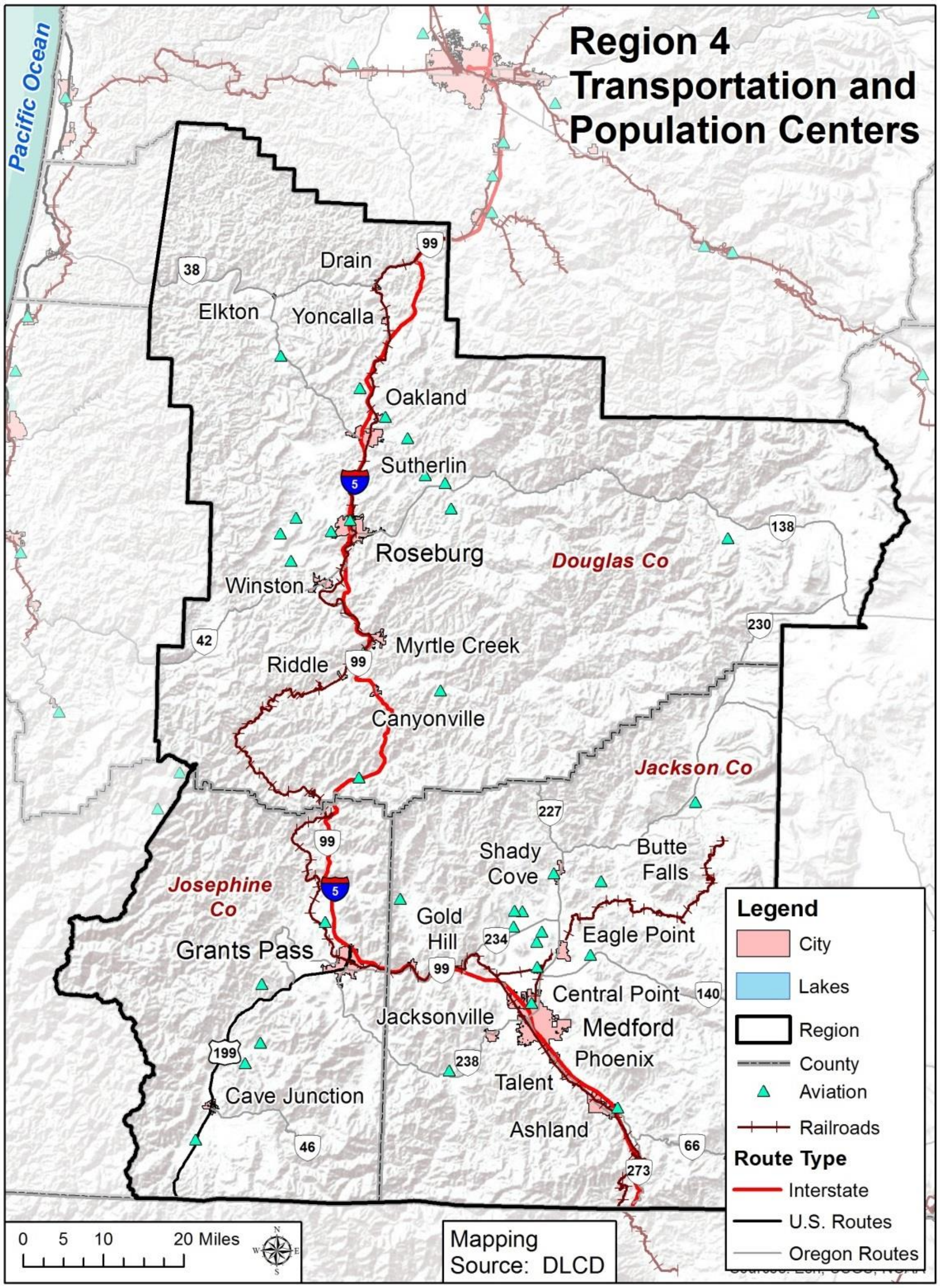
The largest population bases in Region 4 — the Cities of Ashland, Grants Pass, Medford, and Roseburg — are located along I-5. I-5 runs north-south through Region 4 and is the main passage for automobiles and trucks traveling along the West Coast.

Region 4's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the region has exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's Seismic Lifeline Report findings for Region 4 see **Seismic Lifelines**.

Figure 2-143. Region 4 Transportation and Population Centers



Source: Oregon Department of Land Conservation and Development, 2014

Bridges

Because of earthquake risk in Region 4, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-254 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). About 18% of the region's ODOT bridges are distressed, compared to 22% for the state.

Table 2-254. Bridge Inventory for Region 4

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 4	64	362	18%	81	508	16%	14	56	25%	4	10	40%	163	905	18%	11
Douglas	28	174	18%	44	252	17%	6	23	26%	2	6	33%	80	440	18%	6
Jackson	24	128	21%	16	152	11%	8	32	25%	0	0	-	48	300	16%	4
Josephine	12	60	21%	21	104	20%	0	1	0%	2	4	50%	35	165	21%	1

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 4 support cargo and trade flows. The region's rail providers are the Central Oregon & Pacific and the White City Terminal Railroad. There is no passenger rail line through the region. The Central Oregon & Pacific Line follows I-5 through the region, then runs west through Lane County and loops back into Region 4 through Reedsport. The White City Terminal Railroad is a short spur off the Central Oregon & Pacific Line in Jackson County (Loy et al., 1976). Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and carry products from other states to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 4. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Rogue Valley International-Medford Airport is the only commercial airport in the region and is the third busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated and administered by Jackson County Aviation Authority. It serves eight hubs and four air carriers with approximately 56 arriving and departing flights daily (Jackson County, Oregon, airport website, http://www.co.jackson.or.us/SectionIndex.asp?SectionID=5).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-255. Public and Private Airports in Region 4

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 4	10	26	0	13	49
Douglas	4	12	0	4	20
Jackson	4	11	0	7	22
Josephine	2	3	0	2	7

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

Several power supply companies serve Region 4. The Bonneville Power Administration is the area's wholesale electricity distributor. The majority of the region is powered by PacifiCorp (Pacific Power and Light). The Coos-Curry Electric Cooperative and the Douglas Electric Cooperative serve portions of Douglas and Josephine Counties. The Umpqua Indian Utility Cooperative serves the Cow Creek Band of Umpqua Tribe of Indians, including the site of the Seven Feathers Casino Resort located in Douglas County north of Grants Pass and south of Roseburg.

Table 2-256 lists electric power-generating facilities within Region 4. The region has a total of eight power-generating facilities: three are hydroelectric power facilities, and five are categorized as "other" (primarily biomass). In total the power-generating facilities have the ability to produce up to 391 megawatts of electricity.

Table 2-256. Power Plants in Region 4

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 4	3	0	0	0	5	8
Douglas	1	0	0	0	3	4
Jackson	2	0	0	0	1	3
Josephine	0	0	0	0	1	1
Energy Production (MW)	**305**	**0**	**0**	**0**	**86**	**391**

* "Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The majority of electrical power in Region 4 is generated through hydropower. Dams for hydropower generation are primarily situated on the Applegate, Rogue, and Umpqua Rivers. Dams operated by the Bonneville Power Administration (BPA) provide hydro-generated electricity to the state's consumer owned utilities. Major BPA dams in the region are located on the Applegate and Rogue Rivers.

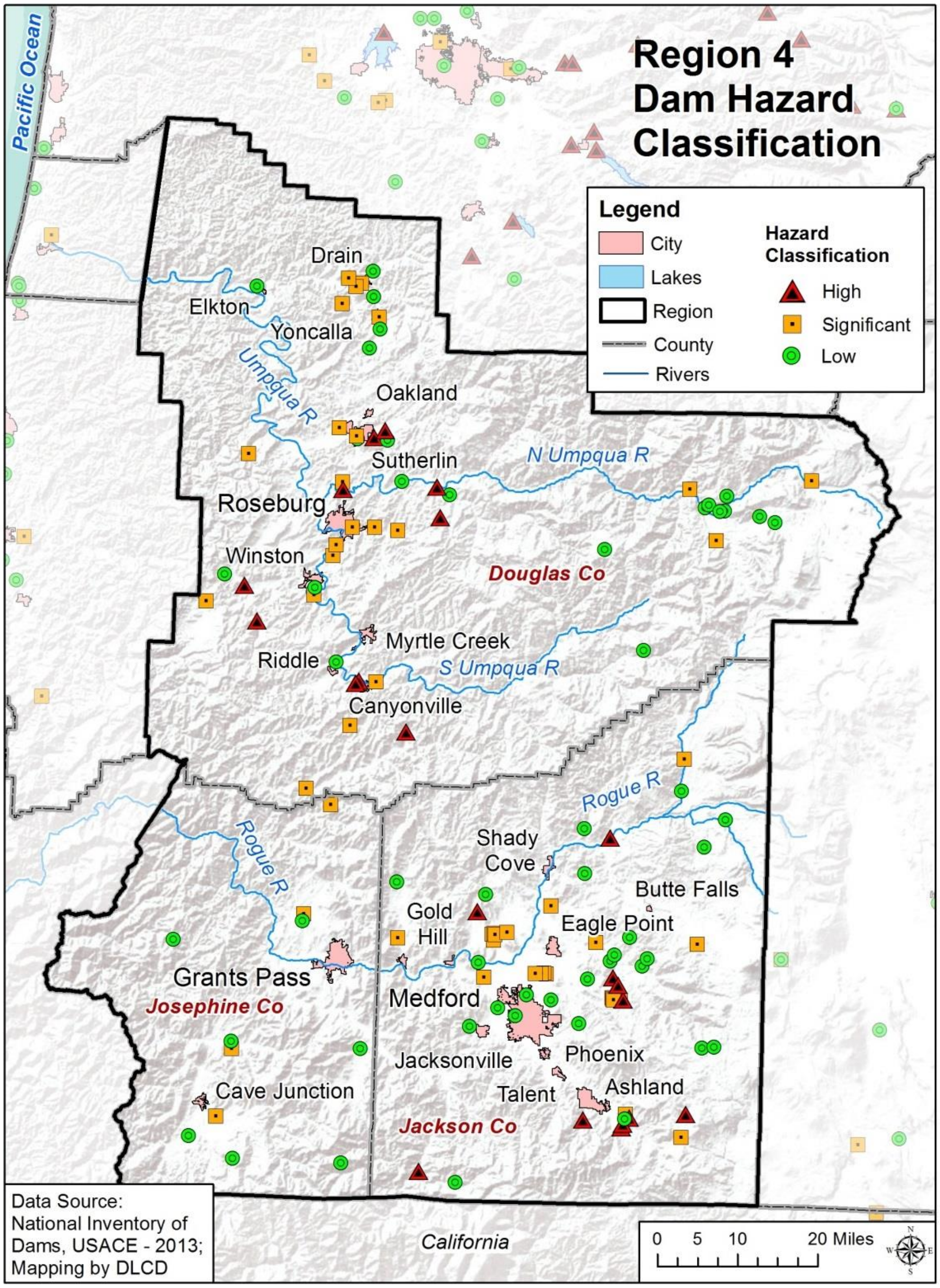
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Table 2-257 lists the number of dams included in the inventory. The majority of dams in the region are located in Douglas and Jackson Counties. There are 28 High Threat Potential dams and 42 Significant Threat Potential dams in the region.

Table 2-257. Threat Potential of Dams in Region 4

	Threat Potential			
	High	Significant	Low	Total Dams
Region 4	28	42	113	183
Douglas	13	20	52	85
Jackson	14	19	42	75
Josephine	1	3	19	23

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-144. Region 4 Dam Hazard Classification

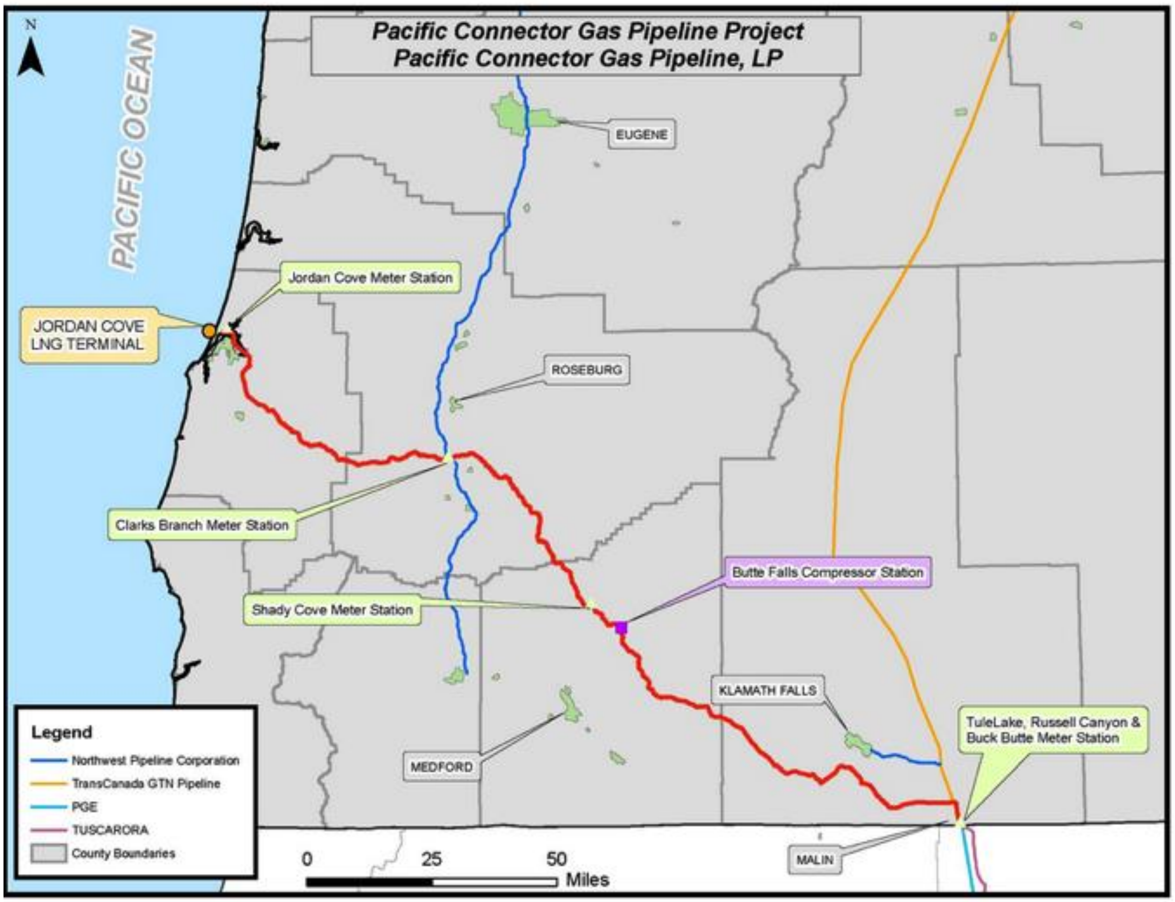


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to Pacific Power's portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. Figure 2-145 shows existing LNG pipelines and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). One pipeline, owned by the Northwest Pipeline Corporation, runs though Douglas and Josephine Counties. LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Figure 2-145. Liquefied Natural Gas Pipelines in Region 4



Source: Oregon Department of Environmental Quality, 2014

Utility Lifelines

Southwestern Oregon primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California through a separate network. The electric, oil, and gas lifelines that run through the county are both municipally and privately owned (Loy et al., 1976). These utility lifelines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

The network of electrical transmission lines running through Region 4 is operated by Pacific Power and Light and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 4 is part of the Southern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013), which also includes Coos, Curry, and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 5, Medford; and
- Channel 49, Grants Pass.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 4. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors (I-5, US-199, etc.) (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 4 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Southern Oregon Operational Area are (Oregon Office of Emergency Management, 2013):

- WWF-97, 162.475 MHZ, Ashland;
- WXL-85, 162.400 MHZ, Medford; and
- WXL-98, 162.550 MHZ, Roseburg.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 4 is served by ARES District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 4 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Douglas County: K7AZW;
- Jackson County: K7VS; and
- Josephine County: none available at this time.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 4 the majority of the municipal drinking water supply is obtained from surface water. In Jackson and Josephine Counties, the Rogue River provides municipal water supplies to most cities. The City of Cave Junction is an exception, obtaining water from the Illinois River. In Douglas County, most cities source their water from the Umpqua River and its tributaries.

Rural residents may get water from groundwater wells or surface water. Most rural residents in Douglas County use surface water sources for potable water. The majority of rural residents in Jackson and Josephine Counties use domestic wells outside of municipal boundaries. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways. Acid mine drainage from the Formosa mine, a U.S. Environmental Protection Agency Superfund site, is another non-point source of pollution. Acid mine drainage threatens the health of Middle Creek in southern Douglas County, a tributary to the Umpqua River.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 4, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 4. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speeds, and at lower temperatures. While some jurisdictions in Region 4 refer to LID techniques in their stormwater management plans, Medford is the only city that requires LID stormwater mitigation strategies in its development code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Older and structurally unsound bridges in Region 4 compromise transportation systems. The effects of bridge and road failures on the economy and health of the Region's residents could be devastating. About 18% of the region's bridges owned by the state are distressed.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are eight power-generating facilities in Southwest Oregon. Three are hydroelectric power facilities. The others are primarily biomass facilities. The major Bonneville Power Administration dams in the region are on the Applegate and Rogue Rivers. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential.

Buried natural gas transmission lines run through Douglas and Josephine Counties and are vulnerable to seismic activity.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from major transportation corridors. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lack system redundancies Drinking water is primarily sourced from surface water. The region is at risk in case of high levels of pollutants entering waterways through CSO's during high-water events. The implementation of decentralized low impact development (LID) stormwater systems can increase the region's capacity to better manage high-precipitation events. Medford is the only city that requires LID stormwater mitigation strategies in its development code.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Between 2000 and 2010 urban populations in Region 4 have grown by about 14%; more than 4 times the percent growth in rural areas. Jackson and Josephine Counties are experiencing the most urban growth in people and housing. Growth in Douglas County is more evenly distributed between urban and rural areas. Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Ashland, Medford, Grants Pass and Roseburg.

Table 2-258. Urban and Rural Populations in Region 4

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 4	238,659	271,312	13.7%	118,735	122,274	3.0%
Douglas	58,411	63,332	8.4%	41,988	44,335	5.6%
Jackson	141,112	162,458	15.1%	40,157	40,748	1.5%
Josephine	39,136	45,522	16.3%	36,590	37,191	1.6%

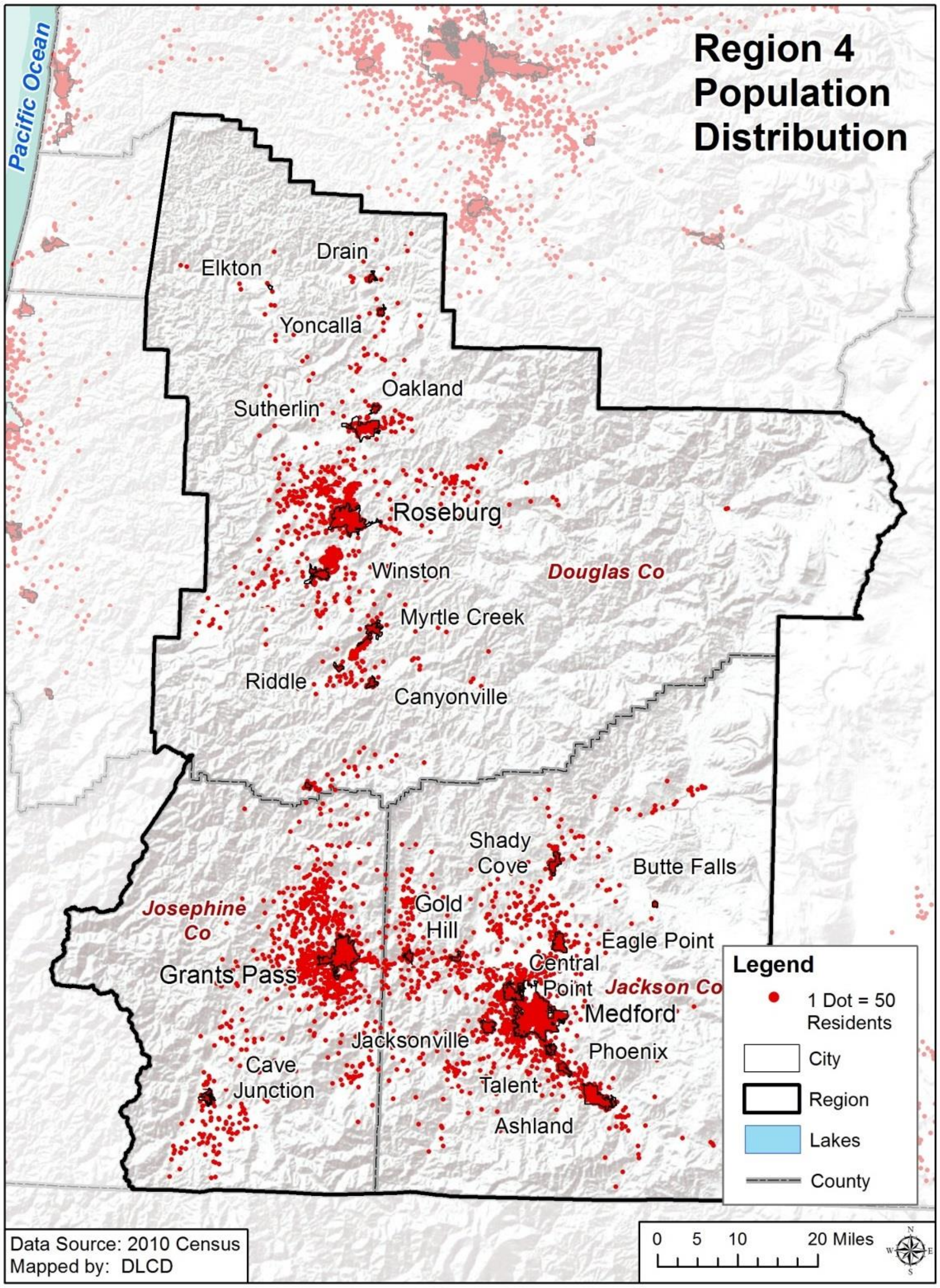
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-259. Urban and Rural Housing Units in Region 4

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 4	101,546	121,709	19.9%	50,714	56,144	10.7%
Douglas	25,273	28,553	13.0%	18,011	20,362	13.1%
Jackson	59,255	72,470	22.3%	16,482	18,467	12.0%
Josephine	17,018	20,686	21.6%	16,221	17,315	6.7%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-146. Region 4 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns (Lettman, 2011)

Land use for Region 4 is dominated by forestry (78%), with the majority of land owned by the Federal Government. Agricultural activities (15%) are the second major land use, for primarily field crops, orchard and livestock.

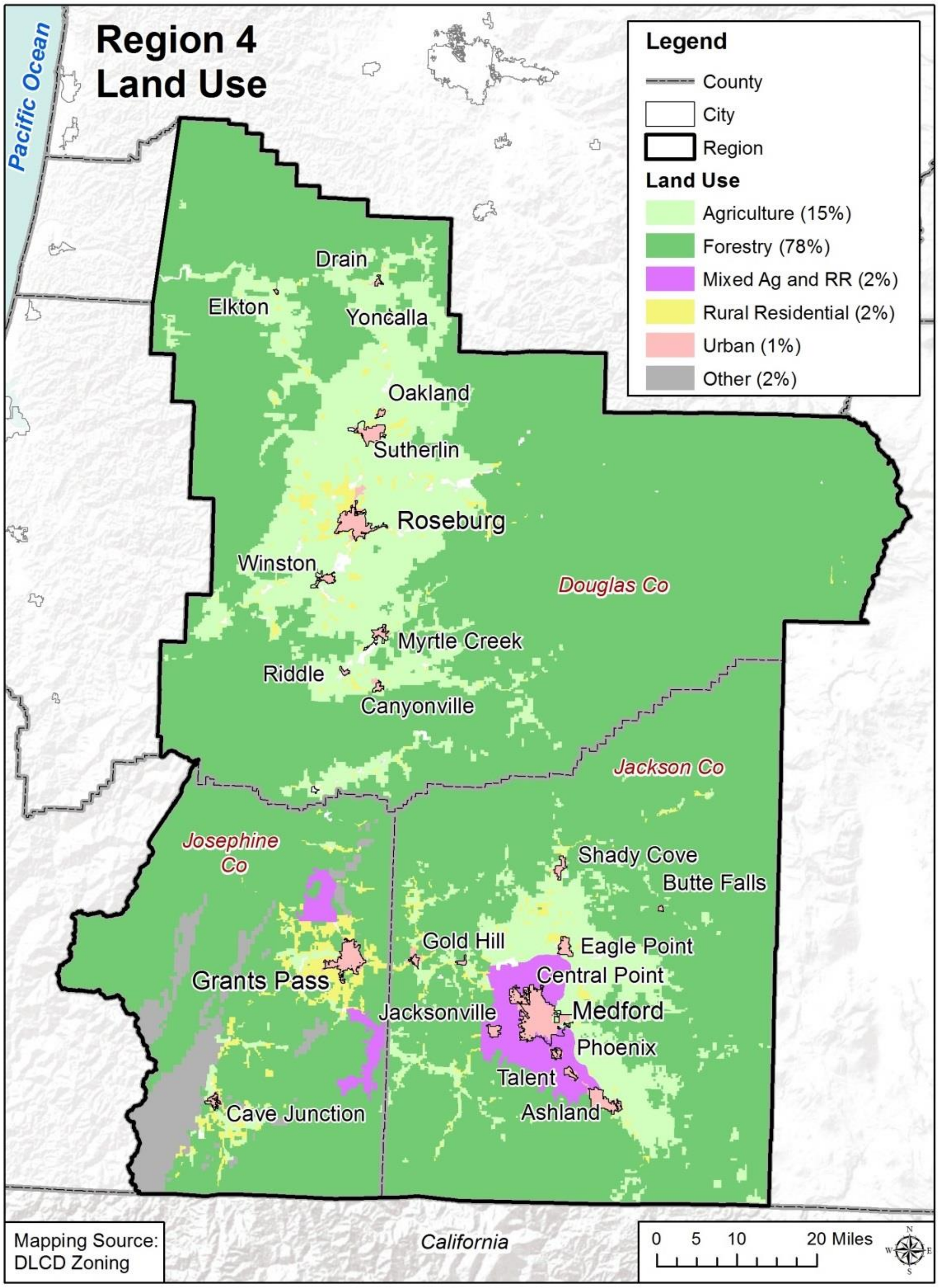
Under Oregon's land use system, each urban area is required to define an Urban Growth Boundary (UGB). Housing tracts, shopping malls, and other kinds of urban development are not allowed to sprawl past that boundary, while agricultural lands and open space outside a UGB are preserved. In Region 4, Roseburg has a significant area to the north along I-5 that can accommodate growth. Grants Pass has room to expand in several directions. Other communities, such as Medford, Central Point, and Jacksonville have little land reserved for urban expansion.

During the 25-year period between 1984 and 2009, Josephine County had a high rate of conversion of private land to developed uses. 14% of the county's 237,000 acres of private land in forest and agricultural uses was converted to low-density residential or urban uses — most of this change occurred between 1974 and 1984. However, the rates of conversion of private land in resource land uses to low-density residential or urban uses declined in the region and almost stopped between 2000 and 2009. Strong farm and forest land protections played a role in this decline. State statutes and rules establish standards for dwellings, uses and land divisions in rural areas to limit incompatible development and land fragmentation and to ensure that newly created farm and forest parcels remain commercially viable for farm and forest use (Lettman, 2011).

These changing land use development patterns and protections contribute to a slowing of the growth in the region's wildland-urban interface and other developed areas. While this does not necessarily lessen the wildfire risk in Region 4, it does provide the communities an opportunity to use tools such as the Josephine and Jackson County Integrated Fire Plans to reach vulnerable communities with wildfire risk assessment, outreach, and education.

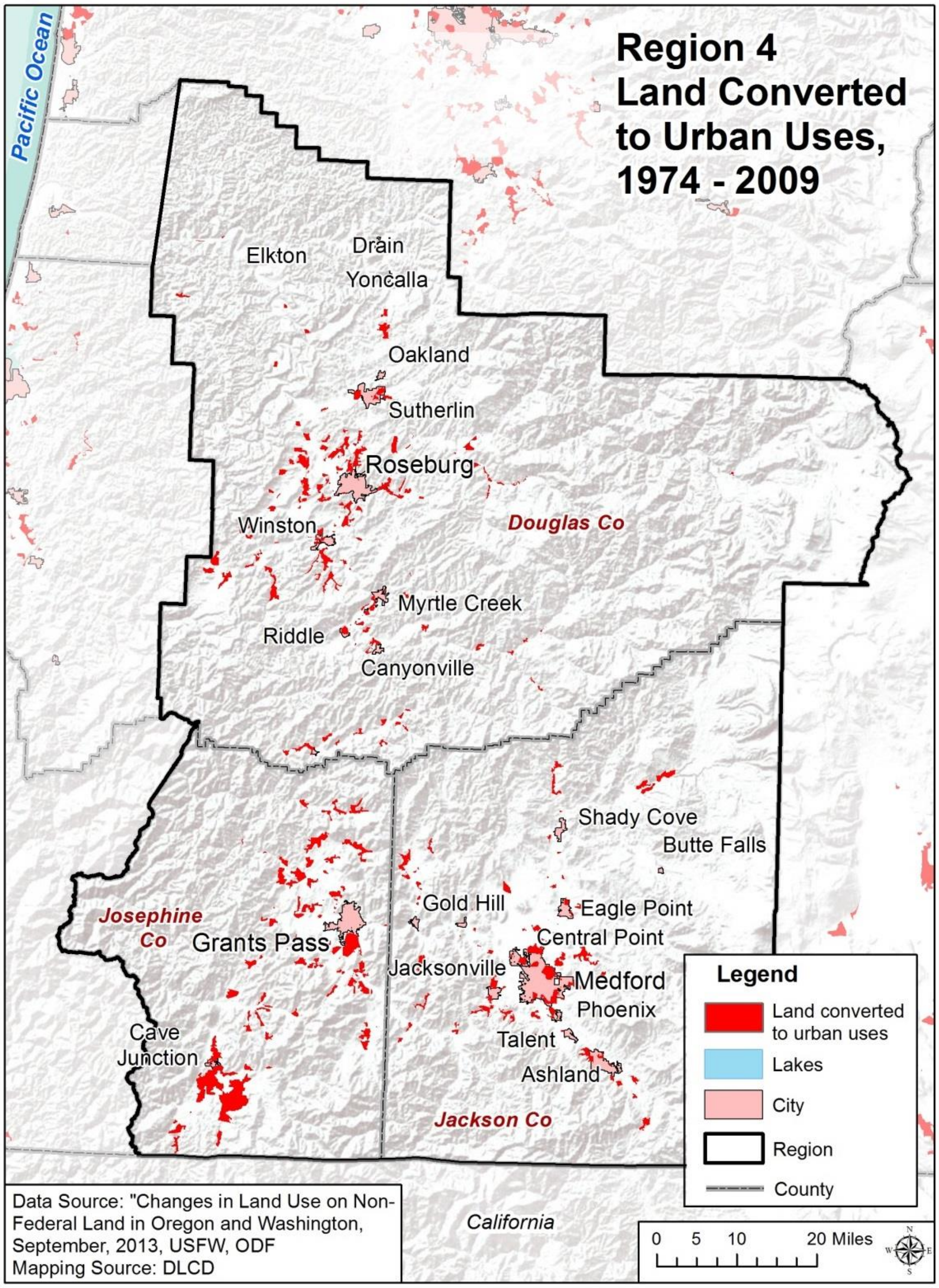
Regional problem solving activities are also addressing land use and development issues and how to guide growth. The "Greater Bear Creek Valley Regional Problem Solving Project" involves Jackson County and six cities in the Rogue Valley in guiding urban growth and development, while preserving priority farmland and floodplain.

Figure 2-147. Region 4 Land Use



Source: Department of Land Conservation and Development

Figure 2-148. Region 4 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. A significant portion of Douglas and Josephine Counties' housing stock is mobile homes. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-260. Housing Profile for Region 4, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 4	177,544	124,002	69.8%	25,846	14.6%	26,540	14.9%
Douglas	48,775	33,820	69.3%	5,613	11.5%	8,820	18.1%
Jackson	90,814	63,378	69.8%	15,730	17.3%	11,469	12.6%
Josephine	37,955	26,804	70.6%	4,503	11.9%	6,251	16.5%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25024

Aside from location and type of housing, the year structures were built (Table 2-261) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally 32% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. A larger share of housing in Jackson and Josephine Counties was built after 1990 than does Douglas County.

Table 2-261. Age of Housing Stock in Region 4, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 4	177,544	56,763	32.0%	59,336	33.4%	61,445	34.6%
Douglas	48,775	18,489	37.9%	16,749	34.3%	13,537	27.8%
Jackson	90,814	27,815	30.6%	28,322	31.2%	34,677	38.2%
Josephine	37,955	10,459	27.6%	14,265	37.6%	13,231	34.9%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. Table 2-262 shows the initial and current FIRM effective dates for Region 4 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-262. Community Flood Map History in Region 4

	Initial FIRM	Current FIRM
Douglas County	December 15, 1978	February 17, 2010
Canyonville	November 1, 1978	February 17, 2010
Drain	August 1, 1979	February 17, 2010
Elkton	September 5, 1979	February 17, 2010
Glendale	September 29, 1978	February 17, 2010
Myrtle Creek	February 15, 1978	February 17, 2010
Oakland	June 19, 1985	February 17, 2010
Reedsport	April 3, 1984	February 17, 2010
Riddle	August 1, 1979	February 17, 2010
Roseburg	June 1, 1977	February 17, 2010
Sutherlin	February 17, 2010	February 17, 2010 (M)
Winston	December 31, 1974	February 17, 2010
Yoncalla	February 17, 2010	February 17, 2010 (M)
Jackson County	April 1, 1982	May 3, 2011
Ashland	June 1, 1981	May 3, 2011
Butte Falls	June 30, 1976	June 30, 1976 (M)
Central Point	September 30, 1980	May 3, 2011
Eagle Point	September 30, 1980	May 3, 2011
Gold Hill	September 17, 1980	May 3, 2011
Jacksonville	December 4, 1979	May 3, 2011
Medford	April 15, 1981	May 3, 2011
Phoenix	May 3, 1982	May 3, 2011
Rogue River	January 2, 1980	May 3, 2011
Shady Cove	September 30, 1980	May 3, 2011
Talent	February 1, 1980	May 3, 2011
Josephine County	June 1, 1982	December 3, 2009
Cave Junction	June 1, 1982	December 3, 2009
Grants Pass	April 15, 1981	December 3, 2009

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 4 can be found in **Table 2-263**. The region contains 2.2% of the total value of state-owned/leased critical/essential facilities.

Table 2-263. Value of State-Owned/Leased Critical and Essential Facilities in Region 4

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 4	$164,409,632	2.2%
Douglas	$66,660,507	0.9%
Jackson	$60,819,133	0.8%
Josephine	$36,929,992	0.5%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 3 is largely urban with development focused around the major cities along I-5 including Ashland, Medford, Grants Pass and Roseburg. Douglas County's urban population is growing at about half the state's rate. The region's housing stock is largely single-family homes. The region has about twice the percentage of mobile homes than the state, with Douglas County having the greatest share of mobile units and Jackson County having the greatest number of units overall. Over 38% of homes in Jackson County were built after 1990 to current seismic building standards. All of the region's FIRMs have been modernized or updated.

2.3.4.3 Hazards and Vulnerability

Droughts

Characteristics

In Region 4, drought conditions can affect commerce, agriculture, fisheries, and overall quality of life. All three counties in Region 4 experienced drought conditions in 1992, 1994, 2001 and 2002. The Governor has not issued a formal drought declaration in Region 4 since 2002. In August 2013, the U.S. Department of Agriculture declared Jackson and Josephine Counties, along with Klamath and Lake Counties in Region 6, as federal primary natural disaster areas due to damages and losses caused by recent drought.

The lack of snow in the basin forced the Mount Ashland Ski Resort to close the 2013-14 season on March 13, 2014. For the first time in its 50-year history, Mount Ashland did not open for skiing or snowboarding (http://www.mtashland.com/News.asp?NewsID=400). On March 19, 2014, the Jackson County Commission declared a local drought disaster and had plans to ask the state for assistance. USDA reports showed snowpack in the Rogue Basin at 31% of average. The NRCS reported that without significant spring rainfall, water users in the Rogue and Umpqua basins could anticipate a water shortage in summer 2014. In early May, the Governor issued a drought emergency declaration for Jackson County. Josephine County was declared a few weeks later. Communities, such as Ashland, did not plant any new trees or shrubs to help offset drought-related concerns, and also decided to move forward on a new water pipeline to bring Medford water to Ashland for potential emergency use during the late summer months.

Historic Drought Events

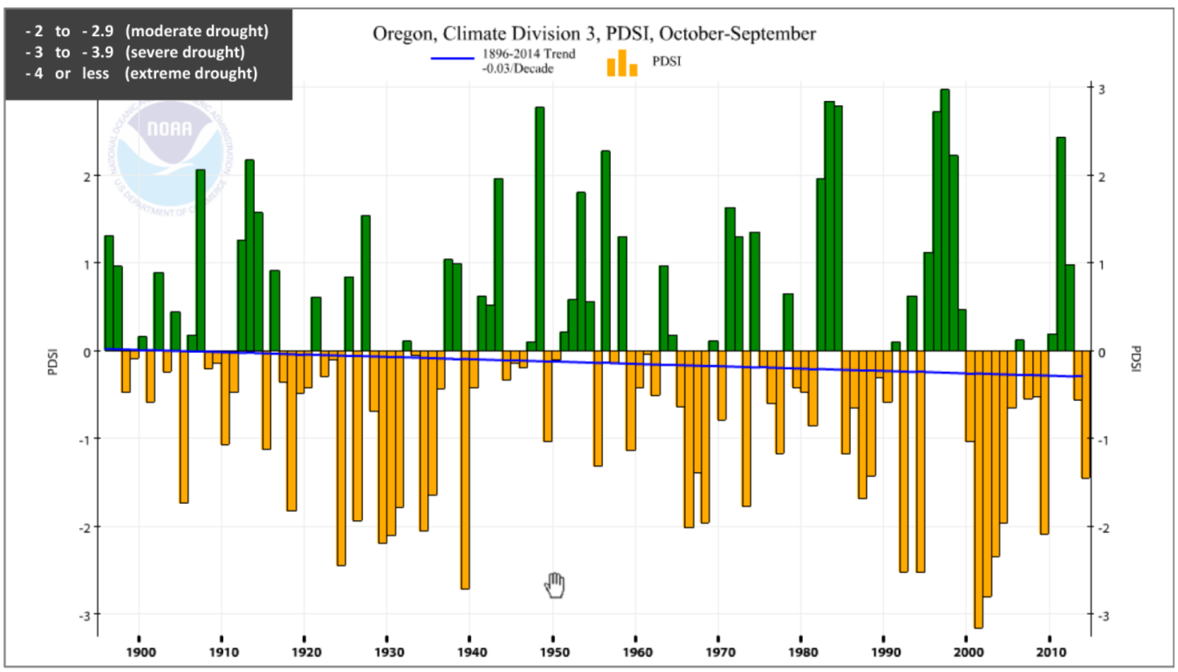
Table 2-264. Historic Droughts in Region 4

Date	Location	Description
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; water year 1939 was one of the more significant drought years in Region 4 during that period
1976-77	SW Oregon eastern Oregon	despite an insignificant PDSI value, the 1976-77 drought affected agriculture in Region 4; the water year was significantly drier than normal, but temperatures were near normal; the 1976-77 drought is included in this table because of the very large water year precipitation departures
1992	statewide	1992 fell toward the end of a generally dry period, which caused problems throughout the state
1994	SW Oregon eastern Oregon	In 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2001	SW Oregon eastern Oregon	Governor-declared drought in effect for all counties in Region 4 during 2001 as well as most counties in Regions 5, 6, 7, and 8
2002	coast; SW Oregon eastern Oregon	2001 Drought Declaration still in effect; five additional counties declared
2014	Regions 4, 6, 7, 8	Governor has declared drought in 10 counties in Oregon, including Region 4's Josephine and Jackson Counties

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Hazard Region 4, which encompasses Jackson, Josephine, and Douglas Counties, is prone to frequent droughts. Historic drought information can be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon because it does not account for snow or ice (delayed runoff), however, it has the advantage of providing the most complete, long-term record. During this record, the index shows that the southwestern valley experienced an extreme drought on one occasion (2001) and moderate drought on several occasions in the 1920s and 1930s, the early 1990s, the early 2000s and again in 2009 ([Figure 2-149]). Water Year 2014 has been a very dry for this area as well, with reservoir levels well below normal. The snowpack in this region peaked significantly below normal and set many record lows for snowpack levels at long term monitoring sites.

Figure 2-149. Palmer Drought Severity Index for Region 4



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 4 will experience drought is shown in **Table 2-265**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-265. Local Probability Assessment of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	—	M	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis should be completed statewide to analyze and compare the risk of drought across the state.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-266**. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-266. Local Vulnerability Assessment of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	—	M	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 4 is vulnerable to drought-related impacts. All three counties — Douglas, Josephine, and Jackson — have each received 4 drought declarations since 1992. These occurred in 1992, 1994, 2001, and 2002.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

This part of Oregon has experienced no historic earthquakes of any significance that were centered in the region. However, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. The magnitude 7.3 deep-seated intraplate event centered near Brookings in 1873 was probably felt throughout Southwest Oregon. There have been no known intraplate events in the region's history or pre-history. The 1993 Klamath Falls earthquake was felt in the region, but no damage was reported.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 2, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Historic Earthquake Events

Table 2-267. Significant Earthquakes Affecting Region 4

Date	Location	Magnitude (M)	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	based on studies of earthquake and tsunami at Willapa Bay, Washington; these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	approximately 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area	7.3	chimneys fell at Port Orford, Grants Pass, and Jacksonville; no aftershocks; origin probably Gorda block of the Juan de Fuca plate; intraplate event
Apr. 14, 1920	Fort Klamath, Oregon	5.0	three shocks felt at Fort Klamath; center: probably in the vicinity of Crater Lake
Mar. 1993	Scotts Mills	5.6	$28 million in damage; damage to homes, schools, businesses, state buildings (Salem); crustal event (FEMA-985-DR-Oregon)
Sep. 1993	Klamath Falls	5.9 to 6.0	two earthquakes causing two deaths and extensive damage; $7.5 million in damage to homes, commercial, and government buildings; crustal event (FEMA-1004-DR-Oregon)

*BCE: Before Common Era.

Source: Wong and Bolt (1995)

Probability and Vulnerability

As stated in the **State Risk Assessment**, section, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience earthquakes is shown in **Table 2-268**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-268. Local Probability Assessment of Earthquake in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	M	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

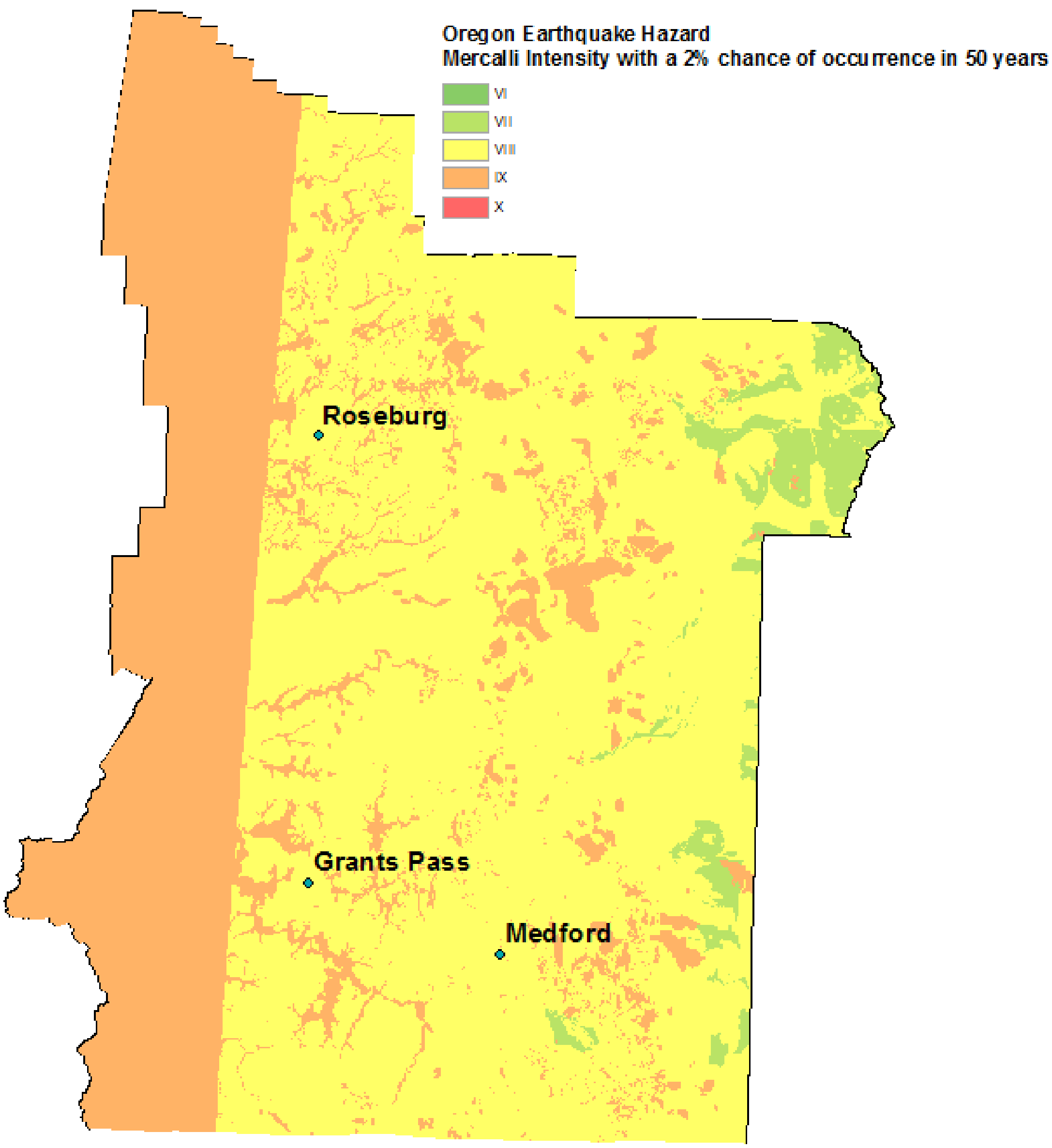
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 4 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

The probabilistic earthquake hazard for Region 4 is depicted in **Figure 2-150**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone (CSZ).

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-150**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37-43%

Figure 2-150. Probabilistic Earthquake Hazard in Region 4



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-269**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-269. Local Vulnerability Assessment of Earthquake in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Region 4 is especially vulnerable to earthquake hazards because much of the area is susceptible to earthquake-induced landslides, liquefaction, or strong ground shaking. Based on DOGAMI's projected loss estimates to either a CSZ event or to combined crustal events using a 500-year model, all three counties in Region 4 are among the top 15 counties in the state projected to experience the greatest losses and damages.

In 2007, DOGAMI (Lewis, 2007) completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI surveyed a total of 3,349 buildings, giving each a "low," "moderate," "high," or "very high" potential of collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore *approximate* rankings (Lewis, 2007). To fully assess a building's potential of collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help prioritize buildings for further study. **Table 2-270** shows the number of buildings surveyed in each county with their respective rankings.

Table 2-270. Building Collapse Potential in Region 4

Region 4 Counties	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Douglas*	74	45	40	10
Jackson	139	13	87	22
Josephine	37	15	16	1

*Does not include the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007)

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) a Cascadia Subduction Zone (CSZ) 8.5 event, and (b) combined crustal events (using a 500-year

Model). Loss and damage estimates based on these models are founds in Table 2-271 and Table 2-272. For more information on these models, see the State Risk Assessment section.

Table 2-271. Projected Dollar Losses in Region 4, Based on an M8.5 Subduction Event and a 500-Year Model

Region 4 Counties	Economic Base Loss in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) From an 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year (Crustal) Event
Douglas	$4,631,000	$275,000	$546,000
Jackson	$7,829,000	$538,000	$1,191,000
Josephine	$3,240,000	$593,000	$848,000

Source: Wang and Clark (1999)

Table 2-272. Estimated Damages and Losses in Region 4 Associated with Two Earthquake Models

	M8.5 CSZ Event			500-Year Model[1]		
Damage/Loss Type	**Douglas**	**Jackson**	**Josephine**	**Douglas**	**Jackson**	**Josephine**
Injuries	151	428	418	294	930	585
Deaths	2	8	7	4	18	11
Displaced households	255	650	573	534	1,458	872
Economic losses for buildings[2]	$275 m	$538 m	$593 m	$546 m	$1.2 b	$847 m
Operational the “day after” the event[3]:						
Fire stations	66%	75%	22%	N/A	N/A	N/A
Police stations	57%	62%	45%	N/A	N/A	N/A
Schools	44%	70%	34%	N/A	N/A	N/A
Bridges	74%	84%	73%	N/A	N/A	N/A
Economic losses to:						
Highways	$43 m	$10 m	$16 m	$69 m	$34 m	$29 m
Airports	$5 m	$2 m	$5 m	$9 m	$8 m	$10 m
Communications	$7 m	$2 m	$4 m	$12 m	$9 m	$8 m
Debris generated (thousands of tons)	222	434	476	411	889	614

Notes:

[1]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults, each with a 10% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single “average” earthquake during this time. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]There are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat” (Wang, 1998, p. 5)

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the “day after” cannot be calculated.

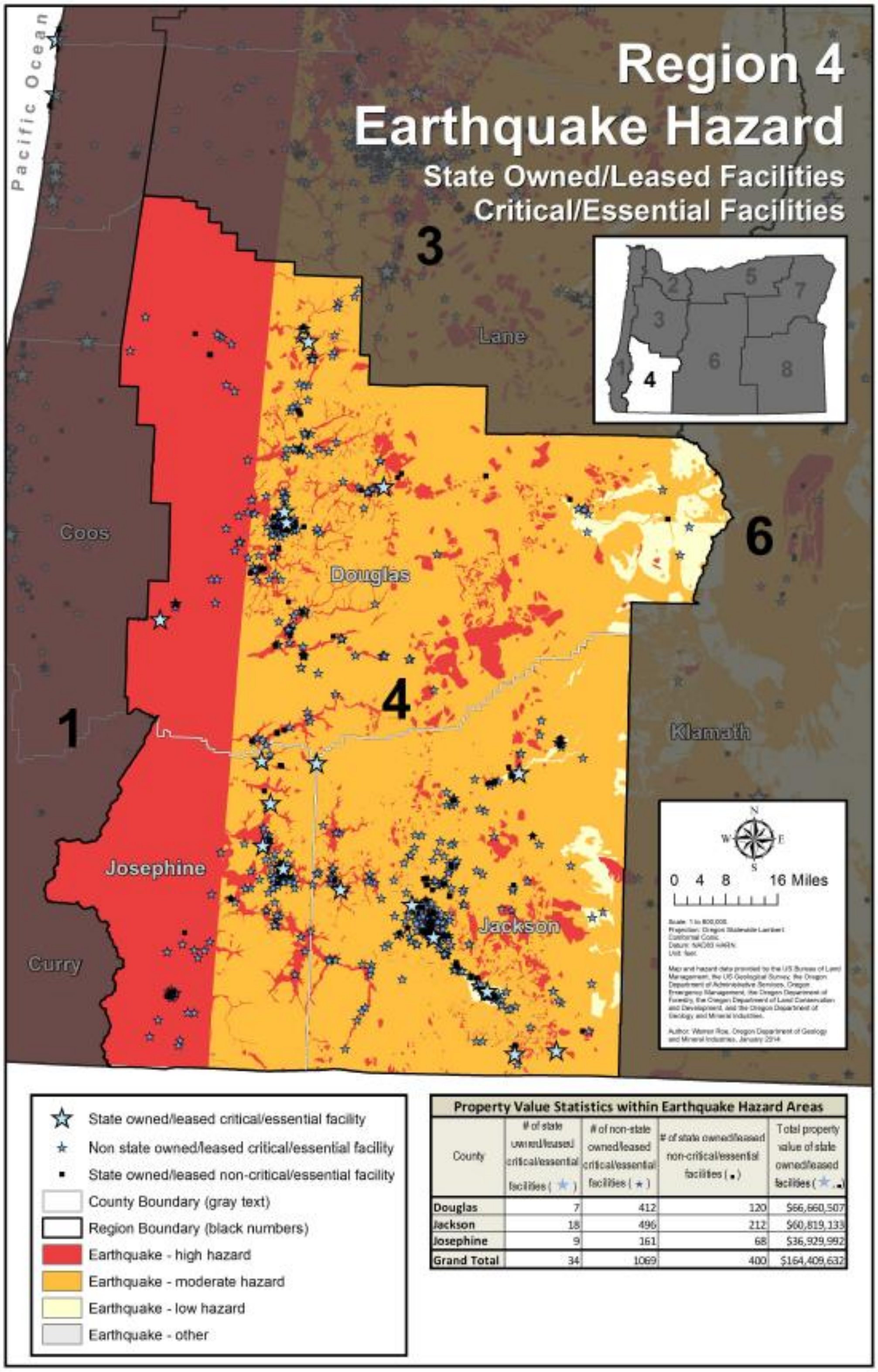
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information

Of 5,693 state facilities evaluated, 434 totaling $164.4 million worth of property fall into an earthquake hazard zone in Region 4 (**Figure 2-151**). Among the 1,141 critical or essential state facilities, 34 are in an earthquake hazard zone in Region 4. Additionally, 1,069 non-state-owned/leased critical or essential facilities in Region 4 are located in an earthquake hazard zone.

Figure 2-151. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 4



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	7	412	120	$66,660,507
Jackson	18	496	212	$60,819,133
Josephine	9	161	68	$36,929,992
Grand Total	34	1069	400	$164,409,632

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 4 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 4:

- *South I-5 Geographic Zone:* Region 4 is primarily in this geographic zone where the only recommended seismic lifeline is I-5 from Eugene to the California border. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. All of I-5 in this zone was designated a Tier 1 route (highest priority roadway) due to its importance in the region and the lack of alternate corridors.
- *Cascades Geographic Zone:* Region 4 also includes the southerly portion of the Cascades Geographic Zone. The only seismic lifeline in this area is the Tier 2 route (second highest priority roadway) on OR-140 from Medford to US-97 in Klamath County, the southernmost route that can also serve as a connection from Medford to the Klamath Falls area in a seismic event. OR-140 is a mountain road that has risks related to dam failure, landslide, and rockfall and also runs through some high-water-table areas.
- *Coastal Geographic Zone:* Region 4 includes a Tier 3 lifeline (third highest priority) in the Coastal Zone: US-199 from I-5 to the Oregon-California border, connecting with US-101 near Crescent City, California. US-199 has a high risk of rockfall approaching its western end and also runs closely along a riverbed so may be vulnerable to liquefaction damage.

REGIONAL IMPACT. Routes in Region 4 are vulnerable to ground shaking, landslides, rockfall, and liquefaction.

- Ground Shaking: In Region 4 ground shaking will be the most significant vulnerability in populated areas. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents from either a CSZ or Klamath Falls event.
- Landslides and Rockfall: Many roadways in the foothills within and around the valley include landslide prone features. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Liquefaction: Structures in wetland, alluvial and other saturated areas, including the many Umpqua and Rogue River crossings, may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

REGIONAL LOSS ESTIMATES. Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so for example, it does not include productivity losses due to business site damage. The highway-related losses include disconnection from supplies and replacement inventory and the loss of tourists and other customers who must travel to do business with affected businesses.

MOST VULNERABLE JURISDICTIONS. Inland Douglas, Jackson, and Josephine Counties are generally equally vulnerable to ground shaking from a CSZ event. A Klamath Falls event has the potential to affect Ashland and Jackson County more that it would Josephine or Douglas County. All three counties have steep rural areas and to some extent steep developed areas that may experience landslides. All three have some transportation facilities along river beds or river crossings that may be vulnerable to liquefaction. The biggest risk is from a CSZ event with an epicenter off the southern Oregon coast.

Floods

Characteristics

A number of large floods have been recorded in Southwest Oregon, many of which were very destructive. Recurrence is virtually assured, since some areas at risk are rapidly urbanizing. This region has the distinction of having two major rivers – the Umpqua and Rogue Rivers – that have their origins in the Cascade Mountains and continue to flow through the Coast Range to the Pacific Ocean. Their headwaters receive an abundance of mountain snow. At lower elevations they may receive runoff from intense Pacific storms, which are not uncommon in western Oregon. A combination of rapidly melting snow and intense rain can produce disastrous flood conditions. **Table 2-273** lists some significant floods that affected southwest Oregon communities. **Table 2-274** includes tributary streams that also have produced disastrous floods.

The physical beauty of the area has attracted a large number of people to various stream valleys, where they are placed at risk despite National Flood Insurance Program (NFIP) requirements. This is somewhat offset by Oregon's land use program, which generally prohibits the subdivision of farm and forestland for residential purposes.

Historic Flood Events

Table 2-273. Significant Historic Flood Events Affecting Region 4

Date	Location	Characteristics	Type of Flood
Mar. 1931	western Oregon	wet, mild weather; bridges and homes destroyed	rain on snow
Oct. 1950	southwest Oregon	severe flooding in Region 4; six fatalities; bridges and roads destroyed	rain on snow
Jan. 1962	western Oregon	heavy rain (3-4 inches in Rogue Valley); 84 people evacuated; great loss of farmland	rain on snow
Dec. 1964	entire state	infamous 1964 flood that has become an Oregon benchmark; record flows on Rogue and Umpqua Rivers	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt with rapid runoff	rain on snow
Jan. 1986	entire state	significant flooding in western Oregon attributable to warm, intense rain	snow melt
Jan. 1990	western Oregon	significant flooding in western Oregon	rain on snow
Nov. 1996	entire state	tropical air mass; intense rain; landslides; power outages (FEMA-1149-DR-Oregon)	rain on snow
Dec. 1996	entire state	mild weather continues; severe flooding in Ashland; FEMA declaration (FEMA-1160-DR-Oregon)	rain on snow
Dec. 2005	Douglas, Jackson and Josephine Counties	$2,840,000; damage estimate includes areas outside of Region 4	
June 2006	Jackson	heavy rain brought flash flooding to Jacksonville, but no reported damages	riverine
Aug. 2007	Jackson	heavy rains caused flash flooding near Ashland, no major estimated damages	riverine
Nov. 2012	Jackson	heavy rains resulted in at least 4 NFIP losses in the area around Central Point	riverine
Jan. 2012	Douglas	heavy rains resulted in at least two NFIP losses in the Roseburg areas	riverine

Source: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; 2014 BureauNet; National Climatic Data Center, Storm Events, available at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvnt~Storms

Table 2-274. Principal Flood Sources by County in Region 4

Douglas (Non-Coastal)	Jackson	Josephine
North and South Umpqua Rivers and tributaries	Rogue River and tributaries	Rogue River and tributaries
Tributaries: Scholfield Creek Deer Creek North and South Myrtle Creeks Cow Creek Newton Creek	Tributaries: Jump Off Joe Creek Louse Creek Waters Creek Applegate River Slate Creek Murphy Creek Illinois Creek East and West Forks of the Illinois River Deer Creek	Tributaries: Lazy Creek Larson Creek Griffin Creek Pleasant Creek Foots Creek Little Butte Creek Lone Pine Creek Lassen Creek Crooked Creek Daisy Creek Evans Creek Wagner Creek Ashland Creek Colman Creek Clay Creek Bear Creek

Sources: FEMA, April 21, 1999, Douglas County Flood Insurance Study (FIS); and FEMA, May 15, 2002, Jackson County FIS; and FEMA, Sept 27, 1991, Josephine County FIS

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience flooding is shown in **Table 2-275**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-275. Local Probability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 4 counties have digital Flood Insurance Rate Maps (FIRM); however, most of the modeling used to compile these maps is old and could be outdated. The effective FIRM maps are:

- Douglas, February 2010;
- Jackson, May 2011; and
- Josephine, December 2009.

Damaging floods occur approximately every 10-15 years.

According to the Draft Jackson County Hazard Mitigation Plan (2012) the most significant of the FEMA-determined floodplains and floodways surround the Rogue River, Bear Creek, Ashland Creek and Applegate River. Properties in and near the floodplains in the cities of Rogue River and Shady Cove are subject to frequent flooding events (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014). The Rogue and Applegate Rivers also are sources of flooding in Josephine County, along with Slate Creek and the Illinois River. Rogue River flooding affects the City of Grants Pass and Illinois River flooding affects the City of Cave Junction (http://www.oregonriskmap.com/index.php/county-profiles/county-profiles/143-example-county-profile-template-sp-23168, accessed 3/21/2014).

In Douglas County the highest stream flows in the Umpqua River basin usually occur during November through March as a result of heavy winter rains augmented by snowmelt. Most of the flooding occurs in the valley areas of the South Umpqua and Umpqua Rivers, although the tributary streams of Cow Creek, Calapooya Creek, and Elk Creek also have extensive flood plains. Most of the land subject to flooding along the South Umpqua River is below Days Creek. Because these valleys are the most densely populated and intensively developed in Douglas County, the principal flood problems occur along this stream. Flood potential also exists along the Umpqua River between Elkton and the confluence of the North and South Umpqua Rivers. In the Glendale-Azalea valley of Cow Creek, much bank erosion and channel shifting occurs during floods (http://www.oregonriskmap.com/index.php/county-profiles/county-profiles/142-douglas, accessed 3/21/2014).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-276**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-276. Local Vulnerability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-277**.

Table 2-277. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each county in Region 4 received a flood vulnerability score of 6, which is about average. A portion of Douglas County is in Region 1, but the vulnerability scoring process could only calculate scores countywide.

Josephine and Jackson County's Hazard Mitigation Plans report flood hazard probability is high but vulnerability as moderate. No explanation of these results was provided (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014; http://jocosheriff.us/your-sheriffs-office/emergency-management/nhmp, accessed 3/21/2014)., Douglas County cited insufficient information to estimate countywide vulnerability (http://www.co.jackson.or.us/Page.asp?NavID=3903, accessed 3/21/2014).

FEMA has identified 18 Repetitive Loss properties in Region 4, none of which are Severe Repetitive Loss properties.

Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Douglas and Jackson Counties participate in CRS, as do the cities of Ashland, Central Point, Grants Pass, Medford, Rogue River, Roseburg, and Talent.

Table 2-278. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 4

County	RL	SRL	# of CRS Communities per County
*Douglas	6	—	2
Jackson	7	—	6
Josephine	5	—	1
Totals	**18**	**0**	**9**

*Includes non-coastal sections of Douglas County

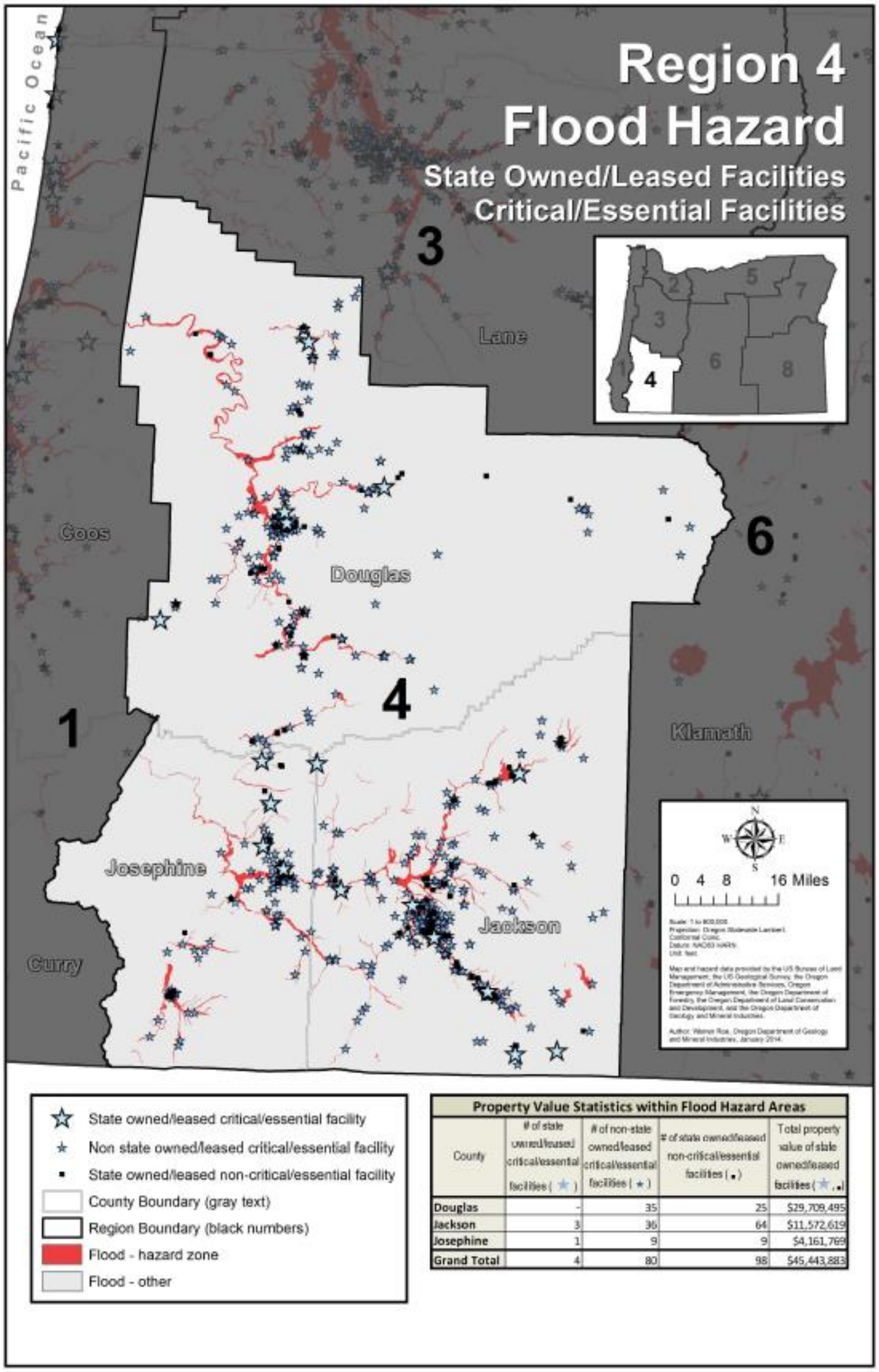
Source: FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 102 are currently located within a flood hazard zone in Region 4 and have an estimated total value of $45.4 million (**Figure 2-152**). Of these, four are identified as a critical or essential facility. An additional 80 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 4.

Figure 2-152. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Zone in Region 4



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (☆)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (☆, ▪)
Douglas	-	35	25	$29,709,495
Jackson	3	36	64	$11,572,619
Josephine	1	9	9	$4,161,769
Grand Total	4	80	98	$45,443,883

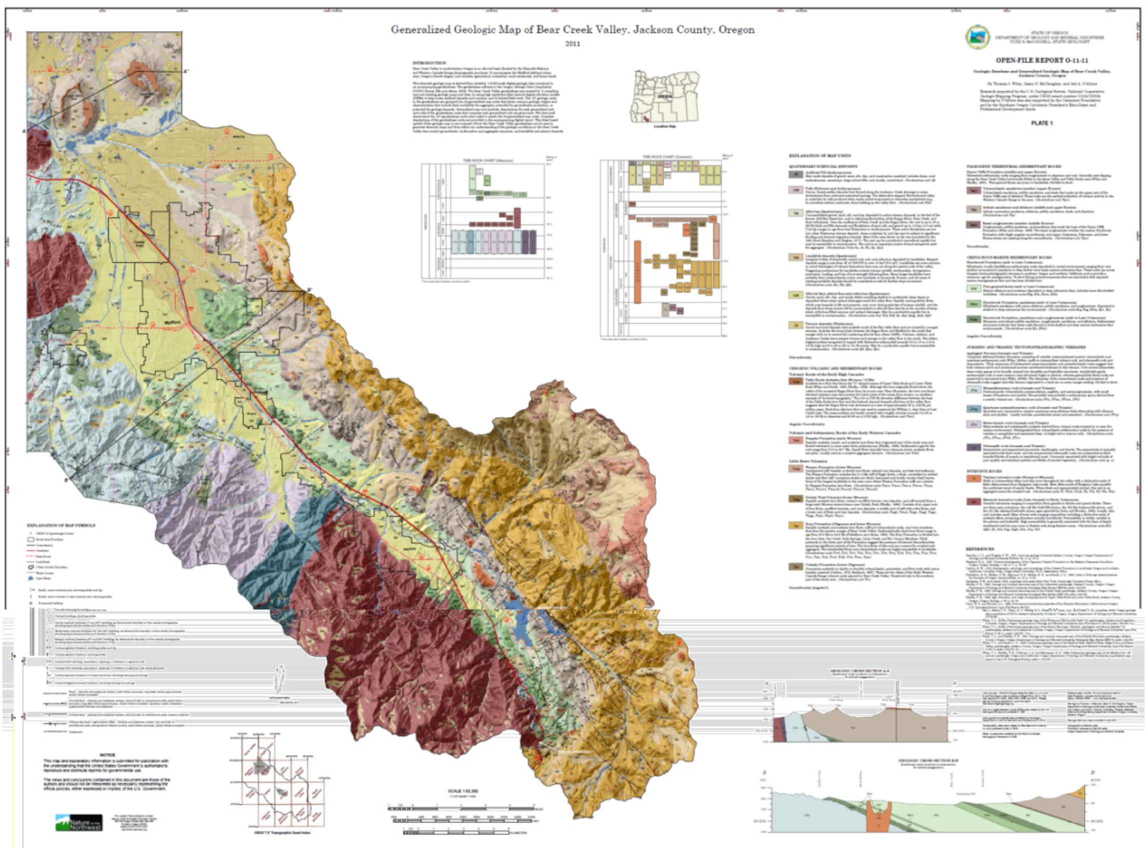
Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Klamath Mountains have a high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage. For example, new geologic mapping of the Medford area found 1,734 landslide, debris fan, and colluvium deposits indicating a high level of hazard in this small area (**Figure 2-153**).

Figure 2-153. Generalized Geologic Map of Bear Creek Valley, Jackson County, Oregon



Source: Wiley et al. (2011)

Historic Landslide Events

Table 2-279. Historic Landslide Events in Region 4

Date	Location	Incident
Jan. 1974	near Canyonville, Oregon	nine employees working in a telephone building were killed when the building was pushed by a mudslide into Canyon Creek
Feb. 1996		heavy rains and rapidly melting snow contributed to hundreds of landslides / debris flows across the state; many occurred on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	heavy rain triggered mudslides (Lane and Douglas Counties); eight fatalities and several injuries (Douglas County)

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience landslides is shown in **Table 2-280**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-280. Local Probability Assessment of Landslide in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-281**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-281. Local Vulnerability Assessment of Landslides in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

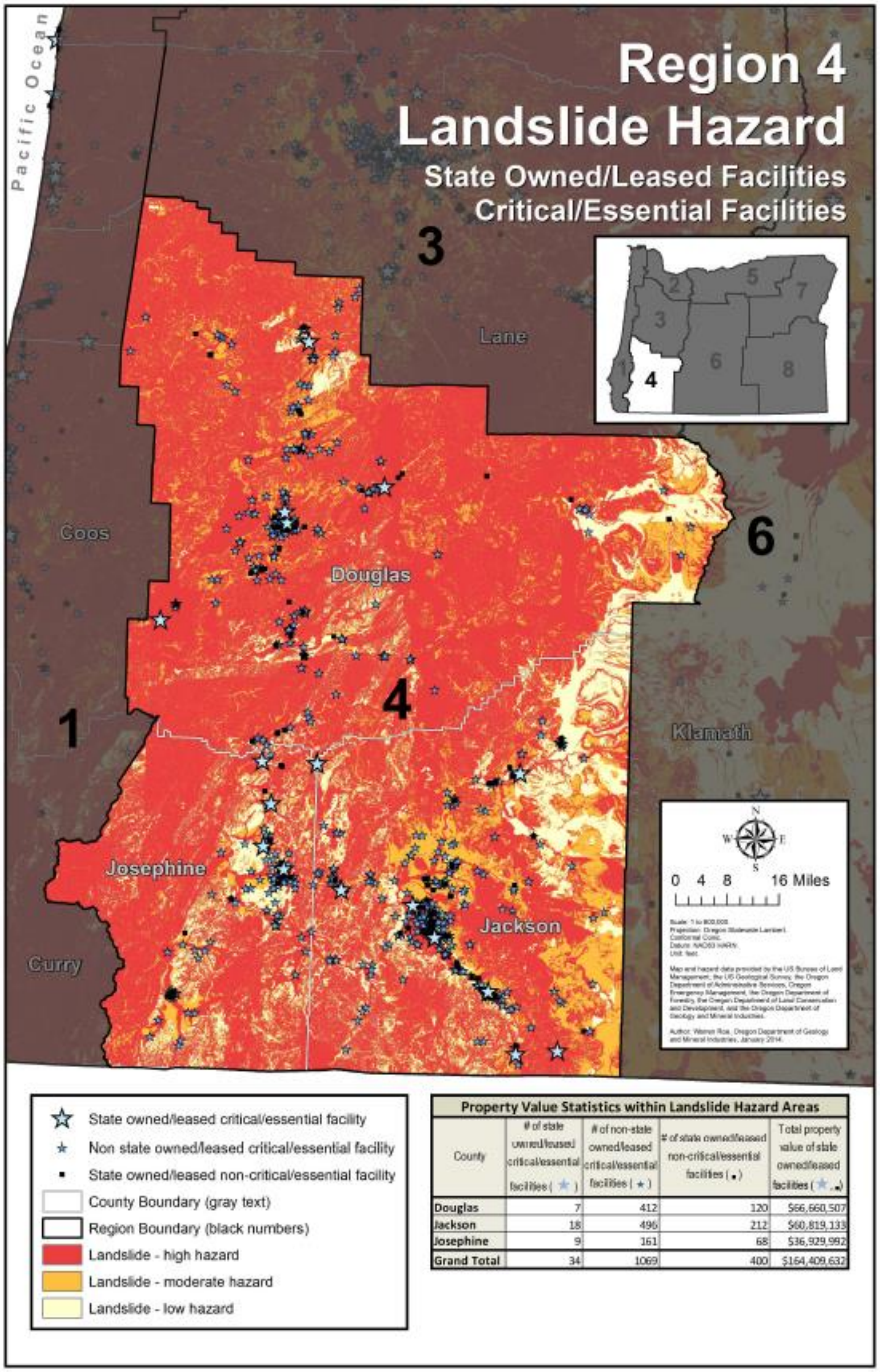
Many of the communities in this region are vulnerable to landslides; for example, the city of Medford and Ashland have a moderate exposure to landslides.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 434 are located within landslide hazard areas in Region 4, totaling roughly $164.4 million (**Figure 2-154**). This includes 34 critical or essential facilities. An additional 1,069 critical or essential facilities not owned/leased by the state are located within a landslide hazard zone in Region 4.

Figure 2-154. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 4



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	7	412	120	$66,660,507
Jackson	18	496	212	$60,819,133
Josephine	9	161	68	$36,929,992
Grand Total	34	1069	400	$164,409,632

Source: DOGAMI

Volcanoes

Characteristics

The eastern boundaries of Douglas and Jackson Counties coincide with the crest of the Cascade Mountains, a volcanic range. The Cascade Mountains are still active as has been demonstrated by Mount St. Helens in Washington State. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Both Douglas and Jackson Counties are at some risk from volcano-associated hazards however remote. Josephine County is west of the Cascade Mountains and is not subject to the same risks.

Southwest Oregon communities are close to several prominent volcanic peaks, one of which is a national park (Crater Lake). The other peaks include Mount Bailey (elevation 8,363 ft), Mount Thielsen (9,182 ft), and Mount McLaughlin (9,495 ft). Of the three, Crater Lake (6,178 ft) may pose the greatest risk. It is a caldera and the remnant of a mountain (Mount Mazama) that probably had an elevation between 10,800 and 12,000 ft. The massive eruption, which produced the caldera, took place about 7,700 years ago. The long history at Mount Mazama strongly suggests that this volcanic center will be active in the future (Bacon et al., 1997). The presence of the lake means that any future eruption likely will be violent; there are many examples of explosive activity brought about by magma coming into contact with water.

Douglas and Jackson Counties should consider the impact of volcano-related activity on small mountain communities, tourist attractions (e.g., Crater Lake) dams, reservoirs, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products, tourism, and recreation).

Historic Volcanic Events

Table 2-282. Historic Volcanic Events in Region 4

Date	Location	Description
about 7,780 to 15,000 YBP	Cinnamon Butte, southern Cascades	basaltic scoria cone and lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Bacon et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience volcanic hazards is shown in **Table 2-283**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-283. Local Probability Assessment of Volcanic Activity in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	—	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall. Ashfall could come from several sources in the Cascade Range, including Mount Shasta in California or Crater Lake in Oregon. The probability of ashfall totaling 1 cm or more in Josephine County, from any Cascade volcano, is about 1 in 10,000.

Douglas and Jackson Counties are at greater risk of volcanic hazards. The probability of a 1 cm or greater ashfall varies from 1 in 5,000 to 1 in 10,000 (Sherrod et al., 1997).

Based on the total number of eruptive episodes in the past 100,000 years, the average recurrence interval in the Crater Lake area is about 10,000 years. The annual probability of an eruption then, is about 1 in 10,000; the 30-year probability is about 1 in 330 (Bacon et al., 1997). The probability of an event is summarized in **Table 2-284** for each of the counties in Region 4.

Table 2-284. Probability of Volcano-Related Activity in Region 4

Volcano-Related Hazard	Douglas	Josephine	Jackson	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000 to 1 in 10,000	1 in 10,000	1 in 5,000 to 1 in 10,000	Sherrod et al. (1997)
Lahar	Source: Crater Lake	no risk	Source: Crater Lake	Bacon et al. (1997)
Lava flow	no risk	no risk	no risk	Bacon et al. (1997)
Debris flow / avalanche	no risk	no risk	Source: Crater Lake	Bacon et al. (1997)
Pyroclastic flow	Source: Crater Lake	no data available	Source: Crater Lake	Bacon et al. (1997)

Sources: Sherrod et al. (1997); Bacon et al. (1997)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-285**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-285. Local Vulnerability Assessment of Volcanic Activity in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	—	L	—

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

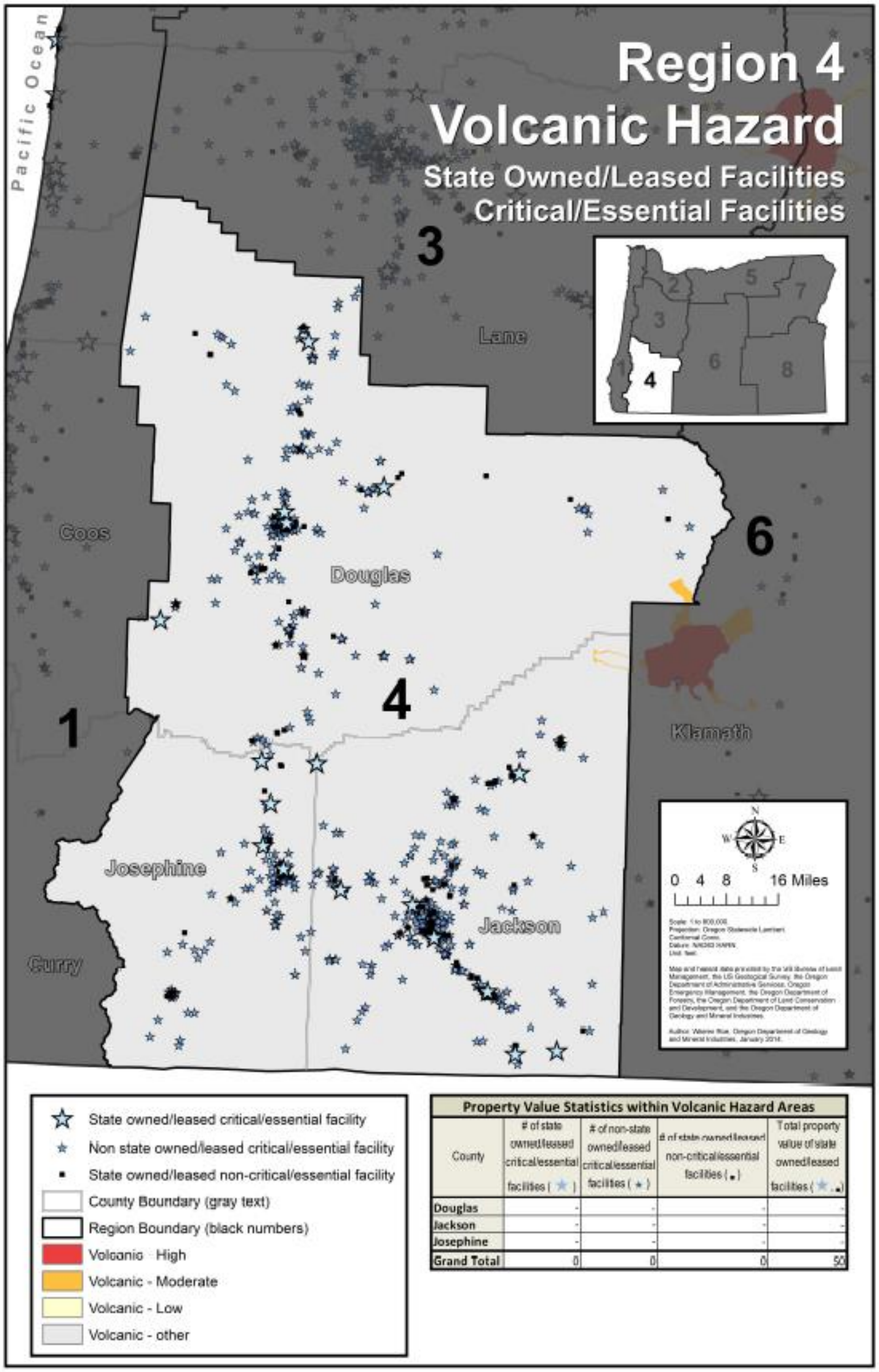
The U.S. Geological Survey has addressed volcanic hazards in the Crater Lake region (Bacon et al., 1997). This report includes maps depicting the areas at greatest risk. The park itself is in the greatest risk category. In Douglas County, the upper reaches of the Umpqua and Clearwater rivers are subject to volcano-associated hazards, as is the OR-62 corridor in Jackson County (Bacon et al., 1997; http://pubs.usgs.gov/of/1997/0487/). There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. (See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, none are located within a volcanic hazard area in Region 4. Furthermore, there are no non-state-owned/leased critical or essential facilities located within a volcanic hazard zone in Region 4 (**Figure 2-155**).

Figure 2-155. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Activity Hazard Zone in Region 4



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	-	-	-	-
Jackson	-	-	-	-
Josephine	-	-	-	-
Grand Total	0	0	0	50

Source: DOGAMI

Wildfires

Characteristics

While the residents in Region 4 enjoy moderate winters, during the summer residents can expect long drought periods, low humidity with temperatures that sometimes exceed 100 °F, and frequent lightning storms. Some landscapes are affected by autumn east winds that occur when stable air pushes across a mountain range and then descends on the leeward side. The air becomes warmer and drier as it descends and can lead to increased, sometimes extreme, fire behavior in lower lee-side locations.

Summers in Region 4 bring perfect weather conditions for extreme wildfires. Lightning strikes are frequent during the summer months, and the numerous strikes have the potential to ignite numerous fires.

Fire exclusion in Region 4 has created vegetation and fuel conditions for large and catastrophic fires that are more difficult to suppress than smaller fires. Throughout the watersheds, forests present a continuous fuel supply both vertically, in small, thin trees and dead branches (*ladder fuels*), and horizontally, in an abundance of dead and downed material. When a fire gets started in such a forest, the dead branches, sticks, twigs, and other material increase fire intensity and, with ladder fuels present, provide great opportunity for the fire to reach the forest canopy, resulting in a stand-killing crown fire. These conditions also affect the means in which prescribed fire and fuels treatment are applied to the landscape.

Current climate conditions, especially in drought years, influence the frequency, intensity, duration, and extent of fire. Summers are dry and lightning prone because a Pacific coast high-pressure system typically blocks precipitation for much of the season. In the upper elevations, where temperatures are low and rainfall is high, fires are less frequent than in the valleys. Larger climatic factors such as long-term global variations related to El Niño or to sunspot cycles also influence fire regimes, but this influence is confounded by local climatic variations, recent land management activities, and burns.

Historic Wildfire Events

Table 2-286 describes some of the more noteworthy fires in Oregon's history.

Table 2-286. Historic Wildfires in Region 4

Year	Name of Fire	County	Acres Burned	Remarks
1951	Hubbard Creek, Russell Creek, Vincent Creek Fires	Douglas	16,094	the Hubbard Creek Fire burned 15,774 acres and destroyed 18 homes; the Russell Creek Fire burned 350 acres and killed one person; the Vincent Creek Fire burned 23,000 acres near Scottsburg
1966	Oxbow Fire	Douglas	43,368	the Oxbow Fire killed one person
1987	Bland Mountain	Douglas	10,300	near Canyonville; 14 structures lost, 2 people killed
1992	E. Evans Creek	Jackson	10,135	four structures lost
1994	Hull Mountain	Jackson	8,000	one life and 44 structures were lost; the fire was an act of arson
1994	Sprignett Butte	Jackson	1,631	arson
2000	Antioch road	Jackson	376	
2002	Squires Peak/Wall Creek	Jackson	3,125	
2002	Timbered Rock	Jackson	27,111	
2002	Biscuit	Curry, Josephine	500,000	estimated to be one of Oregon's largest in recorded history, the Biscuit Fire encompassed most of the Kalmiopsis Wilderness
2003	Cove Road	Jackson	700	3 miles east of Ashland
2004	Bland Mtn. #2	Douglas	4,700	two homes lost
2008	Doubleday	Jackson	1,244	threatened Butte Falls
2010	Oak Knoll Fire	Jackson County	< 100	Oak Knoll Fire in Ashland destroyed 11 homes in less than 45 minutes
2013	Douglas Complex	Douglas, Josephine, Wasco, Grant	48,324	combined with fires in Region 5, 6, and 7, the most acres burned in since 1951 on lands protected by the Oregon Department of Forestry
2013	Brimstone	Josephine	2,377	part of southern Oregon fire storm that included the Douglas Complex above
2013	Big Windy	Josephine	26,725	part of southern Oregon fire storm that included Brimstone and Douglas Complex; one firefighter death

Source: 2013 Fire Statistics, Oregon Department of Forestry

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience wildfire is shown in **Table 2-287**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-287. Local Probability Assessment of Wildfire in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, 2013, County Hazard Analysis Scores

State Assessment

Hot and dry summers combined with frequent lightning events, rugged terrain, and an abundance of fuels makes Region 4 a hotbed of fire activity. Historically, some of Region 4's largest fires have been caused by human activity. While lightning-caused fires accounted for nearly 70% of the fires in 2013, the 10-year average for lightning-caused fires is closer to 25%.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-288**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-288. Local Vulnerability Assessment of Wildfire in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	M	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Region 4 is one of the state's regions most susceptible to wildfire. Based on data from the 2013 West Wide Wildfire Risk Assessment, all counties in Region 4 have a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Note: WWRA data does not differentiate between coastal and non-coastal Douglas County. Therefore, all of Douglas County is considered most vulnerable to wildfire.

Douglas, Josephine, and Jackson Counties are made up of several smaller communities that lie within the wildland-urban interface and have a distinct vulnerability to wildfire given their proximity to forestland, high summer temperatures, rugged terrain, and likelihood of summer thunderstorm activity. The human element is a factor as well with several populations intermixed in wildland areas. Arson continues to be a concern in this part of the state as well as the high number of fires caused by debris burning and equipment use.

Table 2-289. Region 4 Wildland-Urban Interface Communities

Douglas		Jackson	Josephine
Azalea	Lelomo Lake	Antelope Creek	Galice
Camas Valley	Lookingglass	Applegate	Grants Pass
Canyonville	Myrtle Creek	Ashland	Illinois Valley
Curtin	Oakland	Butte Falls	Merlin
Days Creek	Rice Hill	Colestin	Murphy
Diamond Lake	Riddle	Crow Foot	Oregon Caves
Dillard	Roseburg	Elk Creek	Selma
Dixonville	Steamboat	Gold Hill	Sunny Valley
Drain	Sutherlin	Green Springs	Wilderville
Dry Creek	Tenmile	Jacksonville	Williams
Elkton	Tiller	Lake Creek	Wolf Creek
Fair Oaks	Toketee	Medford	
Glenbrook	Tri City	Prospect	
Glendale	Umpqua	Rogue River	
Glide	Union Gap	Sams Valley	
Green Acres	Wilber	Shady Cove	
Winston	Wolf Creek	Trail	
Yoncalla		Union Creek	
		Upper Applegate	
		Wimer	

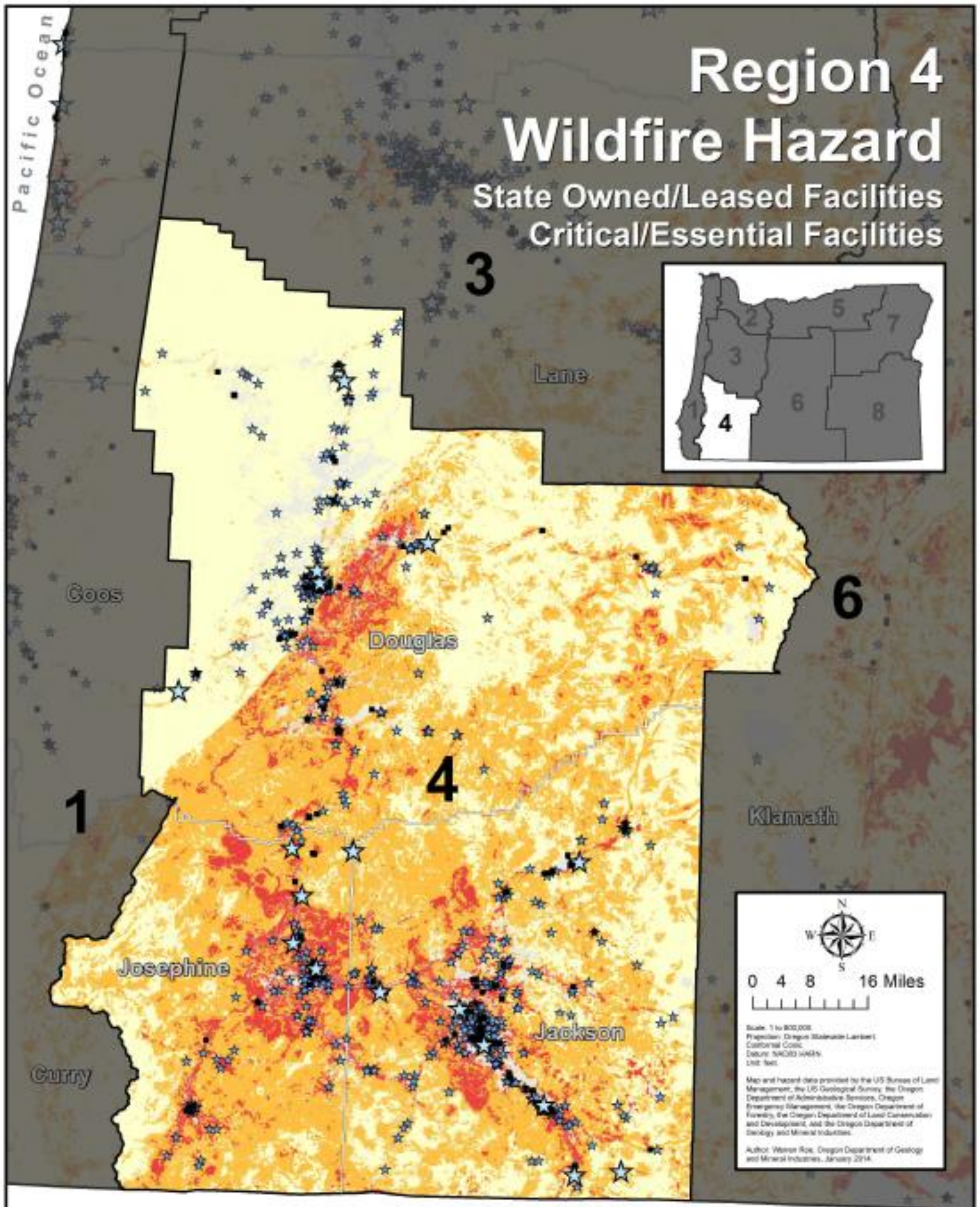
Source: ODF Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 198 are within a wildfire hazard zone in Region 4 and total about $44 million in value (**Figure 2-156**). Among state-owned/leased critical or essential facilities, 11 have a wildfire hazard in any category. An additional 408 non-state-owned/leased critical or essential facilities are located in Region 4.

Figure 2-156. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Zone in Region 4



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Douglas	4	226	49	$23,736,607
Jackson	5	158	109	$13,749,674
Josephine	2	66	29	$6,591,842
Grand Total	11	450	187	$44,078,123

Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. A majority of the destructive surface winds in Oregon are from the southwest. Under certain conditions, very strong east winds may occur, but these usually are limited to small areas in the vicinity of the Columbia River Gorge or other low mountain passes. The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 4.

Tornadoes have not been recorded in Jackson, Josephine, or central Douglas Counties.

Historic Windstorm Events

Table 2-290. Historic Windstorms in Region 4

Date	Affected Area	Characteristics
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71-mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million
Feb. 2004	Jackson County	heavy winds caused $4,000 in damages in Jackson County
Dec. 2006	Douglas and Josephine Counties	high winds up to 90 mph caused $150,000 in damages in Douglas and Josephine; the storm also impacted Coos and Curry Counties for a storm damage total of $300,000
July 2007	Josephine and Jackson Counties	severe thunderstorms with winds up to 60 mph down numerous trees damaging vehicles and trailers; $100,000 in damage in Jackson County; lightning struck the steeple of a church in Josephine County, causing $60,000 in damages

Sources: Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience windstorms is shown in **Table 2-291**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-291. Local Probability Assessment of Windstorm in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, 2013, County Hazard Analysis Scores

State Assessment

The 100-year event in Region 4 consists of 1-minute average winds of 80 mph. A 50-year event is 70 mph. A 25-year event has average winds of 60 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorms is shown in **Table 2-292**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-292. Local Vulnerability Assessment of Windstorm in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 4 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods and can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 4 can be characterized by extreme cold, snow, ice, and sleet. In higher elevations such as the lower Cascade Range and the Siskiyou Mountains and passes, moderate to heavy snowfall is expected on an annual basis. Some Region 4 communities are unprepared, financially and otherwise, for the impact of severe winter storms. An historical summary of extreme winter conditions in this region is shown in **Table 2-293**.

Historic Winter Storm Events

Table 2-293. Severe Winter Storms in Region 4

Date	Location	Characteristics
Dec. 1861	statewide	snow covered entire Pacific Northwest 1–3 feet
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Jan. 1932	SW Oregon mountains	Crater Lake record snowfall: 879 inches
Jan.- Feb. 1937	statewide	heavy snow throughout state
Jan. 1950	statewide	heaviest snowfall since 1890; highway closures; considerable property damage
Jan. 1951	Crater Lake, Oregon	new annual record snowfall at Crater Lake
Jan. 1956	western Oregon	packed snow became ice; automobile accidents throughout region
Mar. 1960	statewide	snowfall: 3–12 inches; over 100 accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; 47 inches in Eugene ; $3 to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	2-4 inches of snow in western valleys; massive power failures (tree limbs broke power lines)
Feb. 1986	Cascades, Oregon	heavy snowfall
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures
Nov. 1989	Siskiyou, Oregon	unusually heavy snowfall
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-1999	statewide	series of storms; one of the snowiest winters in Oregon history
Winter 2003-2004	statewide	most significant winter storm in several years brought snowfall to most of Oregon; largest snowstorm in the Siskiyou Pass (Jackson County) in a quarter century; shut down I- 5

Source: Taylor and Hatton (1999)

Source: Oregon Department of Transportation, 2008. *State Natural Hazards Mitigation Plan*, Winter Storm chapter.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 4 will experience winter storms is shown in **Table 2-294**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-294. Local Probability Assessment of Winter Storms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 4. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time. Higher elevations through the Siskiyou Mountains and the Cascade Range are expected to have higher annual snowfall amounts and this is planned for at the state and local level.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-295**. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-295. Local Vulnerability Assessment of Winter Storms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	H

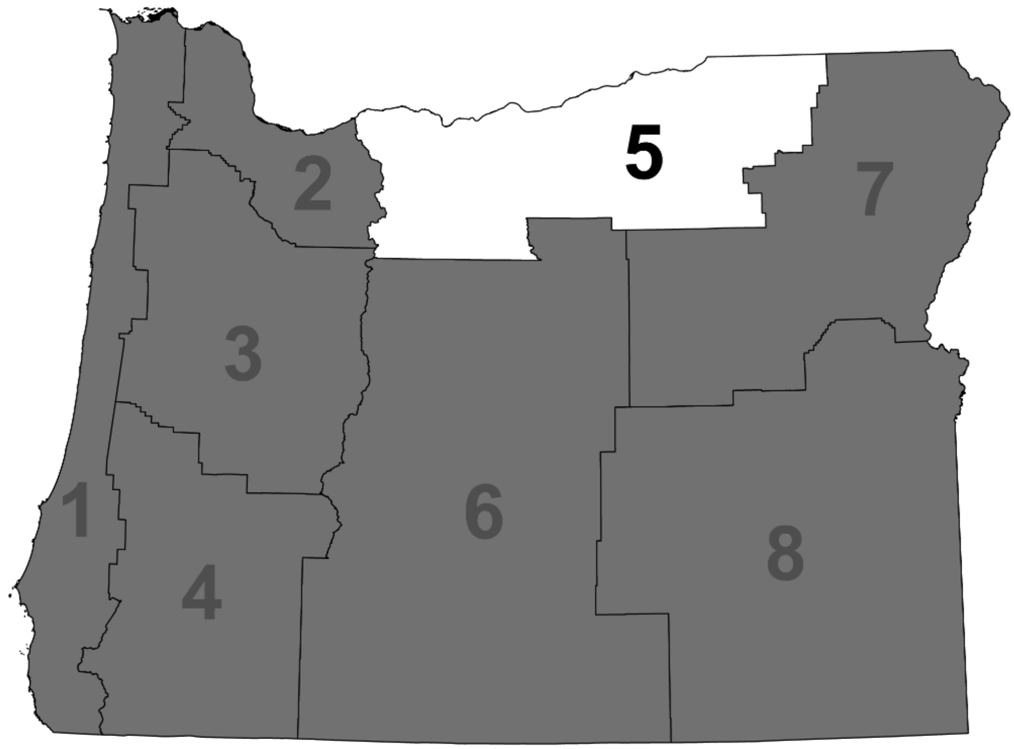
Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

All three counties in Region 4 are impacted by severe winter storms. The I-5 corridor passes through the Siskiyou Mountains in this region and is key to intermodal transportation. As well as the link to California and commodity flow. Severe winter storms can shut down this vital link for extended periods and can have a direct adverse impact on Oregon's economy.

2.3.5 Region 5: Mid-Columbia Region

Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties



2.3.5.1 Summary

Regional Profile

The region's demographic, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Across the region, social vulnerability is driven by fewer college degrees and high numbers of housing rentals and vacancies. At the county level the numbers of disabled persons in Gilliam; homeless people in Wasco and Umatilla; children in Hood River, Morrow, and Umatilla; seniors in Gilliam and Sherman; and people who do not speak English very well in Hood River and Umatilla are notable.

Overall, Region 5 has been rebounding from the financial crisis that began in 2007. Economic vulnerability is driven by high unemployment rates in Morrow and Umatilla Counties and low wages in Morrow and Hood River Counties.

Interstate-84, two rail yards, Amtrak lines, three ports, and one commercial airport support the economy and daily operations in Region 5. These integral transportation systems are susceptible to many natural hazards. Damage or interruption to the services these systems provide could be devastating to the region and state.

There are 31 power-generating facilities in the Mid-Columbia Region, including hydroelectric, natural gas, wind, and coal facilities. Liquid natural gas pipelines run through Gilliam, Morrow, and Umatilla Counties. Four additional wind facilities are proposed for the region. The diverse energy and drinking water systems here help reduce the area's vulnerability to damage and disruptions in service that can happen during a natural hazard event.

Surface water, wells, and springs supply local drinking water. These systems are vulnerable to non-point source pollution, erosion, and sedimentation that can adversely impact water quality. Rigid, buried infrastructure is vulnerable to seismic activity.

Region 5 is largely rural, with urban development occurring in communities along I-84 in Hood River County. Mobile homes, which are inherently more vulnerable to natural hazards, make up a significant share of the region's housing units. Over 80% of homes in Gilliam and Sherman Counties were built before 1990 and current seismic building standards. With the exception of Morrow and Umatilla Counties, none of the region's FIRMs have been modernized or updated — leaving this region's flood maps less up to date as other areas of the state.

Hazards and Vulnerability

Region 5 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in Region 5, particularly within Gilliam, Morrow, and Sherman Counties. Agricultural industries in the region are vulnerable to scarcity of water supplies during drought events.

Dust Storms: Strong winds can carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Dust storms affect the region annually, during summer months and periods of drought. Morrow and Umatilla Counties are the counties most vulnerable to dust storms in the state.

Earthquakes: Over all, the region is moderately vulnerable to three types of earthquakes: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) the offshore Cascadia Subduction Zone (CSZ) Fault. Primary vulnerabilities are due to shallow crustal and intraplate earthquakes that cause earthquake-induced landslides in the Cascades, ground shaking, and liquefaction. A CSZ event will affect markets to east upon which communities in Region 5. There are 411 state-owned/leased facilities, valued at over $528 million, in the earthquake hazard zone in this region. Of these, 76 are critical/essential facilities. An additional 1,446 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Rain-on-snow events during unseasonably warm winters create disastrous riverine flooding events in the Mid-Columbia Region. Flash floods associated with summer thunderstorms are also exceptionally damaging. All of the region's counties are considered moderately vulnerable to flooding. There are 265 state-owned/leased facilities, valued at approximately $6 million, located in the region's flood hazard zone. Of these, three are considered critical/essential facilities. An additional 35 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides at any time. Vulnerability is increased in populated areas within the Columbia River Gorge, along the I-84 corridor and in the Cascade Mountains. There are 631 state-owned/leased facilities, valued at over $744 million, located in this hazard zone in Region 5. Of these, 121 are critical/essential facilities. An additional 1,541 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: There are several active and potentially active volcanoes in the Cascade Range along the western border of the Mid-Columbia Region. Areas particularly vulnerable to volcanic activity include the Cities of Parkdale and Hood River near Mount Hood, and communities along the White River in Wasco County. Though most volcanic activity is considered local, lahars and ashfall can travel many miles, impacting small mountain communities, dams, reservoirs, energy-generating facilities, and highways. There are 321 state-owned/leased facilities, valued at approximately $259 million, located in a volcanic hazard zone in this region. Of these, 59 are critical/essential facilities. An additional 1,377 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Wildfires: This region has unique geographic features, weather characteristics, a history of unmanaged fuels, and an expanding wildland-urban interface that contribute to the region's susceptibility to wildfire. The majority of the forestlands in Region 5 are historically prone to wildfire. Summer weather patterns can produce lightning storms that start many fires. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 5, Umatilla and Wasco

Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 239 state-owned/leased facilities, valued at approximately $81.5 million, located in this region's wildfire hazard zone. Of these, 23 are identified as critical/essential facilities. An additional 1,072 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: High winds within Region 5 in the Columbia River Gorge are legendary, sometimes reaching 80 miles per hour. Windstorms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland. Special building codes in this region require tie downs for mobile homes within 30 miles of the Columbia River. The most vulnerable communities are those near the Columbia Gorge within Gilliam, Hood River, Morro, and Sherman Counties.

Winter Storms: Frigid air emanating from the Wallowa Mountains and traveling through the Columbia River Gorge bring winter storms to this region annually. Though winter storms have the potential to affect the entire region, particularly along the I-84 corridor, the area is known for cold winters so residents and visitors are usually prepared for these storms.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 5 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increased incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. While winter storms and windstorms affect Region 5, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section, **Introduction to Climate Change**.

2.3.5.2 Profile

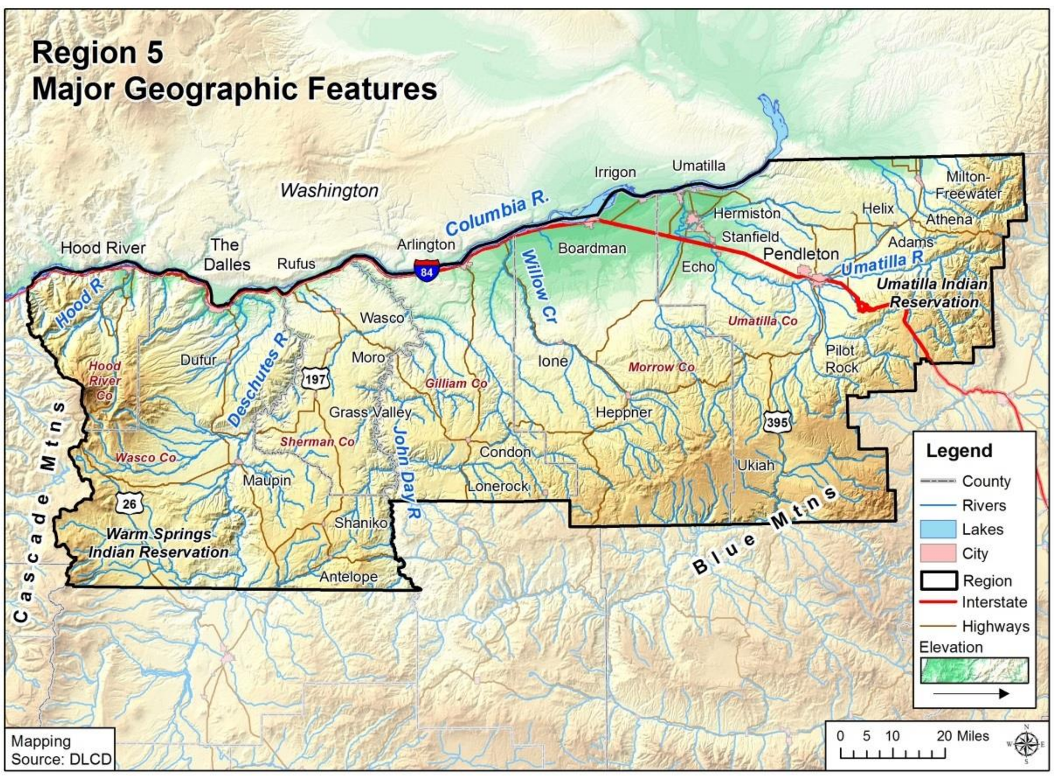
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Oregon's Mid-Columbia Region is approximately 10,178 square miles in size and includes Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties. The Columbia River and the eastern slope of the Cascades shape the region's topography. Region 5 begins at the Cascades crest in the west and extends east to the Idaho border. The region's northern border is the Columbia River and extends to the northern ridges of the Blue Mountains in the south. The region's major watershed is the Columbia River with all smaller water bodies feeding it as it flows west into the Pacific Ocean. The region supports crop farming as well as livestock grazing.

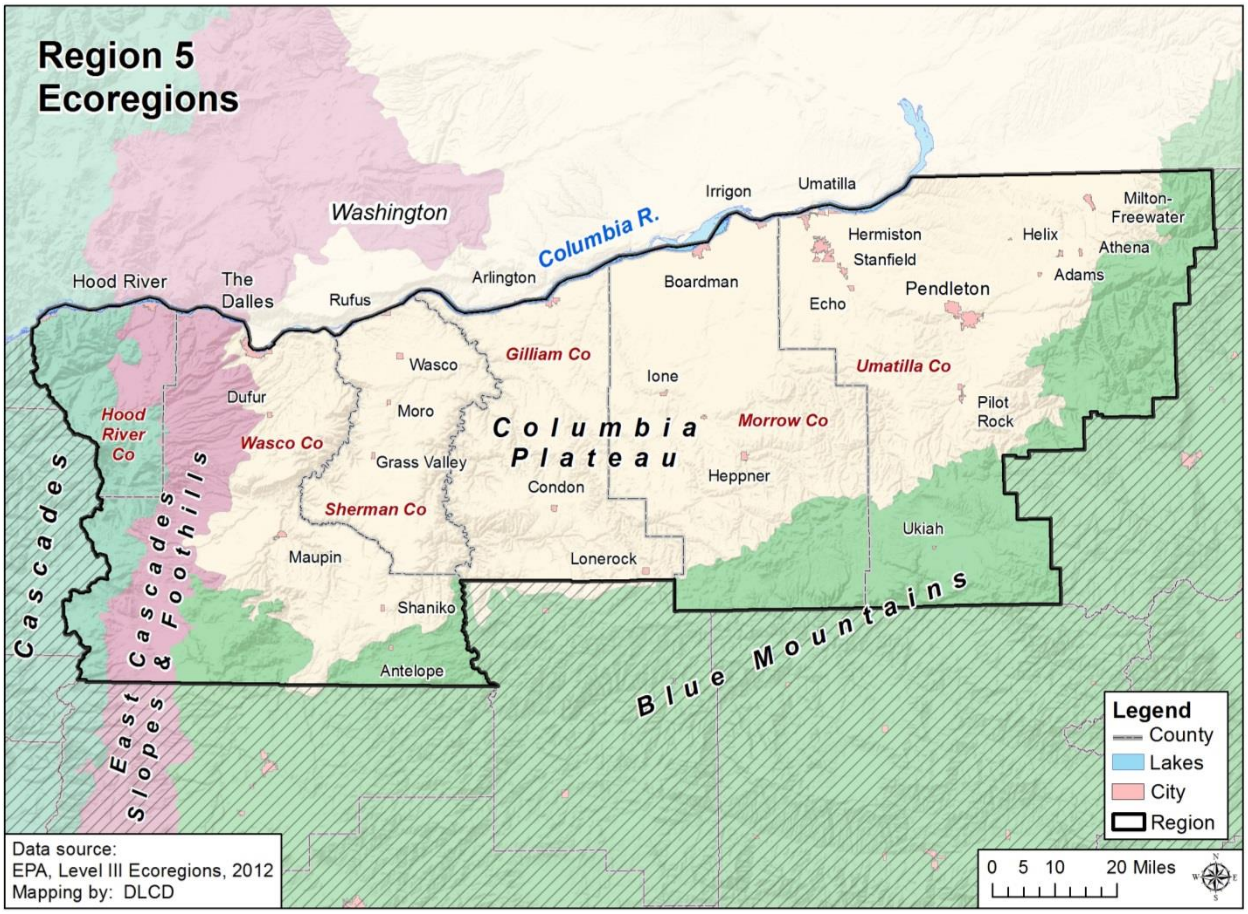
Figure 2-157. Region 5 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 5 is composed of four ecoregions: the Cascades, the Eastern Cascades Slope and Foothills, the Blue Mountains and, predominantly, the Columbia Plateau (Figure 2-158).

Figure 2-158. Region 5 Ecoregions



Blue Mountains: This ecoregion is complex and diverse, with many sub-ecoregions with unique conditions. In general, the Blue Mountains areas of Region 5 have a dry continental climate with marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are underlain with volcanic rock, land in the Wallowa and Elkhorn Mountain ranges is composed of granitic intrusives, deep sea sediments, and metamorphic rocks. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories. The ecoregion’s Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some high meadows also exist within the Blue Mountains in Region 5 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer (Thorson et al., 2003).

Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Columbia Plateau: The Columbia River has shaped this arid, sagebrush steppe. This ecoregion is underlain by basaltic bedrock up to two miles deep. Naturally occurring wheatgrass, sagebrush, sage grass and other drought-tolerant plants have given way to crop farming and grazing. Higher elevation areas support Douglas fir and ponderosa pine forests while narrow canyons provide habitat for riparian species such as white alders and mock orange. Deep loess soil deposits cover some areas, making them more agriculturally productive than areas with spare soils (Thorson et al., 2003).

Eastern Cascades Slope and Foothills: The Region 5 section of this ecoregion is dominated by grand fir mixed forests in the uplands and mixed oak/conifer forests in the foothills. The Columbia River Gorge influences lower elevations with marine weather systems while the uplands are moister with richer soils. Because of its location in the rain shadow of the Cascades, the ecoregion often experiences dramatic temperature extremes and native plants are adapted to dry climates and frequent wildfires. Logging and recreation are common land uses throughout and rural residential development and agricultural uses can be found in the foothills (Thorson et al., 2003).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 5 has diverse ecoregions with varying climatic conditions with the majority of the region's land in Columbia Plateau. The Columbia Plateau's arid climate supports a variety of agricultural activities, most notably wheat, barley, alfalfa, corn and potato production. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-296** shows mean annual precipitation and temperatures for the three ecoregions in Region 5 (Thorson et al., 2003). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-296. Average Precipitation and Temperature Ranges in Region 5 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	55–140	16/41	38/78
Eastern Cascades slopes and foothills*	16–55	16/40	40/82
Columbia Plateau*	7–25	24/41	52/89
Blue Mountains*	8–60	16/41	43/84

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 5.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Overall, from 2000 to 2013 Region 5's growth rate is roughly 5% less than the state. The majority of the region's growth occurred in the largest cities and in Hood River, Umatilla, and Wasco Counties. Sherman was the only county in the region to decline in population. By 2020, all counties in Region 5, except Hood River County, are projected to grow at a rate less than the state overall.

Table 2-297. Population Estimate and Forecast for Region 5

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 5	129,594	142,150	9.7%	152,460	7.3%
Gilliam	1,915	1,945	1.6%	2,062	6.0%
Hood River	20,411	23,295	14.1%	25,628	10.0%
Morrow	10,995	11,425	3.9%	12,307	7.7%
Sherman	1,934	1,780	-8.0%	1,716	-3.6%
Umatilla	70,548	77,895	10.4%	83,359	7.0%
Wasco	23,791	25,810	8.5%	27,388	6.1%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 5 are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA, 2011e). Over 9% (2.5 million) of all overnight trips to Oregon included time within Region 5. (Data for Morrow and Umatilla Counties are not included in this count.) Two thirds of trips to the region occur between April and September, and the average travel party contains four persons. The average trip length is over four nights. (Data for Morrow and Umatilla Counties are not included in this count.) From 2011 to 2013, the majority of visitors to the Mid-Columbia Region lodged in hotels/motels or other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-298. Annual Visitor Estimates in Person Nights in Region 5

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 5	3,907	—	3,835	—	3,878	—
Gilliam and Sherman	149	100%	153	100%	142	100%
Hotel/Motel	50	33.6%	51	33.3%	40	28.2%
Private Home	36	24.2%	37	24.2%	36	25.4%
Other	63	42.3%	65	42.5%	66	46.5%
Hood River	819	100%	853	100%	850	100%
Hotel/Motel	367	44.8%	389	45.6%	386	45.4%
Private Home	284	34.7%	292	34.2%	289	34.0%
Other	168	20.5%	172	20.2%	175	20.6%
Morrow	252	100%	244	100%	261	100%
Hotel/Motel	77	30.6%	72	29.5%	82	31.4%
Private Home	114	45.2%	110	45.1%	116	44.4%
Other	61	24.2%	62	25.4%	63	24.1%
Umatilla	1,681	100%	1,588	100%	1,652	100%
Hotel/Motel	668	40%	597	38%	628	38%
Private Home	775	46%	748	47%	779	47%
Other	238	14%	243	15%	245	15%
Wasco	1,006	100%	997	100%	973	100%
Hotel/Motel	401	40%	380	24%	359	37%
Private Home	247	25%	250	16%	250	26%
Other	358	36%	367	23%	364	37%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). The same percentage of people in Region 5 identify as having a disability as do people throughout the state. Notably, roughly 22% of Gilliam County's population and half of its seniors (65 and older) report having a disability. Morrow and Umatilla Counties also have high percentages (over 40%) of seniors reporting a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-299. People with a Disability by Age Groups in Region 5, 2012

	Total Population*	With a Disability (Total Population)		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 5	133,922	18,074	13.5%	1,282	3.6%	7,355	39.6%
Gilliam	1,897	425	22.4%	21	5.8%	199	49.9%
Hood River	22,118	2,217	10.0%	140	2.4%	874	31.9%
Morrow	11,137	1,748	15.7%	163	5.1%	621	45.5%
Sherman	1,865	339	18.2%	19	4.8%	159	39.7%
Umatilla	72,178	9,710	13.5%	684	3.4%	3,990	42.5%
Wasco	24,727	3,635	14.7%	255	4.5%	1,512	35.1%

Note: *Total population does not include institutionalized population

Note: **Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless are performed in Oregon each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless people (Thomas et al., 2008). Throughout the region, with the exception of Gilliam and Sherman Counties, this population increased significantly from 2009 to 2010. The next year these numbers almost doubled in Wasco and Umatilla Counties, and decreased by half or more in Hood River and Morrow.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-300. Homeless Population Estimate for Region 5

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 5	310	1,052	939	767
Gilliam	14	0	9	8
Hood River	18	482	284	261
Morrow	179	241	10	143
Sherman	5	0	N/A	3
Umatilla	61	104	235	133
Wasco	33	225	401	220

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

Region 5 has slightly more males than females (male, 51.1%; female, 48.9%), an inverse ratio to that of the state (Cutter et al., 2003). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

More than one fifth of the population in Gilliam and Sherman are seniors. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Children constitute over a quarter of the population in Hood River, Morrow, and Umatilla Counties. Special consideration should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-301. Population by Vulnerable Age Groups, in Region 5, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 5	138,081	35,502	25.7%	19,148	13.9%
Gilliam	1,904	361	19.0%	406	21.3%
Hood River	22,207	5,740	25.8%	2,799	12.6%
Morrow	11,146	3,173	28.5%	1,368	12.3%
Sherman	1,865	393	21.1%	401	21.5%
Umatilla	75,846	20,130	26.5%	9,685	12.8%
Wasco	25,113	5,705	22.7%	4,489	17.9%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

There are considerably high percentages of the populations in Hood River and Morrow Counties who do not speak English “very well,” roughly 18% and 14%, respectively. Outreach materials used to communicate with and plan for these populations should take into consideration language needs.

Table 2-302. English Usage in Region 5, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 5	115,667	90.0%	12,842	10.0%
Gilliam	1,781	98.9%	20	1.1%
Hood River	17,134	82.5%	3,629	17.5%
Morrow	8,928	86.3%	1,422	13.7%
Sherman	1,695	96.7%	58	3.3%
Umatilla	64,574	91.9%	5,716	8.1%
Wasco	21,555	91.5%	1,997	8.5%

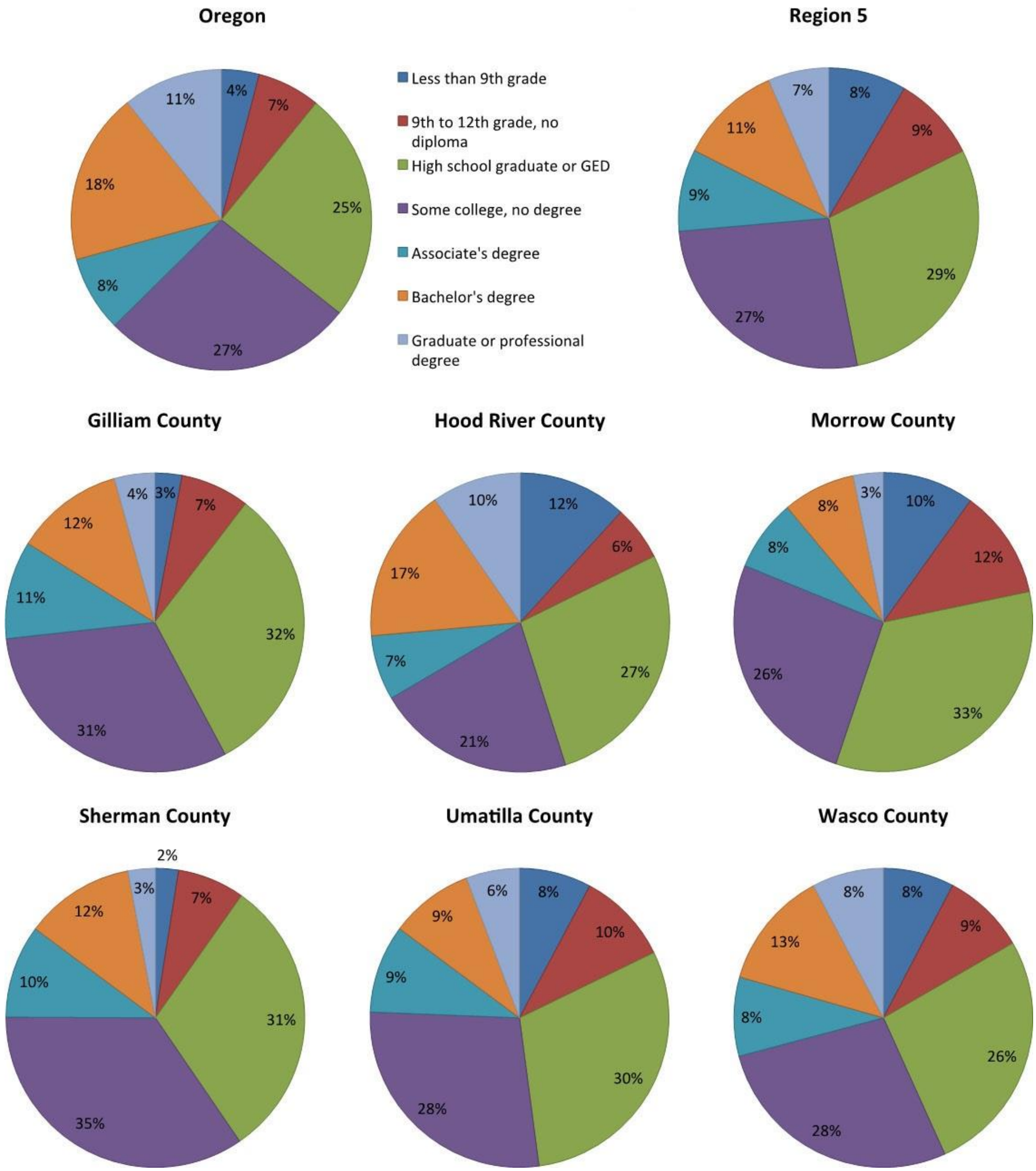
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 7% lower rate of high school graduates (including GEDs) and a 12% lower rate of persons with a bachelor's degree compared to statewide percentages. Hood River County has the largest percentage population with a bachelor's degree or higher, while Morrow County has the lowest percentage.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-159. Educational Attainment in Region 5, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event” (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

The financial crisis that began in 2007 appears to have minimally affected Region 5’s median household incomes. Contrary to statewide trends between 2009 and 2014, median household incomes increased in all counties in Region 5, except in Wasco County. Sherman County experienced the largest growth (almost 190%) in household income. In all but one county in the region, median household incomes are lower than the statewide average by $1,500-$6,400. The exception is Hood River County, in which households earn on average of $6,300 more than the statewide average.

Table 2-303. Median Household Income in Region 5

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 5	N/A	N/A	N/A
Gilliam	$45,070	$45,833	1.7%
Hood River	$53,289	$56,355	5.8%
Morrow	$46,639	$48,457	3.9%
Sherman	$37,578	$44,583	18.6%
Umatilla	$48,404	$48,452	0.1%
Wasco	$44,206	$43,601	-1.4%

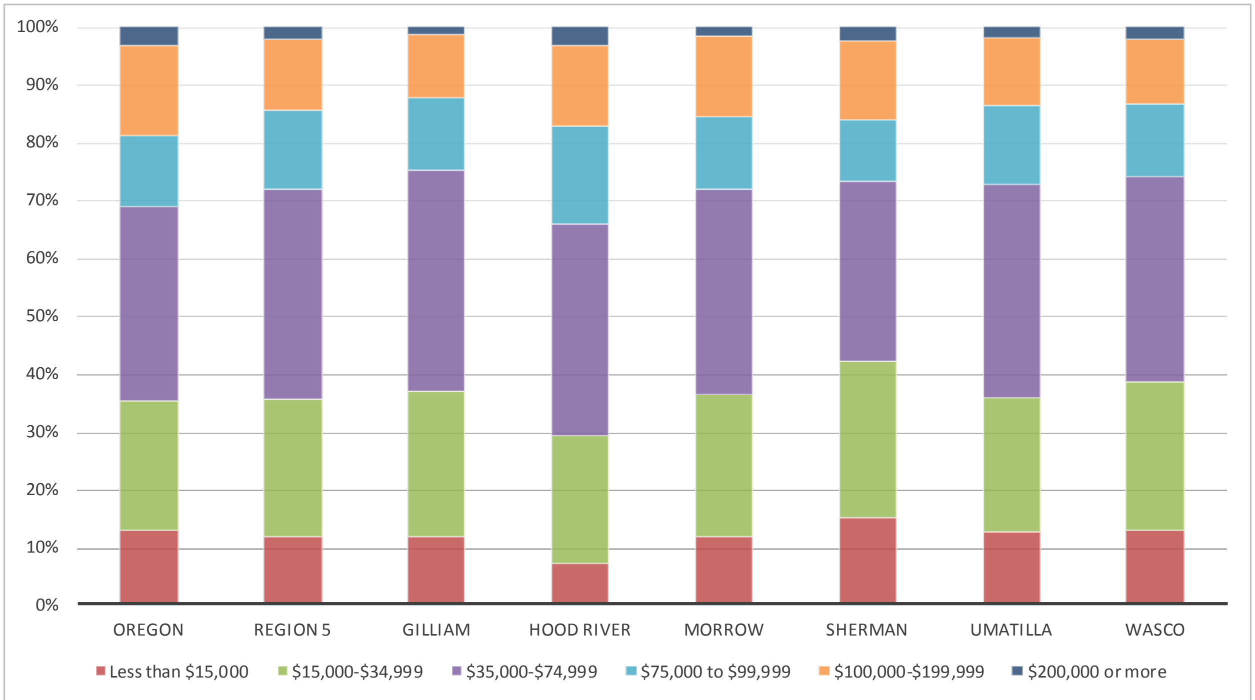
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

The region has about the same household income distribution as the state as a whole. Within the region, Sherman County has the highest percentage of households (42.1%) earning less than $35,000 per year, while Hood River County has the highest percentage of households (34.2%) earning more than $75,000 per year. Just over one third of the region’s households earn between $35,000 and $75,000 per year.

Figure 2-160. Median Household Income Distribution in Region 5, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The share of the Mid-Columbia Region's individuals and children living in poverty is comparable to statewide numbers. Sherman and Wasco Counties have the highest percentages of their populations living in poverty. Gilliam and Wasco Counties have had the greatest increases in poverty rates. Conversely, poverty has been on the decline in Hood River and Morrow Counties. Child poverty rates have significantly increased by more than 25% in Sherman and Wasco Counties. Notably, 44% of children in Sherman County are living in poverty.

Table 2-304. Poverty Rates in Region 5, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 5	20,495	15.6%	8.1%	7,415	21.2%	13.1%
Gilliam	238	12.6%	36.0%	41	11.6%	2.5%
Hood River	2,235	10.1%	-6.3%	682	12.0%	-5.8%
Morrow	1,726	15.5%	-9.6%	723	22.9%	-8.6%
Sherman	413	22.4%	11.0%	165	44.1%	27.9%
Umatilla	11,149	15.5%	6.5%	4,451	22.4%	17.1%
Wasco	4,734	19.3%	29.5%	1,353	24.6%	25.9%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Collectively, about one third of housing units in Region 5 are rentals. Morrow County has the highest percentage of owner-occupied units — 10% more than the regional average. Gilliam County has the highest percentage of rental units. The region has a roughly 3% higher vacancy rate than the state, with the highest percentage in Gilliam County (about 15%), and the highest number of units in Umatilla County (2,044). In addition, the region has a slightly higher percentage of seasonal or recreational homes than the state (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-305. Housing Tenure in Region 5, 2012

	Occupied Units	Owner-occupied		Renter-occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 5	50,034	33,156	66.3%	16,878	33.7%	4,346	9.5%
Gilliam	894	561	62.8%	333	37.2%	174	14.8%
Hood River	8,027	5,498	68.5%	2,529	31.5%	666	7.2%
Morrow	3,791	2,769	73.0%	1,022	27.0%	435	9.8%
Sherman	788	525	66.6%	263	33.4%	93	10.3%
Umatilla	26,786	17,391	64.9%	9,395	35.1%	2,044	6.9%
Wasco	9,748	6,412	65.8%	3,336	34.2%	934	8.2%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 5 is predominantly composed of family households, and roughly one third of those have children. Similar to the state as a whole, more than twice as many single-parent households are headed by females than by males.

Table 2-306. Family vs. Non-family Households in Region 5, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 5	50,034	34,196	68.3%	15,838	31.7%	13,162	26.3%
Gilliam	894	543	60.7%	351	39.3%	321	35.9%
Hood River	8,027	5,341	66.5%	2,686	33.5%	2,100	26.2%
Morrow	3,791	2,737	72.2%	1,054	27.8%	874	23.1%
Sherman	788	476	60.4%	312	39.6%	254	32.2%
Umatilla	26,786	18,553	69.3%	8,233	30.7%	6,954	26.0%
Wasco	9,748	6,546	67.2%	3,202	32.8%	2,659	27.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-307. Family Households with Children by Head of Household in Region 5, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 5	15,236	30.5%	1,349	2.7%	3,665	7.3%	10,222	20.4%
Gilliam	185	20.7%	23	2.6%	46	5.1%	116	13.0%
Hood River	2,545	31.7%	150	1.9%	314	3.9%	2,081	25.9%
Morrow	1,335	35.2%	132	3.5%	323	8.5%	880	23.2%
Sherman	176	22.3%	10	1.3%	46	5.8%	120	15.2%
Umatilla	8,711	32.5%	880	3.3%	2,280	8.5%	5,551	20.7%
Wasco	2,284	23.4%	154	1.6%	656	6.7%	1,474	15.1%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

The social and demographic analysis shows that Region 1 is particularly vulnerable during a hazard event in the following ways:

- Almost a quarter of the population has a disability, including half the senior population, in Gilliam County.
- The homeless population in Wasco and Umatilla Counties has increased significantly.
- Children comprise over one quarter of the population in Hood River, Morrow, and Umatilla Counties.
- Over one fifth of the population in Gilliam and Sherman Counties are seniors.
- High numbers of people who do not speak English "very well" in Hood River and Umatilla Counties.
- The region has a lower share of people with a college degree then the state as a whole.
- Roughly one third of housing units are rentals.
- Gilliam and Sherman Counties have high vacancy rates.

Economy

Economic characteristics include the financial resources present and revenue generated in the community to achieve a higher quality of life. Employment characteristics, income equality, employment, and industry sectors are measures of economic capacity. However, economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce, resources, and infrastructure are interconnected in the existing economic picture.

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against losses due to natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region has made a broad recovery since the financial crisis that began in 2007, with an 11% increase in its labor force (Tauer, 2014). Regional unemployment rates have been declining steadily. Umatilla County has the largest labor force in the region and the highest unemployment rate. Average salaries are low, between 73% and 92% of the statewide average. (Data are for "Covered Employment," workers covered by state Unemployment Insurance [UI] laws and for civilian workers covered by the program of Unemployment Compensation for Federal Employees.) For example, the average salary in Morrow County is $41,352 and $31,215 in Hood River County.

Table 2-308. Unemployment Rates in Region 5, 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 5	9.1%	9.4%	8.8%	8.1%	7.5%	-1.6%
Gilliam	6.8%	7.0%	7.5%	7.6%	6.9%	0.1%
Hood River	8.1%	8.3%	7.9%	7.1%	6.1%	-2.0%
Morrow	9.2%	9.4%	8.8%	8.3%	7.8%	-1.4%
Sherman	9.0%	9.9%	9.2%	8.7%	7.3%	-1.7%
Umatilla	9.6%	10.0%	9.2%	8.5%	8.1%	-1.5%
Wasco	8.9%	9.4%	8.6%	8.0%	7.1%	-1.9%

Source: Oregon Employment Department, 2014

Table 2-309. Employment and Unemployment Rates in Region 5, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 5	74,367	68,801	92.5%	5,566	7.5%
Gilliam	1,050	978	93.1%	72	6.9%
Hood River	14,215	13,353	93.9%	862	6.1%
Morrow	5,339	4,923	92.2%	416	7.8%
Sherman	1,000	927	92.7%	73	7.3%
Umatilla	38,255	35,138	91.9%	3,117	8.1%
Wasco	14,508	13,482	92.9%	1,026	7.1%

Source: Oregon Employment Department, 2014

Table 2-310. Employment and Payroll in Region 5, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 5	60,049	$34,649	77.0%
Gilliam	746	$36,145	80.3%
Hood River	12,892	$31,215	69.4%
Morrow	4,805	$41,352	91.9%
Sherman	751	$38,746	86.1%
Umatilla	29,275	$35,594	79.1%
Wasco	11,580	$32,939	73.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 5 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Natural Resources and Mining; (d) Education and Health Services; and (e) Manufacturing. Between 2012 and 2022, projected growth is expected to create a 9% increase in employment in the Columbia Basin, including Morrow and Umatilla Counties, and a 15% increase in employment in the Columbia Gorge Region, including Gilliam, Hood River, Sherman, and Wasco Counties (Oregon Employment Department, n.d.b).

Table 2-311. Covered Employment by Sector in Region 5, 2013

		Gilliam County		Hood River County		Morrow County	
Industry	**Region 5**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	60,049	746	100%	12,892	100%	4,805	100%
Total Private Coverage	80.6%	522	70.0%	11,661	90.5%	3,978	82.8%
Natural Resources & Mining	14.4%	43	5.8%	2,667	20.7%	1,062	22.1%
Construction	2.8%	51	6.8%	296	2.3%	129	2.7%
Manufacturing	11.3%	(c)	0.0%	1,362	10.6%	1,504	31.3%
Trade, Transportation & Utilities	18.1%	127	17.0%	1,905	14.8%	584	12.2%
Information	1.0%	(c)	0.0%	138	1.1%	70	1.5%
Financial Activities	2.2%	15	2.0%	226	1.8%	73	1.5%
Professional & Business Services	6.2%	134	18.0%	898	7.0%	210	4.4%
Education & Health Services	12.1%	55	7.4%	1,822	14.1%	152	3.2%
Leisure & Hospitality	9.8%	45	6.0%	2,008	15.6%	149	3.1%
Other Services	2.6%	33	4.4%	337	2.6%	45	0.9%
Private Non-Classified	0.0%	(c)	0.0%	2	0.0%	-	0.0%
Total All Government	19.4%	224	30.0%	1,231	9.5%	828	17.2%
Federal Government	1.8%	10	1.3%	107	0.8%	57	1.2%
State Government	4.0%	17	2.3%	118	0.9%	109	2.3%
Local Government	13.6%	198	26.5%	1,006	7.8%	662	13.8%

		Sherman County		Umatilla County		Wasco County	
Industry	**Region 5**	**Employment**	**Percent**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	60,049	751	100%	29,275	100%	11,580	100%
Total Private Coverage	80.6%	434	57.8%	22,284	76.1%	9,509	82.1%
Natural Resources & Mining	14.4%	13	1.7%	2,919	10.0%	1,950	16.8%
Construction	2.8%	(c)	0.0%	877	3.0%	300	2.6%
Manufacturing	11.3%	(c)	0.0%	3,235	11.1%	702	6.1%
Trade, Transportation & Utilities	18.1%	235	31.3%	6,079	20.8%	1,953	16.9%
Information	1.0%	-	0.0%	174	0.6%	194	1.7%
Financial Activities	2.2%	(c)	0.0%	687	2.3%	301	2.6%
Professional & Business Services	6.2%	12	1.6%	1,999	6.8%	478	4.1%
Education & Health Services	12.1%	14	1.9%	3,196	10.9%	2,055	17.7%
Leisure & Hospitality	9.8%	124	16.5%	2,376	8.1%	1,184	10.2%
Other Services	2.6%	19	2.5%	739	2.5%	392	3.4%
Private Non-Classified	0.0%	(c)	0.0%	4	0.0%	(c)	0.0%
Total All Government	19.4%	317	42.2%	6,991	23.9%	2,072	17.9%
Federal Government	1.8%	130	17.3%	511	1.7%	288	2.5%
State Government	4.0%	38	5.1%	1,761	6.0%	334	2.9%
Local Government	13.6%	149	19.8%	4,719	16.1%	1,450	12.5%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Natural Resources and Mining: The primary industries within this sector regionally are largely crop and animal production. These industries tend to fluctuate seasonally and are vulnerable to a variety of natural hazards (winter storms, floods, etc.). In addition to the loss of farm production, wages could be lost due to natural disasters. In addition, these industries are dependent upon transportation systems that are vulnerable to disasters.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 5. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $2.9 billion (83% total revenue) for the region (**Table 2-312**). Trade (Retail and Wholesale) is the largest grossing sector in all counties.

Note: Due to the small size and few industries in the region, data are withheld in several categories, especially manufacturing data, to avoid disclosing information on individual companies. Therefore, data are aggregated at the county level.

Table 2-312. Revenue of Top Industries (in Thousands of Dollars) in Region 5

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 5	$3,447,733	61.7%	—	14.4%
Gilliam	$46,622	96.8%	—	—
Hood River	$1,047,637	49.4%	23.5%	10.3%
Morrow	$115,354	57.9%	D	9.7%

Sherman	$74,222	91.7%	—	0.3%
Umatilla	$1,545,252	67.8%	D	15.6%
Wasco	$618,646	61.7%	—	22.2%

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Source: U.S. Census, Economic Census. 2007. Table EC0700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022 the largest job growth in Region 5 is expected to occur in the following sectors: (a) Education and Health Services; (b) Trade, Transportation, and Utilities (including retail trade); (c) Natural Resources and Mining; (d) Leisure and Hospitality; (e) Government; and (f) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 5. The Natural Resources and Mining sector has the second most businesses. Professional and Business Services, Education and Health Services, Leisure and Hospitality, and the Other Services round out the regions' top five sectors (Oregon Employment Department, 2012). While many of these are small businesses employing fewer than 20 employees, collectively they represent almost three fourths of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 5 is particularly vulnerable during a hazard event due to:

- Higher unemployment in Morrow and Umatilla Counties, and
- Significantly lower regional wages than the state as a whole in Hood River and Morrow Counties.

This region has largely rebounded from the financial crisis that began in 2007. Much of the region's growth in employment is spurred by the health care and construction industries, which are driven by an aging population and an increase in retiring baby boomers (Oregon Employment Department, n.d.b). Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

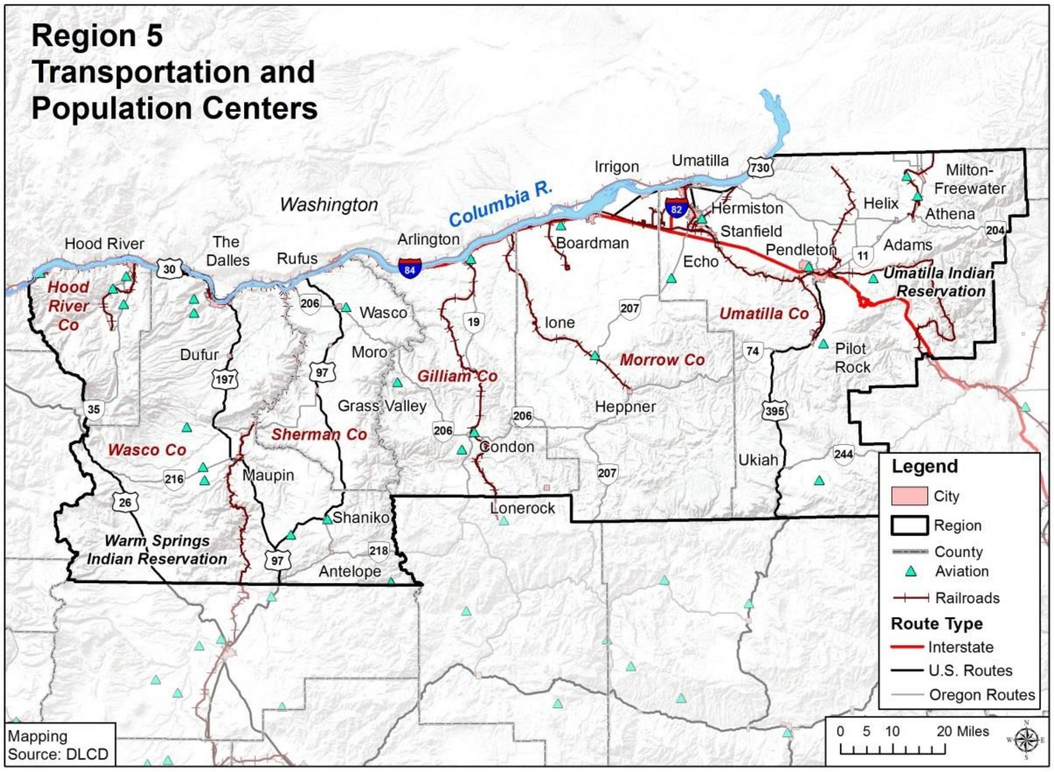
The largest population bases in Region 5 are located along the region's major freeways, I-84. I-84 is the main east-west passage for automobiles and trucks traveling between the northwest and states to the east.

Region 5's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-84 corridor create additional stresses on transportation systems. Some of these stresses are added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), ground shaking from a CSZ event is not expected to cause damage to the region's major highways. The region has relatively low vulnerability to ground shaking from a CSZ event. However, connections to markets and services will likely be disrupted. For information on ODOT's Seismic Lifeline Report findings for Region 5, see **Seismic Lifelines**.

Figure 2-161. Region 5 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 5, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-313 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). The region has about the same percentage of bridges that are distressed or deficient (20%), as does the state.

Table 2-313. Bridge Inventory for Region 5

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 5	31	123	25%	8	73	11%	2	13	15%	2	3	67%	43	215	20%	50
Gilliam	4	19	21%	2	16	13%	0	1	0%	0	0	—	6	36	17%	1
Hood River	16	45	33%	1	15	7%	0	0	—	2	2	100%	19	66	29%	8
Morrow	2	24	9%	3	33	9%	2	11	18%	0	1	0%	7	68	10%	3
Sherman	9	35	26%	2	9	22%	0	1	0%	0	0	—	11	45	24%	2
Umatilla	9	117	8%	37	168	22%	4	22	18%	0	0	—	50	299	17%	15
Wasco	11	51	26%	9	65	14%	1	5	20%	1	2	50%	22	115	19%	21

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 5 support cargo and trade flows. The region's major freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. There are two major rail yards in the region — in The Dalles and Hinkle — operated by UP (Cambridge Systematics, 2014). The Hinkle Yard serves as UP's system yard and locomotive service and repair yard for Oregon and the greater northwest area (Cambridge Systematics, 2014).

Amtrak provides passenger rail service along the Columbia Gorge and eastward via the Empire Builder line.

Rails are sensitive to icing from winter storms that can occur in Region 5. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

The Eastern Oregon Regional Airport is the only commercial airport in the region (City of Pendleton website, http://www.pendleton.or.us/pendleton-airport). It serves one passenger airline, SeaPort Airlines, providing service to Portland and North Bend (Portland International Airport, 2014).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-314. Public and Private Airports in Region 5

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 5	9	18	0	8	35
Gilliam	2	2	0	0	4
Hood River	2	2	0	1	5
Morrow	2	0	0	1	3
Sherman	1	0	0	0	1
Umatilla	2	6	0	5	13
Wasco	0	8	0	1	9

Source: FAA Airport Master Record (Form 5010), 2014

Ports

Oregon's ports have historically been used for timber transport, and commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and river, rail, road, and air infrastructure. There are three ports within Region 5: The Port of Cascade Locks, The Port of The Dalles, and the Port of Hood River. The Port of Cascade Locks includes industrial land, a marine park, and the Bridge of the Gods, and promotes recreation tourism (Port of Cascade Locks website, http://portofcascadelocks.org/http://portofcascadelocks.org/). The Port of Hood River encompasses industrial land, business parks, an expo center, the Hood River Marina and waterfront area, Hood River Airport, and the Hood River – White Salmon Bridge (Portland Hood River website, http://www.portofhoodriver.com/http://www.portofhoodriver.com/). The Port of The Dalles is approximately 425,000 square acres and covers the northern third of Wasco County. It contains industrial land and The Dalles Marina (Port of The Dalles website, http://www.portofthedalles.com/http://www.portofthedalles.com/).

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving portions of Gilliam, Hood River, Morrow, Sherman, and Umatilla Counties. The region's electric cooperatives are: the Hood River Electric Cooperative (Hood River County), Wasco Electric Cooperative (Gilliam, Hood River, Sherman, Wasco), Columbia Basin Cooperative (Gilliam, Morrow, Umatilla), Umatilla Cooperative (Umatilla), Columbia Power Cooperative (Umatilla) and Central Electric Cooperative (Wasco). Two utility districts serve the region: City of Cascade Locks (Hood River) and Milton-Freewater (Umatilla). In addition, the Northern Wasco People's Utility District (Wasco) serves portions of the region.

The region has a total of 31 power-generating facilities: 4 hydroelectric power facilities, 3 natural gas power facilities, 23 wind power facilities, and 1 coal power facility. In total, the power-generating facilities have the ability to produce up to 11,227 megawatts (MW) of electricity. The region also includes four wind power facilities that are approved but not constructed. The wind power facilities will have the capacity to generate up to 1,205 MW of electricity (Oregon Department of Energy).

Table 2-315. Power Plants in Region 5

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 5	4	3	23	1	0	31
Gilliam	0	0	8**	0	0	8
Hood River	1	0	0	0	0	1
Morrow	0	1	3**	1	0	5
Sherman	1	0	7	0	0	8
Umatilla	1	2	5	0	0	8
Wasco	1	0	0	0	0	1
Energy Production (MW)	**6,458**	**1,265**	**3,044**	**460**	**0**	**11,227**

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste

**There are four wind power facilities that are located in both Gilliam and Morrow Counties, this table places half of each facility in each county.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

The Bonneville Power Administration (BPA) provides hydro-generated electricity to the state's consumer-owned utilities. The major BPA dams in the region are located on the Columbia River in communities of The Dalles, John Day, and McNary.

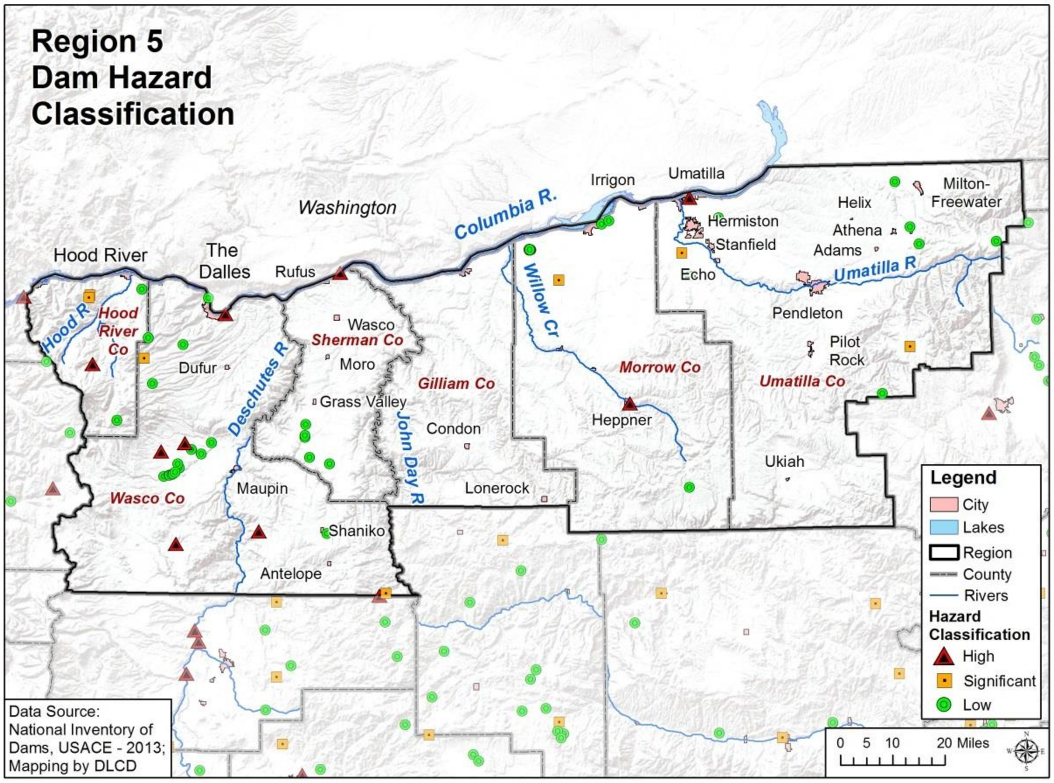
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon by using the National Inventory of Dams (NID) threat potential methodology. **Table 2-316** lists the number of dams included in the inventory. The majority of dams in the region are located in Umatilla (19) and Wasco (30) Counties. There are 14 High Threat Potential dams and 6 Significant Threat Potential dams in the region.

Table 2-316. Threat Potential of Dams in Region 5

	Threat Potential			Total
	High	Significant	Low	Dams
Region 5	14	6	57	77
Gilliam	0	0	0	0
Hood River	1	2	8	11
Morrow	1	1	4	6
Sherman	1	0	10	11
Umatilla	3	3	13	19
Wasco	8	0	22	30

Source: Oregon Water Resources Department, Dam Inventory Query 2014

Figure 2-162. Region 5 Dam Hazard Classification

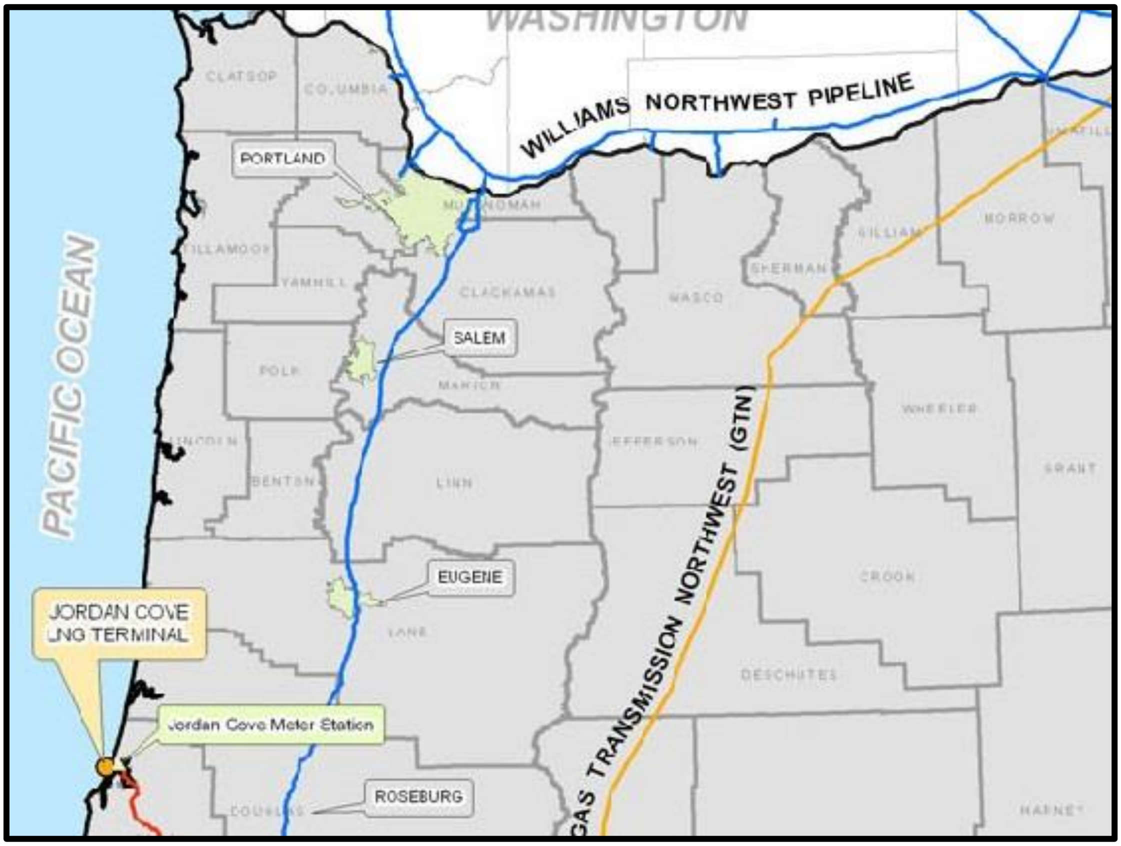


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-163** shows the Gas Transmission Northwest (GTN) line, which runs through Gilliam, Morrow, and Umatilla Counties (in green) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-163. Liquefied Natural Gas Pipelines in Region 5



Source: Oregon Department of Environmental Quality

Utility Lifelines

The Mid-Columbia region is an important thoroughfare for oil and gas pipelines and electrical transmission lines. The region is also a major producer of hydropower. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Communities in this region primarily receive oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California via a separate network. The electric, oil, and gas lifelines that run through the region are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 5 is operated primarily by Pacific Power, regional electrical cooperatives, and Bonneville Power Administration (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 5 is part of the Columbia Gorge Operational Area (Hood River, Wasco, Sherman, Gilliam), Central Oregon Operational Area (Wheeler, Southern Wasco), and Eastern Oregon Operational Area (Morrow, Umatilla) under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation’s status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 5. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the southern parts of the region (south of I-84) (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 5 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Columbia Gorge Operational Area are (Oregon Office of Emergency Management, 2013):

- KMSW-FM, 92.7 MHZ, The Dalles, 102.9 MHZ, Hood River;
- KHRV-FM, 90.1 MHZ, Hood River, OPB Radio Network; and
- KOTD, 89.7 MHZ, The Dalles, OPB Radio Network.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 5 is served by ARES Districts 2 and 3. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 5 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Gilliam County: W7ILD;
- Hood River County: K7VEW;
- Morrow County: N7ZHG;
- Sherman County: WB7PPK;
- Umatilla County: N7ZHG; and
- Wasco County: KF7LN.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

The drinking water supply in Region 5 is drawn from a combination of surface, well, and spring sources. Surface water is drawn from rivers and smaller tributaries. In the eastern and western portions of the region these surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months. However, in the region’s central counties municipal wells drawing from the aquifer are primary sources with springs used as a backup where they are available. In this central part of the region water shortages in wells are increasing although flow levels tend to stay consistent throughout the year. Water quality in the region’s municipal supply is high. Chemical and fuel spills are a concern when surface waterways intersect with or parallel major roadways. Water quality could be threatened as older or damaged well infrastructure may not filter coliform and other bacteria as effectively as newer infrastructure.

Rural residents draw water from surface water, groundwater wells, or springs. Surface water is usually used for irrigation, and wells are used as backup source. Groundwater wells serve residential needs. In rural areas storage ponds or small dams are sometimes created on private land to provide additional on-site drinking water storage. Water quality for rural residents is primarily affected by nitrates from agricultural activities and by low flow levels, which can increase the density of pollutants.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. An example of non-point source pollution is stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. Landslides, flood events, earthquakes, and liquefaction can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures, adversely affecting habitat health. Furthermore, fast-moving large volumes of stormwater entering surface waterways can cause flooding and erosion.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 5, most municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 5. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction’s storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. The four largest municipalities in the region, Hood River, Hermiston, The Dalles and Pendleton, do not require LID strategies in their building codes. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems and could increase a community’s resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

The effects of road, bridge, rail, and port failures could be devastating to the economy and public health in the Mid-Columbia Region. I-84 supports the main east-west passenger and freight transport and is subject to winter storms and wind storms. Rail systems are vulnerable to icy conditions in the Gorge. In Region 5, there are two rail yards that service the state and greater Northwest region. Amtrak provides passenger service through the Columbia River Gorge. Three ports and one commercial airport are economic engines for the region, providing for tourism and recreation and supporting business and industrial parks.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. A diverse energy portfolio helps increase the area's ability to communicate and transport goods and emergency services after a hazard event. There are 31 power-generating facilities: four hydroelectric, three natural gas, 23 wind, and one coal facility. Four additional wind facilities have been proposed for this region. Three of BPA's large dams and hydroelectric projects are here on the Columbia River. LNG pipelines run through Gilliam, Morrow, and Umatilla Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from I-84. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Drinking water is sourced from surface water, wells, and springs. Water quality can be threatened by non-point source pollution from stormwater runoff and agricultural activities in the area. Erosion and sedimentation caused by natural hazard events could also threaten the water quality. In addition, outdated, damaged, or rigid buried water infrastructure is vulnerable to seismic activity. Though low impact development (LID) stormwater systems can increase the region's capacity to better manage high-precipitation events, no communities in this region require LID practices.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website, http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Gilliam and Sherman Counties do not meet either definition; therefore even though both counties contain incorporated cities, they are considered 100% rural.

Between 2000 and 2010, growth in the region's urban areas has been about 10% less than urban growth statewide. While Umatilla County has the greatest number of people and housing in urban areas, urban populations, and homes in Hood River County have grown considerably, by roughly 22% and 32%, respectively. Gilliam and Sherman Counties do not have urban populations and are also losing the greatest share of their rural populations. Rural homes have increased by almost 10% in Gilliam and Wasco Counties. The region's population is clustered around the I-84 corridor and the cities of Hood River, Pendleton, and The Dalles.

Table 2-317. Urban and Rural Populations in Region 5

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 5	79,500	87,442	10.0%	50,094	50,815	1.4%
Gilliam	0	0	—	1,915	1,871	-2.3%
Hood River	8,727	10,687	22.5%	11,684	11,659	-0.2%
Morrow	5,790	6,048	4.5%	5,205	5,125	-1.5%
Sherman	0	0	—	1,934	1,765	-8.7%
Umatilla	49,253	53,831	9.3%	21,295	22,058	3.6%
Wasco	15,730	16,876	7.3%	8,061	8,337	3.4%

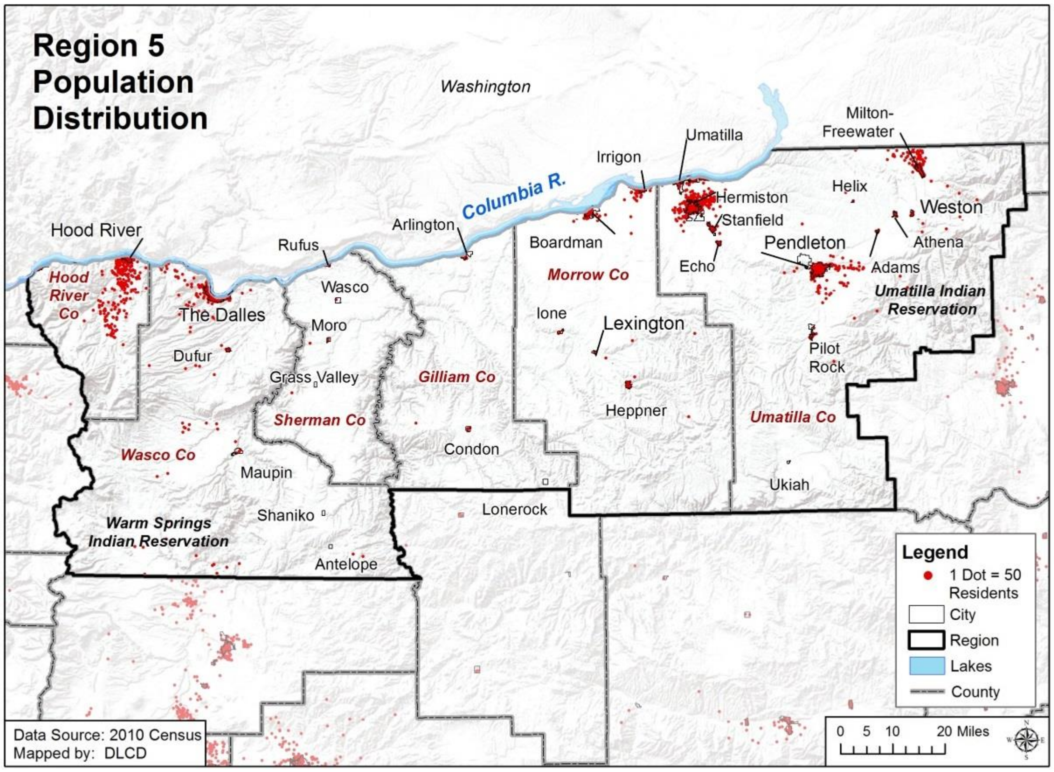
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-318. Urban and Rural Housing Units in Region 5

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 5	31,453	34,811	10.7%	20,946	22,156	5.8%
Gilliam	0	0	—	1,043	1,156	10.8%
Hood River	3,681	4,870	32.3%	4,137	4,401	6.4%
Morrow	1,957	2,010	2.7%	2,319	2,432	4.9%
Sherman	0	0	—	935	918	-1.8%
Umatilla	19,124	20,755	8.5%	8,552	8,938	4.5%
Wasco	6,691	7,176	7.2%	3,960	4,311	8.9%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-164. Region 5 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Region 5 embraces the Columbia River Plateau, where land uses have traditionally been dominated by agriculture and beef cattle.

Over the past 40 years — since all counties and incorporated municipalities were required to prepare comprehensive land use plans in accordance with 19 statewide planning goals (the Land Conservation and Development Act in 1973) — little has changed in this region's land use. According to a study by the Department of Forestry, between 1974 and 2009 very little loss in the area of private land in forest, agricultural, and range uses occurred in Wasco, Gilliam, Sherman Counties. The study does note an exception in Morrow County between 1974 and 1984, where private owners converted an estimated 33,000 acres of land in wildland range use to agricultural use (Lettman, 2011).

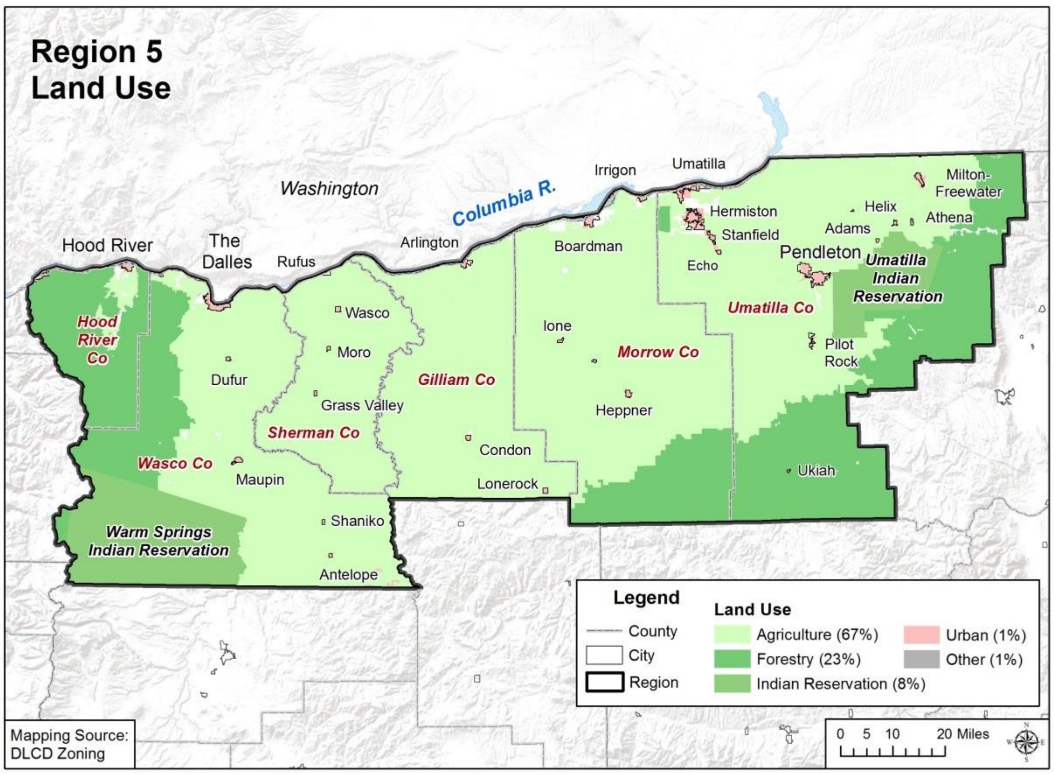
The community of Arlington (Gilliam County) has maintained a steady growth rate, and the Port of Morrow, 25 miles to the east in Umatilla County, remains the second busiest port in Oregon. Development can be limited in Region 5 along the Columbia River partly due to the geography. For example, buildable land in the community of Hood River is partly constrained by floodplains.

In the past few years, there has been significant growth in the development of wind farms. Shepherds Flat — located in both Morrow and Gilliam Counties — officially opened in 2012 and is one of the largest land-based wind farms in the world. Built entirely on private land, construction of nearly 100 miles of power lines and 85 miles of roads is expected on the 30-

square-mile project. Through the Mid-Columbia Region the potential effect of wind turbines, distribution lines, road building, and the region's changing viewshed is a developing conversation.

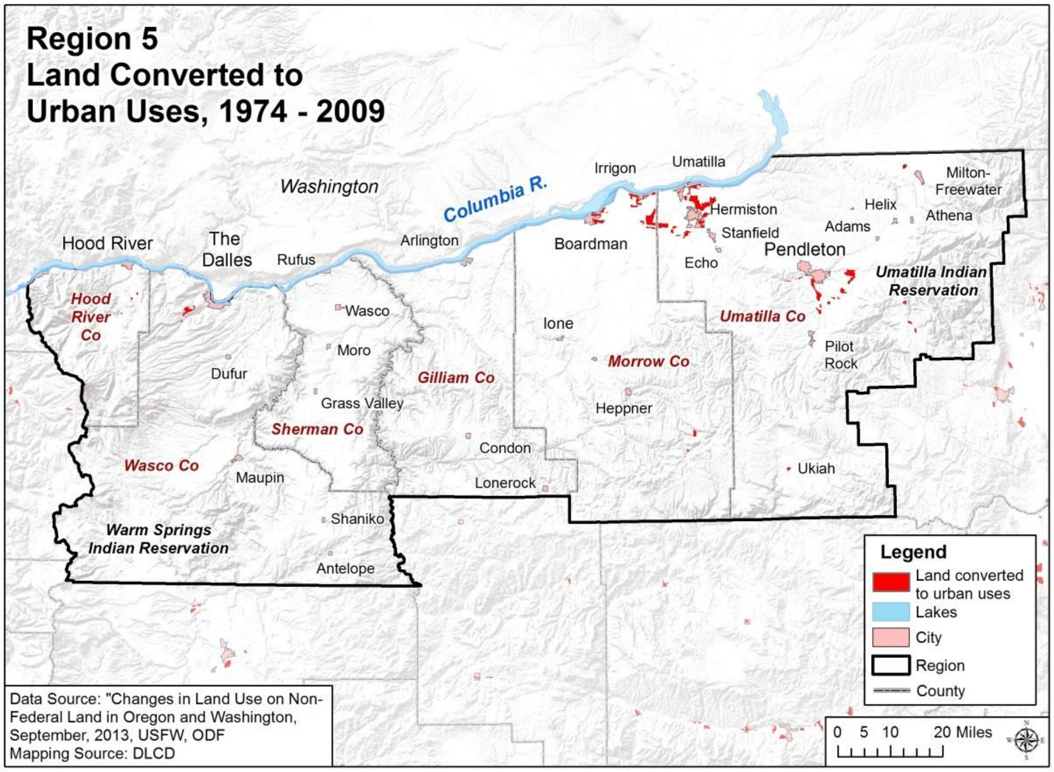
New FEMA floodplain mapping in Umatilla County in 2010 brought significant changes for the community of Milton-Freewater: the major levee along the Walla Walla River providing protection for much of the community was de-certified, effectively moving three quarters of the population into the NFIP regulatory floodplain. After some effort, the community approved a bond to repair the levee and new maps went into effect in 2013 reflecting that change.

Figure 2-165. Region 5 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-166. Region 5 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. **Table 2-319** provides a breakdown by county of housing types (single, multi-family, and mobile home; note that the total housing units value includes boats, RVs, vans, etc. that are used as a residence. These homes are not included in the table as a separate category since they represent a small percentage of the overall housing profile.).

The data show that the majority (69.1%) of the region's housing stock is single-family homes. Multi-family housing represents a smaller portion (15.5%) of housing within the region. Umatilla County has nearly half of the region's supply of multi-family units (5,049). Mobile residences make up 15.1% of Region 5's housing (Umatilla County has the highest number of mobile homes, while almost one third of the total housing units in Morrow and Sherman Counties are mobile homes). In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-319. Housing Profile for Region 5, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 5	56,938	39,319	69.1%	8,808	15.5%	8,586	15.1%
Gilliam	1,173	827	70.5%	92	7.8%	248	21.1%
Hood River	9,280	7,116	76.7%	1,399	15.1%	765	8.2%
Morrow	4,448	2,690	60.5%	485	10.9%	1,245	28.0%
Sherman	900	589	65.4%	50	5.6%	254	28.2%
Umatilla	29,707	20,433	68.8%	5,049	17.0%	4,076	13.7%
Wasco	11,430	7,664	67.1%	1,733	15.2%	1,998	17.5%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built has implications (Table 2-320). Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as a part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Table 2-320 illustrates the age of housing stock through 2012. Regionally, 44.5% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances (about 60% within Gilliam and Sherman Counties). Regionally, approximately 75% of the housing stock was built before 1990 and the codification of seismic building standards. Twenty-five percent of the region's housing stock was built after 1990.

Table 2-320. Age of Housing Stock in Region 5, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or Later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 5	56,938	25,313	44.5%	16,881	29.6%	14,744	25.9%
Gilliam	1,173	706	60.2%	246	21.0%	221	18.8%
Hood River	9,280	4,078	43.9%	2,128	22.9%	3,074	33.1%
Morrow	4,448	1,259	28.3%	1,618	36.4%	1,571	35.3%
Sherman	900	551	61.2%	186	20.7%	163	18.1%
Umatilla	29,707	13,055	43.9%	9,556	32.2%	7,096	23.9%
Wasco	11,430	5,664	49.6%	3,147	27.5%	2,619	22.9%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. **Table 2-321** shows the initial and current FIRM effective dates for Region 5 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-321. Community Flood Map History in Region 5

	Initial FIRM	Current FIRM
Gilliam County	Sep. 24, 1984	Sep. 24, 1984 (M)
Arlington	Sep. 24, 1984	Sep. 24, 1984 (M)
Condon	Sep. 24, 1984	Sep. 24, 1984 (M)
Hood River	Sep. 24, 1984	Sep. 24, 1984 (M)
Cascade Locks	Sep. 24, 1984	Sep. 24, 1984 (M)
City of Hood River	Sep. 24, 1984	Sep. 24, 1984 (M)
Morrow County	Apr. 1, 1981	Dec. 18, 2007
Boardman	Dec. 18, 2007	Dec. 18, 2007 (M)
Heppner	Apr. 1, 1981	Dec. 18, 2007
Ione	Apr. 1, 1981	Dec. 18, 2007
Irrigon	Dec. 18, 2007	Dec. 18, 2007
Lexington	Apr.1, 1981	Dec. 18, 2007
Sherman County	Sep. 24, 1984	Sep. 24, 1984 (M)
Grass Valley	Sep. 24, 1984	Sep. 24, 1984 (M)
Rufus	Sep. 24, 1984	Sep. 24, 1984 (M)
City of Wasco	Sep. 15, 1989	Sep. 15, 1989
Umatilla County	June 15, 1978	Sep. 3, 2010
Adams	May 15, 1984	Sep. 3, 2010
Athena	July 16, 1984	Sep. 3, 2010
Echo	May 15, 1984	Sep. 3, 2010
Helix	June 1, 1984	Sep. 3, 2010
Hermiston	Oct. 28, 1977	Sep. 3, 2010
Milton-Freewater	Sep. 12, 1978	Sep. 3, 2010
Pendleton	Nov. 3, 1978	Sep. 3, 2010
Pilot Rock	Aug. 4, 1988	Sep. 3, 2010
Stanfield	Aug. 15, 1984	Sep. 3, 2010
Ukiah	Sep. 24, 1984	Sep. 3, 2010 (M)
City of Umatilla	Sep. 24, 1984	Sep. 3, 2010 (M)
Weston	Sep. 18, 1987	Sep. 3, 2010
Umatilla Indian Reservation	Sep. 3, 2010	Sep. 3, 2010
Wasco County	Sep. 24, 1984	Sep. 24, 1984 (M)
Dufur	Sep. 24, 1984	Sep. 24, 1984 (M)
Maupin	Sep. 24, 1984	Sep. 24, 1984 (M)
Mosier	Feb.17, 1989	Feb. 17, 1989
The Dalles	Sep. 24, 1984	Sep. 24, 1984 (M)
Warm Springs Reservation	See Jefferson County	See Jefferson County

(M) = no elevation determined; all Zone A, C, and X.

Note: The Umatilla and Warm Springs Indian reservation information is provided for reference only. The State of Oregon has no jurisdiction over tribal lands.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 5 are shown in **Table 2-322**. The region contains 10.1% of the total value of state-owned/leased critical/essential facilities.

Table 2-322. Value of State-Owned/Leased Critical and Essential Facilities in Region 5

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 5	$744,388,079	10.1%
Gilliam	$2,316,597	0.0%
Hood River	$16,806,289	0.2%
Morrow	$9,176,310	0.1%
Sherman	$1,153,185	0.0%
Umatilla	$665,356,499	9.1%
Wasco	$49,579,199	0.7%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 5 is largely rural with urban development focused along I-84 and around the population centers of Hood River, The Dalles and Pendleton. Hood River County has the fastest growing urban population in the region, while Gilliam and Sherman Counties are entirely rural and declining in population. The region’s housing stock is largely single-family homes. However, there is nearly double the state’s percentage of mobile homes. The regions housing stock is also older than that of the state. Over 80% of homes in Gilliam and Sherman Counties were built before 1990 and current seismic building standards. With the exception of Morrow and Umatilla Counties, none of the region’s FIRMs have been modernized or updated, leaving this region’s flood maps less up to date than those of other regions.

2.3.5.3 Hazards and Vulnerability

Droughts

Characteristics

Region 5 has experienced drought conditions on several occasions. Most recently, Gilliam and Morrow County had drought emergencies declared by the Governor in 2013. Region 5 is susceptible to drought impacts, particularly since this region is predominantly supported by an agriculturally based economy.

Historic Drought Events

Table 2-323. Historic Droughts in Region 5

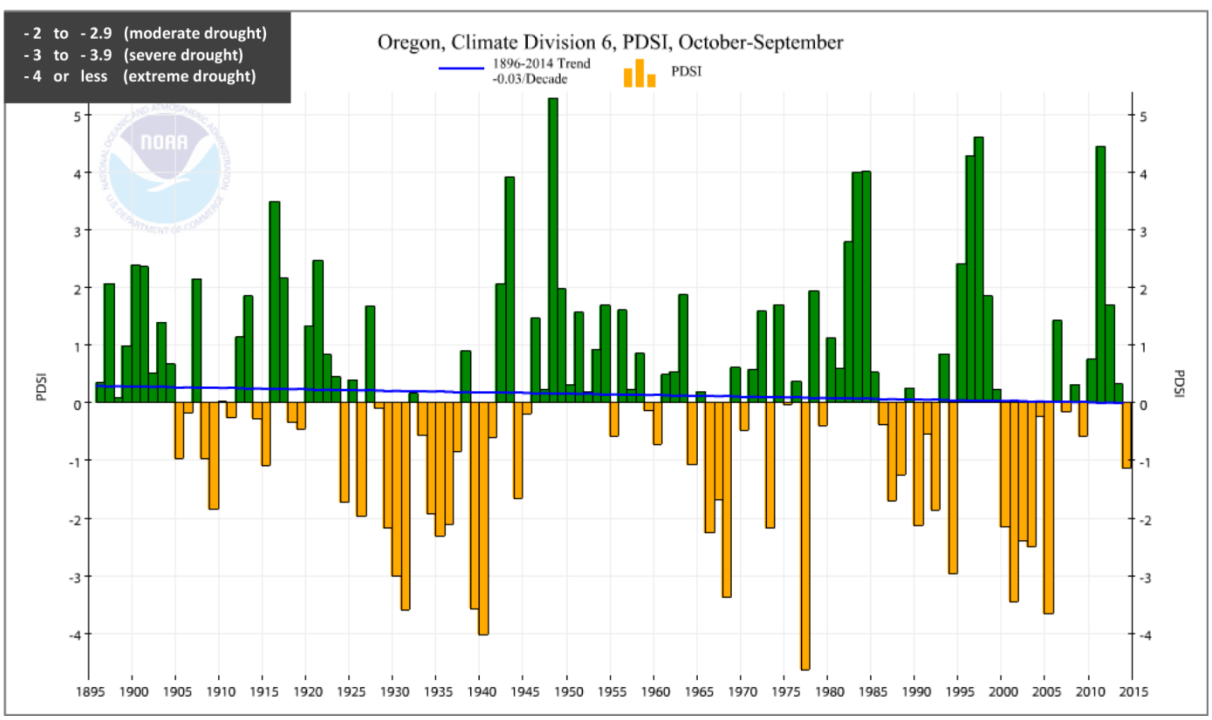
Water Year	Location	Description
1939	statewide 1938-1939, extreme drought in Region 5 in 1939-1940	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	Regions 4–8	the 1976-1977 drought was the most severe drought in the region with significant agricultural impacts
1994	Regions 4–8	in 1994 the Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2001	Regions 4–8 (18 counties)	Governor declared drought in Hood River, Wasco, Sherman, Gilliam, and Morrow Counties
2002	Regions 1 and 4–8	2001 drought declaration still in effect; Governor declares 5 additional counties, including Umatilla County
2003	Regions 5–8	eight counties declared; for Region 5, this included Sherman County; Hood River, Wasco, Gilliam, Morrow, and Umatilla County drought declarations from 2001 and 2002 were in effect through June 23, 2003; other counties outside of Region 5 under a drought declaration included Wheeler and Crook County from Region 6; Baker, Union, and Wallowa from Region 7; and Malheur and Harney County from Region 8; the Klamath County (Region 6) 2001 drought declaration remained in effect through December 31, 2003
2004	eastern Oregon	Governor declared drought for Morrow County in Region 5; three other counties also declared in neighboring regions
2005	Regions 5–7	all six counties within Region 5 declared drought by the Governor, along with five counties in Region 6, and two counties in Region 7
2008	Region 5 only	Governor issued a drought declaration for Sherman and Gilliam Counties in September
2013	Regions 5–8	five counties affected statewide; for Region 5: Gilliam and Morrow; Region 6: Klamath County, Region 7: Baker County, and Region 8: Malheur County

Sources: Taylor Hatton 1999); Oregon Secretary of State's Archives Division; NOAA's Climate at a Glance; Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt; personal communication, Kathie Dello, Oregon Climate Service, Oregon State University

Historical drought information can also be obtained from the National Climatic Data Center, which provides climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon because it does not account for snow or ice (delayed runoff); however, it has the advantage of providing the most complete, long-term record. **Figure 2-167** shows years where drought or dry conditions affected the Hazard Region 5, the north central area of Oregon (Climate Division 6).

Based on this index, there were two extreme drought years for this region: 1940 (- 4.02) and 1977 (- 4.63). During the 1930s, there were many moderate and severe drought years. 1968 was another severe drought year. The 1994 water year was nearly as severe, and the early 2000s experienced many moderate drought water years in the north central region.

Figure 2-167. Palmer Drought Severity Index for Region 5



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 5 will experience drought is shown in **Table 2-324**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-324. Local Probability Assessment of Drought in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	—	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

A comprehensive risk analysis is needed to fully assess the probability and impact of drought on Oregon communities. Such an analysis should be completed statewide to analyze and compare the risk of drought across the state.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is depicted **Table 2-325**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-325. Local Vulnerability Assessment of Drought in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	H	H	—	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of Governor drought declarations since 1992, Region 5 is vulnerable to drought-related impacts. Sherman, Gilliam, and Morrow have been under seven different drought declarations each since 1992.

Dust Storms

Characteristics

The characteristics of dust storms in Region 5 are well described in the State Risk Assessment, **Dust Storms** section. There is nothing about the dust storms in this region that differs from the general description, except to note that some of these storms in Morrow and Umatilla Counties in the past were possibly exacerbated by the agricultural practices at that time.

There are many examples of dust storms in this region. One of the most recent significant storms occurred on January 4, 2008. That morning, Oregon State Police responded to three semi-trailer trucks overturned on I-84 in Region 5, a day of blowing snow, dust, and debris that created near-zero visibility in some locations. The eastbound freeway lanes were closed near mile point 193 west of Pendleton because of high winds, crashes, and visibility issues in Morrow and Umatilla Counties. However, no injuries were reported related to the overturned vehicles between milepost 216 and 218 east of Pendleton. Five police patrol cars and two pickup trucks operated by troopers responding to the overturned vehicles received windshield and body damage from wind-blown rocks. Also that day, ODOT closed Oregon 11 between Pendleton and Milton-Freewater. Police reported several accidents there caused by low visibility, blowing dust and debris.

Historic Dust Storm Events

Table 2-326. Historic Dust Storms in Region 5

Date	Location	Description
May 1843[1]	Columbia Gorge	Rev. Gustavus Hines, who was traveling by canoe with a Dr. Davis in the Columbia Gorge, reported this storm
Feb. 1909	between Pendleton and Pilot Rock	"The dust storm (is) now blowing great holes in the ground wherever there are any plowed fields… sand and soil are being scooped up in vast quantities (and) deposited in large drifts… roads are being blocked… travelers were obliged to stop and wait until the blackness caused by the dust disappeared before they could tell where they were going." [2]
June 1912	Pendleton area	"The worst wind storm of the year… brought with it a great burden of dust (which) made it extremely disagreeable as well as harmful."
May 1975[3]	near Echo Junction	winds up to 45 mph blew dust from nearby plowed fields, resulting in a seven-car accident on a Friday afternoon in the eastbound lanes of I-80 (now I-84); four injured
Mar. 1976[4]	near Stanfield	18 vehicles piled-up in two separate accidents on I-80, now I-84; these accidents killed one and injured 20 people; they were caused by a dust storm (referred to in the press as a sand storm) that produced "near zero" visibility; one of the pileups was a fiery accident involving a loaded fuel tanker truck, two other trucks, and two cars; this dust storm also caused road closures both south and north of Hermiston and caused other accidents on OR-207 about 9 miles south of I-80 (84)
July 1979[5]	near Stanfield	this dust storm caused two deaths and six injuries in a freeway pileup on I-80 (I-84) very close to the location of the previous event; winds near 60 mph; some of the injured were hit as pedestrians while trying to assist those already injured or pinned in automobiles
Apr. 1996	near Hepner	"Strong winds in the Columbia Basin produced a dust storm near Hepner."[6]
June 1997	near Hermiston	"Highway 395 south of Hermiston was closed for a few hours when high wind and blowing dust reduced visibility to less than 50 feet. The dust is believed to have played a role in a minor accident on the highway." [7]
Sep. 1999[8]	Morrow and Umatilla Counties	blowing dust off wheat fields killed eight and injured more than twenty people in chain-reaction auto crashes
Sept. 2001	near Pendleton	blowing dust contributed to an eight vehicle accident on OR-11 10 miles northeast of Pendleton; windy conditions, combined with loose topsoil from a freshly plowed field, created blowing dust that locally reduced visibilities to less than 100 feet; a series of chain reaction collisions occurred as vehicles slowed as they entered into the area of low visibility; five minor injuries were reported according to the Oregon State Police[9]
Oct. 2003	Morrow and Umatilla Counties	"A dust storm lowered visibilities to less than a quarter mile along the foothills of the Blue Mountains… ODOT led traffic on Highway 11 from Milton-Freewater to Weston… one way at a time." This event also affected an area 11 miles southwest of Boardman. [10]
Mar. 2005	Morrow and Umatilla Counties	weather stations at 19 locations measured peak wind gusts from 45 to 64 mph; visibility restrictions down to near zero due to blowing dust occurred along I-84 between Boardman and Pendleton; extremely low visibilities led to road closures and multiple vehicle pileups; vehicles pulled off the road to avoid collisions. "On Highway 207 near Hermiston visibility was reduced to near zero due to blowing dust. The extremely low visibility contributed to a non-injury collision near the Boardman Bombing Range. In addition, four miles north of Heppner on State Route 207, blowing dust reduced visibilities to near zero." [11]
May 2006	near Boardman	"I came around the corner (to) a giant dust cloud that looked like a brown fog bank… within the cloud was regular lightning bolts." [12]

Date	Location	Description
Jan. 2008	Morrow and Umatilla Counties	ODOT closed the freeway's westbound lanes between Baker City and La Grande about noon because of blowing snow, dust, and debris that created near-zero visibility in the Ladd Canyon area east of La Grande; the eastbound freeway lanes were closed between mile point 193 west of Pendleton and Baker City because of high winds, crashes, and visibility issues; five patrol cars and two pickup trucks operated by troopers responding to overturned vehicles received windshield and body damage from wind-blown rocks; ODOT also closed Oregon 11 between Pendleton and Milton-Freewater; police reported several accidents caused by low visibility, blowing dust and debris
May 2010	Morrow and Umatilla Counties	"Blowing dust in the Columbia Basin reduced visibility to near zero around Stanfield, Pendleton, and between Lexington and Hermiston. The blowing dust caused traffic accidents with an injury near Stanfield on I-84." [13]
Sept. 2013[14]	Umatilla County	dust storms two weeks apart hit Weston

Sources:

(1) Diary of Rev. Gustavus Hines

(2) East Oregonian, February 3, 1909

(3) East Oregonian, May 24, 1975

(4) East Oregonian, March 24, 25, and 26, 1976, including articles titled "18 Vehicles Crash in Dust Storm; Woman Killed" and "Dust Problem Stymies Farmers"; Oregon Statesman, "Dust Storms Hit E. Oregon…", March 25, 1976

(5) Oregon Statesman, "2 Dead, 6 Injured in Freeway Accident; Dust Storm Blamed," July 11, 1979

(6) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5556785

(7) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5597478

(8) La Grande Observer, "State Gives Dust Storm Driving Advice," October 1, 1999 and "Report Blames Speed," November 20, 1999; Statesman Journal, "Six Die in 50-car Pileup on I-84: Dust Blinds Drivers on the Interstate near Pendleton," September 26, 1999, "Dust Brownout Led to Fatal Wrecks: Dry Weather and High Winds Created the Deadly Eastern Oregon Storm," September 27, 1999, and "Road Warnings Needed: Motorists Can Learn from Last Week's Fatal Dust Storm Collisions," October 5, 1999; Corvallis Gazette-Times, "Corvallis Couple Recovering from Highway Crash," September 27, 1999; Learning to Fly, April Henry; East Oregonian, Mitchell Zach; Associated Press news story dated September 26, 1999; also post-event documents of the Community Solutions Team (meeting minutes) and Oregon State Police

(9) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5268728

(10) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5372265 and https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5335873

(11) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439648 and https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439653

(12) This is from a letter to the editor of The Dalles Chronical dated July 6, 2006; it conveys trucker Greg Jones' experience on a "run one night in May… to Hermiston."

(13) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=222144

(14) Daily Mail, September 16, 2013; YouTube, Fredrik Anderson, September 12, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 5 will experience dust storms is shown in **Table 2-327**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-327. Local Probability Assessment of Dust Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	—	—	H	—	H	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Using history as a guide (nine significant storms in Region 5 over the past 40 years), the probability of dust storms occurring in Region 5 is high. These storms may be slightly less likely than in the past due to changes in agricultural practices, but changes in climate, ENSO cycles, and other natural factors may offset reductions in occurrence linked to farming.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storm is shown in **Table 2-328**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-328. Local Vulnerability Assessment of Dust Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	—	—	M	—	H	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Morrow and Umatilla Counties are not only the counties most vulnerable to dust storms in this region, but are also the most vulnerable in the State of Oregon. These two counties seem to be most vulnerable due to a combination of soil types, exposed soil due to farming, periodic high wind events, and big open areas that help dust storms to develop. Wasco County is also vulnerable in this region.

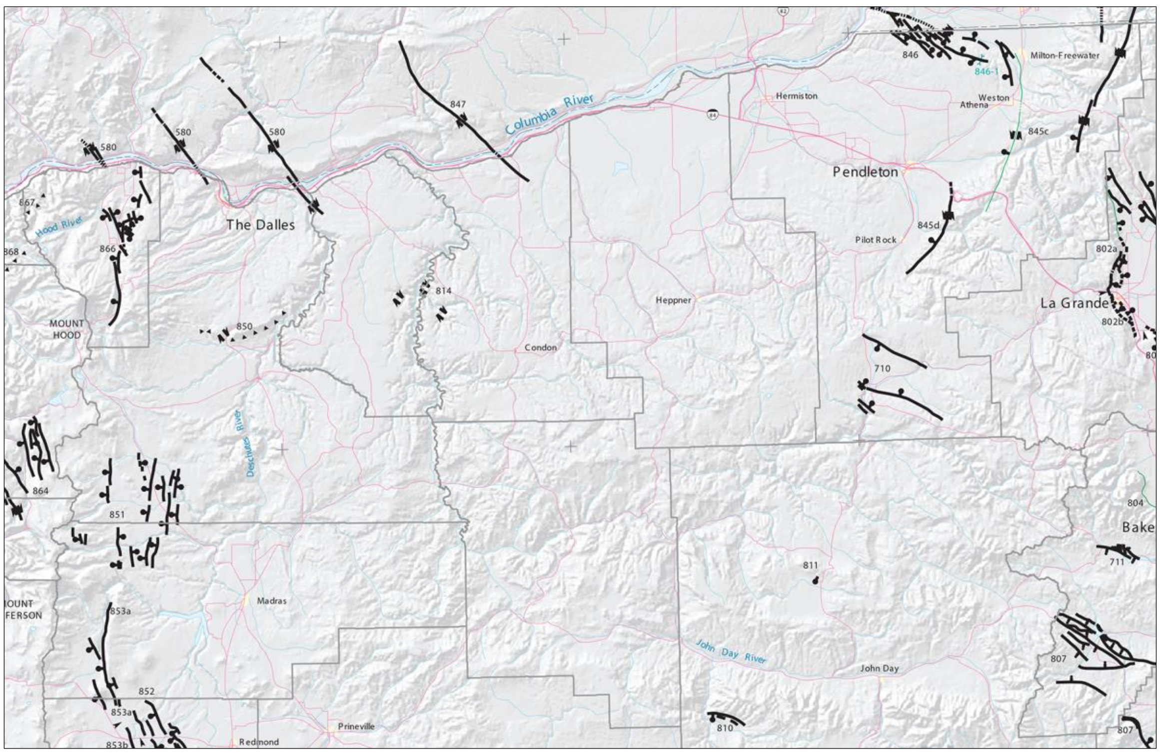
Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from three sources: subduction zone, intraplate, and crustal events. The map below shows the location of the known crustal faults which could affect the region. Because only certain faults have been studied in detail and determined to be active, there may be many more crustal faults in the region capable of producing earthquakes which have not yet been identified. **Figure 2-168** shows the locations of faults in Region 5.

Figure 2-168. Quaternary Faults and Folds in Region 5

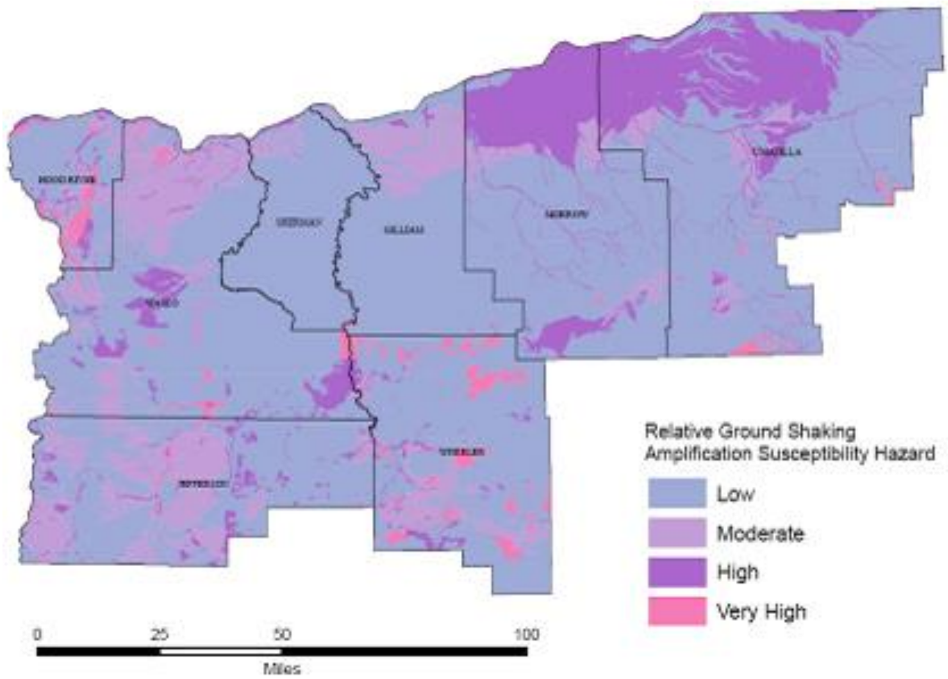


Source: Modified from Personius et al., 2003

When all of these earthquake sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relatively moderate seismicity area, except for Hood River and Wasco Counties which are mostly within relatively moderate to high zones.

[Figure 2-169](#) displays the relative ground shaking amplification hazard throughout Region 5.

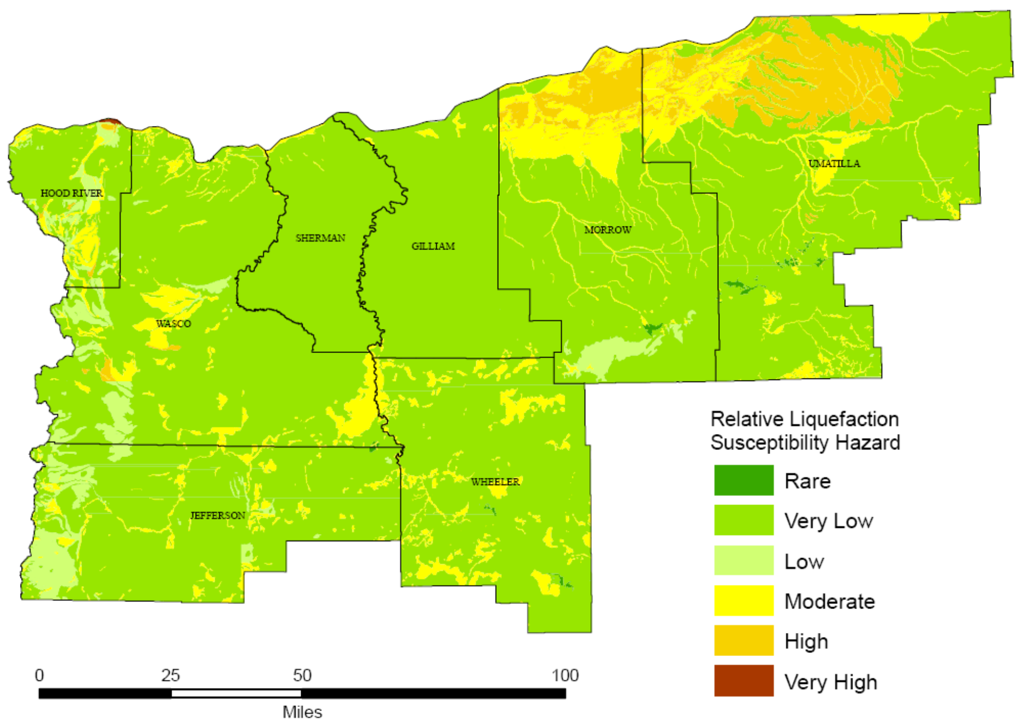
Figure 2-169. Relative Ground Shaking Amplification Hazard in Region 5



Source: Burns, 2007

During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and its ability to support loads. Figure 2-170 displays the relative liquefaction hazard throughout Region 5.

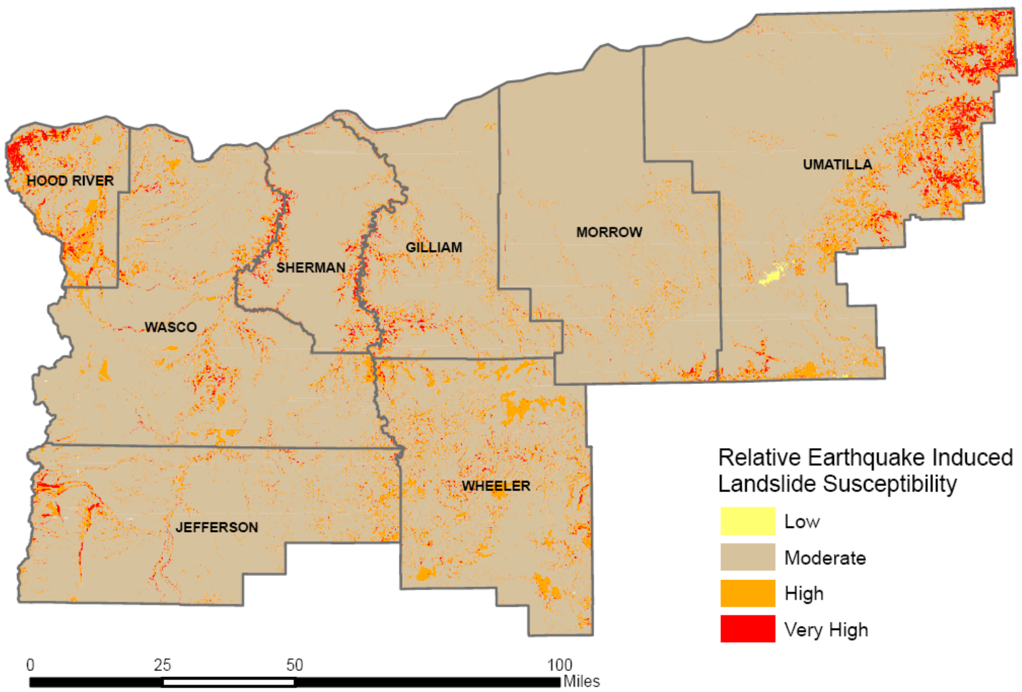
Figure 2-170. Relative Liquefaction Susceptibility Hazard in Region 5



Source: Burns, 2007

Strong ground shaking can also cause landslides and reactivate dormant landslides. Commonly, slopes that are marginally stable prior to an earthquake become unstable and fail. Some landslides result from liquefaction that causes lateral movement of soil, or lateral spread. Figure 2-171 displays the relative earthquake induced landslide hazard throughout Region 5.

Figure 2-171. Relative Earthquake-Induced Landslide Susceptibility Hazard in Region 5

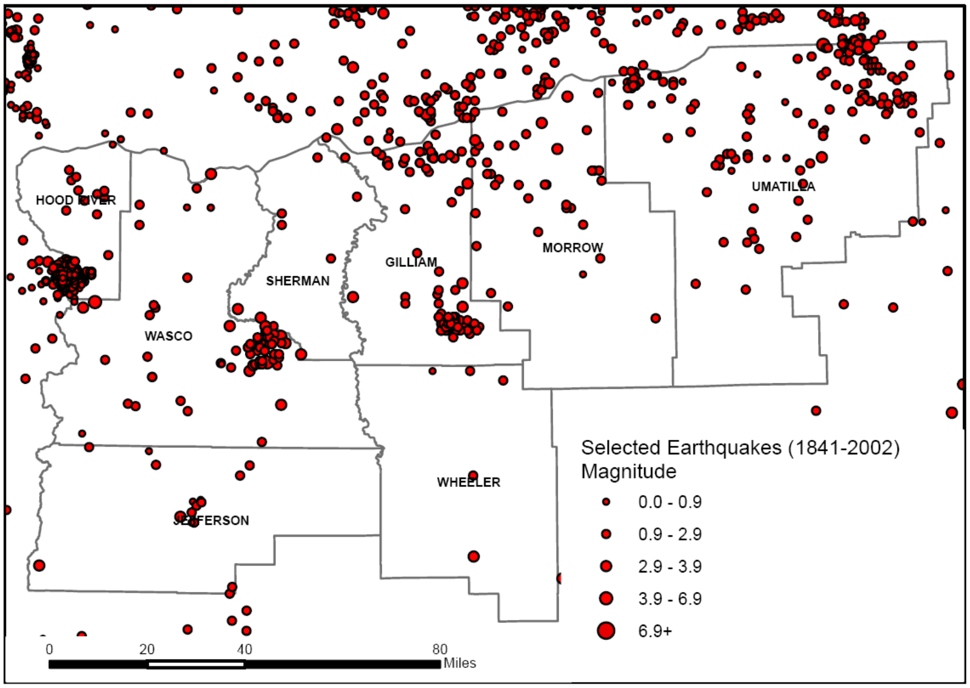


Source: Burns, 2007

Region 5 has experienced many earthquakes as shown in Figure 2-172 and Table 2-329. Three historic earthquakes of significance that were centered in the region are the 1893 Umatilla, 1936 Milton-Freewater (M6), 1951 Hermiston, and 1976 Maupin area (M4.8), all shallow crustal earthquakes. There are faults in the region that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area.

The map displays over 1,000 earthquakes that have been recorded in the region during the last century. Because the instrument network in the region was very sparse until the mid-2000s, it is likely that thousands of earthquakes have occurred in the region but were not recorded and thus do not appear on this map.

Figure 2-172. Selected Earthquakes in Region 5, 1841–2002



Source: Niewendorp and Neuhaus (2003)

Historic Earthquake Events

Table 2-329. Significant Earthquakes Affecting Region 5

Date	Location	Magnitude (M)	Comments
Approximate years: 1400 BCE, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia subduction zone	probably 8-9	these are the midpoints of the age ranges for these six events
Jan. 26, 1700	offshore, Cascadia Subduction zone	about 9	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 23, 1873	near Brookings, Oregon, at the Oregon-California border	6.8	may have been an intraplate event because of lack of aftershocks; felt as far away as Portland and San Francisco
Mar. 1893	Umatilla, Oregon	VI-VII (Modified Mercalli Intensity)	damage: unknown
July 15, 1936	Milton-Freewater, Oregon	6.4	two foreshocks and many aftershocks felt; damage: $100,000 (in 1936 dollars)
Apr. 13, 1949	Olympia, Washington	7.1	fatalities: eight; damage: $25 million (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon
Jan. 1951	Hermiston, Oregon	V (Modified Mercalli Intensity)	damage: unknown
Nov. 5, 1962	Portland, Oregon and Vancouver, Washington	5.5	shaking up to 30 seconds; chimneys cracked, windows broke, furniture moved
May- June 1968	Adel	5.1	Increased flow at a hot spring
Apr. 12, 1976	near Maupin, Oregon	4.8	sounds described as distant thunder, sonic booms, and strong wind
Apr. 25, 1992	Cape Mendocino, California	7.0	subduction earthquake at the triple-junction of the Cascadia subduction zone and the San Andreas and Mendocino faults
Mar. 25, 1993	Scotts Mill	5.6	center: Mount Angel-Gates Creek fault; damage: $30 million, including Molalla High School and Mount Angel church
Sep. 20, 1993	Klamath Falls	5.9 and 6.0	fatalities: two; damage: $10 million, including county courthouse; rockfalls

*BCE: Before Common Era.

Sources: Wong et al. (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience earthquakes is shown in **Table 2-330**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-330. Local Probability Assessment of Earthquakes in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	M	M	L	L	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

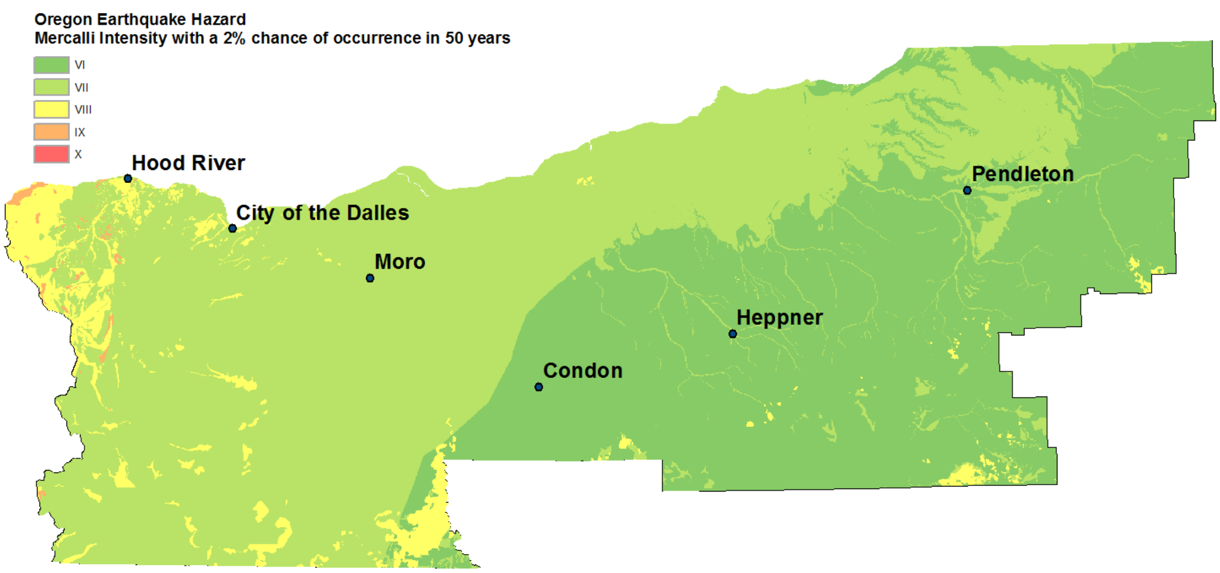
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 5, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 5 in **Figure 2-173**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

For Oregon west of the crest of the Cascades, the Cascadia subduction zone is responsible for most of the hazard. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller M_W 8.3–8.5 earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-173. Probabilistic Earthquake Hazard in Region 5



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

- VI Felt by all, weak buildings cracked;
- VII Chimneys break, weak buildings damaged, better buildings cracked;
- VIII Partial collapse of weak buildings, unsecured wood frame houses move;
- IX Collapse and severe damage to weak buildings, damage to wood-frame structures; and
- X Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-331**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-331. Local Vulnerability Assessment of Earthquakes in Region 5

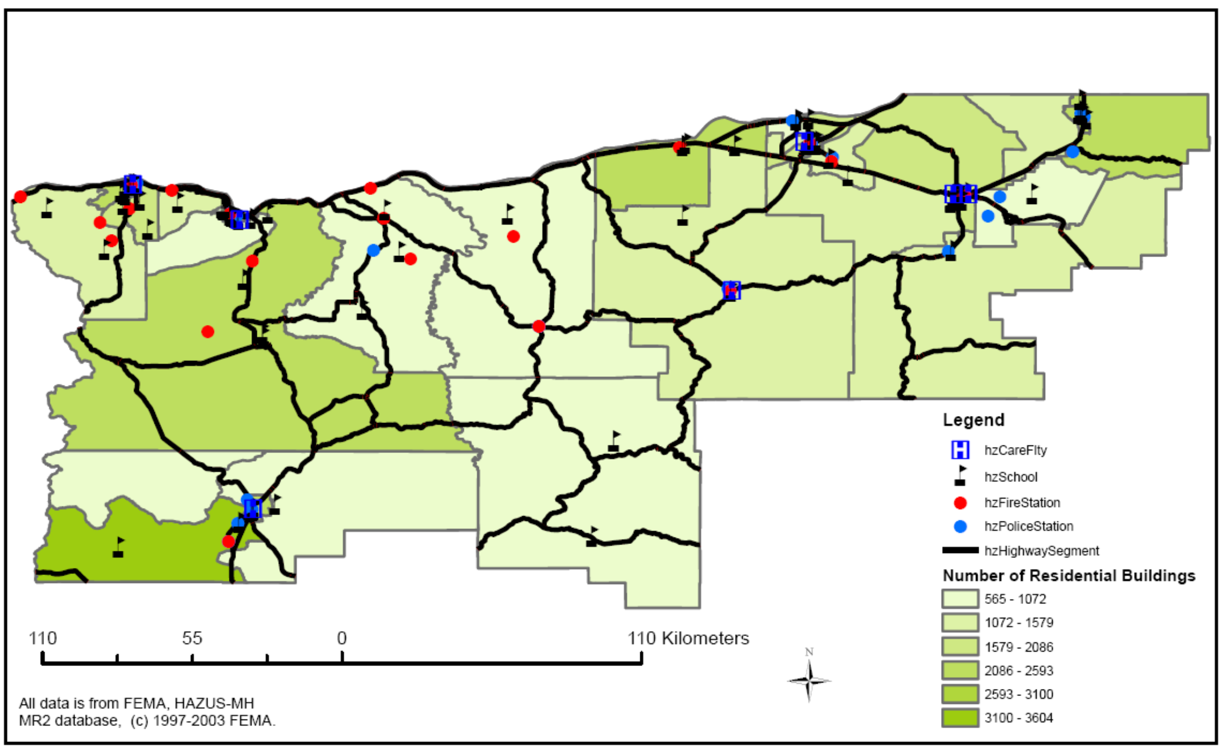
	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	H	L	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

According to the ranking of the counties' expected damages and losses, based on the 500 year model, none of the counties in Region 5 were ranked among the top 15. Nonetheless, the Mid-Columbia Region is considered moderately vulnerable to earthquake hazards from earthquake-induced landslides in the Cascades, ground shaking, and liquefaction.

Figure 2-174. Region 5 Generalized Earthquake Hazard Exposure



Data are from Hazus-MH MR2 database.
Source: Burns (2007)

Most of the people and infrastructure are along the I-84 corridor, which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang and Chaker, 2004). **Figure 2-175** displays the general exposure of the region.

The geographic size of the region is roughly 13,700 square miles and contains 36 census tracts. There are over 54,000 households in the region and it has a total population of over 150,000 people (FEMA, 2006). There are an estimated 52,000 buildings in the region with a total building replacement value (excluding contents) of $8.5 billion. Approximately 99% of the buildings (and 84% of the building value) are associated with residential housing. The replacement values of the transportation system and utility lifeline systems are estimated to be approximately $16.5 billion and $4.8 billion, respectively.

Table 2-332 shows the number of school and emergency response buildings surveyed in each county and their respective rankings.

Table 2-332. School and Emergency Response Buildings Collapse Potential in Region 5

	Level of Collapse Potential			
County	**Low (< 1%)**	**Moderate (>1%)**	**High (>10%)**	**Very High (100%)**
Gilliam	4	2	5	4
Hood River	18	14	7	13
Morrow	11	10	7	5
Sherman	5	4	3	—
Umatilla	40	24	46	16
Wasco	23	7	10	—

Source: DOGAMI 2007. Open-File Report 07-02, Statewide Seismic Needs Assessment Using Rapid Visual Assessment.

As mentioned in the State Risk Assessment, DOGAMI developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) a M6.5 Arbitrary Crustal event and (b) a 2,500 year mean return period probabilistic earthquake scenario (2,500-year Model). Both models are based on Hazus-MH, a computer program currently used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The arbitrary crustal event is based on a potential M6.5 earthquake generated from an arbitrarily chosen fault using the Hazus software, and assuming a worst-case scenario. The 2,500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults, each with a 2% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single "average" earthquake during this time.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the models do provide some approximate estimates of damage. Results are found in **Table 2-333**, **Table 2-334**, and **Table 2-335.**

Table 2-333. Total Building, Transportation, and Utility Exposure and Potential Losses in Region 5 from a 2,500-Year-Return Interval Ground Motion

Region 5 Counties	Building Exposure	Transportation Exposure	Utility Exposure	Total Exposure	
Gilliam	$148,000,000	$1,777,000,000	$153,000,000	$2,078,000,000	
Hood River	$1,282,000,000	$1,413,000,000	$702,000,000	$3,397,000,000	
Jefferson	$1,009,000,000	$1,185,800,000	$405,910,000	$2,600,710,000	
Morrow	$517,000,000	$1,592,600,000	$740,040,000	$2,849,640,000	
Sherman	$124,000,000	$1,299,700,000	$117,520,000	$1,541,220,000	
Umatilla	$3,837,000,000	$4,956,900,000	$1,390,340,000	$10,184,240,000	
Wasco	$1,513,000,000	$3,305,400,000	$1,162,950,000	$5,981,350,000	
Region Total	$**8,430,000,000**	$**15,530,400,000**	$**4,671,760,000**	$**28,632,160,000**	
	Building Losses	**Transportation Losses**	**Utility Losses**	**Total Losses**	**Loss % of Total**
Gilliam	$6,300,000	$12,700,000	$6,040,000	$25,040,000	1.2%
Hood River	$153,510,000	$85,900,000	$102,990,000	$342,400,000	10.1%
Jefferson	$54,580,000	$15,600,000	$16,790,000	$86,970,000	3.3%
Morrow	$178,540,000	$49,300,000	$106,800,000	$334,640,000	11.7%
Sherman	$5,600,000	$45,300,000	$5,810,000	$56,710,000	3.7%
Umatilla	$736,640,000	$200,600,000	$135,480,000	$1,072,720,000	10.5%
Wasco	$191,010,000	$82,400,000	$116,890,000	$390,300,000	6.5%
Region Total	$**1,326,180,000**	$**491,800,000**	$**490,800,000**	$**2,308,780,000**	**8.0%**

Source: W. J. Burns, 2007, unpublished report: Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage and Loss Estimates for Seven Counties in the Mid-Columbia River Gorge Region Including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

Table 2-334. Estimated Losses in Region 5 Associated with an Arbitrary M6.5 Crustal Event

	Region 5 Counties					
	Gilliam	**Hood River**	**Morrow**	**Sherman**	**Umatilla**	**Wasco**
Injuries (5 pm time frame)	3	120	126	4	208	220
Deaths (5 pm time frame)	0	6	7	0	10	13
Displaced households	3	419	521	6	1,048	720
Economic Losses for buildings	$9.21 mil	$189.96 mil	$109.9 mil	$8.4 mil	$248.68 mil	$307.09 mil
Operational the day after the event:						
Fire stations	100%	60%	50%	0%	75%	50%
Police stations	100%	0%	100%	0%	79%	0%
Schools	100%	21%	43%	33%	88%	27%
Bridges	100%	100%	100%	88%	99%	98%
Economic losses to infrastructure:						
Highways	$0.1 mil	$37.2 mil	$43.5 mil	$33.1 mil	$77 mil	$35.5 mil
Airports	$3.2 mil	$7.3 mil	$1.7 mil	$2 mil	$16.5 mil	$13.3 mil
Communications	0	$0.08 mil	0	0	$0.05 mil	$0.08 mil
Debris generated (million tons)	0	0	0	0	0	0

Source: W. J. Burns, 2007, DOGAMI unpublished report: Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage and loss estimates for seven counties in the Mid-Columbia River Gorge Region including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

Table 2-335. Estimated Losses in Region 5 Associated with a 2,500-Year Probable M6.5 Driving Scenario

	Region 5 Counties					
	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Injuries (5 pm time frame)	2	111	164	2	623	136
Deaths (5 pm time frame)	0	6	8	0	32	8
Displaced households	0	303	768	1	2,957	373
Economic Losses for buildings	$6.3 mil	$153.51 mil	$178.54 mil	$5.68 mil	$736.64 mil	$191.01 mil
Operational the day after the event:						
Fire stations	100%	20%	0%	66%	25%	75%
Police stations	100%	100%	50%	100%	21%	67%
Schools	100%	14%	14%	100%	28%	33%
Bridges	100%	82%	100%	76%	93%	96%
Economic losses to infrastructure:						
Highways	$6.3 mil	$71.9 mil	$36.4 mil	$42.2 mil	$173.8 mil	$63.1 mil
Airports	$5.7 mil	$7.6 mil	$5.2 mil	$1.8 mil	$19.7 mil	$15.8 mil
Communications	$0	$0.05 mil	$0	$0	$ 0.24 mil	$0.05 mil
Debris generated (million tons)	0	0	0	0	0	0

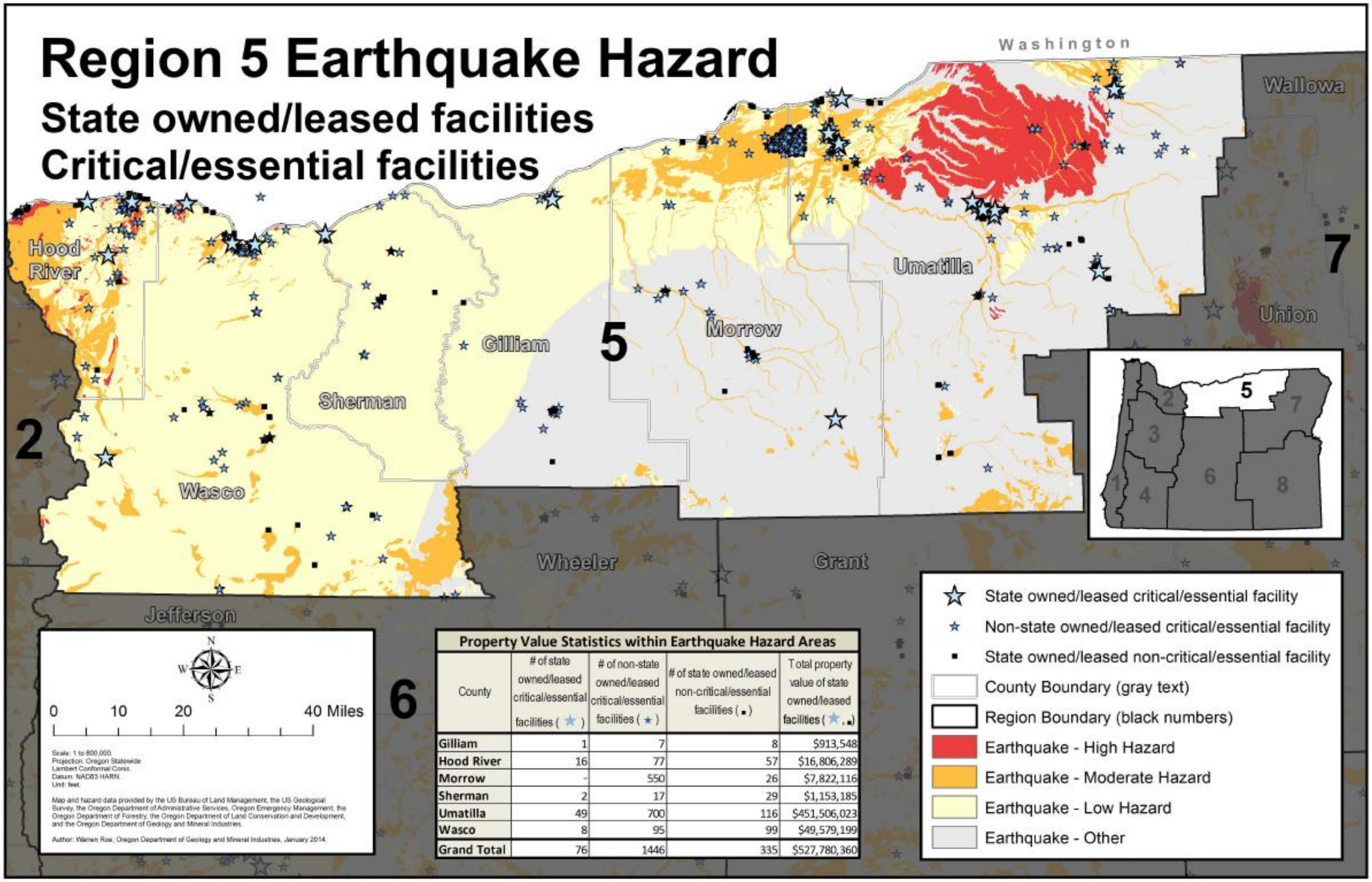
Source: W. J. Burns, 2007, DOGAMI unpublished report: Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage and loss estimates for seven counties in the Mid-Columbia River Gorge Region including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 411 totaling roughly $528 million are located in an earthquake hazard zone in Region 5 (**Figure 2-175**). Among the 1,141 state-owned/leased critical/essential facilities, 76 are in an earthquake hazard zone in Region 5. Additionally, 1,446 non-state-owned/leased critical or essential facilities in Region 5 are located in an earthquake hazard zone.

Figure 2-175. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 5



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	1	7	8	$913,548
Hood River	16	77	57	$16,806,289
Morrow	-	550	26	$7,822,116
Sherman	2	17	29	$1,153,185
Umatilla	49	700	116	$451,506,023
Wasco	8	95	99	$49,579,199
Grand Total	76	1446	335	$527,780,360

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 5 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 5:

- Cascades Geographic Zone: OEM Mitigation Planning Region 5 is located in part within the OSLR Cascades Geographic Zone. Two crossings of the Cascades from western to central Oregon are partly within this zone and connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The area contains one Tier 1 route: I-84. It also contains part of the Tier 2 route: OR-212 and US-26.
- Central Geographic Zone: Region 5 also encompasses the northerly part of the Central Geographic Zone, which contains Tier 1 routes I-84 from The Dalles to Biggs Junction and US-97. These roadways are subject to rockfall risks in several areas. There are no Tier 2 routes in this region, and one Tier 3 corridor: the north end of US-197.

REGIONAL IMPACT.

- Ground shaking: Ground shaking damage from a CSZ event is not expected to be significant in Region 5.
- Landslides and rockfall: Landslide and rockfall damage are not anticipated to be activated by a CSZ event in Region 5.
- Liquefaction: Structures in wetland, alluvial, and other saturated areas may be subject to liquefaction damage, particularly in areas associated with the Columbia River near the western end of Region 5.
- Other: Damage to shipping channels and shore facilities, and failure of Columbia River bridges west of Region 5 may have long-term impacts on freight shipments into and out of Region 5.

REGIONAL LOSS ESTIMATES. The highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

MOST VULNERABLE JURISDICTIONS. Gilliam, Hood River, Morrow, Sherman, Umatilla and Wasco Counties have similar, relatively low vulnerability to ground shaking from a CSZ event. However, connections to markets and services will likely be disrupted due to the vulnerability of river transportation, ports, and surface routes to freight intermodal connections in the Portland Metro area.

Floods

Characteristics

Region 5 is subject to a variety of flood conditions. The most common type of flooding is associated with unseasonably warm weather during the winter months, which can quickly melt snow. This condition has produced devastating floods throughout the region. Flash floods, another type of flooding experienced in the region, are almost always a summer phenomenon associated with intense local thunderstorms. The flash flood of June 1903 in the City of Heppner (Morrow County) is a benchmark event. No flood in Oregon has been more lethal: 247 fatalities. Heppner's vulnerability to flash flood hazards has since been reduced through the construction of the Willow Creek Dam. The region's other flood events are linked to normal seasonal snowmelt and runoff from agricultural fields.

There are several rivers in the region that produce natural extreme flood conditions. Surprisingly, the Columbia is not one of them, nor is the lower Deschutes or the John Day. The Columbia is regulated by up-stream dams. A swollen Columbia River, however, can back up tributary streams to the point where they constitute a significant hazard. This has occurred on a number of occasions. The lower Deschutes and John Day are confined to fairly deep canyons with small floodplains. Consequently, they do not present the flood problems associated with smaller rivers, such as the Umatilla, the Walla Walla, and their tributaries.

Historic Flood Events

Table 2-336. Significant Historic Floods Affecting Region 5

Date	Location	Description	Type of Flood
June 1894	main stem Columbia River (Region 5 communities)	largest flood observed on the Columbia River (1,200,000 cfs); City of Umatilla inundated; widespread damage	snow melt
June 1903	Morrow County (Willow Creek)	very devastating flash flood; 40-ft wall of water in City of Heppner; 247 fatalities; 141 homes destroyed	flash flood
Jan. 1923	Mid-Columbia region	widespread flooding; unusually warm weather, intense rain	rain on snow
Jan. 1933	Mid-Columbia region	widespread flooding; heavy mountain snowpack followed by rain and mild temperatures	rain on snow
Dec. 1955	Mid-Columbia region	mild temperatures and rain; farms, highways flooded	rain on snow
Dec. 1964	entire state	record-breaking floods throughout state; heavy snow in mountains followed by intense rain; considerable flood damage	rain on snow
July 1965	Lane/Spears Canyons (Umatilla County)	thunderstorm; 8–10 ft wall of water from canyon; considerable damage; one fatality; several people injured	flash flood
Dec. 1980	Polallie Creek (Hood River County)	debris flow from vicinity of Mount Hood; debris dam formed a small lake that was later breeched; damage to highways and utilities	debris flow
Feb. 1985	Umatilla County	warm rain on snow at higher elevations; flooding throughout county	rain on snow
Feb. 1986	entire state	warm rain on snow; widespread flooding; considerable damage	rain on snow
May 1998	central and eastern Oregon	widespread flooding; rain melting mountain snow	rain on snow
Aug. 2003	Gilliam County	$7,000 in property damage	
Aug. 2003	Sherman County	Flash flood (Gerking Canyon) *excerpted from State Plan, 2006	
Apr. 2005	Morrow County	$2,000 in property damage	
Apr. 2005	Umatilla County	$170,000 in property damage	
Mar. 2006	Morrow County	flash flood from a collapsed irrigation dike embankment floods the south side of I-84 near Boardman, closing down the road	flash flood
Nov. 2006	Hood River County	Hood River near the City of Hood River caused extensive damage on OR-35 closing the highway for a month; moderate damage done to irrigation works; total $30 million in damage	riverine
May/ June 2011	Morrow County	intense rainfall in the Heppner and Lexington areas resulting in damage to roads, bridges, and the Morrow County Fairgrounds; total of $164,000 in damage	flash flood

Sources: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007); The Spatial Hazard Events and Losses Database for the United States, version 5.1 [online database]. Columbia, SC: University of South Carolina, available from http://www.sheldus.org; State Interagency Hazard Mitigation Team (2006). National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms

Table 2-337. Principal Flood Sources by County in Region 5

Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Columbia River Thirty Mile Creek	Columbia River Hood River Indian Creek	Columbia River Hinton Creek Little Blackhorse Canyon Creek Shobe Creek Willow Creek Rhea Creek	Columbia River	Columbia River Birch Creek McKay Creek Mill Creek Patawa Creek Stage Gulch Tutuilla Creek Umatilla River Walla Walla River Waterman Gulch Pine Creek Greasewood Creek	Columbia River Spanish Hollow Creek Fifteen Mile Creek Mosier Creek

Source: FEMA Flood Insurance Studies for Gilliam, Hood River, Morrow, Sherman, Umatilla, and Wasco Counties

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience flooding is shown in **Table 2-338**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-338. Local Probability Assessment of Flood in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100-year) upon which the National Flood Insurance Program is based. All of the Region 5 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are old and could be outdated. The FIRM maps were issued at the following times:

- Gilliam, September 24, 1984;
- Hood River, September 24, 1984;
- Morrow, December 18, 2007;
- Sherman, September 24, 1984;
- Umatilla, September 2010; and
- Wasco, September 24, 1984.

Significant flooding occurs at least once every 5-7 years.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-339**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-339. Local Vulnerability Assessment of Flood in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	H	M	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-340**.

Table 2-340. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each of the counties in Region 5 had a flood vulnerability score of 5, except for Sherman County with a score of 4. This is below average for the state.

Region 5 is exposed to flood hazards. Most of the people and infrastructure are along the I-84 corridor, which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang & Chaker, 2004).

The vulnerability from the hazard can be examined through the spatial relationship of the percent of a city's total area versus the percent of the city's area within the 100 year flood zone. Four of the top 10 cities in Oregon examined using this metric are located in Region 5: Helix, Ione, Adams, and Athena. This indicates that damaging floods are indeed possible in developed areas of the Region, but lower than average vulnerability is due to low populations in those cities. Nevertheless, floods can devastate these small cities.

FEMA has identified no Repetitive Loss properties in Region 5 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

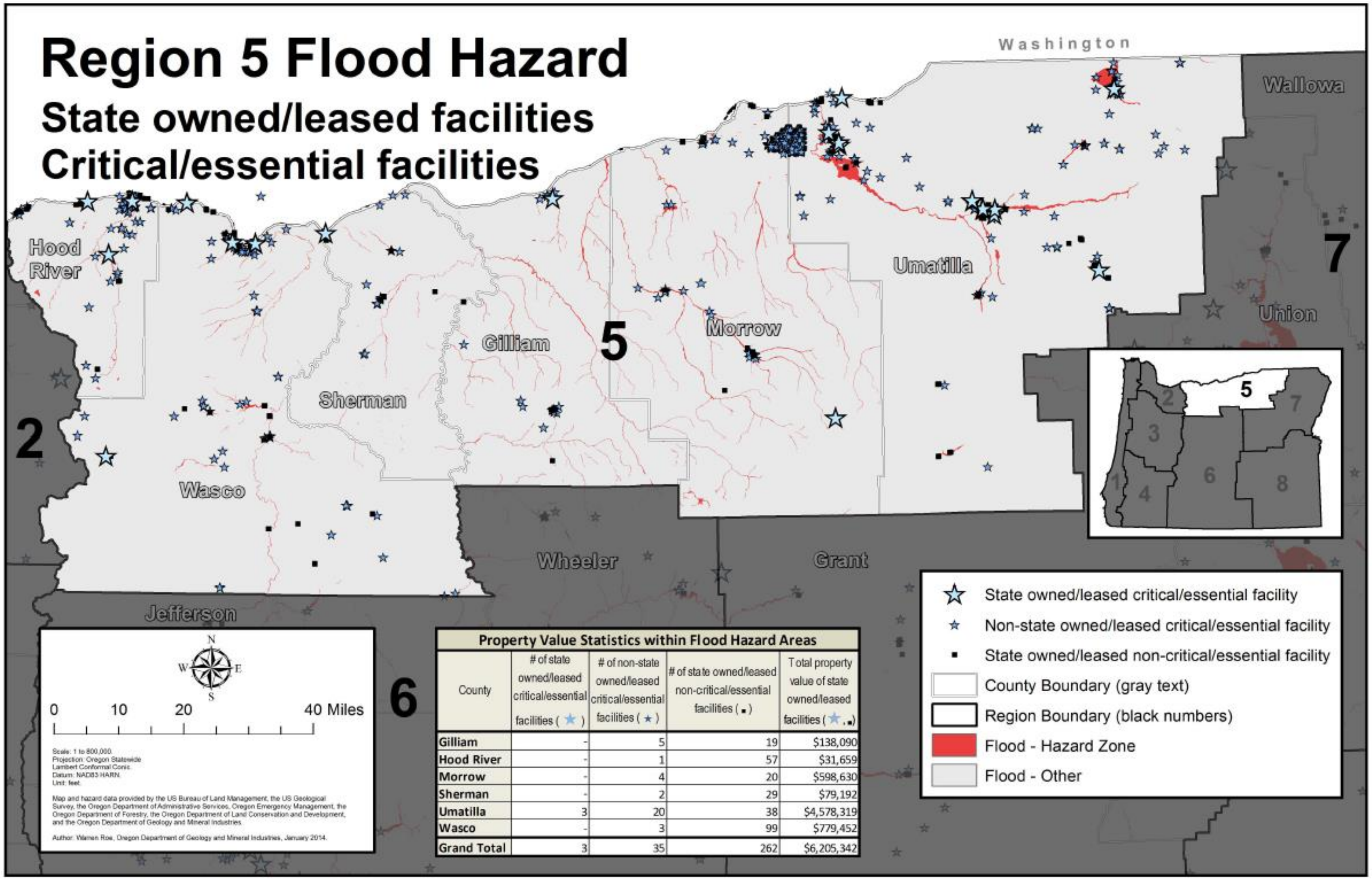
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. The cities of Stanfield and Heppner belong to CRS.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 265 are currently located within a flood hazard zone in Region 5 and have an estimated total value of $6 million (**Figure 2-176**). Of these, three are identified as a critical or essential facility. An additional 35 non-state-owned/leased critical or essential facilities are located in a flood hazard zone in Region 5.

Figure 2-176. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 5



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	-	5	19	$138,090
Hood River	-	1	57	$31,659
Morrow	-	4	20	$598,630
Sherman	-	2	29	$79,192
Umatilla	3	20	38	$4,578,319
Wasco	-	3	99	$779,452
Grand Total	3	35	262	$6,205,342

Source: DOGAMI

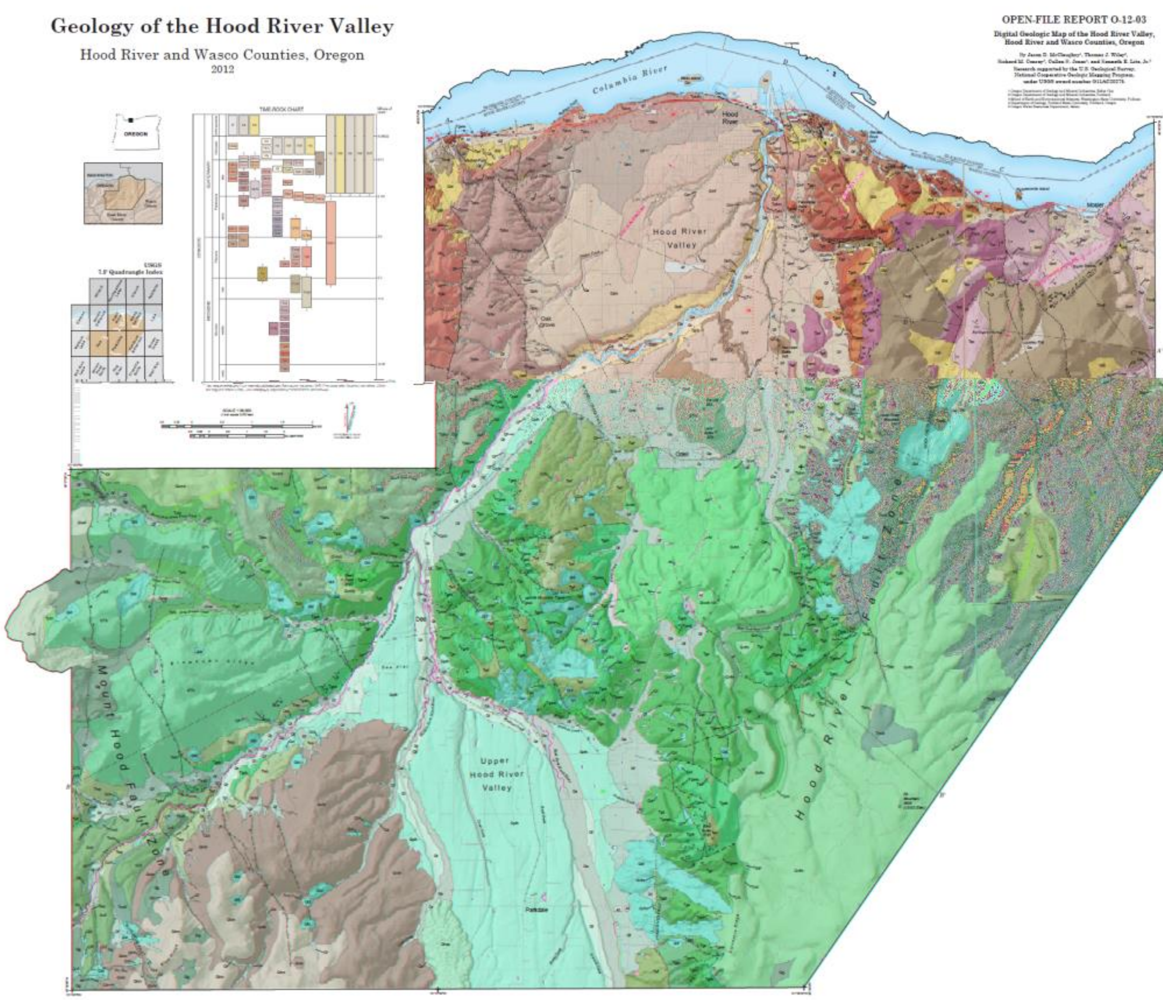
Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Cascade Mountains and the Columbia River Gorge have very high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

For example, the new geology map of the Hood River area and the Mount Hood Multi-Hazard and Risk study both found hundreds of landslides in this area (McClaughry et al., 2012; Burns et al., 2012). In February 2014, a large rock slide in Hood River closed I-84 for almost a week.

Figure 2-177. Geology of the Hood River Valley



Source: Jason D. McClaughry, Thomas J. Wiley, Richard M. Conrey, Cullen B. Jones, and Kenneth E. Lite, Jr., 2012. DIGITAL GEOLOGIC MAP OF THE HOOD RIVER VALLEY, HOOD RIVER AND WASCO COUNTIES, OREGON. Oregon Department of Geology and Mineral Industries Open-File Report O-12-03.

Historic Landslide Events

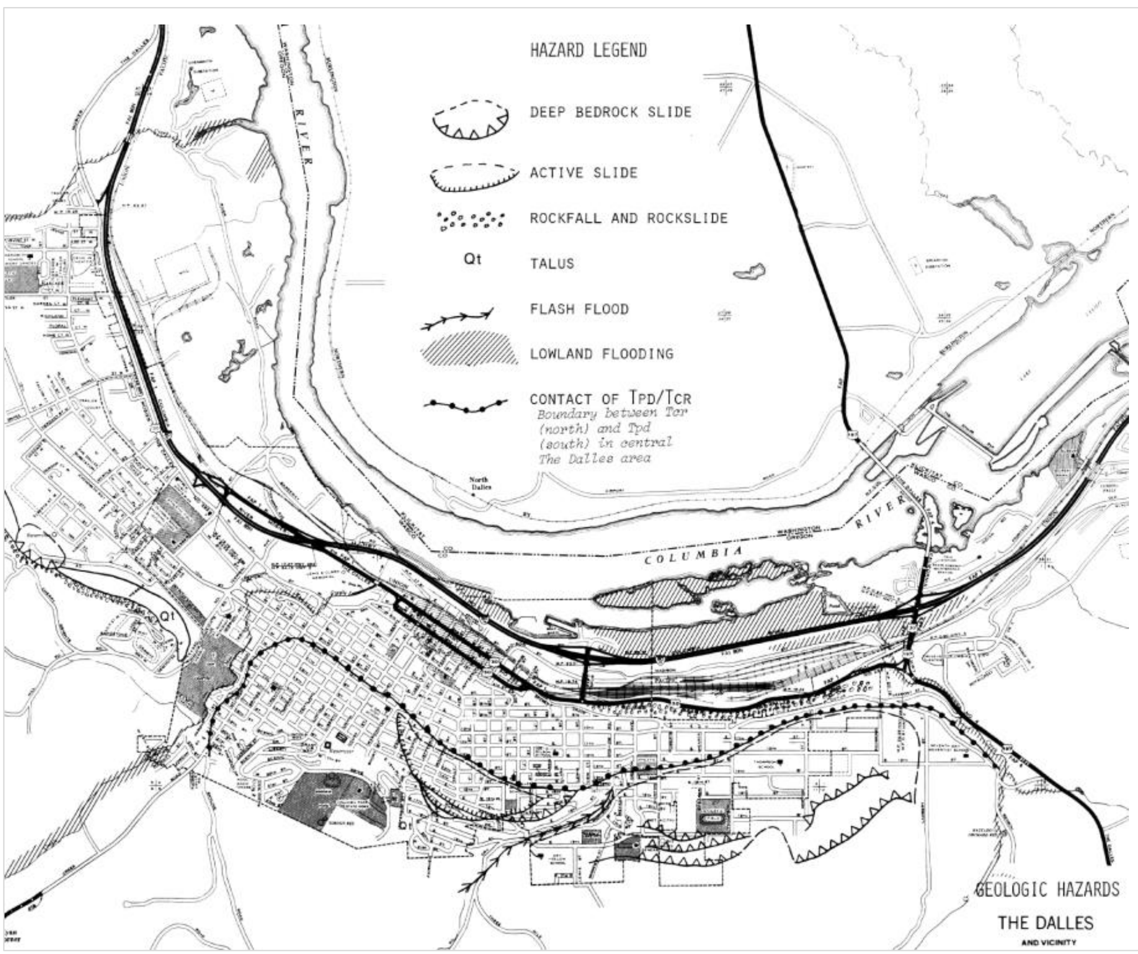
Table 2-341. Historic Landslides in Region 5

Date	Location	Description
2005	Sherman and Wasco Counties	property damage: $35,000 (includes Jefferson County)
2009	Hood River County	property damage: $78,571
2014	Hood River County	rock slide on I-84; interstate closed for days

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org/

Another existing landslide area affecting significant portions of the City of The Dalles was mapped in DOGAMI Bulletin 91 (**Figure 2-178**).

Figure 2-178. Landslides in the The Dalles, Oregon Area



Source: Beaulieu (1977)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience landslides is shown in **Table 2-342**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-342. Local Probability Assessment of Landslides in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	M	H	M	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-343**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-343. Local Vulnerability Assessment of Landslides in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	M	M	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

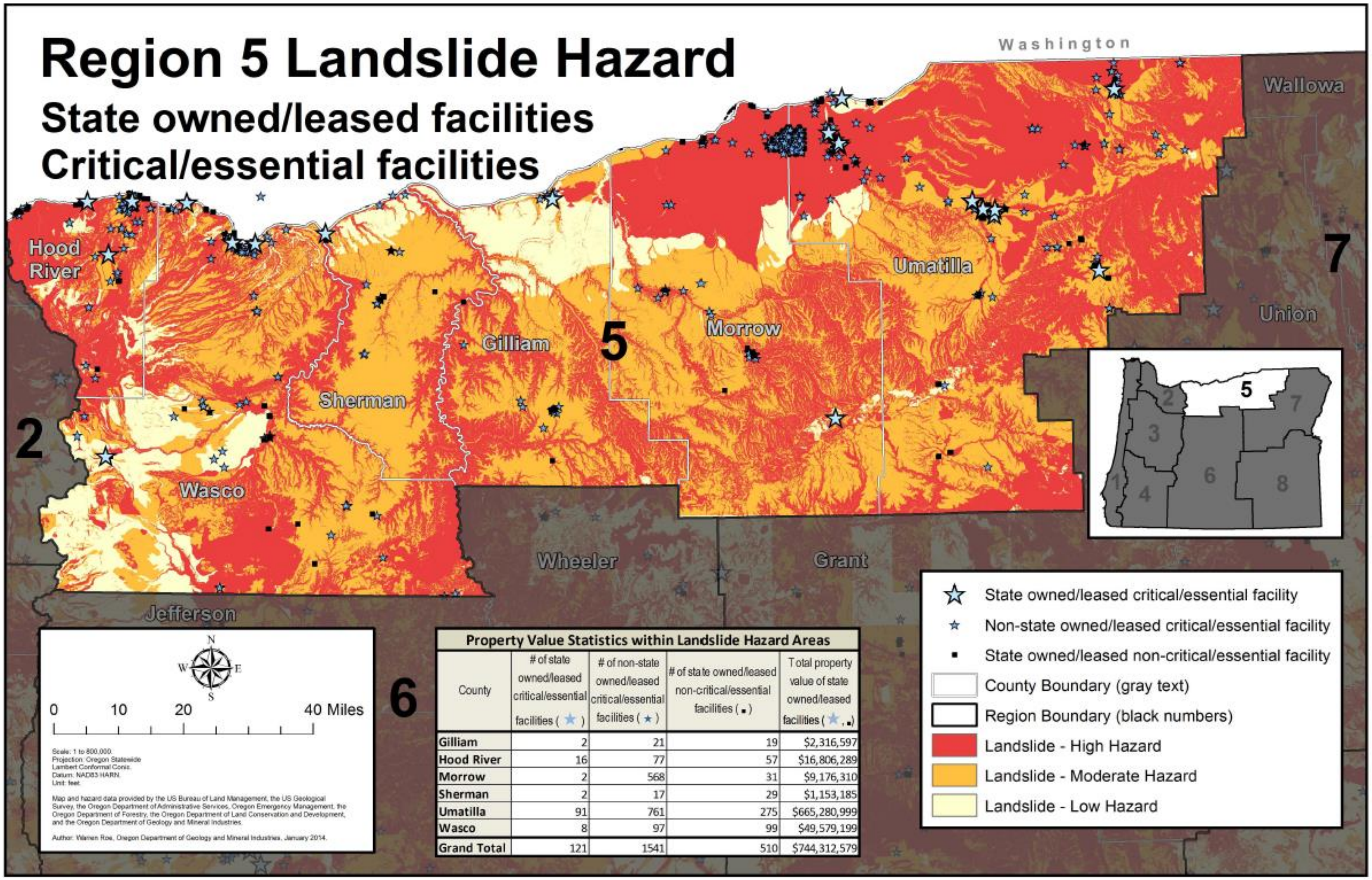
The Mid-Columbia Region is moderate to highly vulnerable to landslide hazards. Most of the people and infrastructure are along the I-84 corridor which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (I-84); two transcontinental rail lines, Union Pacific and Burlington Northern Santa Fe; the Columbia River inland water navigation; major electric power and gas lines; and communication conduits. Roughly $14 billion worth of goods are carried through the corridor each year (Wang and Chaker, 2004). Many of the communities in this region are vulnerable to landslide hazard, for example the cities of Hood River and The Dalles have a moderate to high exposure to landslides.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the **State Risk Assessment**, Oregon Vulnerabilities for more information.

Of the 5,693 state facilities evaluated, 631 are located within landslide hazard areas in Region 5, totaling roughly $744 million (**Figure 2-179**). This includes 121 critical or essential facilities. An additional 1,541 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 5.

Figure 2-179. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 5



County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	21	19	$2,316,597
Hood River	16	77	57	$16,806,289
Morrow	2	568	31	$9,176,310
Sherman	2	17	29	$1,153,185
Umatilla	91	761	275	$665,280,999
Wasco	8	97	99	$49,579,199
Grand Total	121	1541	510	$744,312,579

Source: DOGAMI

Volcanoes

Characteristics

The western boundary of the region coincides with the Cascade Range, which are mountains derived from volcanic activity. Within this range of mountains are several active and potentially active volcanoes. Mount Hood, Mount Jefferson, and Mount Adams are all potentially active volcanoes close to Region 5 that can impact these communities.

Volcanic activity can produce many types of hazardous events including landslides, ashfall, lahars, pyroclastic flows, and lava flows (Scott et al., 2001). Pyroclastic flows are fluid mixtures of hot rock fragments, ash, and gases that can move down the flanks of volcanoes at speeds of 50 to more than 150 kilometers per hour (30 to 90 miles per hour) (Scott et al., 2001). Lahars or volcanic debris flows are water-saturated mixtures of soil and rock fragments that can travel very long distances (over 100 km) as fast as 80 kilometers per hour (50 miles per hour) in steep channels close to a volcano(Scott et al., 1997). Lahars can be very localized (only meters across) or can affect areas hundreds of kilometers away (Walder et al., 1999).

Mount Hood's eruptive history can be traced to late Pleistocene times (15,000–30,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events (1760–1810) consisted of small lahars and debris avalanches; steam explosions and minor tephra falls occurred between 1859 and 1865. Mount Hood's recent history also includes ashfalls, dome building, lahars, pyroclastic flows, and steam explosions.

Historic Volcanic Events

Table 2-344. Historic Volcanic Activity Affecting Region 5

Date	Location	Description
about 20,000 to 13,000 YBP	Polallie Eruptive episode, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
about 7,700 YBP	Parkdale, north-central Oregon	eruption of Parkdale lava flow
about 1,500 YBP	Timberline eruptive period, Mount Hood	lava dome, pyroclastic flows, lahars, tephra
1760–1810	Crater Rock/Old Maid Flat on Mount Hood	pyroclastic flows in upper White River; lahars in Old Maid Flat; dome building at Crater Rock
1859–1865	Crater Rock on Mount Hood	steam explosions and tephra falls
1907 (?)	Crater Rock on Mount Hood	steam explosions

Note: YBP is years before present.

Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Scott et al. (1997)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience volcanic hazards is shown in **Table 2-345**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-345. Local Probability Assessment of Volcanic Activity in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	L	L	—	L	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of ashfall. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent historical time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington during the 1980 eruption and continues to be of concern. The location, size, and shape of the area affected by ashfall are determined by the vigor and duration of the eruption and the wind direction. Because wind direction and velocity vary with both time and altitude, it is impossible to predict the direction and speed of ash transport more than a few hours in advance.

Geoscientists have provided some estimates of future activity in the vicinity of Crater Rock, a well-known feature on Mount Hood. They estimate a 1 in 300 chance that some dome activity will take place in a 30-year period (1996–2026). For comparison, the 30-year probability of a house being damaged by fire in the United States is about 1 in 90.

The probability of 1 cm or more of ashfall from eruptions anywhere in the Cascade Range, include:

- Gilliam County: 1 in 1,000;
- Hood River County: Between 1 in 500 and 1 in 1,000;
- Morrow County: 1 in 1,000;
- Sherman County: 1 in 1,000;
- Umatilla County: Between 1 in 1,000 and 1 in 5,000; and
- Wasco County: Between 1 in 500 and 1 in 1,000.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-346**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-346. Local Vulnerability Assessment of Volcanic Activity in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	L	—	L	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

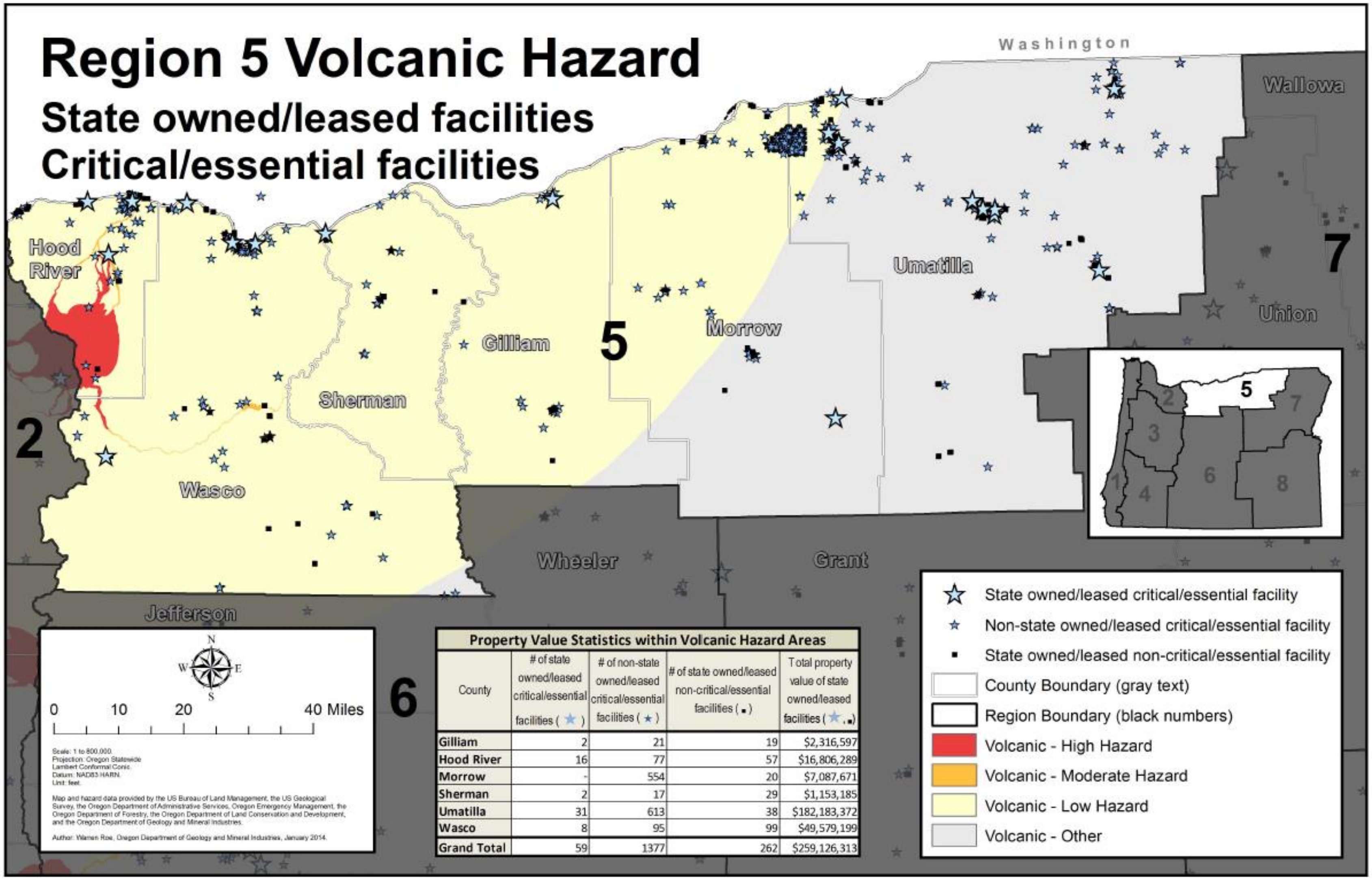
The U.S. Geological Survey has addressed volcanic hazards at Mount Hood (Scott et al., 1997). This report includes maps depicting the areas at greatest risk. The communities which are closer to Mount Hood, such as the Parkdale and the City of Hood River in Hood River County, are at risk from proximal as well as the distal hazards, such as lahars and ashfall. In Wasco County, communities situated along the White River may be at risk from pyroclastic flows and far-reaching lahars. Counties in Region 5, farther east of Mount Hood, are only at risk from the distal hazards such as ashfall.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 321, with a total value $259 million, are located within a volcanic hazard area in Region 5. Furthermore, there are 1,377 non-state-owned/leased critical/essential facilities located within a volcanic hazard zone in Region 5 (**Figure 2-180**).

Figure 2-180. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 5



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	21	19	$2,316,597
Hood River	16	77	57	$16,806,289
Morrow	-	554	20	$7,087,671
Sherman	2	17	29	$1,153,185
Umatilla	31	613	38	$182,183,372
Wasco	8	95	99	$49,579,199
Grand Total	59	1377	262	$259,126,313

Source: DOGAMI

Wildfires

Characteristics

In Region 5, Senate Bill 360 (Oregon Forestland-Urban Interface Protection Act) has been implemented in Hood River, Wasco and Umatilla Counties. Wildfires burn primarily in vegetative fuels outside the urban areas, and can generally be categorized as agricultural, forest, range, or wildland-urban interface fires.

Region 5 has unique geographic features, weather characteristics, a history of unmanaged fuels, and an expanding urban interface. Douglas fir, grand fir, and western hemlock (fire interval 150–400 years) dominate in the wetter forests of the western Columbia River Gorge, while ponderosa pine, Oregon white oak brush, and grass are more characteristic toward the east (15 year fire intervals). Historically, the region consisted of pine forests. More recently, due to decay in forest health and changes in forest practices, ponderosa pine has given way to brush and mixed conifer (Douglas fir, grand fir, and subalpine fir) at higher elevations. North and east facing slopes are typically forested while south and westerly aspects are generally open and grass covered.

This region is subject to weather patterns that can contribute significantly to extreme fire behavior. Annual precipitation levels vary from 8 to 10 inches along the Columbia River, to as high as 60 inches in the higher elevations of the Blue Mountains. Wind in the gorge is a constant variable. Wind at the east end of the gorge tends to be minimal; however, the west portion experiences 20–30 mph winds daily and, at times, winds exceed 40 mph. Significant drying occurs as sustained winds, coupled with high daytime temperatures and drier air from the desert, pushes toward the coast.

OEM Weather Statement

Extreme winds are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge. The Columbia Gorge is the most significant east-west gap in the mountains between California and Canada. It serves as a funnel for east and west winds, where direction depends solely on the pressure gradient. Once set in motion, the winds can attain speeds of 80 mph, halt truck traffic, and damage a variety of structures and facilities. The average wind speed at Hood River is 13 mph.

Land ownership and resultant management and suppression capabilities and protocols in this area also affect the potential for wildfires. In region 5, the most significant land ownership falls to federal agencies, and includes forested and wilderness areas. Federal lands in this area are characterized by dense stands, heavy underbrush, and ladder fuels, increasing the potential for wildfires. County, state, and private lands contribute to the remainder. These lands have a variety of management practices resulting in a mix of stand conditions and resultant fire potential.

Regardless of ownership, the majority of the forestlands in Region 5 are historically prone to wildfire. As the number of dwellings extends into these areas the potential for ignition and losses increases. Many of these communities in the wildland-urban interface fall just outside of any agency's primary protection coverage, which reduces their likelihood of surviving a wildfire.

Historic Wildfire Events

Table 2-347. Historic Wildfires in Region 5

Year	Name of Fire	Location	Acres Burned	Remarks
1977		Wasco		
1979	Pine Grove/Juniper Flat			
1983	Moro	Sherman		
1985	Maupin	Wasco		
1988		Wasco		
1991	Falls		1,100	fire along the Columbia Gorge
1994	Smith Canyon			
1998	Rowena	Wasco	2,208	
1998	Reith Barnhart/Coombs Canyon	Umatilla	45,000	
2000	Willow Creek	Morrow and Gilliam	27,000	
2000	Antelope	Wasco		
2001	Two Rivers	Umatilla	7,011	
2001	Bridge Creek	Umatilla	9,230	
2002	Sheldon Ridge	Wasco	12,681	
2003	Herman Creek	Wasco	300	3 structures were lost in this fire that affected Cascade Locks
2003		Umatilla County		$40,000 in property damage, $200,000 in crop damage
2003		Umatilla County		$15,000 in property damage, $500 in crop damage
2004		Gilliam, Morrow and Umatilla Counties		$6,000 in property damage
2005		Sherman and Wasco Counties		$1,000 in property damage *damage estimate includes Jefferson County
2005		Morrow and Umatilla Counties		$2,500 in property damage and $11,500 in crop damage
Mar. 2005		Gilliam, Morrow and Umatilla Counties		$113,900 in crop damage
July 2005		Umatilla and Morrow Counties		$5,000 in property damage, $23,000 in crop damage
May 2006		Gilliam, Morrow and Umatilla Counties		$10,000 in property damage
June 2006		Gilliam, Morrow and Umatilla Counties		$500,000 in property damage
2009	Microwave Fire	Wasco County		fire threatened Maupin, burned 2 residences
2011	High Cascade Complex	Wasco County	101,292	fire burned into Warm Springs
2013	Government Flats Complex	Wasco County	11,450	fire burned four homes in The Dalles; fire suppression costs more than $15 million

Source: Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience wildfire is shown in **Table 2-348**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-348. Local Probability Assessment of Wildfire in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

In Region 5, weather patterns can produce summer lightning storms that start many fires. These multiple starts can put a strain on the wildland firefighting resources spread across the county. With the drying of fuels over time and the low relative humidity factored in, the probability for large fires can significantly increase during these lightning events. The number of days per season that forest fuels are capable of producing a significant fire event is also important to consider. Oregon Department of Forestry has determined that eastern Oregon is at the highest hazard rating for weather. This value was assigned through an analysis of daily wildfire danger rating indices in each regulated use area of the state.

The west side of the region includes the heavily wooded hills and mountains of the Cascades; the east side is lined with hills that are also wooded but drier, along with significantly more oak and grasses; the west end of the heavily wooded region is pinched between the Columbia River and the near vertical sides of the river gorge.

A healthy forest across this region is never free of insects, disease, or other disturbances and infestations can increase the likelihood of ignition and fire spread. The potential for extreme fire behavior is of concern for any valued property, whether it be a structure or scenic vista at the top of a bluff, hill, or canyon that has enough fuel to sustain a fire. The more fuels on a bluff, hill, or canyon, the more active the fire will become. As the percentage of slope increases more preheating of fuels preceding the fire front will occur. The fire front will proceed up the hill at a faster rate and the fire will burn more intensely. Coupled with high winds and low humidity, this region has the potential for a severe wildfire.

This region is susceptible to wildfire when favorable east wind conditions prevail. Fires have the potential to spread from Washington State across the river into Oregon via long-range spotting.

Sources of human-caused ignition include discarded cigarettes, motor cars and trucks, railroads, mowing, acts of nature, and fire emanating from adjoining land. Most fires adjacent to the freeway start in fine grasses and can rapidly progress into conifers that line the safety zone for almost the entire breadth of the region's west end.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-349**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-349. Local Vulnerability Assessment of Wildfire in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	M	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 5, Umatilla and Wasco Counties have a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and listed in **Table 2-350**.

There is also critical infrastructure beyond the wildland-urban interface that is vulnerable to wildfire. Disruption to the municipal water supply and irrigation water supply from wildfires would negatively impact all of the residents and agricultural operators that depend on this resource by reducing water quality and availability. Roads, bridges, and evacuation routes could be compromised, limiting the ability of firefighters to reach the fire as well as inhibiting evacuation procedures. Utilities including Bonneville Power Administration power lines, Portland General Electric and Northwest Natural Gas electrical and gas distribution lines and communication infrastructure are also at risk.

The economic stability of the Region is dependent on a major interstate highway (I-84). This highway runs east-west, paralleling the Columbia River from MP 35 to MP 69. This four lane highway is considered part of the "National Defense Highway System" and as such some federal entities are sensitive to highway closures that impede or stop the flow of traffic. Most frequently, closures or restrictions are for motor vehicle accidents; however, closures can also be expected in the face of low or no visibility secondary to wildfire or inclement winter weather. Additional economic sectors that could be affected by wildfire are agriculture, forest products, tourism, manufacturing, recreation, and power generation. Community values and natural resources at risk of wildfire include agriculture and livestock, wildlife and salmonids, and historic buildings.

Table 2-350. Wildland-Urban Interface Communities in Region 5

Gillam	Hood River	Morrow	Sherman	Umatilla	Wasco
Arlington	Cascade Locks	Boardman	Moro	Adams	Antelope
Condon	Dee	Heppner	North Sherman	Athena	Dufur
Gilliam	Hood River	Ione	Rufus	East Umatilla	Juniper Flats
Lonerock	Odell	Irrigon	South Sherman	Echo	Maupin
North Gilliam	Parkdale	Lexington	Wasco	Helix	Mid-Columbia
South Gilliam	Pine Grove	Morrow		Hermiston	Mosier
	West Side			Lower McKay	Pine Grove
				McKay	Pine Hollow
				Milton-Freewater	Shaniko
				Pendleton	The Dalles
				Pilot Rock	Tygh Valley
				Riverside	Wamic
				Stanfield	Warm Springs
				Ukiah	Wasco
				Umatilla	
				Weston	

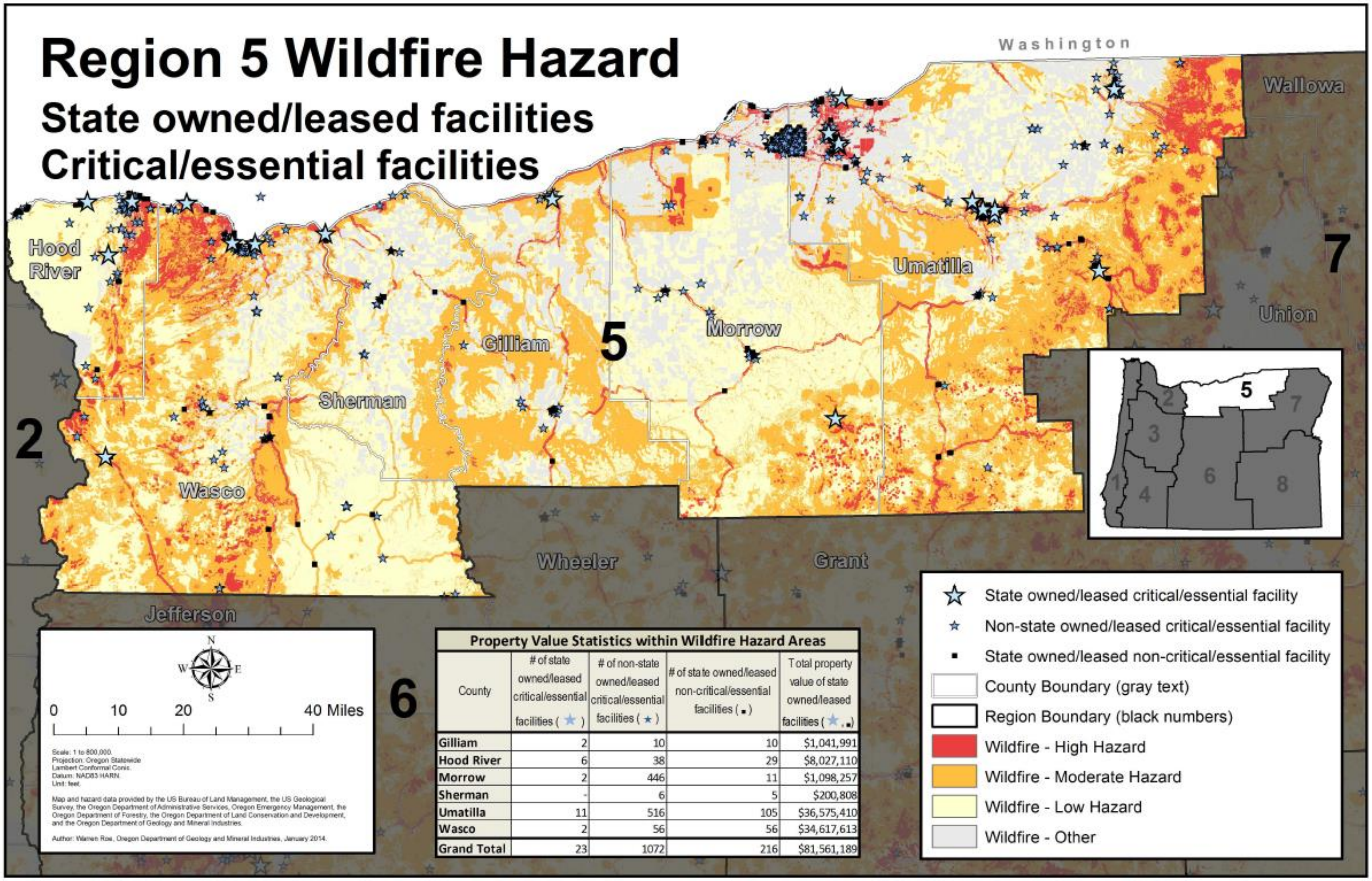
Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state-owned/leased facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 239 are within a wildfire hazard zone in Region 5 and total $81.5 million in value (**Figure 2-181**). Among State0owned/leased critical or essential facilities, 23 are located in a wildfire hazard zone in Region 5. An additional 1,072 non-state-owned/leased critical or essential facilities are also located in Region 5.

Figure 2-181. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 5



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Gilliam	2	10	10	$1,041,991
Hood River	6	38	29	$8,027,110
Morrow	2	446	11	$1,098,257
Sherman	-	6	5	$200,808
Umatilla	11	516	105	$36,575,410
Wasco	2	56	56	$34,617,613
Grand Total	23	1072	216	$81,561,189

Source: DOGAMI

Windstorms

Characteristics

Extreme winds are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge, so much so that these areas have special building code standards. All manufactured homes in Region 5 that are within 30 miles of the Columbia River must meet special anchoring standards. High winds in this area of Oregon are legendary. The Columbia Gorge is the most significant east-west gap in the mountains between California and Canada. It serves as a funnel for east and west winds, where direction depends solely on the pressure gradient. Once set in motion, the winds can attain speeds of 80 mph, halt truck traffic, and damage a variety of structures and facilities. The average wind speed at Hood River is 13 mph, not much less than the notoriously windy Texas and Kansas plains whose wind speeds average 15 mph (Taylor and Hatton, 1999).

Though their occurrence is somewhat less frequent, Region 5 has also experienced tornadoes. For the most part, these tornadoes have not resulted in major damages. Table 2-352 lists historic tornadoes in the region.

Historic Winter Storm Events

Table 2-351. Historic Windstorms Affecting Region 5

Date	Affected Area	Characteristics
Apr. 1931	N. Central Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Dec. 1935	W. Columbia Gorge, Oregon	damage to automobiles; wind gusts at 120 mph
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75 mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69 mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71 mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley.; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	statewide	severe wind storm
Dec. 1987	Umatilla County	damaging wind storm; two fatalities
Mar. 1991	Mid-Columbia / NE Oregon	severe wind storm
Dec. 1991	N. central Oregon	severe wind storm; blowing dust
Jan. 1993	northern Oregon	severe wind storm; damage to utilities
Dec. 1995	statewide	severe wind storm; widespread damage
Oct. 2003	Umatilla County	$1,000 in property damage
Jan. 2004	Morrow and Umatilla Counties	$2,500 in property damage

Date	Affected Area	Characteristics
Feb. 2004	Umatilla County	$3,000 in property damage *damage estimate includes Jefferson County
Apr. 2004	Hood River County	$25,000 in property damage
Apr. 2004	Wasco County	$1,000 in property damage
Oct. 2004	Gilliam, Morrow and Umatilla Counties	$333.33 in property damage
Dec. 2004	Gilliam, Morrow and Umatilla Counties	$166.66 in property damage
Dec. 2004	Sherman and Wasco Counties	$3,333.33 * damage estimate includes Jefferson County
Feb. 2005	Gilliam, Morrow and Umatilla Counties	$3,000 in property damage
Mar. 2005	Sherman and Wasco Counties	$2,500 in property damage *damage estimate includes Jefferson County
Nov. 2005	Umatilla County	$400 in property damage
Apr. 2006	Umatilla County	$10,000 in property damage in Hermiston
May 2006	Morrow County	$500,000 in property damage with a high wind gust measured at 117 mph; $1 million in crop damage
May 2006	Sherman County	$50,000 in property damage in Grass Valley; winds ranged from 70 to 80 mph
Nov. 2006	Morrow and Umatilla Counties	$35,000 in property damage from 80 mph winds; property damage also occurred in Union and Wallowa Counties, for a total storm damage of $70,000
Jan. 2007	Gilliam, Morrow, Sherman, Wasco and Umatilla Counties	$5,000 in property damage from 64 mph winds; damage estimate includes Jefferson County
June 2008	Umatilla County	powerful windstorm with wind speeds at 58 mph caused $10,000 in damage to buildings in Pendleton
June 2008	Morrow and Umatilla Counties	wind damage downed several trees and power lines, caused $250,000 in property damage and $100,000 crop damage in Morrow County, and $108,000 in property damage in Umatilla County
July 2010	Umatilla County	64 mph winds caused $40,000 in property damage in the Hermiston area
Nov. 2012	Wasco, Sherman, Umatilla, Gilliam, Morrow, Union and Wallowa Counties	74 mph winds $120,000 in damage *includes Jefferson County

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR, February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon. and Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org and U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms.

Table 2-352. Historic Tornadoes in Region 5

Date	Location	Result
June 1888	Morrow County (Lexington, Sand Hill, Pine City)	30 buildings, including two schools destroyed; six people killed (including two children); four people injured
Apr. 1925	Gilliam County	warehouse and automobiles destroyed in Condon; about $10,000 in damages
Apr. 1957	Gilliam and Morrow Counties	minor damage (rangeland)
Apr. 1970	Wasco County	observed; no damage
May 1991	Umatilla County	some damage to wheat fields
July 1995	Umatilla County	some damage to wheat fields
May 2006	Morrow County	$20,000 in property damage, F1 intensity
May 2009	Umatilla County	$50,000 in property damage, F1 intensity

Sources: Taylor and Hatton (1999); U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience windstorms is shown in **Table 2-353**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-353. Local Probability Assessment of Windstorm in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	M	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

High winds occur yearly in the Columbia River Gorge. The 100-year event in this region consists of 1-minute average winds of 90 mph. A 50 year event has average winds of 80 mph. A 25-year event has average winds of 75 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-354**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-354. Local Vulnerability Assessment of Windstorm in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	L	H	M	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Gilliam, Hood River, Morrow, and Sherman Counties are the most vulnerable to windstorms because of their proximity to the Columbia River.

Many buildings, utilities, and transportation systems within Region 5 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Uprooted trees growing next to a house have destroyed roofs when they fall as a result of windstorms. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 5 can be characterized by extreme cold, snow, ice, and sleet. Winter storm events are an annual occurrence in Region 5; most communities are prepared for them. This is particularly true through the Columbia River Gorge where frigid air sometimes moves westward out of the Wallowa Mountains. During these periods, it is not unusual to receive snow or ice storms. Severe weather conditions do not last long in Region 5; consequently, winter-preparedness is a moderate priority. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge.

Historic Winter Storm Events

Table 2-355. Historic Winter Storms Affecting Region 5

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1884	Columbia Basin, Oregon	heavy snowfall; 29.5 inches in The Dalles in one day
Dec. 1885	Wasco County, Oregon	most snow recorded (6–10 feet); trains had difficulty reaching Portland
Dec. 1892	northern counties, Oregon	15–30 inches of snow throughout northern counties
Jan. 1916	entire state	two storms; very heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of storms across state; injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities
Feb. 1986	central/eastern Oregon	Heavy snow in Deschutes Basin; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Mar. 1994	Cascade Mountains, Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Jan. 2005	Gilliam, Morrow, and Umatilla Counties	33 injuries
Nov. 2006	Hood River County	heavy freezing rain along I-84, closed the highway near Hood River
Dec. 2006	Hood River County	freezing rain and sleet caused ice conditions from Cascade Locks to Hood River; black ice on I-84
Jan. 2008	Hood River County	heavy freezing rain from Bonneville westward through Columbia Gorge causing accidents on I-84; one fatality

Sources: Taylor and Hatton (1999)

Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Probability and Vulnerability

As stated in the **State Risk Assessment**, section, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 5 will experience winter storms is shown in **Table 2-356**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-356. Local Probability Assessment of Winter Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 5. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-357**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-357. Local Vulnerability Assessment of Winter Storms in Region 5

	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	H	H	H	M	H	H

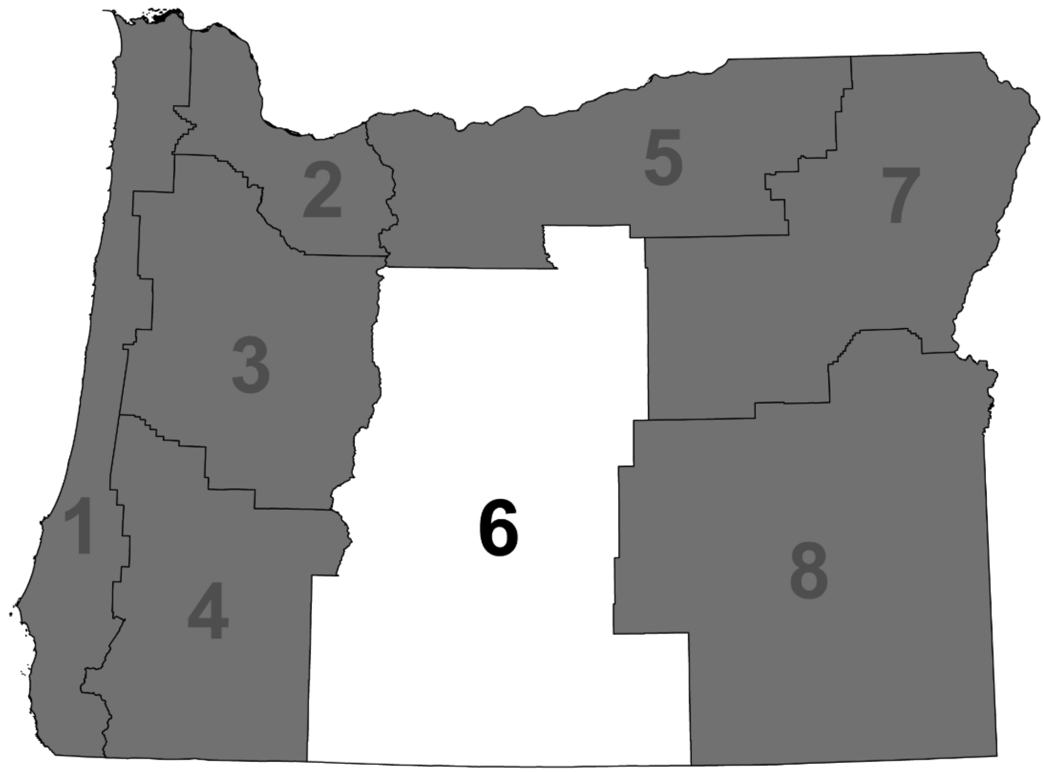
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Within the State of Oregon, Region 5 communities are known for cold winter conditions. This region is the commodity flow route to Eastern Oregon. With long road closures the communities suffer from the loss of traffic and revenue. Drifting, blowing snow has brought highway traffic to a standstill. Also, windy and icy conditions have closed Oregon's principal east-west transportation route, I-84, for hours. In these situations, travelers must seek accommodations — sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.6 Region 6: Central Oregon

Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties



2.3.6.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns suggest that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Regionally, social vulnerability is driven by high percentages of individuals with a disability and low median household incomes. At the county level, vulnerability is driven by a high share of senior citizens in Crook, Lake, and Wheeler Counties; increases in child poverty in Douglas and Deschutes Counties; vacant homes in Deschutes, Lake and Klamath Counties; and single-parent households in Klamath County.

Higher than average unemployment rates and low wages illustrate the region's slow recovery since the financial crisis that began in 2007. Average pay in Wheeler County is especially low, only 57% of the state average.

Road, bridge, rail and port infrastructure across the state are vulnerable to damage and disruption caused by icy conditions, flooding, or seismic events. The Redmond Regional Airport is of particular importance in this region because it has been identified as a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for human health and water quality.

Energy facilities and infrastructure in Central Oregon support the regional economy and are vulnerable to damage and service disruptions due to natural hazard events. Liquid natural gas pipelines run through Klamath, Deschutes, Crook, and Jefferson Counties. The region's diverse energy portfolio — including hydroelectric, natural gas, biomass, and solar voltaic systems — helps boosts its ability to withstand system disruptions.

Region 6 is mostly rural, with the majority of development occurring in communities along I-97. Mobile homes are inherently vulnerable to natural hazard events, and there are a significant number of mobile homes in Jefferson, Lake, and Wheeler Counties. Roughly half the homes in Klamath, Lake, and Wheeler Counties were built before 1970 and floodplain management and seismic building standards, making them especially vulnerable. With the exception of Crook and Deschutes Counties, the region's Flood Insurance Rate Maps (FIRMs) are not as up to date as those of other areas of the state.

Hazards and Vulnerability

Region 6 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common throughout Region 6. When droughts occur they can be problematic, impacting community water supplies, wildlife refuges, fisheries, and recreation. Klamath and Lake Counties are especially vulnerable. The U.S. Department of Agriculture designated both counties "natural disaster areas" due to damages or losses caused by drought – Klamath in 2010 and 2013, and Lake in 2007 and 2013.

Dust Storms: In Central Oregon, dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Dust storms affect the region annually during summer months and during periods of drought. In Region 6, Deschutes, Klamath, and Lake Counties have the most dust storms on record.

Earthquakes: Four types of earthquakes affect Region 6: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with volcanic activity. Shallow crustal and intraplate earthquakes are the primary earthquake risks. In a CSZ event, most of the region's impact will be secondary, due to disruptions to markets to the west. The region's seismic lifelines have low vulnerability to a CSZ event, unless a Klamath Falls event is triggered. Region 6 is vulnerable to earthquake-induced landslides, liquefaction, and strong ground shaking. Klamath County ranks among the top 15 in the state with the highest expected earthquake related damages and losses. This region has 160 state-owned/leased facilities, valued at over $366 million, in an earthquake hazard zone. Of these, 100 are critical/essential facilities. An additional 721 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Flooding affects Central Oregon in a variety of ways, including (a) spring runoff from melting snow, (b) intense warm rain during the winter months, (c) ice-jam flooding (Deschutes County), (d) local flash flooding, (e) lake flooding associated with high winds (Klamath Lake), and (f) flooding associated with the breeching of natural debris dams (Deschutes County). East of the Cascades there have also been rain-on-snow floods associated with La Niña events. All of the region's counties are considered moderately vulnerable to the flood hazard. There are 66 state-owned/leased facilities, valued at approximately $9 million, located in the region's flood hazard zone. Of these, nine are considered critical/essential facilities. An additional 60 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslide events can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides. Most landslides in this region have taken place in the Klamath and Cascade Mountains, along the US-26 corridor near Prineville and Mitchell, and along US-97 just north of Klamath Falls. There are 785 state-owned/leased facilities in a landslide hazard zone in this region, valued at over $371 million. Of these, 103 are critical/essential facilities. An additional 744 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Western areas of the region's counties that coincide with the crest of the Cascade mountain range may be impacted by volcanic activity. Most volcanic activity is considered local, however, some activity (lahars and ashfall) can travel many miles. Due to proximity to potential volcanic activity, small mountain communities, dams, reservoirs, energy-generating facilities, and highways merit special attention. Communities closer to the main volcanoes — Bend, Sisters, La Pine, and Klamath Falls — are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ashfall. Communities on the eastern side of the region may be subject to ashfall from Cascade volcanoes. There are 32 state-owned/leased facilities located in a volcanic hazard zone within this region, a value of approximately $11.6 million. Of these, none are identified as critical/essential facilities. There are 22 non-state-owned/leased critical/essential facilities located in this hazard zone.

Wildfires: Central Oregon is especially vulnerable to wildfires because homes are widely dispersed among ladder fuels and overstocked pine, sage, grassy areas and invasive weeds. Fire risk is highest in late summer and fall when fuel conditions are dry. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 6, Deschutes, Jefferson and Klamath and Wasco Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 504 state-owned/leased facilities located in a wildfire hazard zone with a value of approximately $188 million. Of these, 59 are identified as critical/essential facilities. An additional 350 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms are common in the inter-mountain areas of the region, and can reach speeds of 70-90 miles per hour. Most vulnerable to windstorms are insufficiently anchored mobile homes and buildings needing roof repair. Overturned trees pose problems as they can block roads and emergency routes and can damage buildings and utility lines.

Winter Storms: Annual winter storms bring colder weather and higher precipitation. Communities are typically prepared for light to moderate storms, but are less prepared for severe winter storms that occur less frequently. Winter storms have the potential to affect the entire region, particularly transportation corridors along US-97 and mountain passes to the west.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 6 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increased incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Central Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 6, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.6.2 Profile

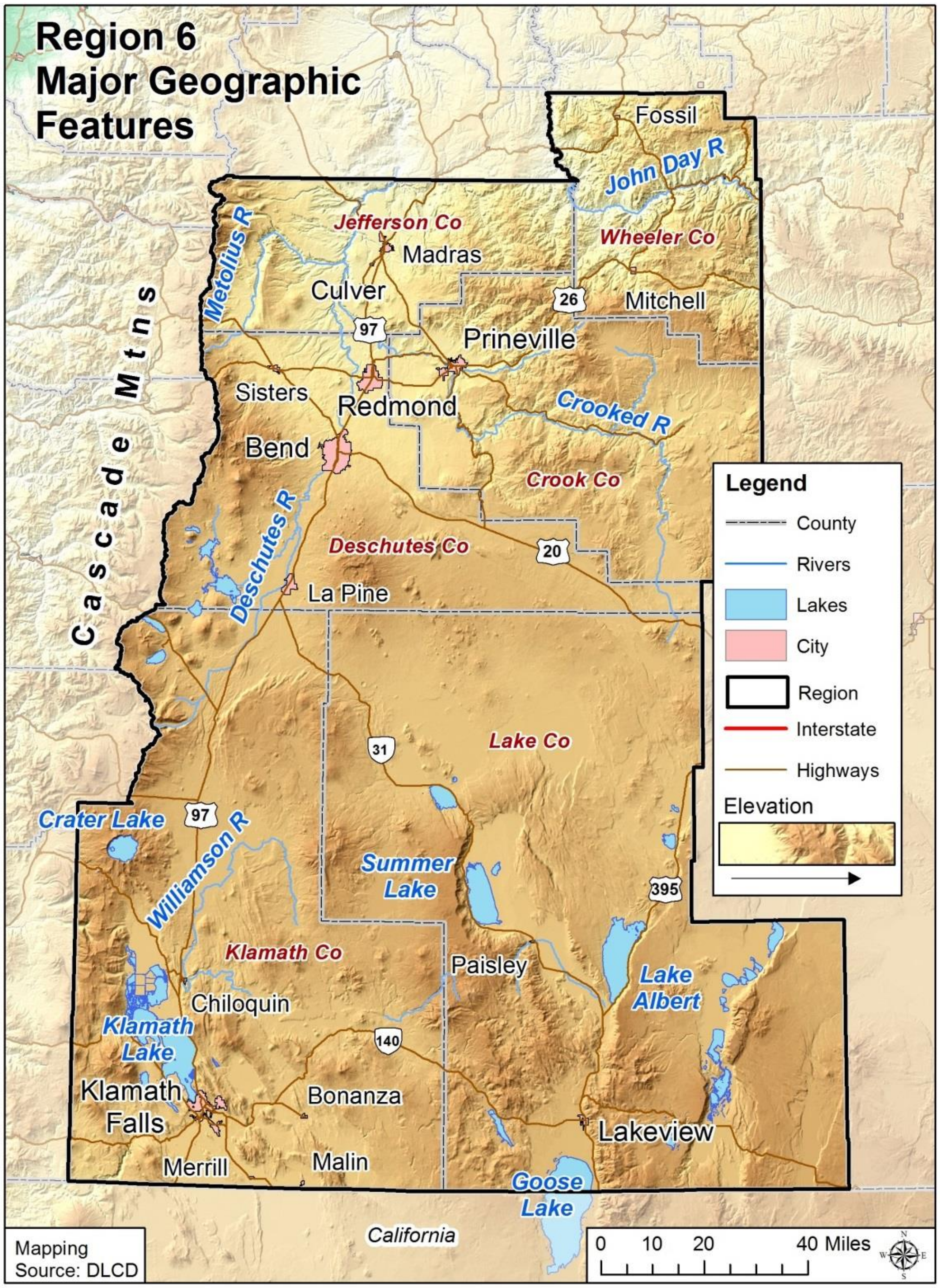
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Central Oregon is approximately 24,144 square miles in size and includes Crook, Deschutes, Jefferson, Klamath, Lake, and Wheeler Counties. The Cascades crest to the west, Blue Mountains in the north and the California border to the south define the region. Region 6 has a diverse variety of ecological zones and is not shaped by any particular watershed, although the Deschutes, John Day, and Crooked Rivers are major watersheds to the north. Large lakes are common in the southern portions of Region 6.

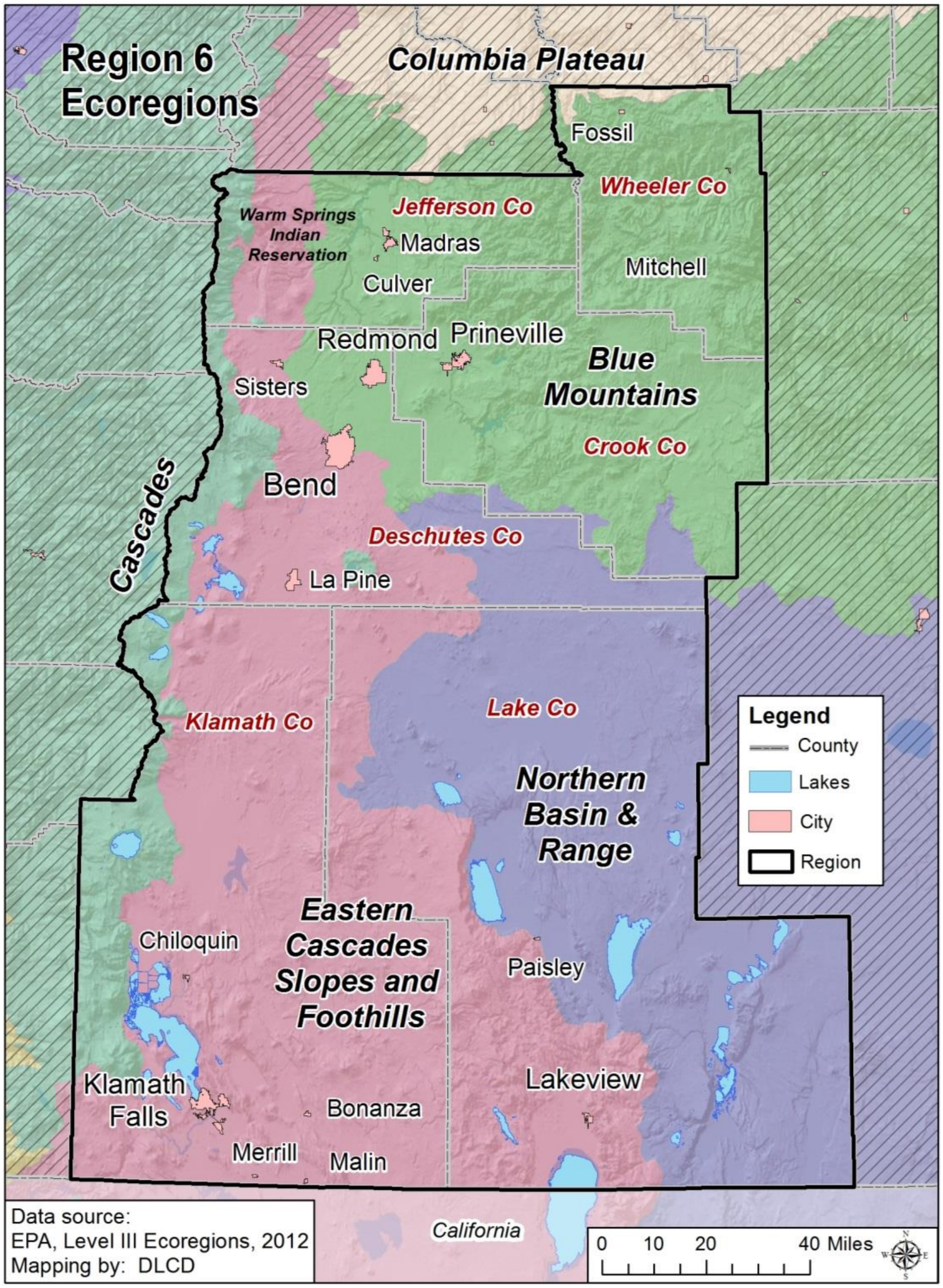
Figure 2-182. Region 6 Major Geographic Features



Source: Department of Land Conservation and Development

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 6 is composed of four ecoregions: the Blue Mountains, the Cascades, the Eastern Cascades Slope and Foothills, and the Northern Basin and Range (**Figure 2-183**).

Figure 2-183. Region 6 Ecoregions



Blue Mountains: This ecoregion is complex and diverse with many sub-ecoregions with unique conditions. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day / Clarno Highlands contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories the ecoregion's Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 6 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer (Thorson et al., 2003).

Cascades: This ecoregion is underlain by volcanic soils and naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have strained the ecological health of streams in the area (Thorson et al., 2003). Waterways in the steeper valleys support threatened cold-water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water. Large volcanic peaks, glaciers, and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson et al., 2003).

Eastern Cascades Slope and Foothills: The Region 6 section of this ecoregion is an ecological mosaic. Wooded areas may be dominated by ponderosa pines or mixed fir canopies while rangelands are dominated by sagebrush, bitterbrush, and bunchgrasses. Most historically wet meadows have been drained to accommodate agricultural uses; however, marshland wildlife refuges have been established to preserve biodiversity, particularly for avian populations. Because of its location in the rain shadow of the Cascades, the ecoregion often experiences dramatic temperature extremes and native plants are adapted to dry climates and frequent wildfires. Much of this ecoregion is underlain by highly permeable volcanic pumice soils, which contribute to the effects of drought in the ecoregion. Logging, livestock grazing, agriculture and recreation are common land uses throughout (Thorson et al., 2003).

Northern Basin and Range: The Region 6 section of this ecoregion contains seasonally wet lake basins, high desert wetlands, high shrub- and grass-covered plains, scattered hills, mountains and buttes, playas, and dunes. Lake levels and salinity in the region can fluctuate seasonally and yearly, with several years passing before some lake beds are filled with water. The majority of this ecoregion is dominated by shrub- and grass-covered rangeland, lending itself primarily to wildlife habitat, recreation, and limited cropland farming and livestock grazing.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 6 has diverse ecoregions with varying climatic conditions with the majority of the region's land divided almost equally between the four ecoregions. The region's predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. Table 2-358 shows mean annual precipitation and temperatures for the three ecoregions in Region 6 (Thorson et al., 2003). Variations in temperature and precipitation vary widely by sub-ecoregion and microclimate. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-358. Average Precipitation and Temperature Ranges in Region 6 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Cascades*	45–140	16/41	38/74
Eastern Cascades slopes and foothills*	10–55	12/40	38/85
Columbia Plateau*	9–25	21/41	52/86
Blue Mountains*	8–60	16/41	43/84
Northern Basin and Range*	6–26	17/42	42/86

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 6.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations post disaster may be stressed or compromised (Cutter et al., 2003).

Overall, from 2000 to 2013, 85% of the region's growth occurred in Deschutes County, an increase of more than 47,000 people. Wheeler was the only county to decline in population. By 2020, all counties in the region, except Deschutes and Jefferson, are projected to grow at a slower rate than the state overall. Population in Lake and Wheeler Counties is expected to decline.

Table 2-359. Population Estimate and Forecast for Region 6

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 6	226,302	281,435	24.4%	306,608	8.9%
Crook	19,182	20,690	7.9%	21,933	6.0%
Deschutes	115,367	162,525	40.9%	182,455	12.3%
Jefferson	19,009	22,040	15.9%	24,054	9.1%
Klamath	63,775	66,810	4.8%	68,853	3.1%
Lake	7,422	7,940	7.0%	7,936	-0.1%
Wheeler	1,547	1,430	-7.6%	1,378	-3.6%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 6 are largely centered on outdoor activities (hiking and backpacking, visiting national and state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA, 2011f). Note that the Longwoods Travel Report includes Crook, Deschutes, Jefferson, and Wheeler Counties within the Central Region (which also includes parts of Gilliam, Sherman, and Wasco Counties). Klamath and Lake Counties are included within the Southern region (which also includes Douglas, Jackson, and Josephine Counties); see Region 4 for the results of this study area. Over 13% (3.6 million) of all overnight trips to Oregon included time within Region 6. Three fourths of all trips to the region occur between April and September, and the average travel party contains 3.7 persons. The average trip length is over 4.4 nights (Longwoods Travel USA, 2011f). Visitors to the region are just as likely to lodge in hotels/motels as in private homes and other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-360. Annual Visitor Estimates in Person Nights in Region 6

	2011		2012		2013	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Region 6	9,434	—	9,684	—	9,892	—
Crook	552	100%	602	100%	634	100%
Hotel/Motel	107	19.4%	144	23.9%	176	27.8%
Private Home	206	37.3%	212	35.2%	212	33.4%
Other	239	43.3%	246	40.9%	246	38.8%
Deschutes	5,649	100%	5,895	100%	6,058	100%
Hotel/Motel	1,821	32.2%	1,957	33.2%	2,067	34.1%
Private Home	2,040	36.1%	2,104	35.7%	2,148	35.5%
Other	1,788	31.7%	1,834	31.1%	1,843	30.4%
Jefferson	827	100%	845	100%	869	100%
Hotel/Motel	101	12.2%	114	13.5%	122	14.0%
Private Home	213	25.8%	215	25.4%	222	25.5%
Other	513	62.0%	516	61.1%	525	60.4%
Klamath	2,071	100%	2,020	100%	2,014	100%
Hotel/Motel	685	33.1%	646	32.0%	626	31.1%
Private Home	847	40.9%	831	41.1%	835	41.5%
Other	539	26.0%	543	26.9%	553	27.5%
Lake	262	100%	252	100%	248	100%
Hotel/Motel	65	25%	58	23%	53	21%
Private Home	78	30%	76	30%	76	31%
Other	119	45%	118	47%	119	48%
Wheeler	73	100%	70	100%	69	100%
Hotel/Motel	13	17.8%	10	14.3%	8	11.6%
Private Home	14	19.2%	14	20.0%	14	20.3%
Other	46	63.0%	46	65.7%	47	68.1%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). In Region 6, the proportion of people who identify as having a disability overall is only one percentage point higher than the proportion of people who do so throughout the state. However, the percentages in the individual counties of Region 6 range 3-8% higher, with the exception of Deschutes County where the percentage is lower. Roughly 42% of seniors in each of Jefferson, Lake and Wheeler Counties have a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-361. People with a Disability by Age Groups in Region 6, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 6	274,535	39,778	14.5%	3,558	5.7%	15,570	34.9%
Crook	20,932	3,825	18.3%	214	4.8%	1,628	38.2%
Deschutes	158,076	19,066	12.1%	2,111	5.8%	7,369	31.0%
Jefferson	20,941	3,540	16.9%	351	6.4%	1,345	41.4%
Klamath	65,826	11,574	17.6%	788	5.3%	4,409	38.9%
Lake	7,479	1,501	20.1%	90	6.0%	650	41.7%
Wheeler	1,281	272	21.2%	4	2.1%	169	41.9%

Note: *Total population does not include institutionalized population

Note: **Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as US-97, tend to have higher concentrations of homeless people (Thomas et al., 2008). This population has held steady in Region 6 from 2009 to 2011 at about 2,800 persons.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-362. Homeless Population Estimate for Region 6

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 6	2,837	2,811	2,756	2,801
Crook	282	244	229	252
Deschutes	1,867	1,688	1,775	1,777
Jefferson	89	329	271	230
Klamath	599	539	428	522
Lake	0	11	52	21
Wheeler	0	0	1	0

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender ratio in Region 6 is similar to that of the state, roughly 50:50 (U.S. Census Bureau; n.d.). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

Region 6 has a slightly higher percentage of seniors than the state. Between 20% and 30% of the population in Crook, Lake and Wheeler Counties are seniors. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The region's percentage of children is similar to that of the state, except in Wheeler County where its 8% less of its population are children. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-363. Population by Vulnerable Age Groups, in Region 6, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 6	277,255	62,920	22.7%	45,080	16.3%
Crook	21,102	4,583	21.7%	4,303	20.4%
Deschutes	158,884	36,349	22.9%	23,965	15.1%
Jefferson	21,746	5,467	25.1%	3,333	15.3%
Klamath	66,350	14,821	22.3%	11,480	17.3%
Lake	7,886	1,508	19.1%	1,593	20.2%
Wheeler	1,287	192	14.9%	406	31.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A greater percentage of the population in this region speak English "very well" compared to the state. Deschutes and Klamath Counties have the largest populations who do not speak English "very well." Outreach materials used to communicate with and plan for these communities should take into consideration their language needs.

Table 2-364. English Usage in Region 6, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 6	252,787	96.9%	8,096	3.1%
Crook	19,623	98.0%	400	2.0%
Deschutes	145,397	97.3%	3,989	2.7%
Jefferson	18,845	93.4%	1,338	6.6%
Klamath	60,246	96.5%	2,208	3.5%
Lake	7,442	98.0%	152	2.0%
Wheeler	1,234	99.3%	9	0.7%

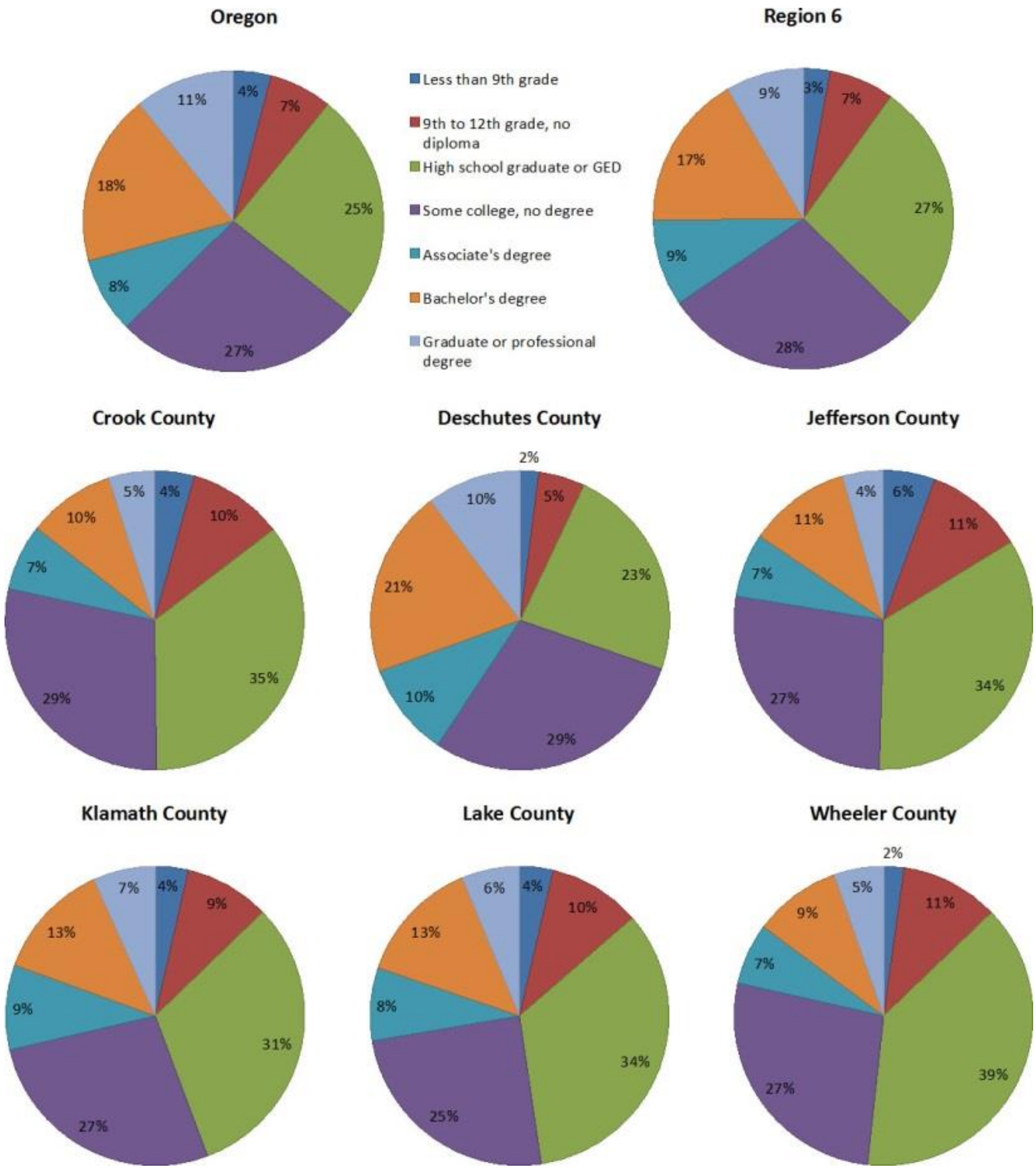
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 2% higher percentage of high school graduates (including GEDs) and a 4% lower share of bachelor's degrees compared to state percentages. Deschutes County has the largest percentage of population with a bachelor's degree or higher (41%), while Wheeler County has the lowest percentage (21%).

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-184. Educational Attainment in Region 6, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. According to Susan Cutter's research on vulnerability to environmental hazards, "the causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event." (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated in communities, are less likely to have the savings to rebuild after a disaster, and less likely to have access to transportation and medical care.

The financial crisis that began in 2007 affected median household incomes in this region in diverse ways. Crook and Deschutes Counties experienced the greatest losses in median household incomes. Only Jefferson County experienced average household income increases. In 2012, with the exception of Deschutes County, median household incomes were $6,700-$13,700 below statewide numbers. Deschutes County was about $1,400 above the state median income.

Table 2-365. Median Household Income in Region 6

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 6	N/A	N/A	N/A
Crook	$49,215	$40,263	-18.2%
Deschutes	$57,697	$51,468	-10.8%
Jefferson	$43,081	$43,330	0.6%
Klamath	$43,920	$41,066	-6.5%
Lake	$40,132	$40,049	-0.2%
Wheeler	$34,609	$36,357	5.1%

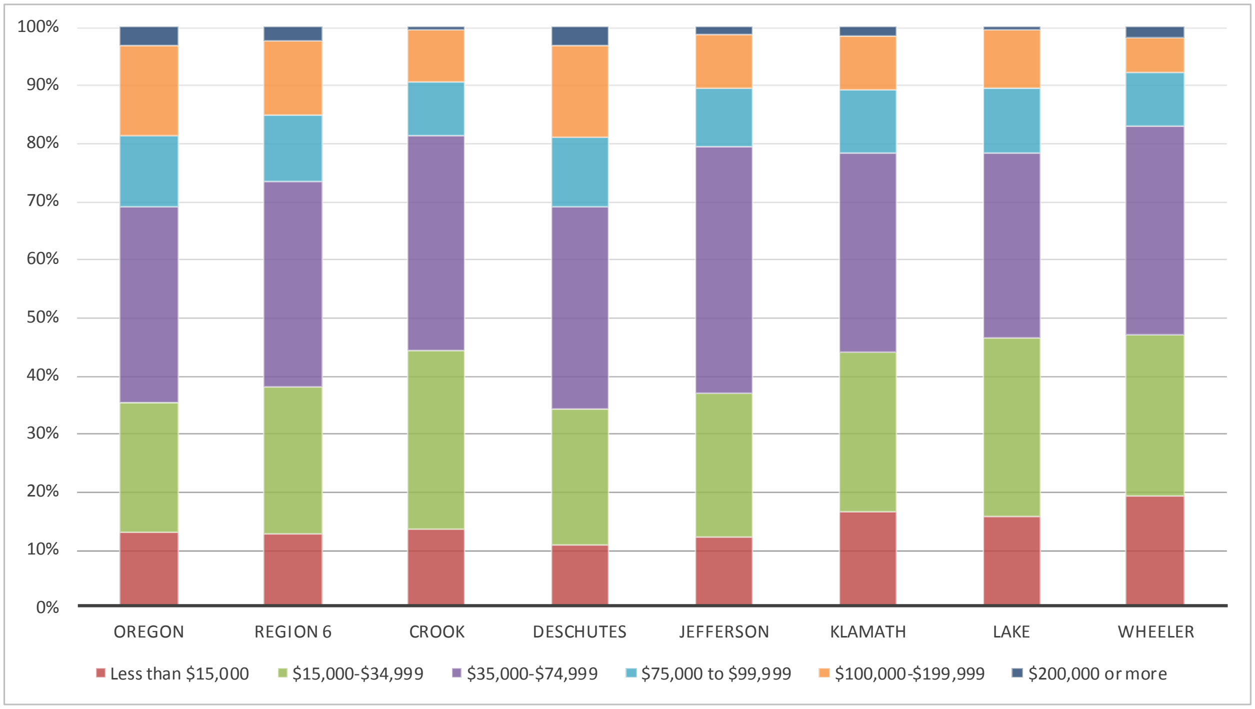
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Compared to statewide numbers, the region has a smaller percentage of households earning more than $75,000 per year. Just over one third of the region's households earn between $35,000 and $75,000 per year. Crook, Klamath, Lake, and Wheeler Counties have the highest percentage of households earning less than $35,000 per year.

Figure 2-185. Median Household Income Distribution in Region 6, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has about the same percentage of individuals and children living in poverty as the state overall. By total population, poverty is declining only in Wheeler County. Jefferson and Klamath Counties have the highest total poverty rates, roughly 19%. Almost one third of all children in Jefferson County live in poverty. The largest increase in child poverty is in Deschutes County, with a dramatic increase of almost 61%.

Table 2-366. Poverty Rates in Region 6, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 6	41,857	15.3%	28.3%	13,224	21.5%	22.1%
Crook	3,631	17.4%	19.6%	1,171	26.1%	-6.8%
Deschutes	20,633	13.1%	53.9%	6,559	18.3%	60.5%
Jefferson	4,015	19.2%	21.1%	1,624	30.0%	10.1%
Klamath	12,143	18.7%	6.0%	3,493	24.6%	-1.6%
Lake	1,284	17.2%	7.4%	354	23.7%	-15.1%
Wheeler	151	12.0%	-26.0%	23	12.0%	-53.1%

Note: *Percent change since 2009.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

A smaller percentage of housing units are rented than average; the highest percentage of rental units are in Jefferson County. Lake County has the greatest percentage of vacant units, while Deschutes and Klamath Counties have the greatest total number of vacancies. In addition, the region has about 8% more seasonal or recreational homes than the state, and 70% of these homes are in Deschutes County (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-367. Housing Tenure in Region 6, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant^	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 6	113,148	75,355	66.6%	37,793	33.4%	11,694	8.5%
Crook	8,745	6,313	72.2%	2,432	27.8%	838	8.2%
Deschutes	64,459	42,620	66.1%	21,839	33.9%	6,466	8.1%
Jefferson	8,005	5,161	64.5%	2,844	35.5%	702	7.2%
Klamath	27,747	18,395	66.3%	9,352	33.7%	3,112	9.5%
Lake	3,566	2,405	67.4%	1,161	32.6%	576	13.1%
Wheeler	626	461	73.6%	165	26.4%	66	7.5%

^ = Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Just over one fourth of all households within the region are family households with children. Similar to the state as a whole, this region has about twice as many single-parent households headed by females than by males. Jefferson County has the highest percentage of single-parent households.

Table 2-368. Family vs. Non-family Households in Region 6, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 6	113,148	76,376	67.5%	36,772	32.5%	28,515	25.2%
Crook	8,745	6,050	69.2%	2,695	30.8%	2,138	24.4%
Deschutes	64,459	43,686	67.8%	20,773	32.2%	15,759	24.4%
Jefferson	8,005	5,604	70.0%	2,401	30.0%	1,858	23.2%
Klamath	27,747	18,411	66.4%	9,336	33.6%	7,451	26.9%
Lake	3,566	2,228	62.5%	1,338	37.5%	1,088	30.5%
Wheeler	626	397	63.4%	229	36.6%	221	35.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-369 shows household structures for families with children in Region 6.

Table 2-369. Family Households with Children by Head of Household in Region 6, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 6	31,005	27.4%	3,373	3.0%	6,349	5.6%	21,283	18.8%
Crook	2,266	25.9%	205	2.3%	434	5.0%	1,627	18.6%
Deschutes	18,223	28.3%	1,805	2.8%	3,273	5.1%	13,145	20.4%
Jefferson	2,208	27.6%	370	4.6%	527	6.6%	1,311	16.4%
Klamath	7,395	26.7%	922	3.3%	1,959	7.1%	4,514	16.3%
Lake	825	23.1%	59	1.7%	137	3.8%	629	17.6%
Wheeler	88	14.1%	12	1.9%	19	3.0%	57	9.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Note: The table shows the percent of total households represented by each family household structure category.

Social and Demographic Trends

This analysis shows that Region 6 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, in the following categories:

- 85% of the region's growth is within Deschutes County.
- Higher percentages of the region's population has a disability than the state as a whole, except in Deschutes County.
- Crook, Lake, and Wheeler Counties have high percentages of seniors.
- All counties except Deschutes have lower than average median household incomes
- Child poverty is increasing in Deschutes and Jefferson Counties.
- Many housing units in Deschutes, Lake, and Klamath Counties are vacant.
- Klamath and Jefferson Counties have high percentages of single-parent households.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate losses created by natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). Though the accelerated growth in Deschutes County has contributed to a broad recovery for the region since the financial crisis that began in 2007, still less than half of the county's 11,000 job losses have been recovered since the recession's peak in 2009 (Tauer, 2014). Deschutes County has the largest labor force and one of the lowest unemployment rates in the region. Wheeler County's labor force has remained relatively stable through the recession due to the county's sparse population and high self-employment rates (Fridley, 2014). Average salaries are lower than state average, ranging from 57% to 89% of that of the state. For example, the average salary in Crook County is $40,118, and in Wheeler County is $25,771.

Table 2-370. Unemployment Rates in Region 1, 2009-2013

	2009	2010	2011	2012	2013	Change (2009-2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 6	14.7%	14.2%	12.8%	11.8%	10.1%	-4.6%
Crook	17.9%	17.1%	15.3%	14.2%	12.3%	-5.7%
Deschutes	14.7%	14.3%	12.7%	11.4%	9.5%	-5.2%
Jefferson	14.8%	14.4%	13.4%	12.3%	10.7%	-4.1%
Klamath	13.9%	13.3%	12.4%	11.9%	10.7%	-3.2%
Lake	12.4%	13.6%	13.3%	12.8%	11.1%	-1.3%
Wheeler	9.0%	10.6%	9.8%	7.7%	7.1%	-2.0%

Source: Oregon Employment Department, 2014.

Table 2-371. Employment and Unemployment Rates in Region 6, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 6	128,738	115,769	89.9%	12,969	10.1%
Crook	8,707	7,639	87.7%	1,068	12.3%
Deschutes	77,752	70,382	90.5%	7,370	9.5%
Jefferson	9,122	8,143	89.3%	979	10.7%
Klamath	28,905	25,798	89.3%	3,107	10.7%
Lake	3,573	3,176	88.9%	397	11.1%
Wheeler	679	631	92.9%	48	7.1%

Source: Oregon Employment Department, 2014.

Table 2-372. Employment and Payroll in Region 6, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 6	99,445	$36,865	81.9%
Crook	5,833	$40,118	89.1%
Deschutes	63,286	$37,749	83.9%
Jefferson	6,172	$34,196	76.0%
Klamath	21,513	$34,550	76.8%
Lake	2,334	$34,621	76.9%
Wheeler	307	$25,771	57.3%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 6 were: (a) Trade, Transportation, and Utilities; (b) Government; (c) Education and Health Services; (d) Leisure and Hospitality; and (e) Professional and Business Services. Between 2012 and 2022, projected growth is expected to create a 18% increase in employment for Central Oregon, including Crook, Deschutes, Jefferson Counties, and a 14% increase in South Central Oregon, including Klamath and Lake Counties. For information on Wheeler County see the Region 5 Risk Assessment (Oregon Employment Department, n.d.b).

Table 2-373. Covered Employment by Sector in Region 6, 2013

Industry	Region 6	Crook County		Deschutes County		Jefferson County	
		Employment	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	99,445	5,833	100%	63,286	100%	6,172	100%
Total Private Coverage	82.0%	4,618	79.2%	54,792	86.6%	3,780	61.2%
Natural Resources & Mining	2.6%	222	3.8%	534	0.8%	457	7.4%
Construction	4.5%	203	3.5%	3,511	5.5%	71	1.2%
Manufacturing	7.9%	731	12.5%	4,209	6.7%	907	14.7%
Trade, Transportation & Utilities	19.3%	1,630	27.9%	12,339	19.5%	793	12.8%
Information	1.7%	70	1.2%	1,407	2.2%	27	0.4%
Financial Activities	4.1%	117	2.0%	3,208	5.1%	111	1.8%
Professional & Business Services	9.7%	297	5.1%	6,879	10.9%	148	2.4%
Education & Health Services	14.8%	556	9.5%	10,330	16.3%	540	8.7%
Leisure & Hospitality	13.6%	553	9.5%	9,901	15.6%	544	8.8%
Other Services	3.7%	236	4.0%	2,457	3.9%	182	2.9%
Private Non-Classified	0.0%	(c)	0.0%	18	0.0%	(c)	0.0%
Total All Government	18.0%	1,216	20.8%	8,494	13.4%	2,392	38.8%
Federal Government	2.4%	304	5.2%	864	1.4%	132	2.1%
State Government	3.0%	203	3.5%	1,245	2.0%	311	5.0%
Local Government	12.5%	709	12.2%	6,385	10.1%	1,949	31.6%

Industry	Region 6	Klamath County		Lake County		Wheeler County	
		Employment	Percent	*Employment*	Percent	Employment	Percent
Total All Ownerships	99,445	21,513	100%	*2,334*	100%	307	100%
Total Private Coverage	82.0%	16,829	78.2%	*1,354*	58.0%	194	63.2%
Natural Resources & Mining	2.6%	999	4.6%	*326*	14.0%	48	15.6%
Construction	4.5%	667	3.1%	*50*	2.1%	(c)	0.0%
Manufacturing	7.9%	1,771	8.2%	*226*	9.7%	(c)	0.0%
Trade, Transportation & Utilities	19.3%	4,077	19.0%	*303*	13.0%	51	16.6%
Information	1.7%	179	0.8%	*18*	0.8%	(c)	0.0%
Financial Activities	4.1%	624	2.9%	*48*	2.1%	(c)	0.0%
Professional & Business Services	9.7%	2,220	10.3%	*61*	2.6%	(c)	0.0%
Education & Health Services	14.8%	3,172	14.7%	*94*	4.0%	55	17.9%
Leisure & Hospitality	13.6%	2,344	10.9%	*164*	7.0%	20	6.5%
Other Services	3.7%	776	3.6%	*60*	2.6%	9	2.9%
Private Non-Classified	0.0%	(c)	0.0%	*(c)*	0.0%	(c)	0.0%
Total All Government	18.0%	4,684	21.8%	*980*	42.0%	113	36.8%
Federal Government	2.4%	883	4.1%	*242*	10.4%	5	1.6%
State Government	3.0%	1,091	5.1%	*176*	7.5%	6	2.0%
Local Government	12.5%	2,710	12.6%	*562*	24.1%	102	33.2%

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Professional and Business Services: This sector is composed of professional service providing industries including scientific and technical, management professionals and administrative and support services (e.g., engineering, law, headquarters, temp help, etc.). In general this sector has low vulnerability to natural disasters. Vulnerability is increased if suppliers are affected and/or physical infrastructure is damaged (buildings, roads, telecommunications, water systems, etc.). Mitigation efforts for this sector should include preparing business recovery plans.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 6. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $8.7 billion (92% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing sector in all counties.

Note: Due to the small size and few industries in the region the collected data is withheld in several categories, especially for manufacturing, to avoid disclosing data for individual companies. Information is aggregated to the county level.

Table 2-374. Revenue of Top Industries (in Thousands of Dollars) in Region 6, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 6	$10,277,989	53.7%	18.4%	12.9%
Crook	$544,066	44.2%	38.6%	8.7%
Deschutes	$7,069,183	57.0%	12.7%	13.8%
Jefferson	$666,466	53.7%	36.4%	D
Klamath	$1,866,429	42.2%	28.9%	15.3%
Lake	$120,934	76.3%	—	15.2%
Wheeler	$10,911	94.9%	—	D

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so workforces and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. According to the Oregon Employment Department, between 2012 and 2022, the largest job growth in Region 6 is expected to occur in the following sectors: (a) Education and Health Services; (b) Leisure and Hospitality; (c) Trade, Transportation, and Utilities (including retail trade); (d) Professional and Business Services; and (e) Manufacturing (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 6, 18.6%. Professional and Business Services has the second most. Other Services, Construction, Education, and Health Services round out the top five sectors in the region (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The Economic analysis shows that Region 6 is particularly vulnerable during a hazard event due to the following characteristics:

- Less than half of the jobs lost at the peak of the financial crisis that began in 2007 have been recovered; and
- Wages in Region 6 are relatively low, particularly in Wheeler County.

Central Oregon has largely rebounded from the financial crisis that began in 2007. This is driven primarily by growth in Deschutes and Crook Counties. The educational and health, professional and business services, leisure and hospitality, and manufacturing sectors, driven by the state's fastest population growth rate and increasing tourism economy (both summer bicycling and winter skiing), drives the growth in employment within the region (Oregon Employment Department, n.d.c). Klamath, Lake, and Wheeler Counties have slower population growth rates and higher rates of unemployment and have not recovered as fully as the rest of the region. Supporting the growth of dominant industries and employment sectors as well as emerging sectors identified in this analysis can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

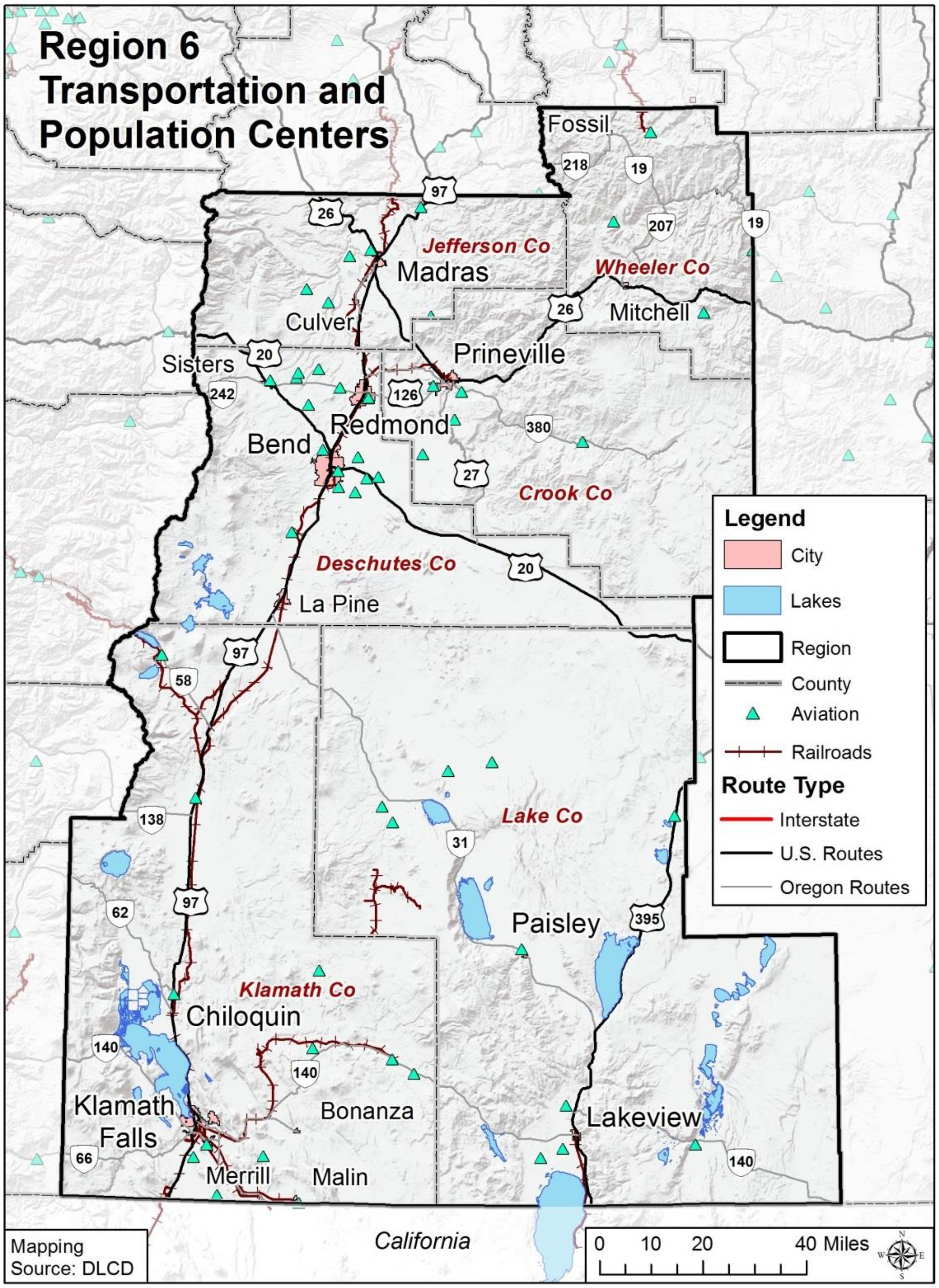
Roads

The largest population bases in Region 6 are located along the region's major highways. Growing population centers bring more workers, automobiles, and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these are added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), ground shaking from a CSZ event is not expected to cause damage in the region's major highways. However, either a local event or possibly one triggered by a CSZ event, can cause extensive damage. For information on ODOT's Seismic Lifeline Report findings for Region 6, see **Seismic Lifelines**.

Figure 2-186. Region 6 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 6, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 6, see **Seismic Lifelines**.

Table 2-375 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). The table shows that the region has a lower percentage of bridges that are distressed and/or deficient (13%), than does the state (21%). About 15% of the region's ODOT bridges are distressed, compared to 22% for the state.

Table 2-375. Bridge Inventory for Region 6

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic Covered
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 6	21	144	15%	27	240	11%	8	57	14%	4	9	44%	60	449	13%	12
Crook	7	28	22%	5	24	21%	1	7	14%	0	0	-	13	63	21%	3
Deschutes	5	48	11%	8	47	17%	5	35	14%	1	4	25%	19	132	14%	2
Jefferson	1	13	7%	9	34	26%	0	4	0%	0	1	0%	10	53	19%	4
Klamath	8	55	16%	5	135	4%	2	11	18%	3	4	75%	18	201	9%	2
Lake	4	25	16%	1	38	3%	0	1	0%	0	0	—	5	64	8%	0
Wheeler	0	23	0%	1	6	17%	0	0	—	0	0	—	1	29	3%	1

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 6 support cargo and trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. There is one major rail yard in the region (in Klamath Falls, Klamath County) operated by BNSF and UP (Cambridge Systematics, 2014). The Klamath Falls Yard, actually two adjacent yards, is used for switching, storing rail cars, and for locomotive repair (Cambridge Systematics, 2014).

Amtrak provides passenger rail service from the Willamette Valley south through Region 6 and southward to Los Angeles, California (with stops in Chemult and Klamath Falls) via the Coast Starlight line.

Rails are sensitive to icing from winter storms that can occur in Region 6. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

The Redmond Regional Airport is the only commercial airport in the region (Redmond Airport website, http://www.flyrdm.com). The airport serves four passenger airlines (American Airlines, Alaska Air, Delta Air, United/United Express) providing direct service to Denver, Los Angeles, Portland, San Francisco, Salt Lake City, and Seattle (Redmond Airport website, http://www.flyrdm.com). This airport has been identified to become a primary airport following a Cascadia Subduction Zone (CSZ) seismic event.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-376. Public and Private Airports in Region 6

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Helipad**	**Private Helipad**	**Total**
Region 6	17	37	0	11	65
Crook	1	5	0	3	9
Deschutes	4	12	0	3	19
Jefferson	2	4	0	2	8
Klamath	5	7	0	2	14
Lake	5	5	0	1	11
Wheeler	0	4	0	0	4

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving portions of Crook, Deschutes, Jefferson, Klamath, and Lake Counties. The region's electric cooperatives include: Central Electric Cooperative (Crook, Deschutes, Jefferson, Lake), Columbia Basin Cooperative (Wheeler), Columbia Power Cooperative (Wheeler), Harney Electric Cooperative (Crook, Deschutes, Harney, Lake), Midstate Electric Cooperative (Deschutes, Klamath, Lake), Surprise Valley Electric Cooperative (Klamath, Lake), and Wasco Electric Cooperative (Jefferson, Wheeler).

Table 2-377 lists electric power-generating facilities that are within Region 6. The region has a total of eight power-generating facilities: three are hydroelectric power facilities, two are natural gas power facilities, and three are categorized as "other" (biomass or solar voltaic). In total the power-generating facilities have the ability to produce up to 1,109 megawatts (MW) of electricity. The region also includes one natural gas power facility (Klamath County) that is approved but not constructed. It will have the capacity to generate up to 500 MW of electricity (Oregon Department of Energy, n.d.).

Table 2-377. Power Plants in Region 6

	Hydroelectric	Natural Gas	Wind	Coal	Other*	Total
Region 6	3	2	0	0	3	**8**
Crook	0	0	0	0	0	**0**
Deschutes	0	0	0	0	0	**0**
Jefferson	2	0	0	0	1	**3**
Klamath	1	2	0	0	0	**3**
Lake	0	0	0	0	2	**2**
Wheeler	0	0	0	0	0	**0**
Energy Production (MW)	**461**	**636**	**0**	**0**	**12**	**1,109**

* "Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

Figure 2-187 shows the major dams operated by the Bonneville Power Administration (BPA), which provides hydro-generated electricity to the states consumer owned utilities. The major BPA dams in the region are located on the Deschutes River (Pelton and Round Butte).

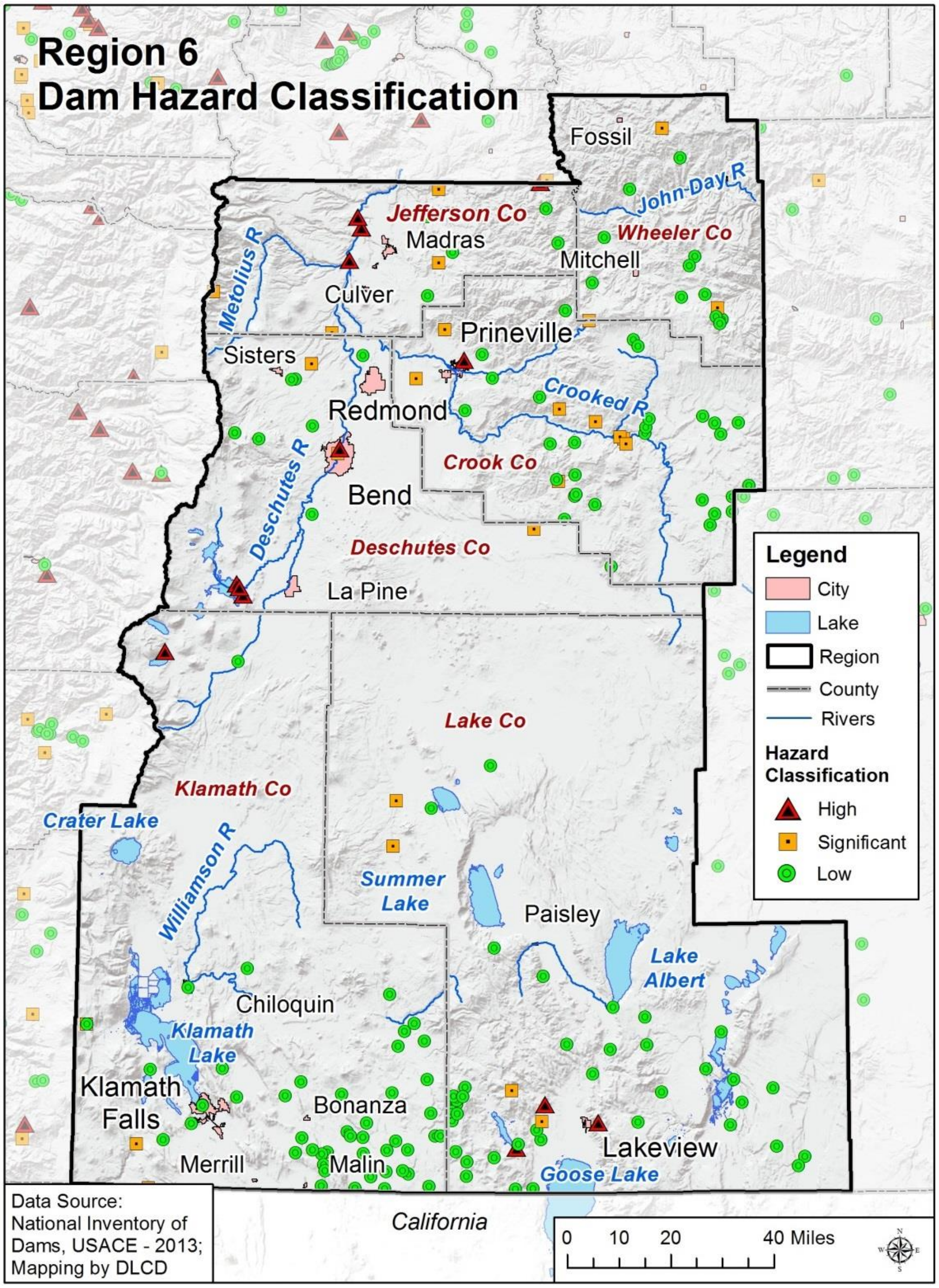
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (Association of Dam Safety Officials, n.d.). The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Table 2-378 lists the number of dams included in the inventory. The majority of dams in the region are located in Crook (53), Klamath (65), and Lake (79) Counties. There are 19 High Threat Potential dams and 23 Significant Threat Potential dams in the region.

Table 2-378. Threat Potential of Dams in Region 6

	Threat Potential			
	High	Significant	Low	Total Dams
Region 6	19	23	212	254
Crook	5	8	40	53
Deschutes	3	3	12	18
Jefferson	4	4	10	18
Klamath	4	3	58	65
Lake	3	5	71	79
Wheeler	0	0	21	21

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-187. Region 6 Dam Hazard Classification

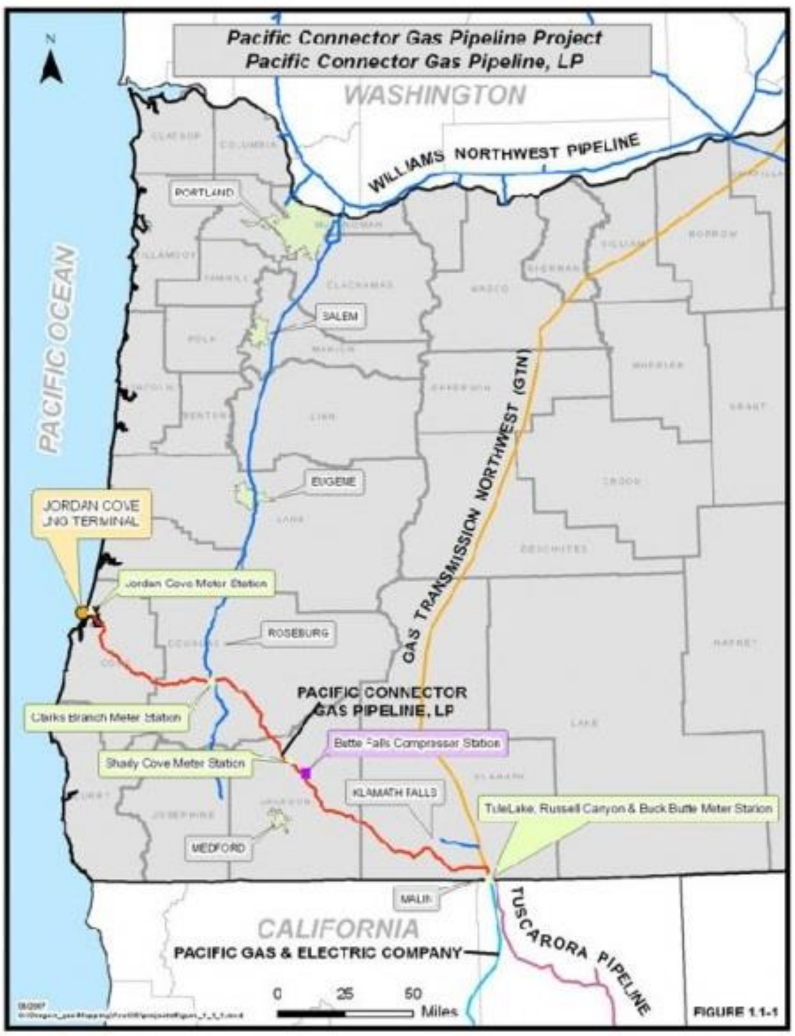


Source: National Inventory of dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Cascade Natural Gas Corporation is the major supplier of natural gas in Central Oregon. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-188** shows the Gas Transmission Northwest (GTN) line, which runs through Klamath, Deschutes, Crook, and Jefferson Counties (in green) and the proposed Pacific Connector that would connect to the GTN line in Klamath County (red) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-188. Liquefied Natural Gas Pipelines in Region 6



Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Utility Lifelines

Central Oregon is an important throughway for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes.

Region 6 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California via a separate network. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 6 is operated primarily by Pacific Power and regional electrical cooperatives (and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976b). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline in southern Oregon while Cascade Natural Gas supplies the greater part of Central Oregon (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 6 is part of the Central Oregon Operational Area (Crook, Deschutes, Jefferson, Wheeler), the Lake-Harney Operational Area (Lake), and the Southern Oregon Operational Area (Klamath) under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013.) There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages. Messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 6. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 6 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Central Oregon Operational Area are:

- KOAB-FM, 91.3 MHZ, Bend; and
- KWRX-FM, 88.5 MHZ, Redmond (KWAX-FM Network).

The radio transmitter for the Lake-Harney Operational Area is:

- KOAP-FM, 88.7 MHZ, Lakeview.

The radio transmitter for the Southern Oregon Operational Area is:

- KOTI-TV, Ch. 13, Klamath Falls.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 2 (Crook, Deschutes, Jefferson), 3 (Wheeler), and 4 (Klamath, Lake) provide service to Region 6. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 6 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Crook County: W7KFO;
- Deschutes County: KE7TMU;
- Jefferson County: K1GER;
- Klamath County: WA7YPR;
- Lake County: KE7QP; and
- Wheeler County: W7ILD.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 6 municipal drinking water supply is obtained from both surface and ground sources. In Crook, Deschutes, Jefferson, and Klamath Counties rural areas draw water from surface water sources. In the upper basin of Klamath County rural drinking water is drawn from springs, while the lower basin draws water from Klamath Lake for drinking water and irrigation. In rural areas of Lake County drinking water is primarily drawn from wells. Rural drinking water and irrigation water is primarily drawn from surface water sources and may be delivered by localized irrigation districts or may be drawn directly by landowners with water rights. The region's cities primarily draw drinking water from groundwater wells with the exception of the City of Bend, which draws water from Bridge Creek, a spring-fed waterway. A small portion of the City of Lakeview's drinking water is drawn from springs.

Region 6 is impacted by several threats to water quality and quantity. Low levels of snowpack and rain can lead to water shortages in a region that is often subject to annual shortages. Water rights in the region are fully appropriated in the summer season, which may impact opportunities for new development of urban and farm lands in the region. Above-ground storage in reservoirs is a tool used throughout the region to help prepare for potential water shortages. Aging wells in the region may also contribute to shortages because of decreased efficiency in water delivery. However, the age and maintenance level of wells is mostly a concern because older equipment may not filter minerals and bacteria as effectively as well maintained infrastructure.

Water quality in Crook, Deschutes, and Jefferson Counties is generally high, partially due to the volcanic nature of the area's soil and bedrock, which lacks high levels of sedimentation. However, concerns regarding water quality do exist. Sedimentation could be caused by river bank erosion due to freeze-thaw cycles in the winter and weed growth lowering channel capacity. A decrease in channel capacity may in turn contribute to turbidity and sedimentation. Throughout the region, complaints about hydrogen sulfide causing unpleasant odors to the water occasionally occur; however, the unpleasant odor is not indicative of any health concerns. In Lake County, minerals including arsenic and boron are of concern and monitored regularly. In the area surrounding the City of Lakeview tailings and runoff from abandoned mines are a concern for the area's water quality. In Klamath County, the shallow, slow-moving nature of waterways causes high water temperatures, which threatens water quality. Throughout the region, bacterial coliform levels are monitored to ensure that waterborne diseases do not threaten the quality of drinking water.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 6, county and municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. The largest municipalities in the region (Fossil, Madras, Prineville, Redmond, Bend, La Pine, Klamath Falls, and Lakeview) do not require use LID strategies in their building codes. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends/Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Icy winter conditions may disrupt the flow of cargo and trade by rail as well as Amtrak's passenger service. The Redmond Regional Airport will become a primary airport for the state following a catastrophic Cascadia Subduction Zone (CSZ) earthquake event.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. The region has a diverse energy portfolio that boosts its ability to withstand system disruptions due to natural hazard events. This includes eight power-generating facilities: three hydroelectric, two natural gas, and three biomass or solar voltaic facilities. The region has two large dams and hydroelectric projects on the Deschutes River. LNG is transported through the region via the Gas Transmission Northwest (GTN) pipeline that runs through Klamath, Deschutes, Crook, and Jefferson Counties. A natural gas power plant has been proposed for Klamath County. In addition, there is an emerging solar photovoltaic energy infrastructure in Central Oregon.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from US-97. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lacking system redundancies. Furthermore, because most drinking water is sourced from surface water or wells, the region is at risk of high levels of pollutants entering waterways through stormwater runoff and combined sewer overflows (CSOs) during high-water events. The implementation of decentralized LID stormwater systems can increase the region's capacity to better manage high precipitation events.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

The region's percent urban growth between 2000 and 2010 is double that of the state. Deschutes County has the highest population in urban and rural areas and has experienced roughly 57% urban growth. Overall, the region's urban areas are growing about 4 times faster than rural areas. Rural populations have grown significantly, between 10 and 18%, in all counties except Deschutes and Wheeler. Wheeler is the only county that does not have an urban population, even though it contains incorporated cities, and it is also the only county in the region that is losing rural population.

Urban housing is growing at twice the rate of rural housing in the region. Deschutes County gained the most urban housing units (approximately 21,150), growing by 69%. Notably, rural housing has increased by about 30% in Crook and Klamath Counties.

The region's population is clustered around the US-97 corridor and the cities of Bend, Klamath Falls, Madras, and Redmond.

Table 2-379. Urban and Rural Populations in Region 6

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 6	134,438	177,374	31.9%	91,864	98,773	7.5%
Crook	10,290	10,905	6.0%	8,892	10,073	13.3%
Deschutes	72,554	114,130	57.3%	42,813	43,603	1.8%
Jefferson	7,252	8,010	10.5%	11,757	13,710	16.6%
Klamath	41,153	41,434	0.7%	22,622	24,946	10.3%
Lake	3,189	2,895	-9.2%	4,233	5,000	18.1%
Wheeler	0	0	0%	1,547	1,441	-6.9%

Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-380. Urban and Rural Housing Units in Region 6

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 6	57,098	80,325	40.7%	47,792	57,939	21.2%
Crook	4,190	4,884	16.6%	4,074	5,318	30.5%
Deschutes	30,684	51,844	69.0%	23,899	28,295	18.4%
Jefferson	2,735	3,382	23.7%	5,584	6,433	15.2%
Klamath	17,950	18,684	4.1%	10,933	14,090	28.9%
Lake	1,539	1,531	-0.5%	2,460	2,908	18.2%
Wheeler	0	0	0%	842	895	6.3%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

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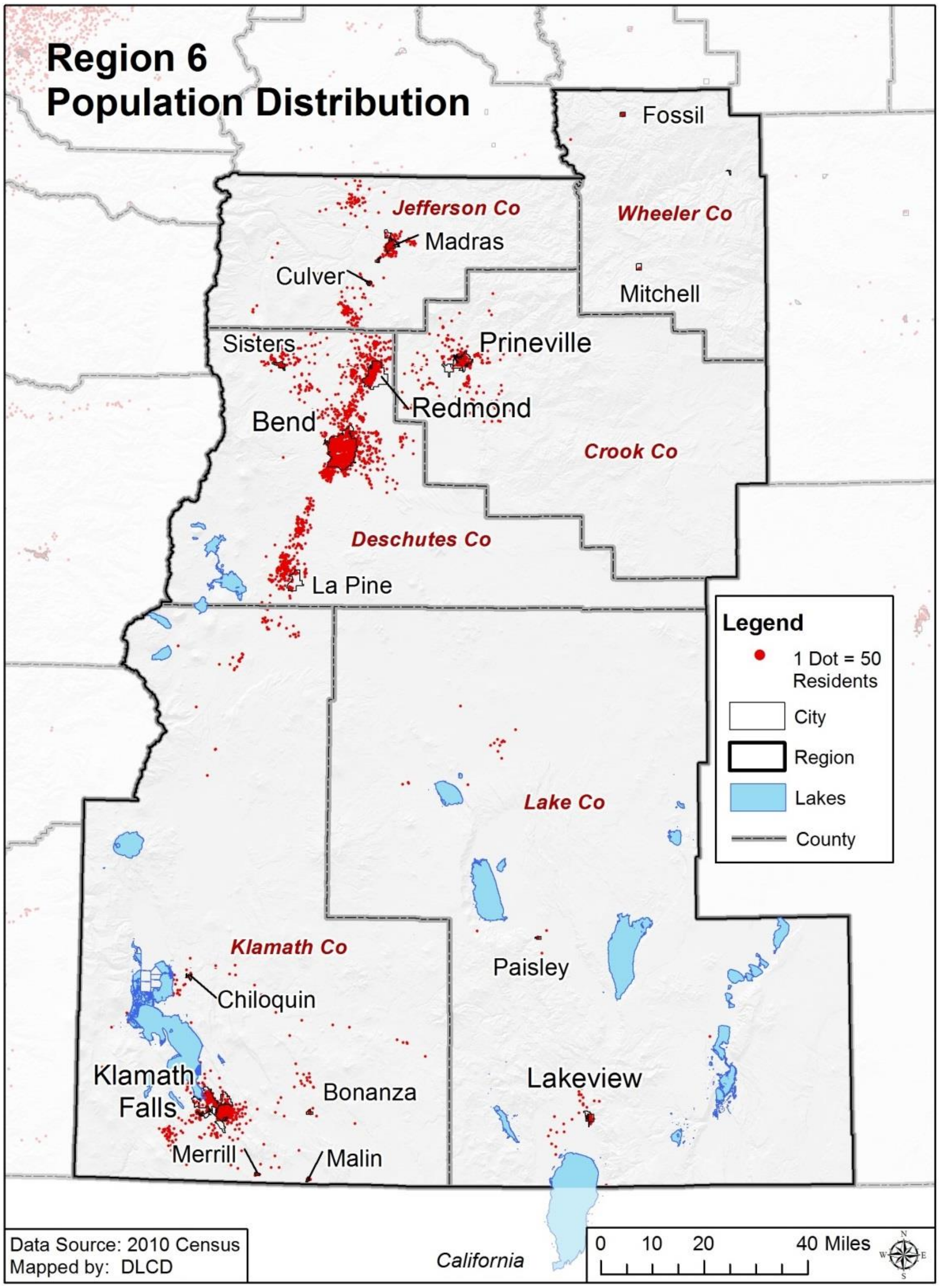
Figure 2-189. Region 6 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Land ownership and geography tend to drive the land use patterns in Region 6. Federal ownership (61%) is made up primarily of the U.S. Forest Service in the western portion ranging up the Cascade crest, and BLM has holdings generally ranging from southeast of Redmond and increasing until dominating the area of Lake County. The majority of land ownership is private holdings (36%) from the north Jefferson County and Madras area through the Prineville/Redmond/Sisters/Bend areas. The Warm Springs Indian Reservation dominates the northeast portion.

Development pressure has been high in the Bend, Sisters, and Redmond areas in the past few decades. Between 1974 and 2009, the Bend area lost 13% of its land in resource land uses to more developed uses. However, since 1984 that rate has declined; annual average rates of conversion of land in resource land uses to low-density or urban uses in Deschutes County was 88% less in the 2005–2009 period when compared to the 1974–1984 period. Similar trends, although less pronounced, are seen in Klamath County (Lettman, 2011).

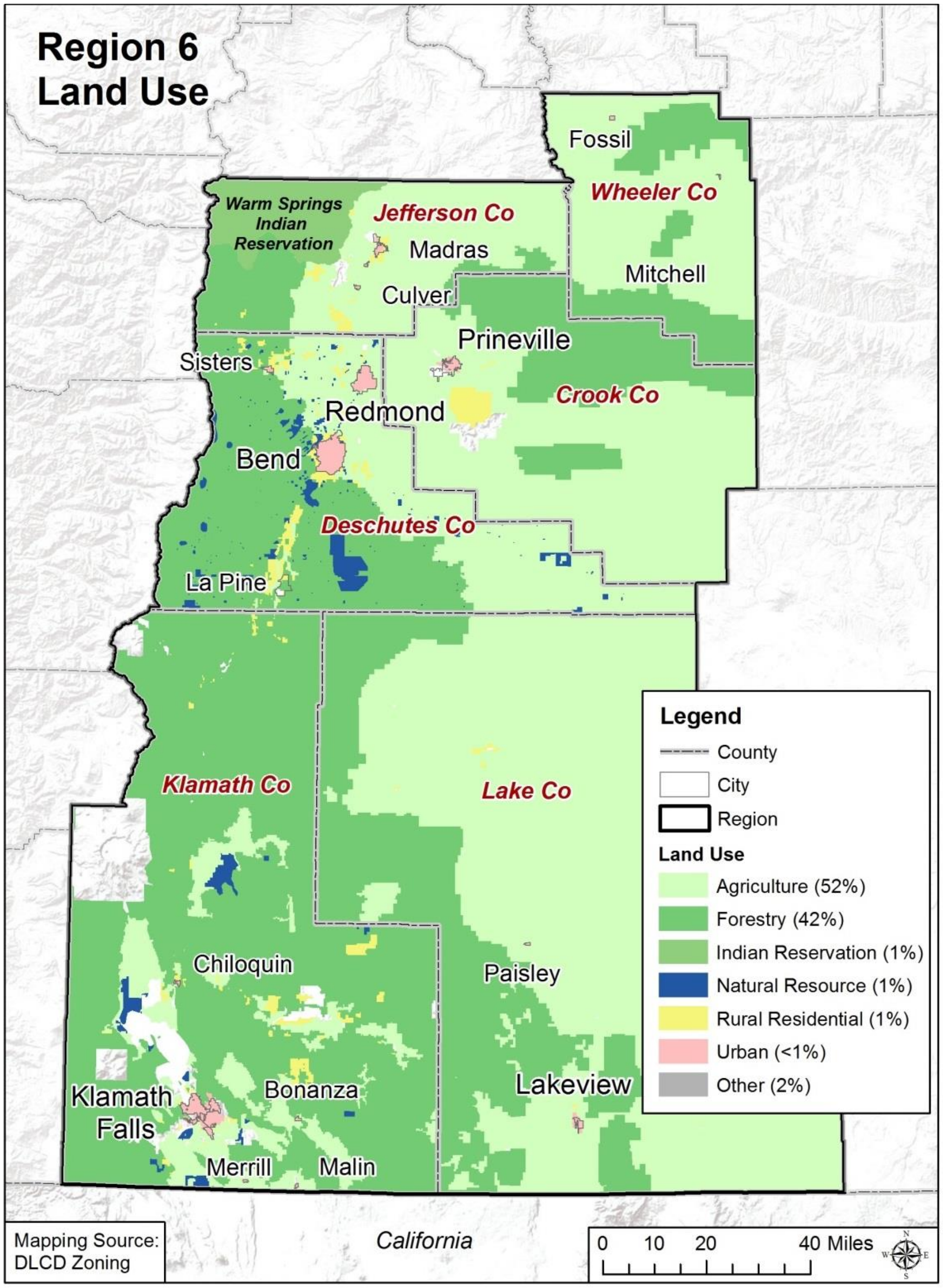
Responding to rapid growth and changing demographics, in 2011 Deschutes County completed a multi-year effort to establish “Plan 2030.” This new plan incorporates updated goals and policies, community plans, and new projects like the South County Plan, destination resort remapping, a 2030 Transportation System Plan, and a South County Local Wetland Inventory.

Increasing federal efforts to protect sage grouse habitat affect large portions of Deschutes, Crook, and Lake County’s resource lands devoted to farm, ranch, or forest uses. Land use threats to habitat have been identified as conversion to agriculture, energy development, mining, infrastructure, and urbanization. Counties have been addressing some of these issues through their land use planning programs.

While periodic flooding is a challenge in the northern portion of the Region, the wildland-urban interface areas are a constant concern for community planners and emergency managers. The Oregon Forestland-Urban Interface Fire Protection Act — often referred to as Senate Bill 360 — enlists the aid of property owners toward the goal of turning fire-vulnerable urban and suburban properties into less volatile zones where firefighters may more safely and effectively defend homes from wildfires. All Region 6 counties implemented this in 2013.

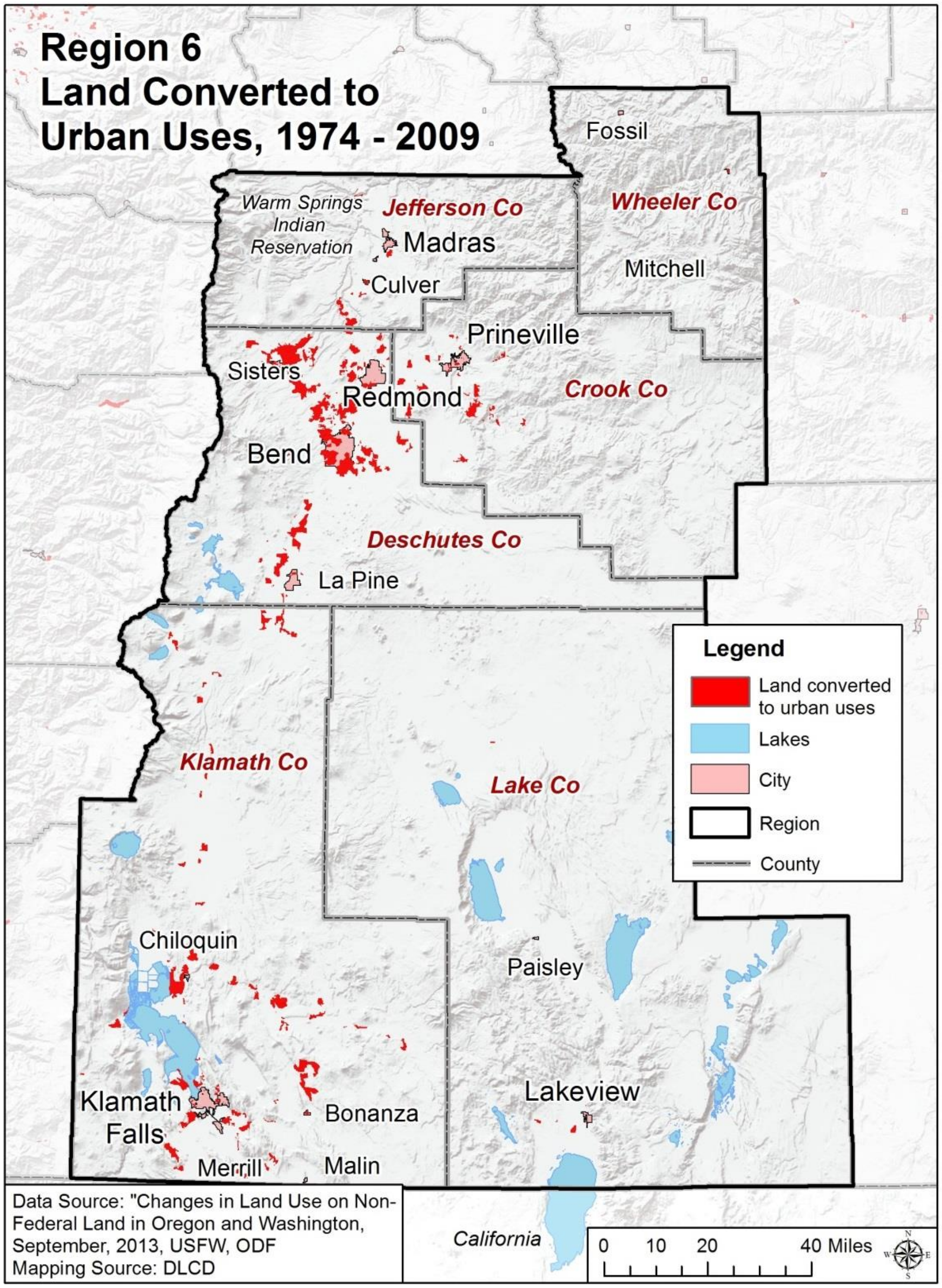
The City of Madras in 2014 began working on integrating portions of its Comprehensive Plan with its Local Natural Hazards Mitigation Plan; this may prove to be a model for others.

Figure 2-190. Region 6 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-191. Region 6 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost two thirds of the region's housing stock is single-family homes. Mobile homes account for 13% of Region 6's housing, and roughly 70% of all mobile homes are located in Deschutes and Klamath Counties. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-381. Housing Profile for Region 6, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 6	138,082	102,288	74.1%	17,474	12.7%	18,017	13.0%
Crook	10,204	7,763	76.1%	663	6.5%	1,669	16.4%
Deschutes	80,039	61,145	76.4%	11,557	14.4%	7,308	9.1%
Jefferson	9,807	6,409	65.4%	1,009	10.3%	2,337	23.8%
Klamath	32,737	23,393	71.5%	4,033	12.3%	5,250	16.0%
Lake	4,413	2,914	66.0%	204	4.6%	1,243	28.2%
Wheeler	882	664	75.3%	8	0.9%	210	23.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-382) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally, about one quarter of the housing stock was built prior to 1970 — including roughly half of the residences in Lake and Wheeler Counties — before the implementation of floodplain management ordinances. Regionally, just under 54% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-382. Age of Housing Stock in Region 6, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 6	138,082	32,008	23.2%	42,128	30.5%	63,946	46.3%
Crook	10,204	2,840	27.8%	2,624	25.7%	4,740	46.5%
Deschutes	80,039	10,166	12.7%	24,414	30.5%	45,459	56.8%
Jefferson	9,807	2,325	23.7%	2,952	30.1%	4,530	46.2%
Klamath	32,737	14,015	42.8%	10,623	32.4%	8,099	24.7%
Lake	4,413	2,183	49.5%	1,286	29.1%	944	21.4%
Wheeler	882	479	54.3%	229	26.0%	174	19.7%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. Table 2-383 shows the initial and current FIRM effective dates for Region 6 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-383. Community Flood Map History in Region 6

	Initial FIRM	Current FIRM
Crook County	July 17, 1989	Feb. 12, 2012
Prineville	July 17, 1989	Feb. 12, 2012
Deschutes County	Aug. 16, 1988	Sep. 28, 2007
Bend	Sep. 4, 1987	Sep. 28, 2007
La Pine	Sep. 28, 2007	Sep. 28, 2007
Sisters	Sep. 29, 1986	Sep. 28, 2007
Jefferson County	July 17, 1989	July 17, 1989
Culver	Sep. 4, 1987	Sep. 4, 1987
Madras	July 17, 1989	July 17, 1989
Klamath	Dec. 18, 1984	Dec. 18, 1984
Bonanza	June 1, 1983	June 1, 1983 (M)
Chiloquin	Aug. 15, 1984	Aug. 15, 1984
Klamath Falls	June 5, 1985	June 5, 1985
Lake	Dec. 5, 1989	Dec. 5, 1989
Lakeview	Nov. 16, 1982	Sep. 5, 1990
Paisley	Sep. 15, 1989	Sep. 15, 1989
Wheeler County	July 17, 1989	July 17, 1989
Fossil	May 4, 1989	May 4, 1989
Mitchell	Apr. 17, 1989	Apr. 17, 1989

(M) = no elevation determined; all Zone A, C and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 6 can be found in **Table 2-384**. The region contains 5.1% of the total value of state-owned/leased critical/essential facilities.

Table 2-384. Value of State-Owned/Leased Critical and Essential Facilities in Region 6

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 6	$371,339,811	5.1%
Crook	$17,310,982	0.2%
Deschutes	$105,581,675	1.4%
Jefferson	$164,051,549	2.2%
Klamath	$41,694,108	0.6%
Lake	$38,521,237	0.5%
Wheeler	$4,180,262	0.1%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 6 is largely a rural county with urban development focused along US-97, around the population centers of Bend, Klamath Falls, Prineville, and Redmond. Deschutes County has the fastest growing urban population in the region while Wheeler County is entirely rural and is declining in population. The region’s housing stock is largely single-family homes, though Jefferson, Lake, and Wheeler Counties have approximately triple the state’s percentage of mobile homes. Roughly half the homes in Klamath, Lake, and Wheeler were built before 1970. With the exception of Crook and Deschutes Counties, none of the region’s FIRMs have been modernized or updated, leaving this region’s flood maps less up to date than those of other regions.

2.3.6.3 Hazards and Vulnerability

Droughts

Characteristics

Every county in Central Oregon has experienced drought conditions at some point during the past 10 years, with Klamath County receiving the most Governor-declared declarations. A summary of Governor-declared droughts since 1995 is given in **Table 2-385**. The U.S. Department of Agriculture can also designate a county as a "natural disaster area" due to damages or losses caused by a drought. In 2007, Lake County was declared a natural disaster area and Klamath County received the same designation in 2010. In August 2013, Klamath and Lake Counties were declared natural disaster areas.

Historic Drought Events

Table 2-385. Historic Droughts in Region 6

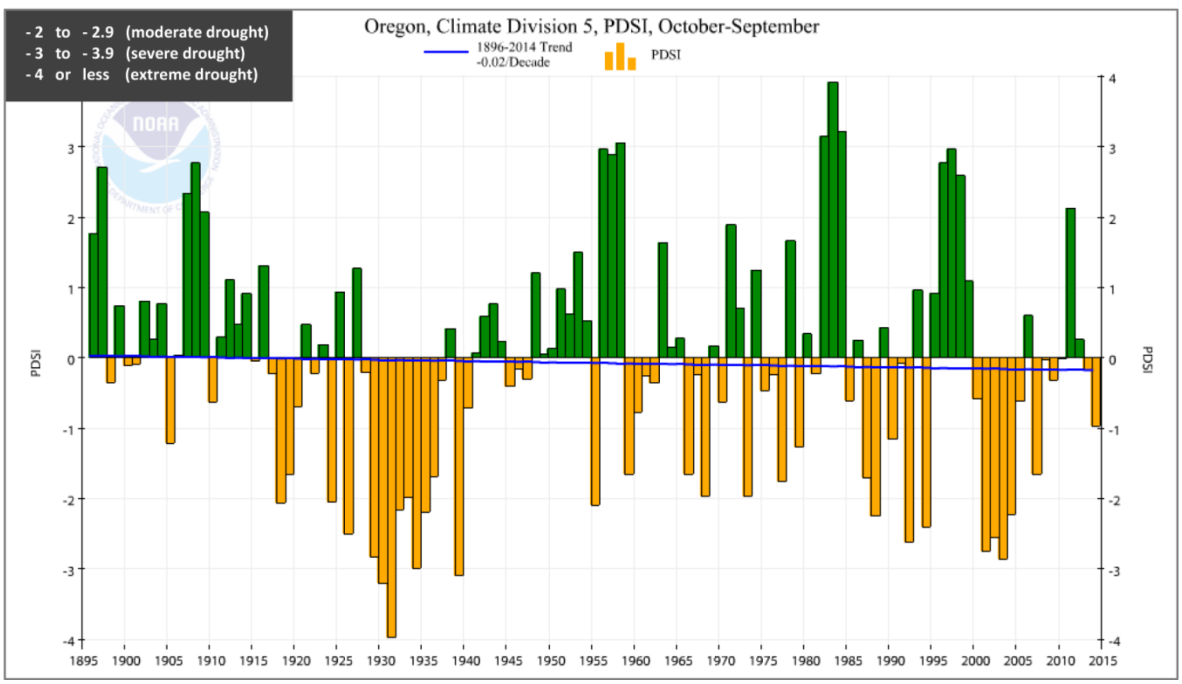
Date	Location	Description
1929–1931	Region 1–3, 5–7 (1929-1930); Region 6 and 7 (1930-1931) (extreme drought)	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N. & S. central and eastern Oregon	the water year was significantly drier than normal, but temperatures were near normal
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within Regions 4–8
2001	southern, eastern OR	Jefferson, Wheeler, Crook, Deschutes, Klamath, and Lake Counties under a Governor-declared drought; in 2001, 18 counties were declared statewide
2002	southern, eastern Oregon	counties declared in 2001 remained in effect; Governor added five additional counties in 2002, bringing the total to 23 counties
2003	southern, eastern Oregon	Jefferson, Deschutes, and Lake Counties' drought declarations expired June 23, 2003; Governor issued new drought declarations for Wheeler and Crook Counties and extended Klamath drought order through December 2003
2004	eastern Oregon	Klamath County under a Governor drought declaration; three other counties declared in neighboring regions
2005	Regions 5–7	Governor declared drought in Wheeler, Crook, Deschutes, Klamath, and Lake Counties; all Region 5 counties declared as well as two counties in Region 7
2007	Regions 6–8	Governor declared drought in Lake County, along with five other counties in Regions 6 and 7
2010	Region 6	Governor declared drought for Klamath County and "contiguous counties"
2012	Region 6	Governor declared drought for Lost River Basin only, located within Klamath and Lake Counties
2013	Regions 5-8	Governor declared drought for Klamath County along with four other counties
2014	Regions 4, 6–8	Governor declared drought in 10 counties including Crook, Wheeler, Klamath, Lake

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division (Governor's Executive Orders); NOAA's Climate at a Glance; Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt; personal communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI), that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. **Figure 2-192** shows years where drought or dry conditions affected the high plateau region of Oregon, which comprises much of Klamath County and smaller portions of Lake and Deschutes Counties (Climate Division 5).

Based on this index, 1931 was the driest year in this record with an index value of -3.98. The late 1920s were moderately dry, followed with many severe droughts in the 1930s. 1992 and 1994 were moderate years, followed by many moderate, nearly severe drought years in the early 2000s.

Figure 2-192. Palmer Drought Severity Index for Region 6



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

The PDSI for Climate Division 7 (south central Oregon), which includes Deschutes, Jefferson, Crook, Wheeler, portions of Lake County, and the southern portion of Klamath County, along with Harney County (a "Region 7" county for hazard planning) had similar dry years, but in terms of severity, these years were higher in PDSI values. Water Year 1934, for example, had a PDSI value of −5.58, compared to the high plateau region value of −2.99. Also the south central region had more occurrences of "severe droughts" than the high plateau region. Water Year 1977 was the fourth driest year for the south central Oregon (PDSI value −3.89), whereas in the high plateau region, 1977 had a PDSI value of −1.76 (normal or mid-range condition).

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 6 will experience drought is shown in **Table 2-386**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-386. Local Probability Assessment of Drought in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

Oregon has yet to undertake a statewide comprehensive risk analysis for drought to determine probability or vulnerability for a given community. Considering that several drought declarations have occurred during the last 10 years, is it reasonable to assume that there is a high probability that Region 6 will experience drought in the near future.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-387**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-387. Local Vulnerability Assessment of Drought in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	L	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Klamath County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Klamath County has been under a drought declaration during 11 of the past 22 years, more than any other county in the state.

In 2013, the Klamath Falls area experienced the second driest January through March period on record with precipitation measuring below average throughout the Klamath Basin. According to the U.S. Bureau of Reclamation, Klamath Basin Project irrigators have not received a full supply of water in nine out of the last thirteen irrigation seasons During dry or drought years, national wildlife refuges in the Klamath Basin received smaller water deliveries as well. These refuges are important nesting and feeding grounds for birds migrating along the Pacific Flyway. Reduced river flows, especially during the summer months, can negatively impact fisheries, recreation, and other uses as well.

Lake County could also be considered one of the communities most vulnerable to drought and its related impacts, based on Governor-declared drought declarations. Declarations have been issued in 1992, 2001 (which continued through June 2003), 2005, 2007, 2012, and most recently in February 2014.

Dust Storms

Characteristics

The characteristics of dust storms in Region 6 are well described in the State Risk Assessment, **Drought** section. There is little about the dust storms in this region that differs from the general description, except to note that agricultural practices generally don't play as big a role as they do in Region 5. That written, Central Oregon farmers, ranchers, homeowners, resort properties, and wildlife sometimes find themselves vying for limited water. This competition for scarce water can affect the locations and amounts of dust lifted into the atmosphere, and blown on the wind.

Examples of dust storms in this region are listed in **Table 2-388**. One of the most recent significant storms occurred in April 2001. High winds blowing dust from a recently plowed field severely limited visibility.

Historic Dust Storms

Table 2-388. Historic Dust Storms Affecting Region 6

Date	Location	Description
Apr. 1931[1]	central Oregon	a heavy bank of clouds filled with dust reportedly worked their way over mountain passes into the Santiam Canyon
Mar. 1935	central Oregon	"A dust storm which reduced visibility to a few hundred yards spread over several Central Oregon counties… slowing traffic on the Dallas (sic) – California highway and spreading a fine coating of dry dust over all adjacent wheat lands." [2]
Apr. 2001	near Klamath Falls	US-97 about 5 miles north of Klamath Falls was closed for approximately 6 hours following three separate crashes; 11 cars were involved, sending nine people to the hospital; the accidents were due to severely limited visibility caused by high winds blowing dust from a recently plowed field across the highway. [3]
June 2004[4]	Lake County	blowing dust from a dry lake bed filled the sky in and near Summer Lake
Mar. 2005	Deschutes and Jefferson Counties	visibilities of a half mile or less due to blowing dust were reported from this event; "Motorists on Highway 97 north of Madras reported visibilities down to near zero at times" [5]
Nov. 2009[6]	Lake County	an alkaline dust storm blew into Lakeview

Sources:

(1) Oregon Statesman, "Dust, Wind, and Fire Cause Great Damage," April 23, 1931, and "Dust Storm Precedent on Record 88 Years Ago," April 26, 1931; information on this event, as well as the 1906 event, may also be found in the Pacific Northwest Quarterly, "The Pacific Northwest Dust Storm of 1931," Paul C. Pitzer, April 1988, pp. 50-55, as informed by the following sources used by Mr. Pitzer:

Albany Democrat-Herald, April 22, 1931
Astoria Evening Budget, April 24, 1931
Coos Bay Times, April 22, 23, 1931
Corvallis Gazette-Times, April 22, 24, 1931
Pendleton East Oregonian, April 22, 1931
Portland Oregonian, April 22, 25, 26 and May 1, 1931
Portland Oregonian, Lancaster Pollard, August 21, 1955 and November 25, 1962
Roseburg News-Review, April 22, 23, 1931
Salem Oregon Journal, April 22, 23, 24, 1931
San Francisco Chronicle, April 25, 1931
The Dalles Optimist, April 24, 1931
Wenatchee Daily World, April 22, 1931
Beef Cattle Industry in Oregon: 1890-1938, Dexter K. Strong, 1940
Wind Erosion and Dust Storms in Oregon, Arthur King, 1938

(2) New York Times, March 25, 1935, p. 17; "the Dallas" clearly should be "The Dalles." It may be that someone in New York believed that they were correcting a typographical error.

(3) One of the sources for this is the Herald and News, April 17, 2001, though there are other sources.

(4) The Oregonian (and Associated Press), June 21, 2004

(5) https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5439654

(6) https://en.wikipedia.org/wiki/Goose_Lake_%28Oregon%E2%80%93California%29

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 6 will experience dust storms is depicted **Table 2-389**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-389. Local Probability Assessment of Dust Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	—	—	—	—	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Five significant storms in 75 years indicates the history and probability of dust storms in Region 6 are both high.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-390**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-390. Local Vulnerability Assessment of Dust Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	—	—	—	—	—

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

It is difficult to specifically identify the communities most vulnerable to dust storms in Region 6, but Deschutes, Klamath, and Lake Counties are the places with an identified history. Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with volcanic activity.

Central Oregon includes portions of five physiographic provinces (High Cascades, Blue Mountains, Basin and Range, High Lava Plains, and Deschutes-Columbia Plateau). Consequently, its geology and earthquake susceptibility varies considerably. There have been several significant earthquakes that have been centered in the region, all in Klamath County: 1920 Crater Lake, and the 1993 Klamath County earthquakes (M5.9 and 6). There are also numerous identified faults in the region (mostly Klamath County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that the Cascade volcanoes are some distance away from the major population centers in Region 6, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Most of the region is within a relative moderate seismicity area, except for portions of Klamath County, which is within a relative high zone as shown in **Figure 2-193**.

There have been several significant earthquakes that have been centered in the region, all in Lake County: 1906 north of Lakeview, 1923 Lakeview area, 1958 Adel (M4.5), and 1968 Adel swarm (M4.7–5.1). There are also numerous identified faults in the region (mostly in Lake County) that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region.

Historic Earthquake Events

Table 2-391. Significant Earthquakes Affecting Region 6

Date	Location	Magnitude (M)	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	Offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Apr. 1906	North of Lakeview, Oregon	V	three felt aftershocks
Apr. 1920	Crater Lake, Oregon	V	one of three shocks
Jan. 1923	Lakeview, Oregon	VI	
1968	Adel, Oregon	5.1	swarm lasted May through July, decreasing in intensity; increased flow at a hot spring
Sep, 1993	Klamath Falls, Oregon	5.9 and 6.0	series of earthquakes, largest: M6.0; damage: considerable (in and around Klamath Falls); fatalities: two (one rock fall on highway and one heart attack)
Apr. 28, 1999	Christmas Valley, Oregon	3.8	damage: unknown
Apr. 1999	Christmas Valley, Oregon	1.9–3.0	at least six earthquakes occurred in the area
June 30, 2004	SE of Lakeview, Oregon	4.4	damage: unknown
June 2004	SE of Lakeview, Oregon	1.9–3.9	at least 20 earthquakes occurred in the area

*BCE: Before Common Era.

Sources: Wong and Bolt (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience earthquakes is shown in **Table 2-392**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-392. Local Probability Assessment of Earthquakes in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	M	L	M	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

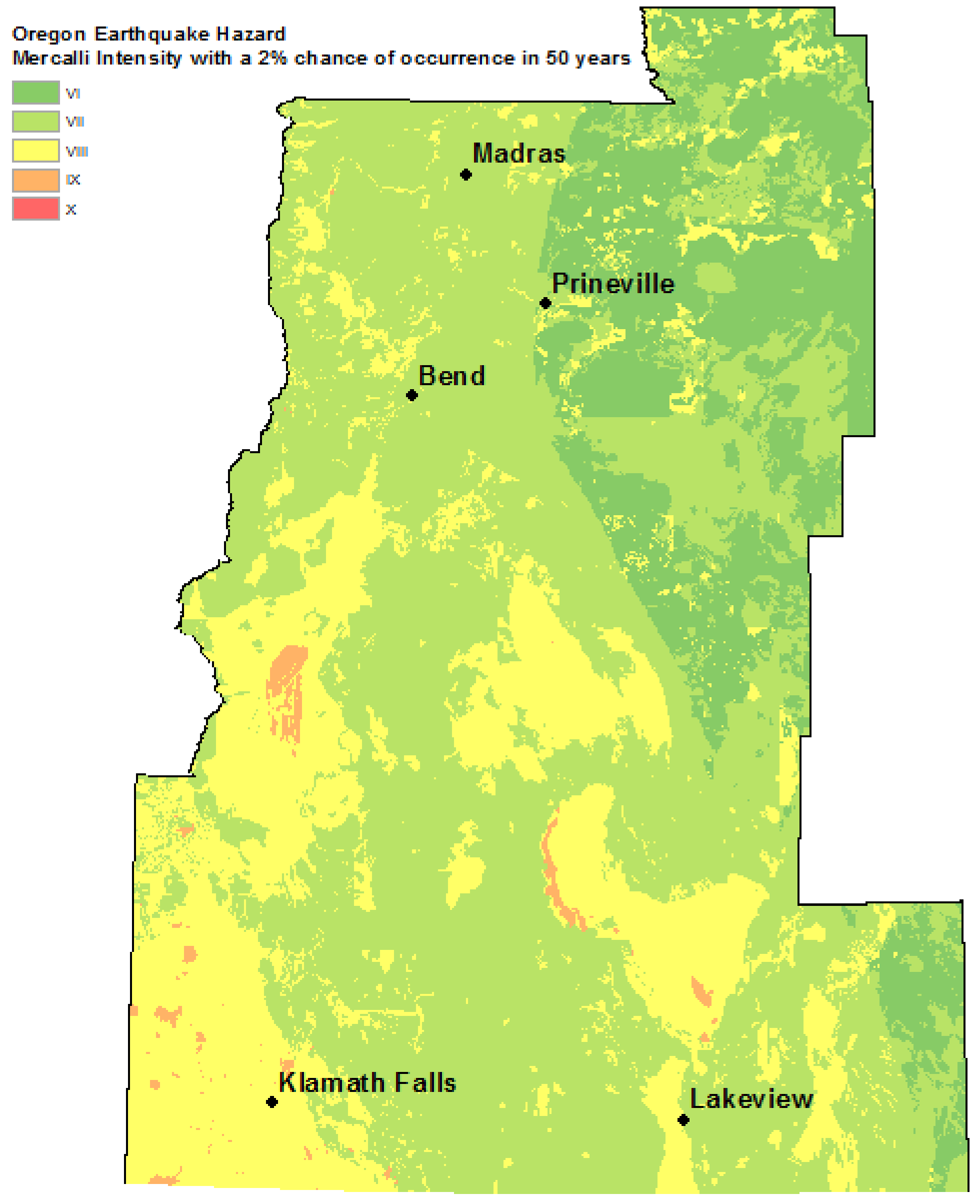
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 6, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 6 is depicted in **Figure 2-193**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-193**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-193. Probabilistic Earthquake Hazard in Region 6



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-393**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-393. Local Vulnerability Assessment of Earthquakes in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	M	L	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models are based on Hazus, a computerized program, currently used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential 8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from the event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model). Rather, it encompasses many faults, each with a 10% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single "average" earthquake during this time. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the models do provide some approximate estimates of damage.

Region 6 is vulnerable to earthquake-induced landslides, liquefaction, and strong ground shaking. Based on the 500 year model, Klamath County is one of the top 15 counties expected to have highest loss and most damage statewide. Results are found in **Table 2-394** and **Table 2-395**.

Table 2-394. Building Collapse Potential in Region 6

	Level of Collapse Potential			
County	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Crook	7	7	3	13
Deschutes	55	35	41	9
Jefferson	11	1	12	11
Klamath	15	10	37	18
Lake	13	1	4	10
Wheeler	5	1	6	3

Source: Lewis (2007)

Table 2-395. Projected Dollar Losses in Region 6, Based on an M8.5 Subduction Event and a 500-Year Model

County	Economic Base in Thousands (1999)	Greatest Absolute Loss In Thousands (1999) from a M8.5 CSZ Event	Greatest Absolute Loss In Thousands (1999) from a 500-Year Event
Crook	$733,000	less than $1,000	$6,000
Deschutes	$4,673,000	$5,000	$71,000
Jefferson	$707,000	less than $1,000	$14,000
Klamath	$3,134,000	$41,000	$939,000

Note: New Hazus data were developed for Jefferson County using Hazus-MH. The data are available through W. J. Burns, unpublished report (2007): Geologic Hazards, Earthquake and Landslide Hazard Maps, and Future Earthquake Damage and Loss Estimates for Seven Counties in the Mid-Columbia River Gorge Region Including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler.

Source: Wang and Clark (1999)

Table 2-396. Estimated Losses in Region 6 Associated with an M8.5 Subduction Event

	Crook	Deschutes	Jefferson	Klamath
Injuries	0	1	0	14
Deaths	0	0	0	0
Displaced households	0	0	0	37
Economic losses for buildings	$156,000	$5 mil	$764,000	$41 mil
Operational the day after the event:				
Fire stations	96%	100%	100%	99%
Police stations	96%	99%	100%	99%
Schools	97%	99%	99%	97%
Bridges	100%	100%	100%	98%
Economic losses to infrastructure:				
Highways	$6,000	$17,000	$9,000	$339,000
Airports	0	$40,000	0	$642,000
Communications	$8,000	$2,000	0	$141,000
Debris generated (thousands of tons)	0	3	1	28

Source: Wang and Clark (1999)

Table 2-397. Estimated Losses in Region 6 Associated with a 500-Year Model

	Crook	Deschutes	Jefferson	Klamath
Injuries	1	17	7	630
Deaths	0	0	0	12
Displaced households	0	5	12	1,409
Economic losses for buildings[2]	5.5 mil	$71 mil	$14 mil	$939 mil
Operational the "day after" the event[3]:				
Fire stations	N/A	N/A	N/A	N/A
Police stations	N/A	N/A	N/A	N/A
Schools	N/A	N/A	N/A	N/A
Bridges	N/a	N/A	N/A	N/A
Economic losses to infrastructure:				
Highways	$879,000	$572,000	$698,000	$28 mil
Airports	$316,000	$2 mil	$395,000	$15 mil
Communications	$18 mil	$1 mil	$104,000	$14 mil
Debris generated (thousands of tons)	0	47	10	610

Note: Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5)

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated

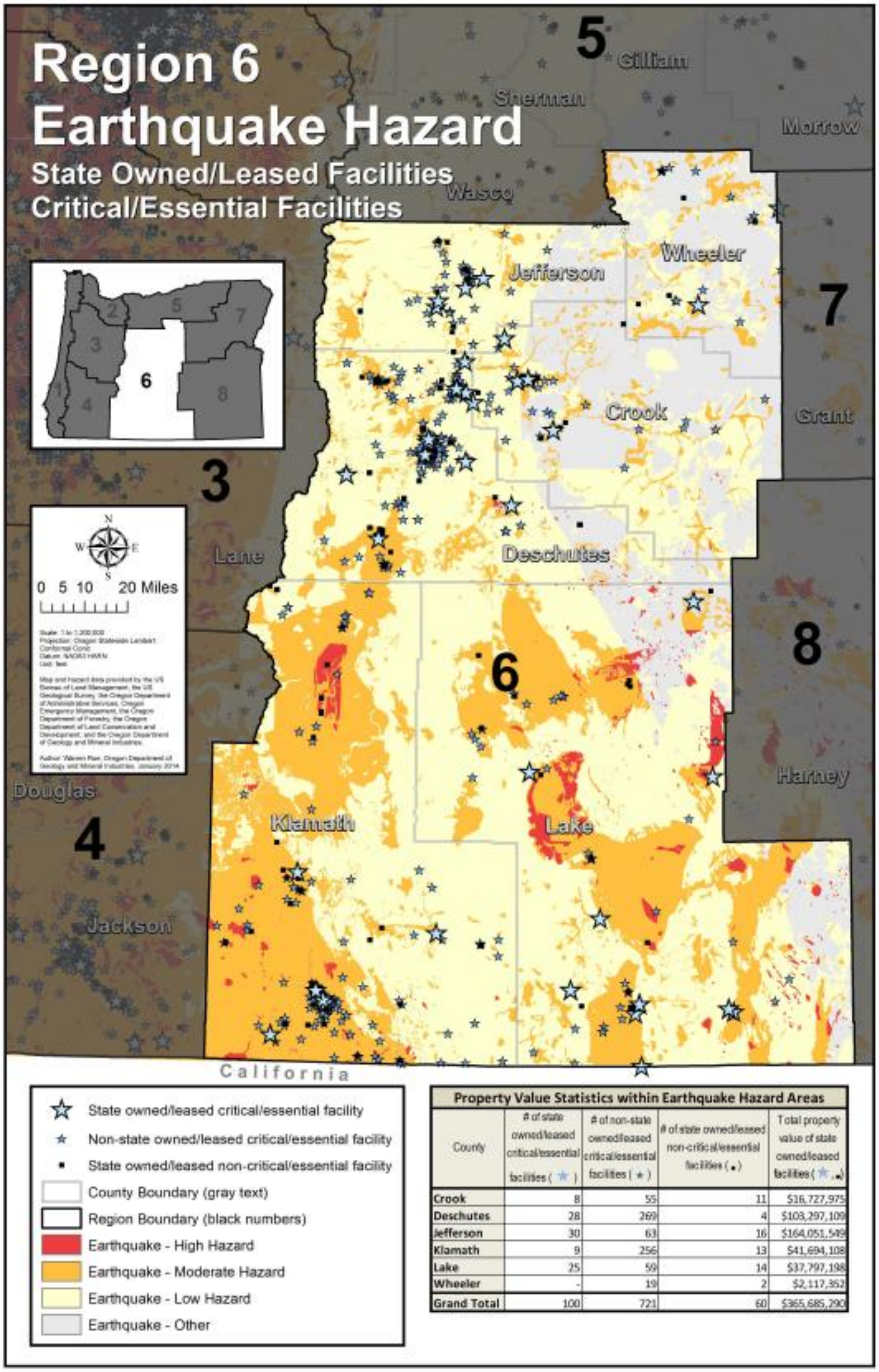
Source: Wang and Clark (1999)

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 160 totaling roughly $366 million worth of property are located in an earthquake hazard zone in Region 6 (**Figure 2-194**). Among the 1,141 critical/essential state facilities, 100 are in an earthquake hazard zone in Region 6. Additionally, 721 non-state critical/essential facilities in Region 6 are located in an earthquake hazard zone.

Figure 2-194. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 6



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Crook	8	55	11	$16,727,975
Deschutes	28	269	4	$103,297,109
Jefferson	30	63	16	$164,051,549
Klamath	9	256	13	$41,694,108
Lake	25	59	14	$37,797,198
Wheeler	-	19	2	$2,117,352
Grand Total	100	721	60	$365,685,290

Source: DOGAMI

SEISMIC LIFELINES

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in **Section 2.2.2.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.13**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 6 have the following vulnerabilities.

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 6 include sections of the OSLR Cascades and Central Geographic Zones, as follows:

- *Cascades Geographic Zone:* The Cascades Geographic Zone consists of five crossings of the Cascades from western to central Oregon. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. In addition, the southernmost route can serve as a connection from Medford to the Klamath Falls area should a seismic event occur in the Klamath Falls area.

  OR-58 is the only Tier 1 transportation lifeline in the Cascades Geographic Zone. The Tier 2 system in the Cascades Geographic Zone consists of OR-22 from Salem to Santiam Junction, US-20 from Santiam Junction to Bend, and OR-140 from Medford to Klamath Falls. There are no corridors designated as Tier 3 in this region.

- *Central Geographic Zone:* Region 6 contains only the southerly portion of the Central Geographic zone. The only Tier 1 system in this area is US-97.

REGIONAL IMPACT.

- Ground Shaking: In Region 6, ground shaking from a CSZ event is not expected to cause damage. However, a Klamath Falls event, either a local event or possibly one triggered by a CSZ event, can cause extensive damage. Unreinforced structures, roadbeds and bridges will be damaged to varying extents. Unreinforced bridges on lifeline corridors may be damaged and require clearing or temporary repairs to remain in service.
- Landslides and Rockfall: The east-west routes in this region are cut into or along landslide prone features. A major seismic event may increase landslide and rockfall activities and may reactivate ancient slides.
- Liquefaction: Structures in wetland, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event. The Klamath Basin is the one area in this region with extensive wetland and otherwise saturated soil areas.

REGIONAL LOSS ESTIMATES. Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so, for example, it does not include productivity losses due to business site damage. The highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses. Losses in this region are expected to be low locally. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

Most Vulnerable Jurisdictions. Crook, Deschutes, Jefferson, Wheeler, Lake and Klamath have similar, relatively low vulnerability to ground shaking from a CSZ event and resulting landslides and rockfall. Relative to the western regions of the state, fewer roadways in this region are sited in landslide prone areas, but those that are may be easily damaged.

Klamath County is the Region 6 county most vulnerable to a local surface fault earthquake, with ground shaking for over 50 miles noted for relatively small earthquakes. A Klamath Falls earthquake could cause damage in Lake and Jackson Counties, as well.

Floods

Characteristics

Central Oregon is subject to a variety of flood conditions, including: (a) spring runoff from melting snow, (b) intense warm rain during the winter months, (c) ice-jam flooding, (d) local flash flooding, (e) lake flooding associated with high winds (e.g., Klamath Lake), and (f) flooding associated with the breeching of natural debris dams. Although not as notable as flash floods, the most common flood condition in Central Oregon is associated with warm winter rain on snow.

Rain-on-snow floods, so common in western Oregon, also occur east of the Cascades. The weather pattern that produces these floods occurs during the winter months and has come to be associated with La Niña events, 3- to 7-year cycles of cool, wet weather. Brief cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes. The intense warm rain associated with this system quickly melts foothill and mountain snow. Above-freezing temperatures may occur well above pass levels in the Cascade Mountains (4,000–5,000 feet). Some of Oregon's most devastating floods are associated with these events (Taylor, 1999).

Although flooding occurs throughout central Oregon, local geology and the relatively low population of the six-county area lessen its effects. Volcanic rocks, some of which have a large capacity for water storage, underlie much of the region. Consequently, the discharge rates for some streams (e.g., Deschutes River) are very low considering the size of their basins (June 8, 1998, Deschutes County Flood Insurance Study). In addition, there are some large reservoirs in the upper watersheds that can contain considerable quantities of runoff. Potential flood losses also are mitigated through land use standards; all Region 6 communities participate in the National Flood Insurance Program.

The Flood Insurance Studies (FIS) for each of the Region 6 counties provide some insights associated with ice jam flooding (Deschutes County), lake level differentials produced by local wind conditions (Klamath County), and possible flooding caused by the failure of natural debris dams (Deschutes County). Although these phenomena have not and would not produce devastation like historical flash floods in Jefferson County, they certainly warrant the consideration of local emergency managers.

Historic Flood Events

Table 2-398. Significant Historic Floods Affecting Region 6

Date	Location	Description	Type of Flood
June 1884	Wheeler County (Painted Hills)	mother and three children perished	flash flood
June 1900	Wheeler County (Mitchell)	large area of county devastated	flash flood
Dec, 1964	entire state	severe flooding in central Oregon	rain on snow
Aug. 1976	Jefferson County (Ashwood)	severe flooding; damaged buildings	flash flood
Feb, 1986	entire state	severe flooding	rain on snow
Aug. 1991	Crook County (Aspen Valley)	severe flooding; one fatality	flash flood
Mar. 1993	Wheeler County	severe flooding	rain on snow
May 1998	Crook County (Prineville)	Federal disaster declaration (FEMA-DR-1221-Oregon); Ochoco Dam threatened	rain on snow
Dec. 2005	Crook, Deschutes Counties	$1,000,000 in property damage	
Dec. 2005	Klamath and Lake Counties	$500,000 in property damage	
June 2006	Klamath County	a dike on Upper Klamath Lake failed, inundating agricultural fields, the Running Y Golf Resort, and OR-140	flash flood

Source: Taylor and Hatton (1999)

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Source: U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-399. Principal Riverine Flood Sources by County Affecting Region 6

Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Crooked River	Deschutes River	Willow Creek	Sprague River	Chewaucan River	Bridge Creek
Ochoco River	Little Deschutes River	unnamed stream north of Culver	Williamson River	N. Goose Lake Basin	Keyes Creek
	Whychus Creek	Muddy Creek	Klamath River		
	Paulina Creek		Williamson River		
	Spring River		Link River		
			Four Mile Creek		
			Varney Creek		
			Upper Klamath Lake		

Sources: FEMA, Crook County Flood Insurance Study (FIS) 07/17/89; FEMA, Deschutes County FIS, 06/08/98; FEMA, Jefferson County FIS, 07/17/89; FEMA, Klamath County FIS, 06/18/84; FEMA

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience flooding is shown in **Table 2-400**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-400. Local Probability Assessment of Floods in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	H	M	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Federal Emergency Management Agency (FEMA) has mapped the 10, 50, 100, and 500-year floodplains corresponding to a 10%, 2%, 1%, and 0.2% chance of a certain magnitude flood in any given year in Region 6 counties. In addition, FEMA has mapped the 100-year floodplain (i.e., 1% flood) in the incorporated cities. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based.

All of the Region 6 counties have Flood Insurance Rate Maps (FIRM); however, some of the maps are old and could be outdated. The FIRMs were issued at the following times:

- Crook, February 2012;
- Deschutes, September 2007;
- Jefferson, July 17, 1989;
- Klamath, December 18, 1984;
- Lake, December 5, 1989; and
- Wheeler, July 17, 1989.

Significant flooding occurs at least once every 5–7 years.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-401**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-401. Local Vulnerability Assessment of Floods in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	L	M	M	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-402**.

Table 2-402. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Each county in this region received a flood vulnerability score of 5, except for Klamath County which received a score of 6.

FEMA has identified no Repetitive Loss properties in Region 6 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

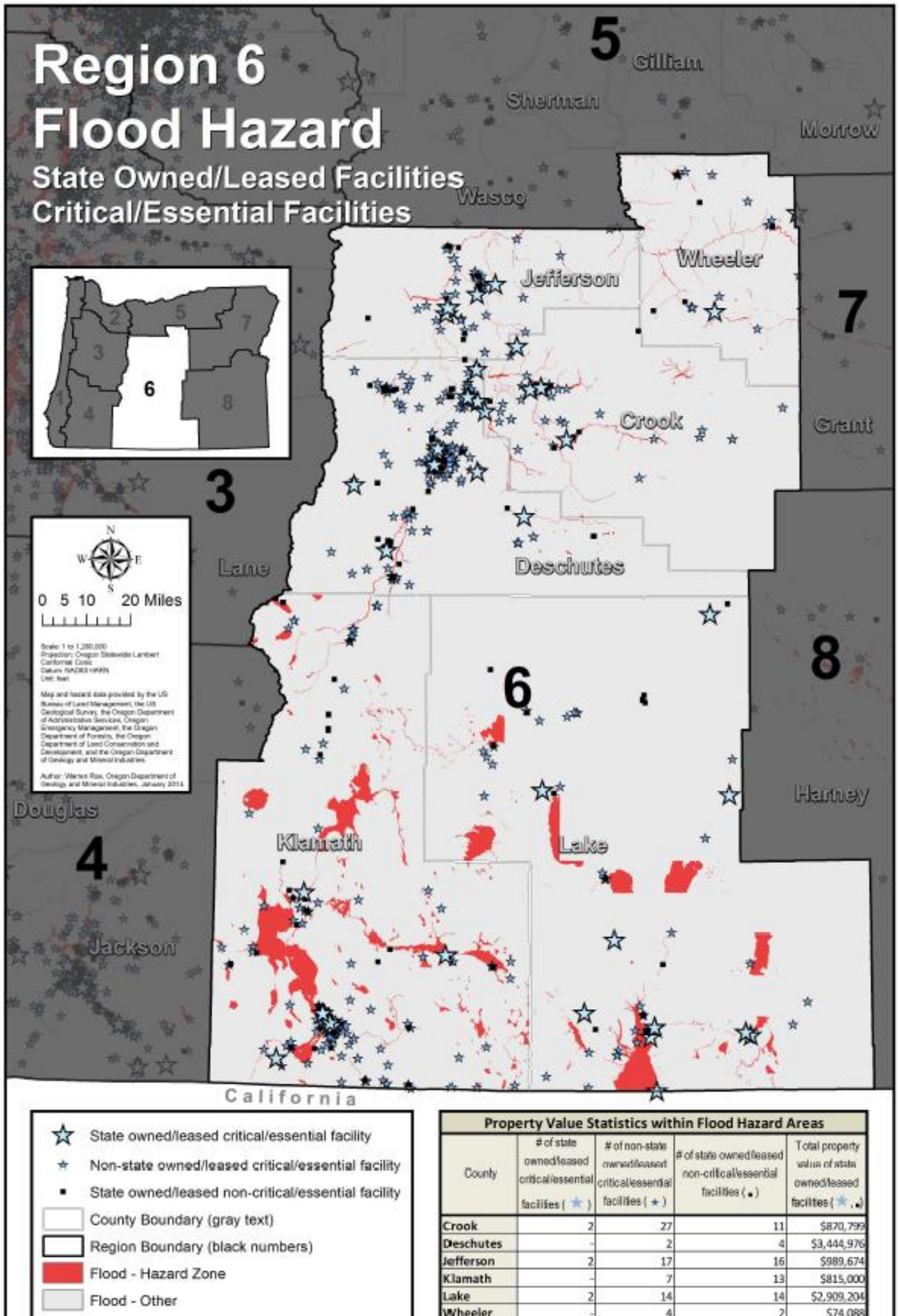
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 6 communities participate in the CRS Program.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 66 are currently located within a flood hazard zone in Region 6 and have an estimated total value over $9 million (**Figure 2-195**). Of these, six are identified as a critical or essential facility. An additional 60 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 6.

Figure 2-195. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 6



Property Value Statistics within Flood Hazard Areas				
County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Crook	2	27	11	$870,799
Deschutes	-	2	4	$3,444,976
Jefferson	2	17	16	$989,674
Klamath	-	7	13	$815,000
Lake	2	14	14	$2,909,204
Wheeler	-	4	2	$74,088
Grand Total	6	71	60	$9,103,740

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Cascade Mountain Range and the Klamath Mountains have a high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Most landslides in Region 6 occur within the US-26 corridor (Prineville-Mitchell). US-97 just north of Klamath Falls has a history of rock falls. One person was killed by a rockslide in this area during the 1993 Klamath Falls earthquake.

Historic Landslide Events

Table 2-403. Significant Landslides in Region 6

Date	Location	Description
Dec. 2005	Jefferson County	damage: $11,666.67 * (includes Sherman and Wasco Counties)

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience landslides is shown in **Table 2-404**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-404. Local Probability Assessment of Landslides in Region 5

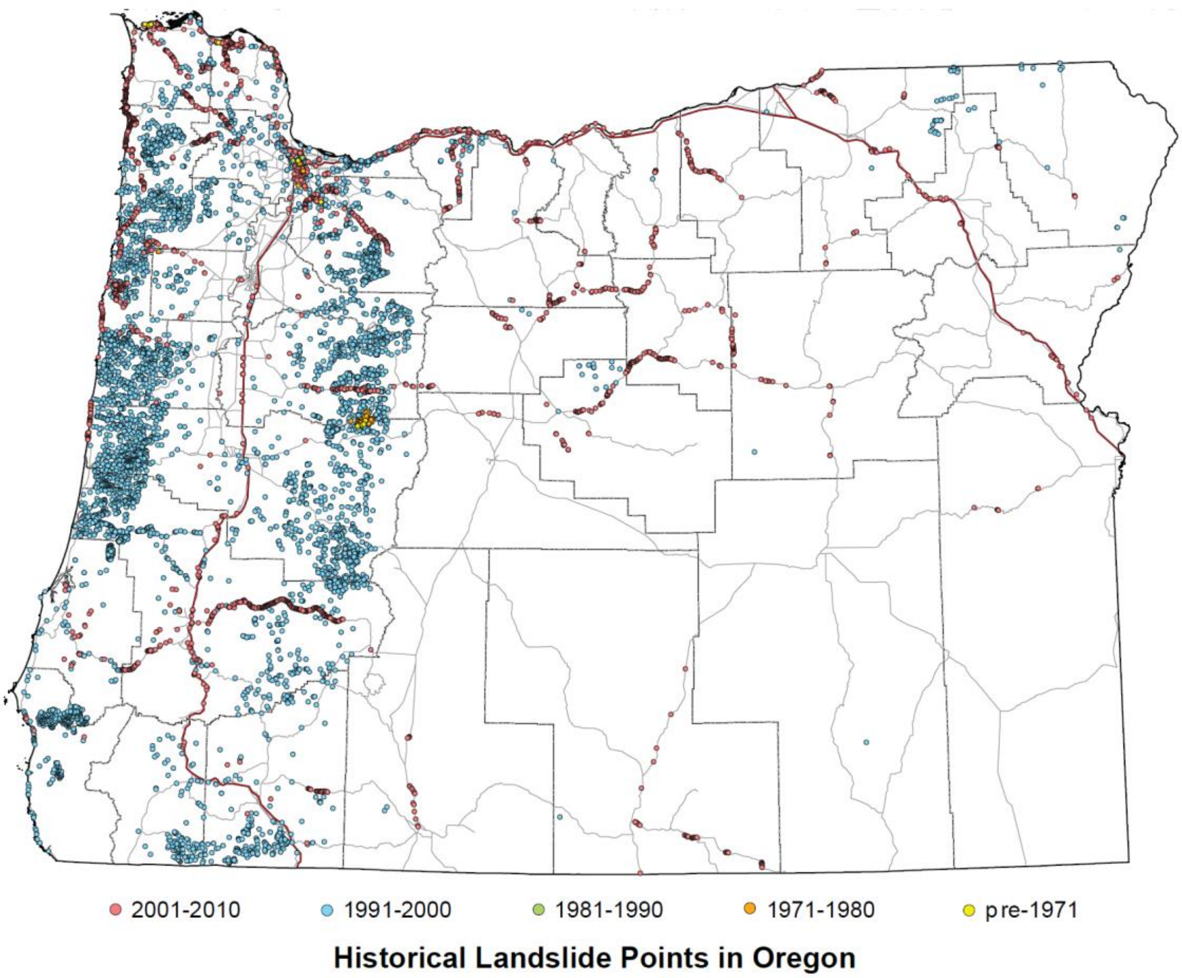
	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	—	M	—	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Figure 2-196. Historic Landslides in Oregon



Source: Burns et al. (2011a)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is depicted **Table 2-405**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-405. Local Vulnerability Assessment of Landslides in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	L	—	L	—	L	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

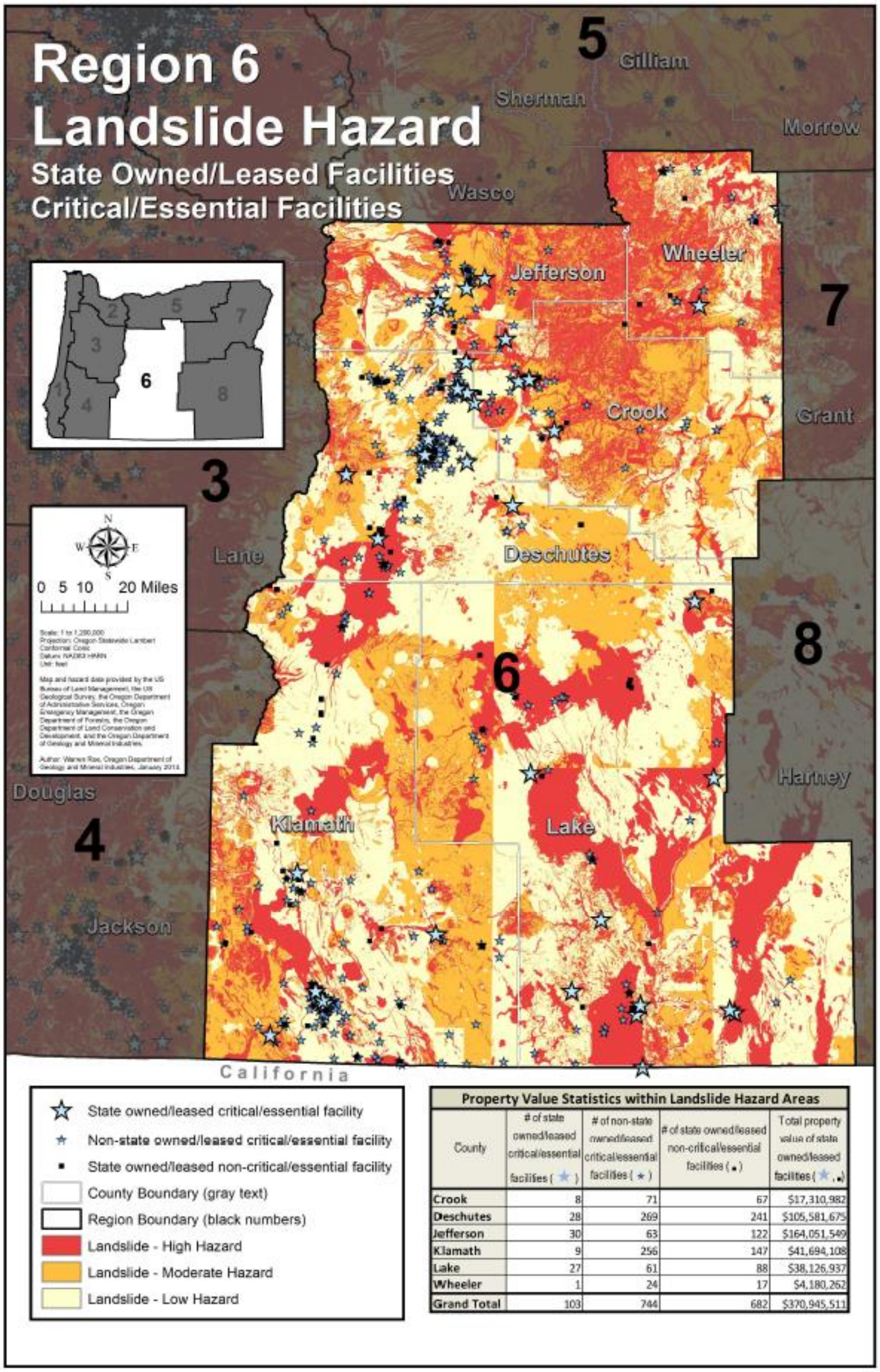
Many of the historic landslides occur along the highways in this region and the areas along the Cascade Mountains (Burns et al., 2012).

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 785 are located within landslide hazard areas in Region 6, totaling roughly $371 million (**Figure 2-197**). This includes 103 critical or essential facilities. An additional 744 critical/essential facilities not owned/leased by the State are located within a landslide hazard zone in Region 6.

Figure 2-197. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 6



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Crook	8	71	67	$17,310,982
Deschutes	28	269	241	$105,581,675
Jefferson	30	63	122	$164,051,549
Klamath	9	256	147	$41,694,108
Lake	27	61	88	$38,126,937
Wheeler	1	24	17	$4,180,262
Grand Total	103	744	682	$370,945,511

Source: DOGAMI

Volcanoes

Characteristics

The western boundaries of Jefferson, Deschutes, and Klamath Counties coincide with the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances through stream valleys and wind-borne ash can blanket areas many miles from the source.

There is virtually no risk from lahars, debris, or pyroclastic flows in Wheeler and Crook Counties, although normal prevailing winds could carry ash into those areas. Jefferson, Deschutes, and Klamath Counties are at risk, however, and should consider the impact of volcano-related activity on small mountain communities, natural debris dams (e.g., South Sister, Broken Top), dams creating reservoirs, tourist destinations (e.g., Crater Lake), highways and railroads. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation) should a volcano-related hazard occur.

The history of volcanic activity in the Cascade Range is contained in its geologic record, and the ages of the volcanoes vary considerably. Some lava flows on Washington's Mount Rainier are thought to be older than 840,000 years; Mount St. Helens erupted in May 1980, and continues to be active. In short, all of the Cascade volcanoes are characterized by long periods of quiescence with intermittent activity, making predictions, recurrence intervals, or probability very difficult to attain.

Several Region 6 communities are within a few miles of prominent volcanoes. Mt. Jefferson, the Three Sisters, Broken Top, and Mt. Bachelor dominate the skyline between Redmond and Bend (Deschutes County). A less imposing, but nonetheless important volcano, Newberry Crater, is within 15 miles of La Pine (Deschutes County) and less than 25 miles from the City of Bend. The string of volcanoes continues south with Mount Thielsen, Mount Scott (Crater Lake), and Mount McLaughlin dominating the horizon. The composition, eruptive behavior, and history of these volcanoes are not the same, which probably has a bearing on any future activity.

Historic Volcanic Events

Table 2-406. Historic Volcanic Events in Region 6

Date	Location	Description
about 18,000 to 7,700 YBP	Mount Bachelor, central Cascades	cinder cones, lava flows
about 13,000 YBP	Lava Mountain, south-central Oregon	Lava Mountain field, lava flows
about 13,000 YBP	Devils Garden, south-central Oregon	Devils Garden field, lava flows
about 13,000 YBP	Four Craters, south-central Oregon	Four Craters field, lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall
< 7,700 YBP; 5,300 to 5,600 YBP	Davis Lake, southern Cascades	lava flows and scoria cones in Davis Lake field
about 10,000 to <7,700 YBP	Cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,300 YBP	Newberry Volcano, central Oregon	eruption of Big Obsidian flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra

Note: YBP is years before present.

Sources: Sherrod et al. (1997); Bacon et al. (1997); Walder et al. (1999); Scott et al. (2001); and U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience volcanic hazards is shown in **Table 2-407**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-407. Local Probability Assessment of Volcanic Activity in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	L	L	L	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The probability of volcanic activity can be very difficult to predict, unless there are obvious precursors. The precursors might include increased seismic activity, temperature, and chemical changes in groundwater, etc. Probability is especially difficult when the volcano has been inactive for many thousands of years and lacks a clear geologic record of past events. Also, the knowledge of volcanoes is too limited to know how long a dormant period at any volcano can last (Walder et al., 1999) and this probably is the case for most Cascade volcanoes. Eruption probabilities generated by the U.S. Geological Survey for the Oregon Cascades are largely based on the position of volcanic rocks in the geologic record. There is a considerable opportunity for error. **Table 2-408** describes the probability of volcano-related hazards in Region 6.

Table 2-408. Probability of Volcano-Related Hazards in Region 6

Volcano-Related Hazards	Jefferson	Deschutes	Klamath	Crook	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000	1 in 5,000	1 in 5,000	1 in 5,000	Sherrod et al. (1997)
Lahar	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County Sources: Walder et al. (1999); Lane County: Scott et al. (2001)
Lahar	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County. Walder et al. (1999); Lane County: Scott et al. (2001)
Lava flow	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake	no risk	Mount Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)
Debris flow / avalanche	Source: Mt. Jefferson	Source: Three Sisters	Source: Crater Lake	no risk	Mt. Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)
Pyroclastic flow	Source: Mt. Jefferson	Source: Newberry Crater and Three Sisters	Source: Crater Lake and Newberry Crater	no risk	Mt. Jefferson: Walder et al. (1999); Three Sisters: Scott et al. (2001)

Source: Sherrod et al. (1997); Walder et al. (1999); Scott et al. (2001)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-409**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-409. Local Vulnerability Assessment of Volcanic Activity in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	H	H	H	L	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

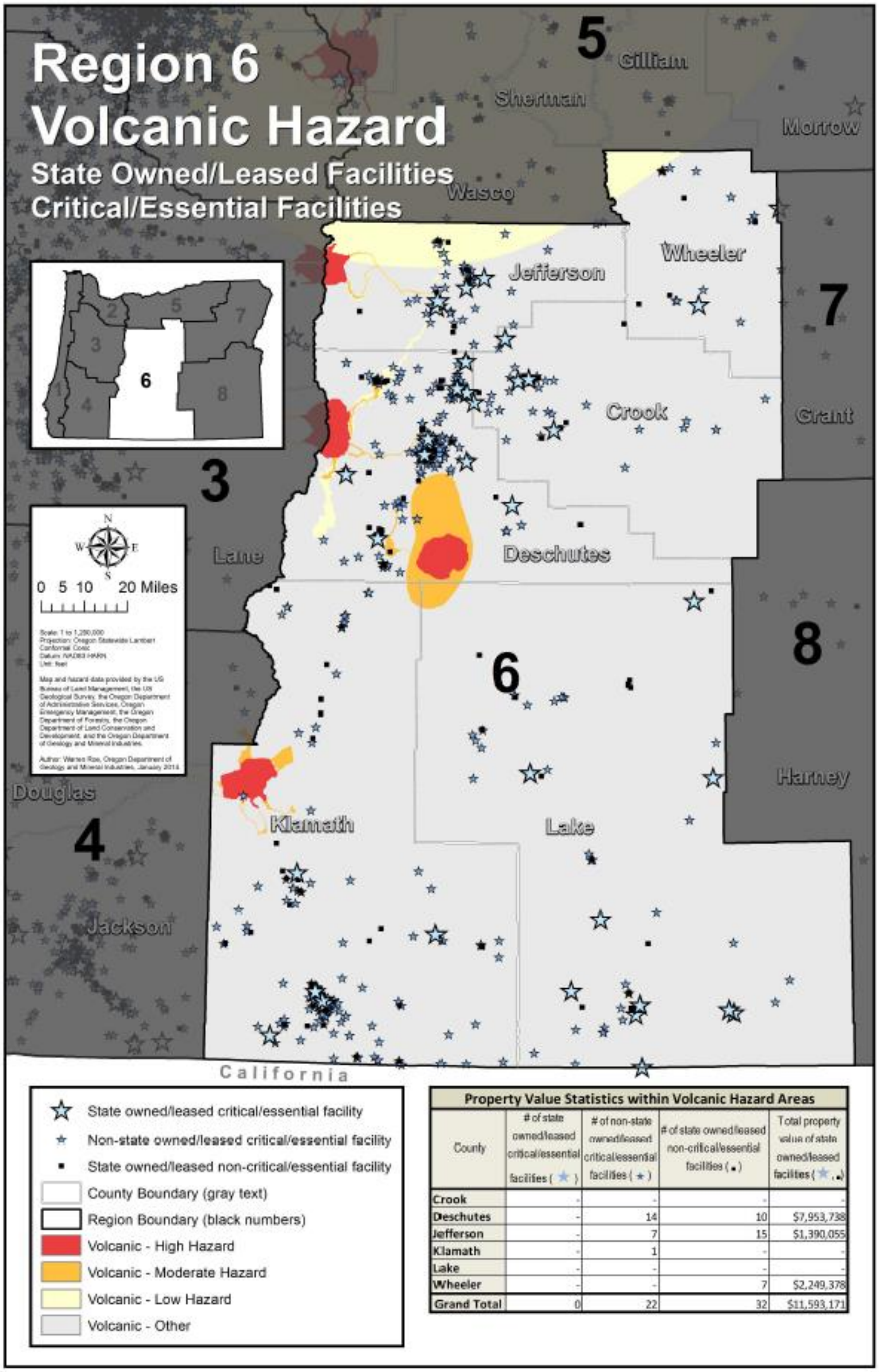
The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder et al., 1999), the Three Sisters (Scott et al., 2001), Newberry Volcano (Sherrod et al., 1997), and Crater Lake (Bacon et al., 1997). These reports include maps depicting the areas at greatest risk. Communities which are closer to the main volcanoes such as Bend, Sisters, La Pine, and Klamath Falls are at the greatest risk for inundation by lava flows, pyroclastic flows, lahars, or ashfall. Counties on the eastern side of Region 6 may be subject to ashfall from Cascade volcanoes.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 32 are within a volcanic hazard zone in Region 6 and total about $11.6 million in property value (**Figure 2-198**). None of these state facilities are critical or essential facilities. 22 non-state critical/essential facilities are located in volcanic hazard zones in Region 6.

Figure 2-198. State-Owned/Leased Facilities and Critical/Essential Facilities in a Volcanic Hazard Zone in Region 6



Property Value Statistics within Volcanic Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Crook	-	-	-	-
Deschutes	-	14	10	$7,953,738
Jefferson	-	7	15	$1,390,055
Klamath	-	1	-	-
Lake	-	-	-	-
Wheeler	-	-	7	$2,249,378
Grand Total	0	22	32	$11,593,171

Source: DOGAMI

Wildfires

Characteristics

Oregon Senate Bill 360 Forestland-Urban Interface Protection Act has been implemented in all counties in Region 6. The growth of the wildland-urban interface occurs in areas dominated by juniper, sage, and grass. As populations increase, so do the number of wildland fires. Homes are widely dispersed in these pine-fringe areas, putting them at a greater risk of a high-intensity wildfire.

The hazard of wildland fire is high in Region 6 due to ladder fuels and overstocked ponderosa pine stands, juniper invasion into sagebrush and grasslands, and the pervasiveness of invasive weeds such as cheat grass and Medusahead grass. Fire risk is extreme during the late summer and fall months when grasses and weeds are dry. These flashy fuels are easily ignited, burn rapidly, and resist suppression. Many structures are at risk because owners do not follow Firewise guidelines for protection.

Historic Wildfire Events

Table 2-410. Significant Wildfires in Region 6

Year	Name of Fire	Location	Acres Burned	Remarks
1981	Redmond			State Conflagration Act Fire
1984	Crooked River Ranch			State Conflagration Act Fire
1985	Crooked River Ranch			State Conflagration Act Fire
1990	Delicious	Deschutes	1704	
1990	Awbrey Hall	Deschutes	3,400	this fire was an act of arson that affected the western fringe of Bend
1992	Hanes Butte	Deschutes	348	
1992	Sage Flat	Deschutes	995	
1992	Round Lake	Klamath	490	
1992	Lone Pine	Klamath	30,320	
1994	LaClair	Jefferson		
1995	Day Road	Deschutes		
1996	Little Cabin	Jefferson	2,438	
1996	Smith Rock	Deschutes	500	one structure destroyed
1996	Simnasho	Jefferson		
1996	Skeleton	Deschutes	17,700	19 structures destroyed, impacting the eastern fringe of Bend
1996	Ashwood/ Donnybrook	Central Oregon	118,000	this fire burned in areas of the state not protected from fire
1996	Wheeler Point	Wheeler	21,980	
1999	McCoin Road	Deschutes	99	Prineville
2002	Eyerly	Jefferson	23,573	37 structures destroyed
2002	Winter	Lake County	35,779	
2002	Cache Mountain	Deschutes	4,200	2 structures destroyed
2003	Booth	Crook	90,800 (acreage also includes BandB fire)	13 structures destroyed
2003	Davis	Deschutes	16,000	
2005		Jefferson		$333.33 in property damage *Damage estimate includes Sherman and Wasco Counties for a total of $1000 in damages
2007		Klamath		$100,000 in property damage
2007	GW	Deschutes	7,357	
2008	Summit Springs Complex	Deschutes	1,973	

Source: Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience wildfire is shown in **Table 2-411**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-411. Local Probability Assessment of Wildfire in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The lightning potential in Region 6 is very high. For example, in Lake County only about 5% of the fires were human ignited, while 95% were lightning caused. There is very little that can be done in terms of ignition prevention from lightning.

Due to many years of fire suppression, logging, and other human activities, the forests and rangelands of Region 6 have changed significantly. Areas that historically experienced frequent, low-severity wildfires now burn with much greater intensity due to the build-up of understory brush and trees. This region's fires are larger and more severe, killing the trees and vegetation at all levels. The combination of steep slope, canyons, open rangeland, and fuel type have a history and potential for fast moving and fast spreading wildfires. The area is highly vulnerable to a wind-driven fires, whose embers could ignite grasses and weeds, and cause spot fires in more populated areas. Typical summer conditions could prove to be problematic due to a fire moving uphill from a structure fire on a lower slope, or from a wildland fire pushing upslope through the trees on a windy day, endangering multiple homes simultaneously in a very short period of time. Residents would have very short notice of an approaching fire.

Fire protection districts are created and staffed to deal with the fire emergency needs of the property within the district. Wildland fires that threaten multiple homes simultaneously can quickly overwhelm the available fire-fighting resources. The areas protected by these fire districts are typically large, with few stations, which causes longer response time for additional fire forces. This could prove to be a negative factor for early fire control. When a wildland fire is threatening structures, additional resources are ordered, but may be several hours away. A wildland fire can easily travel into and through a wildland-urban interface (WUI) community before additional responding resources can arrive. There simply are not enough fire engines to protect all threatened homes. Ultimately, the homes that are less vulnerable to ignition are most likely to survive. A home that is extremely vulnerable may not be able to be protected regardless of protection resources on the scene. Under dry, windy conditions, an advanced house fire could extend within the area, or a rapidly approaching wildland fire could have the potential to overwhelm local firefighters before additional outside resources could arrive.

In more populated areas like Klamath County, historic wildfire occurrence shows that most of the large and damaging wildfires that threatened communities or other improvements were caused by humans.

Recreation is a main attraction for people currently living in and moving to Central Oregon. There are popular recreation destinations for hunting, fishing, camping and water sports, such as Lake Billy Chinook, the Middle Deschutes River, Lake of the Woods, Crescent, Odele, Crater Lake, and Haystack Reservoir. This area swells with visitors on any given weekend in the summer during fire season. Most fires are concentrated near recreation areas and reservoirs. Concerns in this region not only include potential evacuation in the event of an emergency, but also the potential for recreationists to inadvertently start wildfires through improper campfire use, smoking, or use of all-terrain vehicles.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-412**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-412. Local Vulnerability Assessment of Wildfire in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	M	M	L	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 6, Deschutes, Jefferson and Klamath Counties have high percentages of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface area), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and are shown in **Table 2-413**.

The checkerboard pattern of land ownership means that many residences are dispersed on small, scattered private parcels of land. Narrow roads, dead end roads, and long steep driveways are prevalent. Access and egress could be cumbersome with evacuees and fire forces operating in the area at the same time. Evacuation and fire suppression could be problematic due to bottle necking.

Many people choose to live in Central Oregon for its cultural interest and historic values, creating an imperative to protect key homestead, Native American, and other historic sites.

The northwest corner of Region 6 belongs to the Confederated Tribes of the Warm Springs Reservation. The Warm Springs community is an historic community with heavy home densities and infrastructure, and is protected by a structural fire department. Homes are all distributed within Trust and restricted title lands of the Confederated Tribes of Warm Springs.

Economic values at risk include businesses, private forests, farmland, ranchland, grazing land, hunting, and other recreational land. Wildfires have the potential to change the vegetative landscape, which would have a significant effect on the natural resource industries that are the economic staple of this region. Critical infrastructure (communication sites, electrical transmission lines and substations, gas lines, water sources, highways, bridges, and railroad lines) are also vulnerable to wildfires and could be out of service for extended periods of time. . Many of the communities that depend on this infrastructure are very remote and could be very adversely impacted while it is out of service.

There are extensive areas of private land within the county that receive no wildland or structural fire protection. Rural areas have general issues including the absence of formal fire protection and extended response times, dense vegetation capable of causing flame lengths greater than four feet, insufficient water supply, insufficient ingress/egress, and combustible structures.

Table 2-413. Wildland-Urban Interface Communities by County in Region 6

Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Jasper Point Resort	Bend	Ashwood	Beaty	Adel	Fossil
Paulina	Black Butte	Camp Sherman	Beaver Marsh	Christmas Valley	Mitchell
Post	Brothers	Crooked River Ranch	Bly	Drew's Gap	Richmond
Prineville	Elk Lake	Culver	Bly Mountain	Lakeview Basin	Spray
	Hampton	Gateway	Bonanza	New Pine Creek	Twickenham
	La Pine	Madras	Chemult	Paisley	Winlock
	Redmond	Metolius	Chiloquin	Plush	
	Sisters-Cloverdale	Warm Springs	Crater Lake	Silver Lake	
	Sunriver		Crescent	South Drews	
	Terrebonne		Crescent Lake	Summer Lake	
	Tumalo		Dairy	Valley Falls / Chandler	
			Diamond Lake Junction		
			Gilchrist		
			Harriman		
			Keno		
			Klamath Falls		
			Little River		
			Malin		
			Merrill		
			Odell Lake		
			Rocky Point		
			Rosedale		
			Running Y		
			Sand Creek		
			Klamath		
			Sprague River Valley		
			Sycan Estates		

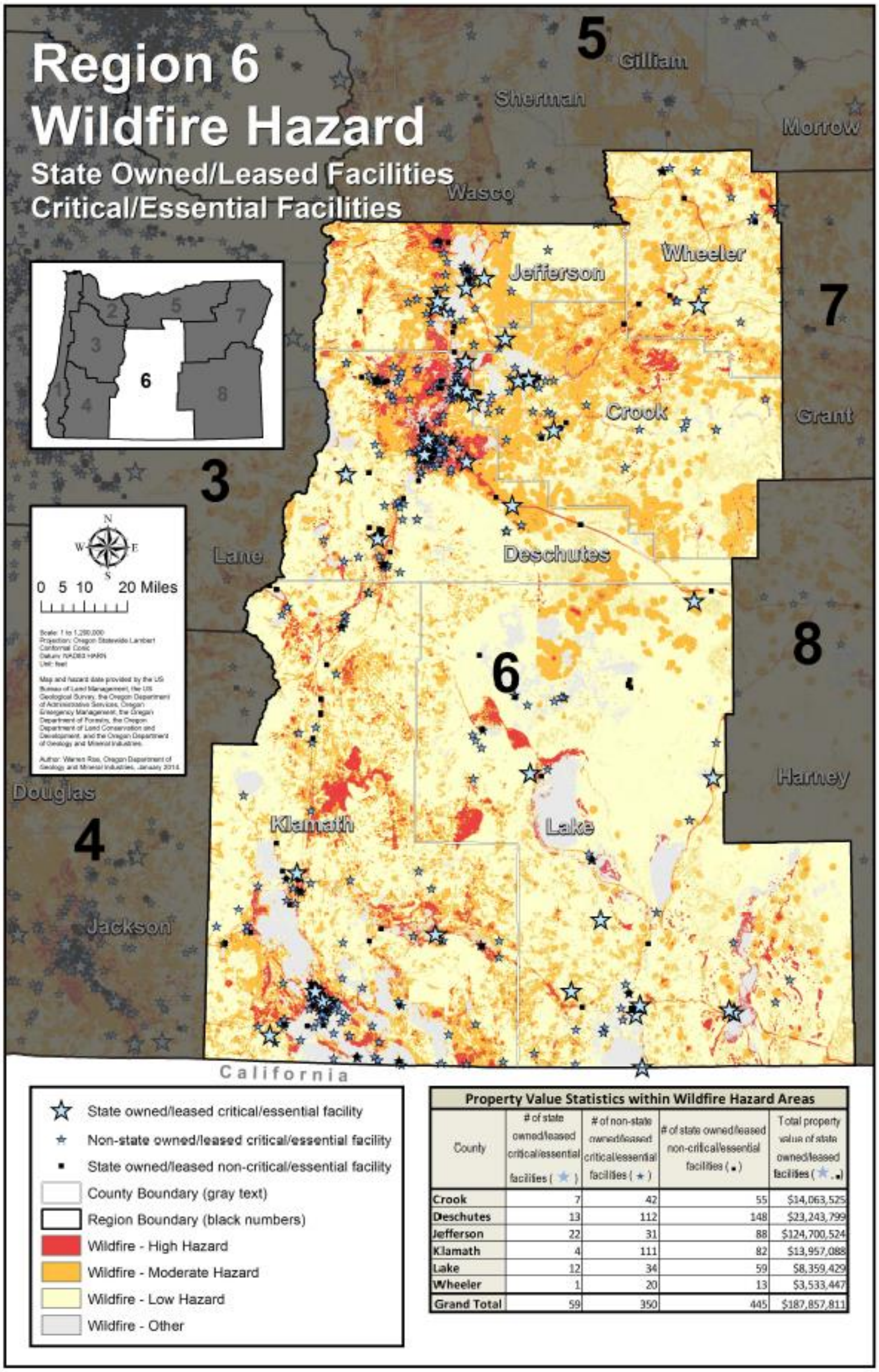
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 504 are within a wildfire hazard zone in Region 6 and total roughly $188 million in value (**Figure 2-199**). Among those, 59 are state critical/essential facilities. An additional 350 non-state critical/essential facilities are also located in Region 6.

Figure 2-199. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 6



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Crook	7	42	55	$14,063,525
Deschutes	13	112	148	$23,243,799
Jefferson	22	31	88	$124,700,524
Klamath	4	111	82	$13,957,088
Lake	12	34	59	$8,359,429
Wheeler	1	20	13	$3,533,447
Grand Total	59	350	445	$187,857,811

Source: DOGAMI

Windstorms

Characteristics

High winds in inter-mountain areas in Central Oregon are not uncommon. For example, stiff winds from the Ochoco Mountains often occur in the City of Prineville (Crook County). These areas experience thunderstorms, which are sometimes accompanied by strong outflow and surface winds. Fallen trees and structural damage from windstorms are not uncommon in these areas. The prominent Cascade Range can act as a buffer to strong storms that mostly affect western Oregon. However, the interior counties in this region may experience strong down sloping winds off the lee side of the mountains.

Historic Windstorm Events

Table 2-414. Historic Windstorms in Region 6

Date	Affected Area	Characteristics
Apr. 1931	N. central Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40-60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	statewide	severe wind storm
Dec. 1991	N. central Oregon	severe wind storm; blowing dust; damage reported in Bend (Deschutes County)
Dec. 1995	statewide	severe wind storm
Apr. 2003	Deschutes County	$10,000 in property damage
Aug. 2003	Wheeler County	$1,000
Nov. 2003	Deschutes County	$2,000 in property damage
Jan. 2004	Jefferson County	$3,000 in property damage
June 2004	Crook and Jefferson Counties	$1,000 in property damage
Aug. 2004	Crook Count	$100 in property damage
Dec. 2004	Jefferson County	$3,333.33 in property damage *damage estimate includes Sherman and Wasco Counties
Mar. 2005	Jefferson County	$2,000 in property damage *damage estimate includes Sherman and Wasco Counties
Mar. 2005	Crook, Deschutes Counties	$9,000 in property damage
Aug.2005	Klamath County	hail storm caused $1,000 in damage
Oct. 2005	Crook and Deschutes Counties	$50,000 in property damage

Date	Affected Area	Characteristics
Nov. 2005	Crook and Deschutes Counties	$40,000 in property damage
June 2006	Jefferson, Deschutes and Crook Counties	strong winds and hail caused $10,000 in damages to grass and alfalfa crops in Jefferson County, $7 million in insurance claims for damage to automobiles and homes in Deschutes County, $20 million in insurance claims for damage to automobiles and homes in Crook County
July 2006	Deschutes County	lightning from a severe storm hit an electrical transmission line, knocking out power to 31,500 people
Aug. 2006	Klamath County	severe windstorm with winds up to 66 mph downed several trees and power lines between Klamath Falls and Chiloquin
July 2007	Klamath County	extensive wind, rain, and hail damage to Malin and Yonna Valleys, and several power lines downed due to falling trees
Oct. 2007	Crook and Deschutes Counties	$1000 in total damage from high wind storm
Oct. 2007	Crook and Deschutes Counties	$50,000 in total damage from high wind storm
Aug. 2009	Jefferson County	high winds broke boat docks off the shore at Pelton Park Reservoir; $50,000 in total damages

Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR, February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-415. Tornadoes Recorded in Region 6

County	Date	Location	Damage
Lake	Dec. 1973	County	no reported damage
Lake	Aug. 2005	Christmas Valley, OR	no reported damage

Source: Taylor and Hatton (1999)

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience windstorms is shown in **Table 2-416**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-416. Local Probability Assessment of Windstorms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	H	H	—	—	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

In this region, a 100-year event is considered to have one-minute average winds of 90 mph. A 50-year event has average winds of 80 mph. A 25-year event has average winds 70 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-417**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-417. Local Vulnerability Assessment of Windstorms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	L	—	—	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 6 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods of time, impacting emergency operations. In addition, uprooted or shattered trees can down power or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted trees felled by high winds. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 6 can be characterized by extreme cold, snow, ice, and sleet. While there are annual winter storm events in Region 6 with an average of 24 inches of snow annually, most communities are prepared for them. Severe winter storms are considered to be unusual. Light to moderate snowfall is prepared for and expected on an annual basis in this central region. Heavier snowfall is expected and planned for in the areas on the west side of the region into the Cascades as elevation increases.

Historic Winter Storm Events

Table 2-418. Significant Winter Storms in Region 6

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountain areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities
Feb. 1986	central/eastern Oregon	heavy snow in Deschutes Basin; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Mar. 1994	Cascade Mountains, Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Dec. 2003–Jan. 2004	entire state	the most significant winter storm in several years brought snowfall to most of Oregon in late December 2003; according to the state climatologist, a combination of cold air near the surface and overrunning moist air from a Pacific weather system was responsible for the storm

Source: Taylor and Hatton (1999); and unknown sources.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 6 will experience winter storms is shown in **Table 2-419**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-419. Local Probability Assessment of Winter Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Probability	M	H	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 6. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-420**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-420. Local Vulnerability Assessment of Winter Storms in Region 6

	Crook	Deschutes	Jefferson	Klamath	Lake	Wheeler
Vulnerability	M	H	H	M	H	H

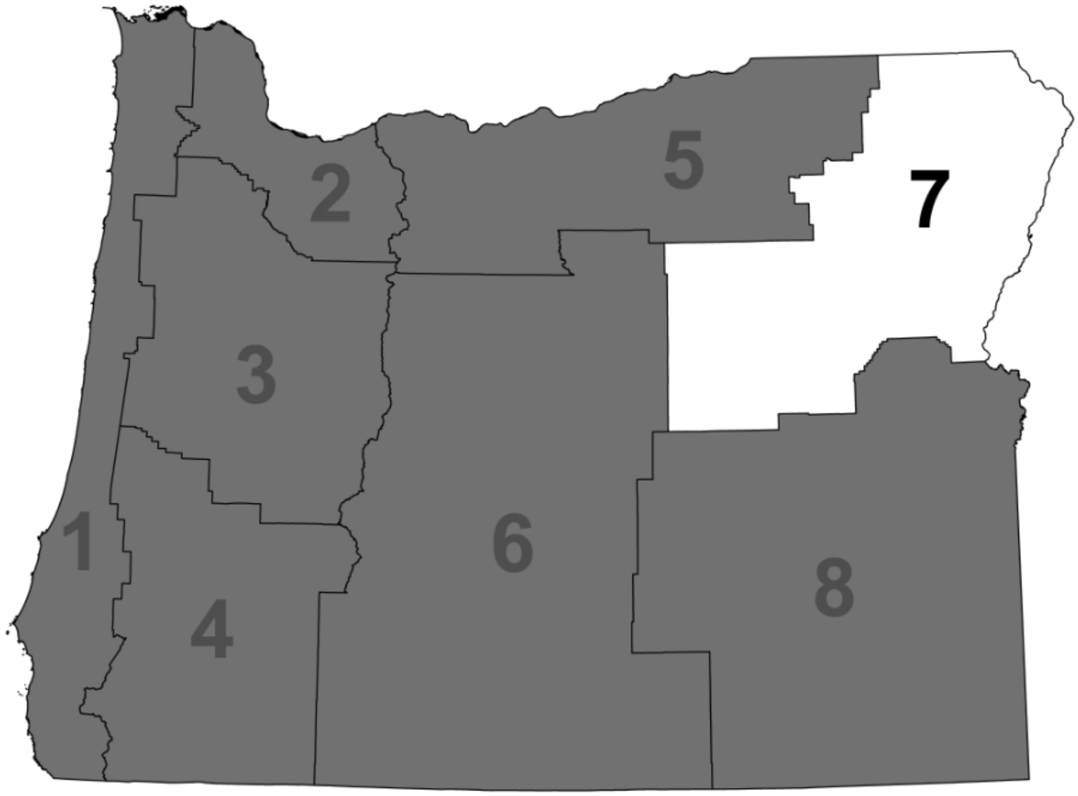
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 6 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and other farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.7 Region 7: Northeast Oregon

Baker, Grant, Wallowa, and Union Counties



2.3.7.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 7 is driven by a declining population; high numbers of senior citizens, many of whom have disabilities; low rates of college degrees; child poverty; and low median household incomes. Additional vulnerabilities at the county level include high numbers of children in Baker and Wallowa Counties and vacant homes in Grant and Wallowa Counties.

Though Region 7 has been recovering jobs lost during the financial crisis that began in 2007, the area lags behind the state overall with fewer jobs and lower wages. Unemployment remains greater than statewide. Regionally, wages remain low, averaging only 75% of the state median wage.

Roads and railways are susceptible to winter storms and flooding. Damage or service interruption to the region's transportation systems can have devastating effects on the region's economy. In addition, many of the bridges in the area are distressed or deficient.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for human health and water quality. Drinking water is sourced from surface water or wells and is susceptible to pollution from stormwater runoff and combined sewer overflows (CSO) during high-water events. Only Baker City employs low impact development (LID) standards in its building regulations.

Northeast Oregon's energy facilities and conveyance system infrastructure support the regional economy and are susceptible to damage and disruptions due to natural hazards. The region has five power-generating facilities (hydroelectric, wind, and biomass). Liquid natural gas pipelines run through Union and Baker Counties. However, diversity of the region's energy sources boosts its ability to provide power should service be disrupted.

The region's limited growth is occurring within Union County and some other areas along I-84. A high share of mobile homes and homes built before floodplain management and seismic building standards coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increase the vulnerability of development in Region 7.

Hazards and Vulnerability

Region 7 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunami do not directly impact this region.

Droughts: Droughts are common in all Northeast Oregon counties, particularly within Lake and Klamath Counties. Drought conditions can result in limited water supplies, losses in agriculture, increased fire risk, and adverse impacts to tourism and therefore to the local economy. Baker County has been under an emergency drought declaration eight times and is considered one of the communities most vulnerable to drought conditions.

Dust Storms: Dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over areas of the dry land that are prevalent in this region. Dust Storms in Region 7 can lead to poor air quality and poor visibility which can lead to traffic accidents. Baker and Union Counties are the counties most vulnerable to dust storms in this region.

Earthquakes: Two types of earthquakes affect Region 7: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Northeast Oregon is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking. The region's seismic lifelines have low vulnerability to a Cascadia Subduction Zone (CSZ) event as most of the region's impact will be secondary, due to disruptions to markets to the west. This region has 344 state-owned/leased facilities, valued at over $130 million, within an earthquake hazard zone. Of these, 47 are critical/essential facilities. An additional 168 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: In this region, the most damaging floods have been rain-on-snow events in the mountains during the winter. Other forms of flooding here have been associated with ice jams, normal spring runoff, and summer thunderstorms. Flooding has also been associated with heavily vegetated stream banks, low stream gradients, breeched dikes, low bridge clearances, over-topped irrigation ditches, and natural stream constrictions. All of the region's counties are considered moderately vulnerable to the flood hazard. There are 89 state-owned/leased facilities, valued at approximately $41 million, located in this region's flood hazard zone. Of these, 14 are considered critical/essential facilities. An additional 28 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though to a lesser extent than in parts of western Oregon. In general, areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. Rain-induced landslides can occur during winter months. Earthquakes can also trigger landslides. The Blue and Wallowa Mountains have a moderate to high incidence of landslides. Landslides can also sever transportation routes along highways and rail lines, which can impact the region's economy. There are 419 state-owned/leased facilities, valued at over $139.5 million, in this region's landslide hazard zone. Of these, 58 are critical/essential facilities. An additional 237 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Though volcanic activity does not occur within this region, ashfall can travel many miles and may affect the region. Communities potentially vulnerable to ashfall are Baker City, La Grande, and John Day. There are no state-owned/leased facilities located in a volcanic hazard zone. Similarly, there are no non-state-owned/leased critical/essential facilities located in this hazard zone.

Wildfires: Though population and development has declined in this region overall, development has increased in this region's non-federal forests and may impact fire protection capability. Summertime lightning-caused fires are prevalent in the mountainous and timbered regions of eastern Oregon. Wildfire in this region can adversely impact timber and rangeland, recreation and tourism, wildlife habitat and diversity including endangered species, and water quality and supply. Vulnerability is further heightened where fire stations are located far distances from many communities, resulting in longer response times. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 7, Grant and Union Counties have high percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 229 state-owned/leased facilities located in a wildfire hazard zone in Region 7, with a value of approximately $84 million. Of these, 32 are identified as critical/essential facilities. An additional 141 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Inter-mountain valley regions of Northeast Oregon are known for high winds. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Winter storms bring colder weather and higher precipitation to this region annually. These storms average 24 inches of snow per year. Moderate to heavy snowfall is prepared for and expected. Heavier snowfall is expected and planned for in higher elevation of the Wallowa Mountains.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 7 include drought and wildfire-climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increase incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Eastern Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 7, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.7.2 Profile

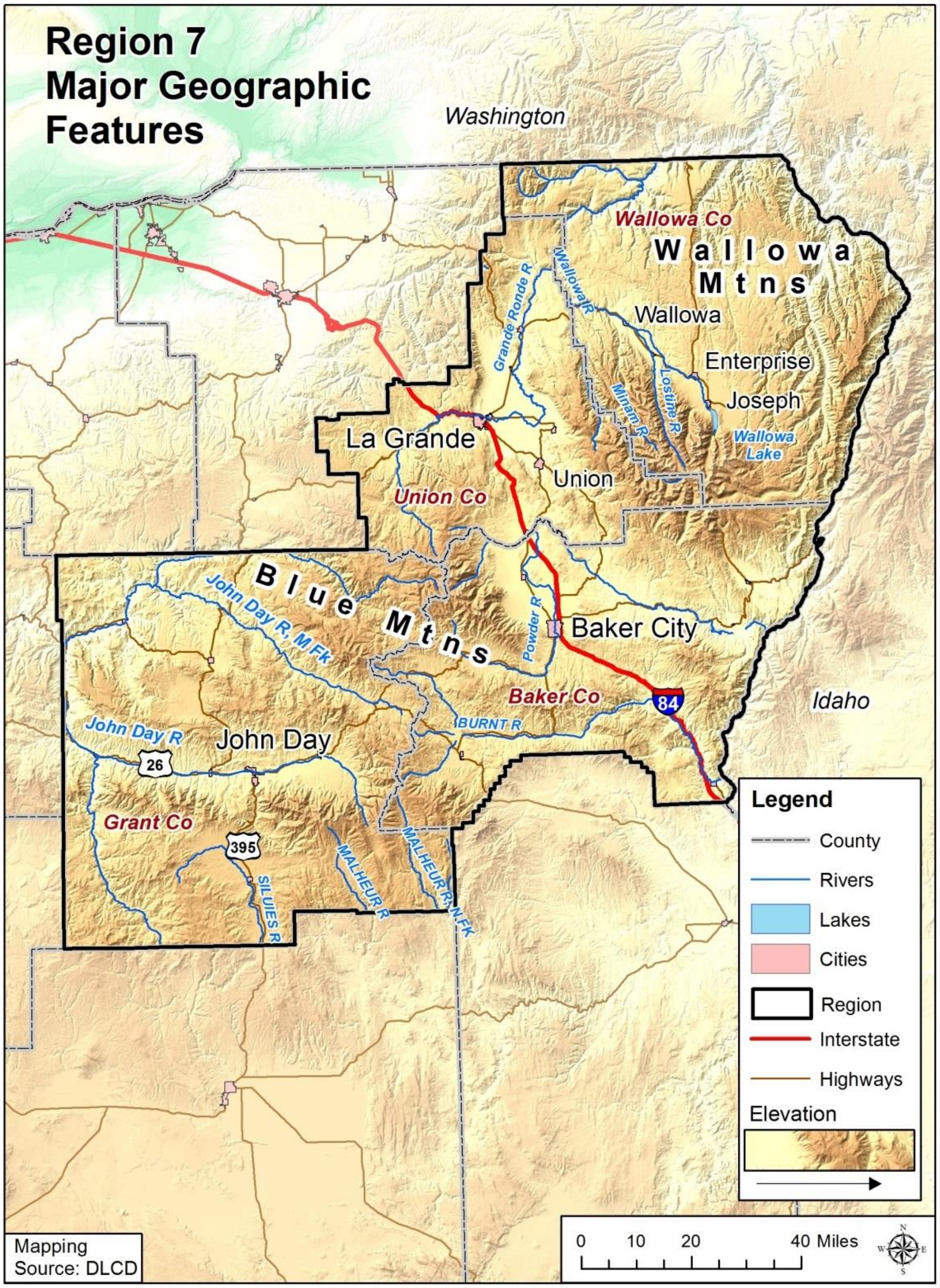
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Northeastern Oregon is approximately 12,765 square miles in size, and includes Baker, Grant, Union, and Wallowa Counties. The region is bordered by the Snake River to the east and the Columbia River to the north. Columbia River Basalt lava flows formed the high plateaus of the region, and the Blue and Wallowa Mountains are included in the region. Major rivers in the region include the John Day, Grande Ronde, and the Snake.

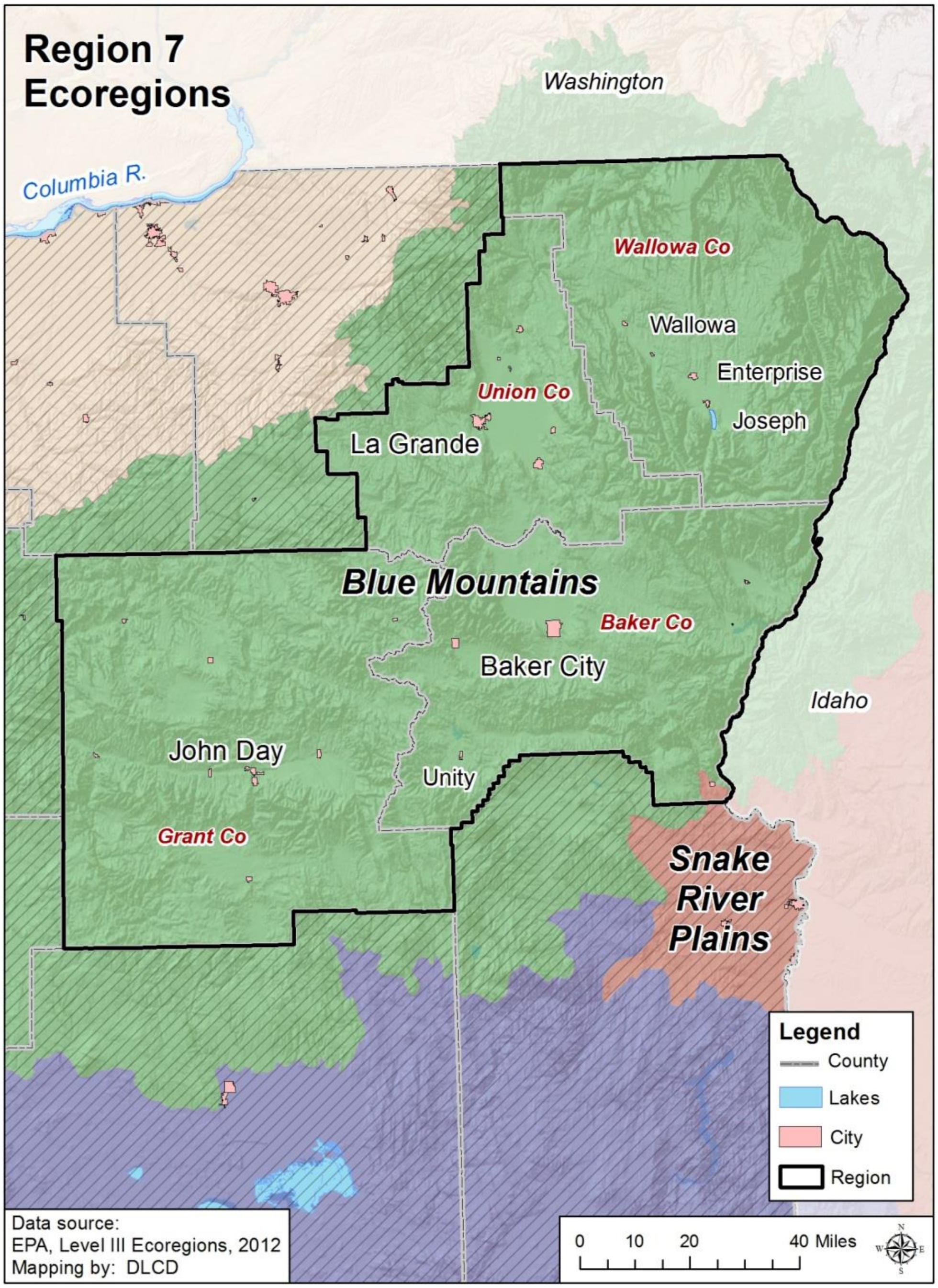
Figure 2-200. Region 7 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 7 is composed of two ecoregions: the Blue Mountains and very small area of the Snake River Plain ecoregion (Figure 2-201).

Figure 2-201. Region 7 Ecoregions



Blue Mountains: This ecoregion is complex and diverse, with many sub-ecoregions having unique conditions. In general, the Blue Mountains areas of Region 7 have dry continental climate with marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day / Clarno Highlands contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Much of the Blue Mountains are underlain with volcanic rock although land in the Wallowa and Elkhorn Mountain ranges is composed of granitic intrusives, deep sea sediments, and metamorphic rocks. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories the ecoregion’s Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 7 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer.

Snake River Plain: The Region 7 portion of the Snake River Plain ecoregion is classified as the “Unwooded Alkaline Foothills,” which is underlain by alkaline lacustrine deposits. The landscape includes rolling foothills, hills, benches, alluvial fans, and badlands. Wyoming sagebrush and associated grasses are the dominant vegetation with salt-tolerant shrubs found on alkaline outcrops. The land is high value rangeland and wildlife habitat.

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide.

Region 7’s predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject drought, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-421** shows mean annual precipitation and temperatures for the two ecoregions in Region 7. Temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-421. Average Precipitation and Temperature Ranges in Region 7 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Blue Mountains*	9–80	15/39	40/85
Snake River Plain	9–12	19/35	57/96

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 7.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised (Cutter et al., 2003).

Overall, for 2000-2013, Region 7 lost population. Union is the only county that grew in population during this 13-year period, offsetting the other counties' losses, and is the only county projected to grow by 2020. Growth in Baker and Wallowa Counties is expected to be relatively flat, while Grant County is expected to continue to decline in population.

Table 2-422. Population Estimate and Forecast for Region 7

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 7	56,432	57,085	1.2%	58,910	3.2%
Baker	16,741	16,280	-2.8%	16,315	0.2%
Grant	7,935	7,435	-6.3%	7,321	-1.5%
Union	24,530	26,325	7.3%	28,216	7.2%
Wallowa	7,226	7,045	-2.5%	7,058	0.2%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2000 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 7 (Longwoods Travel USA, 2011d) are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history, and culture), and special events (such as fairs, festivals, or sporting events) (Longwoods Travel USA, 2011d). Approximately 8% (2.2 million) of all overnight visitor trips to Oregon included time within Region 7. Three fourths of all trips to the region occur between April and September and the average travel party contains 3.8 persons. The average trip length is 4.3 nights (Longwoods Travel USA, 2011d). Visitors to the region are just as likely to be lodged in hotels/motels, private homes or other accommodations. The Longwoods Travel Report includes all of the Region 7 counties, Harney and Malheur Counties (Region 8), and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-423. Annual Visitor Estimates in Person Nights in Region 7

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 7	6,153	—	6,104	—	6,095	—
Baker	4,797	100%	4,736	100%	4,756	100%
Hotel/Motel	1,571	32.7%	1,509	31.9%	1,493	31.4%
Private Home	1,914	39.9%	1,893	40.0%	1,914	40.2%
Other	1,312	27.4%	1,334	28.2%	1,349	28.4%
Grant	208	100%	206	100%	212	100%
Hotel/Motel	31	14.9%	30	14.6%	33	15.6%
Private Home	72	34.6%	72	35.0%	74	34.9%
Other	105	50.5%	104	50.5%	105	49.5%
Union	526	100%	538	100%	526	100%
Hotel/Motel	127	24.1%	130	24.2%	123	23.4%
Private Home	254	48.3%	259	48.1%	252	47.9%
Other	145	27.6%	149	27.7%	151	28.7%
Wallowa	622	100%	624	100%	601	100%
Hotel/Motel	136	21.9%	136	21.8%	124	20.6%
Private Home	69	11.1%	68	10.9%	67	11.1%
Other	417	67.0%	420	67.3%	410	68.2%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). About 5% more people in Region 7 identify as having a disability than do people throughout the state. Over 40% of seniors (65 or older) report having a disability. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-424. People with a Disability by Age Groups in Region 7, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 7	55,230	10,124	18.3%	512	4.4%	4,764	43.3%
Baker	15,702	3,000	19.1%	179	5.5%	1,477	41.7%
Grant	7,285	1,538	21.1%	32	2.3%	833	48.8%
Union	25,363	4,211	16.6%	219	3.8%	1,851	44.4%
Wallowa	6,880	1,375	20.0%	82	6.3%	603	38.1%

*Total population does not include institutionalized population

**Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless populations (Thomas et al., 2008). Between 2009 and 2011 this population has held steady in Region 7.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-425. Homeless Population Estimate for Region 7

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 7	45	43	27	38
Baker	22	4	6	11
Grant	0	0	N/A	0
Union	23	37	21	27
Wallowa	0	2	0	1

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

The gender ratio in Region 7 is similar to that of the state, roughly 50:50 (U.S. Census Bureau; n.d.). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

All counties in Region 7 have a higher percentage of seniors than does the state overall. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

The percentage of children is slightly lower than the statewide percentage in all counties except Union. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children’s childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-426. Population by Vulnerable Age Groups, in Region 7, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 7	56,066	11,721	20.9%	11,273	20.1%
Baker	16,092	3,242	20.1%	3,590	22.3%
Grant	7,366	1,419	19.3%	1,746	23.7%
Union	25,670	5,755	22.4%	4,319	16.8%
Wallowa	6,938	1,305	18.8%	1,618	23.3%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

A very small share of the population does not speak English "very well." Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-427. English Usage in Region 7, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	Percent	Estimate	Percent
Oregon	3,376,744	93.8%	224,905	6.2%
Region 7	52,233	98.5%	778	1.5%
Baker	15,142	99.0%	150	1.0%
Grant	6,988	99.4%	42	0.6%
Union	23,529	97.7%	552	2.3%
Wallowa	6,574	99.5%	34	0.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. Compared to statewide numbers, 8% less of Region 7's population has a bachelor's degree or higher.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-202. Educational Attainment in Region 7, 2012

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to become isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

All counties in the region have lower median household incomes than the state average, ranging from $8,200–$15,700 below state numbers. Decreases in median household incomes were especially notable in Grant and Wallowa Counties between 2009 and 2012.

Table 2-428. Median Household Income in Region 7

	2009	2012	Percent Change
Oregon	$52,474	50,036	-4.6%
Region 7	N/A	N/A	N/A
Baker	$41,096	40,348	-1.8%
Grant	$37,759	34,337	-9.1%
Union	$43,387	41,784	-3.7%
Wallowa	$44,286	40,204	-9.2%

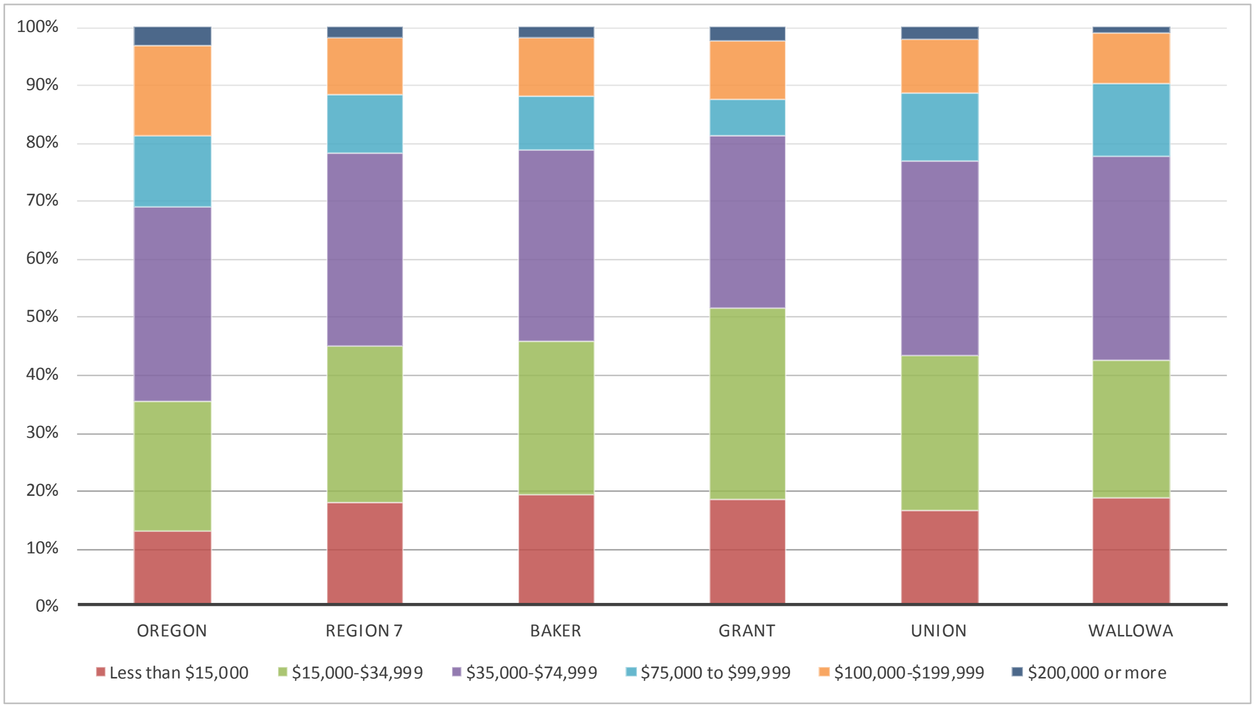
Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Compared to statewide numbers, the region has a greater share (10% more) of its households earning less than $35,000 per year. More than half of all households in Grant County earn less than $35,000 per year. In addition, roughly 9% fewer households earn more than $75,000.

Figure 2-203. Median Household Income Distribution in Region 7, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

The region has about the same percentage of individuals living in poverty as the state overall, but child poverty is 9% higher. Notably, poverty overall grew by almost 40% in Wallowa County. All counties except Union have experienced a growth in child poverty. Though Baker is the only county with a declining poverty rate, one third of all children in the county live in poverty.

Table 2-429. Poverty Rates in Region 7, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 7	9,517	17.3%	11.6%	2,785	29.3%	22.9%
Baker	3,059	19.6%	-0.7%	1,048	33.3%	45.6%
Grant	1,144	15.7%	15.0%	277	19.6%	27.6%
Union	4,318	17.2%	15.5%	1,238	21.6%	6.9%
Wallowa	996	14.5%	39.5%	222	17.1%	29.8%

*Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Slightly lower than statewide numbers, roughly 33% of housing units in this region are rentals. Union County has the highest share of rental units. The region has about a 3% higher vacancy rate than the state. Grant and Wallowa Counties have the highest vacancy rates, and Baker and Union Counties have the highest number of vacant units. In addition, the region has about 5% more seasonal or recreational homes than the state average (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-430. Housing Tenure in Region 7, 2012

	Total Occupied Units	Owner-Occupied		Renter-Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 7	23,729	16,001	67.4%	7,728	32.6%	2,629	9.2%
Baker	7,074	4,827	68.2%	2,247	31.8%	854	9.7%
Grant	3,376	2,368	70.1%	1,008	29.9%	485	11.2%
Union	10,299	6,666	64.7%	3,633	35.3%	858	7.5%
Wallowa	2,980	2,140	71.8%	840	28.2%	432	10.5%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 7 is predominantly composed of family households. Just under one quarter of all households have families with children. About 3 times as many single-parent households are headed by females than by males. These numbers are similar to statewide averages.

Table 2-431. Family vs. Non-family Households in Region 7, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 7	23,729	15,670	66.0%	8,059	34.0%	6,638	28.0%
Baker	7,074	4,781	67.6%	2,293	32.4%	1,941	27.4%
Grant	3,376	2,213	65.6%	1,163	34.4%	1,015	30.1%
Union	10,299	6,852	66.5%	3,447	33.5%	2,635	25.6%
Wallowa	2,980	1,824	61.2%	1,156	38.8%	1,047	35.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-432. Family Households with Children by Head of Household in Region 7, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	286,108	18.9%
Region 7	5,812	24.5%	514	2.2%	1,425	6.0%	3,873	16.3%
Baker	1,714	24.2%	127	1.8%	419	5.9%	1,168	16.5%
Grant	756	22.4%	84	2.5%	164	4.9%	508	15.0%
Union	2,805	27.2%	279	2.7%	651	6.3%	1,875	18.2%
Wallowa	537	18.0%	24	0.8%	191	6.4%	322	10.8%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends and Issues

This analysis shows that Region 7 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event:

- Population has been declining and is expected to continue to decline or stay flat, except in Union County.
- Children constitute about one fifth of the region's population.
- Seniors constitute about one fifth of the region's population, and approximately 40% of seniors are disabled.
- Fewer people have college degrees than the state as a whole.
- Median household incomes are low and have significantly declined in Grant and Wallow Counties.
- Child poverty stands at about 30% regionwide.
- The region has a high percentage of home vacancies.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate losses created by natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region is still recovering from the financial crisis that began in 2007. Unemployment rates have been declining steadily since 2009 but remain 1.4% higher than the state. Union County has the largest labor force and the lowest unemployment rate. Conversely, Grant County has the smallest labor force and the highest unemployment rate. Nonfarm job counts are up in Union and Wallowa Counties, but struggling to mount a sustained recovery in Baker and Grant Counties (Tauer, 2014). Overall, average salaries are 73% that of the state. Wallowa County has the lowest average salary, $30,002, or 66.7% of the state average.

Table 2-433. Unemployment Rates in Region 7, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 7	11.4%	11.0%	10.8%	10.2%	9.1%	-2.3%
Baker	10.2%	10.1%	10.6%	10.1%	9.2%	-1.0%
Grant	13.4%	13.5%	13.5%	13.5%	11.8%	-1.7%
Union	11.4%	10.5%	10.1%	9.3%	8.2%	-3.3%
Wallowa	11.8%	12.0%	11.3%	10.3%	9.9%	-1.9%

Source: Oregon Employment Department, 2014.

Table 2-434. Employment and Unemployment Rates in Region 7, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 7	25,895	23,526	90.9%	2,369	9.1%
Baker	7,073	6,423	90.8%	650	9.2%
Grant	3,337	2,944	88.2%	393	11.8%
Union	11,950	10,974	91.8%	976	8.2%
Wallowa	3,535	3,185	90.1%	350	9.9%

Source: Oregon Employment Department, 2014.

Table 2-435. Employment and Payroll in Region 7, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 7	19,149	$32,868	73.0%
Baker	5,014	$32,063	71.2%
Grant	2,324	$33,503	74.4%
Union	9,488	$33,840	75.2%
Wallowa	2,323	$30,002	66.7%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 7 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Education and Health Services; (d) Manufacturing; and (e) Leisure and Hospitality (9.5%). Table 2-436 shows the distribution of total employment across all sectors. Region 7 is expected to have a 9-10% increase in employment from 2012-2022.

Table 2-436. Covered Employment by Sector in Region 7, 2013

		Baker		Grant	
Industry	Region 7	Employment	Percent	Employment	Percent
Total All Ownerships	19,149	5,014	100%	2,324	100%
Total Private Coverage	74.4%	3,884	77.5%	1,362	58.6%
Natural Resources & Mining	5.0%	176	3.5%	228	9.8%
Construction	4.0%	196	3.9%	57	2.5%
Manufacturing	10.3%	475	9.5%	141	6.1%
Trade, Transportation & Utilities	18.5%	970	19.3%	305	13.1%
Information	1.2%	72	1.4%	38	1.6%
Financial Activities	3.3%	138	2.8%	66	2.8%
Professional & Business Services	5.0%	301	6.0%	119	5.1%
Education & Health Services	13.9%	742	14.8%	169	7.3%
Leisure & Hospitality	9.5%	581	11.6%	174	7.5%
Other Services	3.7%	234	4.7%	63	2.7%
Private Non-Classified	—	—	—	(c)	—

Total All Government	25.6%	1,130	22.5%	962	41.4%
Federal Government	4.2%	218	4.3%	265	11.4%
State Government	7.6%	250	5.0%	138	5.9%
Local Government	13.8%	662	13.2%	559	24.1%

		Union		Wallowa	
Industry	**Region 7**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	19,149	9,488	100%	2,323	100%
Total Private Coverage	74.4%	7,321	77.2%	1,688	72.7%
Natural Resources & Mining	5.0%	377	4.0%	168	7.2%
Construction	4.0%	380	4.0%	127	5.5%
Manufacturing	10.3%	1,207	12.7%	142	6.1%
Trade, Transportation & Utilities	18.5%	1,865	19.7%	402	17.3%
Information	1.2%	115	1.2%	12	0.5%
Financial Activities	3.3%	301	3.2%	136	5.9%
Professional & Business Services	5.0%	450	4.7%	95	4.1%
Education & Health Services	13.9%	1,479	15.6%	275	11.8%
Leisure & Hospitality	9.5%	837	8.8%	220	9.5%
Other Services	3.7%	312	3.3%	109	4.7%
Private Non-Classified	—	(c)	—	(c)	—
Total All Government	25.6%	2,167	22.8%	635	27.3%
Federal Government	4.2%	223	2.4%	95	4.1%
State Government	7.6%	967	10.2%	97	4.2%
Local Government	13.8%	977	10.3%	443	19.1%

Source: Oregon Employment Department, 2013

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are not dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 7. (Revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $1.3 billion (88% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing sector in all counties, except Union County.

Note: Due to the small size and few industries in the region, the collected data is withheld in several categories to avoid disclosing data for individual companies. Data is aggregated to the county level).

Table 2-437. Revenue of Top Industries (in Thousands of Dollars) in Region 7, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 7	$1,436,457	46.2%	33.1%	8.4%
Baker	$362,682	48.1%	38.0%	D
Grant	$82,545	87.9%	—	D
Union	$856,609	39.0%	39.4%	11.2%
Wallowa	$134,621	61.5%	—	18.0%

Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Source: U.S. Census, Economic Census. 2007, Table ECO700A1

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. Between 2012 and 2022, the largest job growth in Region 7 is expected to occur in the following sectors: (a) Education and Health Services; (b) Natural Resources and Mining; (c) Trade, Transportation, and Utilities (including retail trade); (d) Government; and (e) Leisure and Hospitality (Oregon Employment Department, Employment Projections by Industry and Occupation 2012–2022, Northeast and Southeast Oregon Reports, 2012).

Identifying sectors with a large number of businesses, and targeting mitigation strategies to support those sectors, can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region 7 with 18.0% of all businesses. Government (particularly local government) has the second most number of businesses. Construction, Other Services, and Education and Health Services round out the top five sectors (Oregon Employment

Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 7 is particularly vulnerable during a hazard event due to the following characteristics:

- Higher unemployment, especially in Grant County; and
- Lower regional wages.

Northeastern Oregon is still recovering from the financial crisis that began in 2007. Much of the growth in employment within the region is spurred by the health care industrial sector and the region's aging population. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

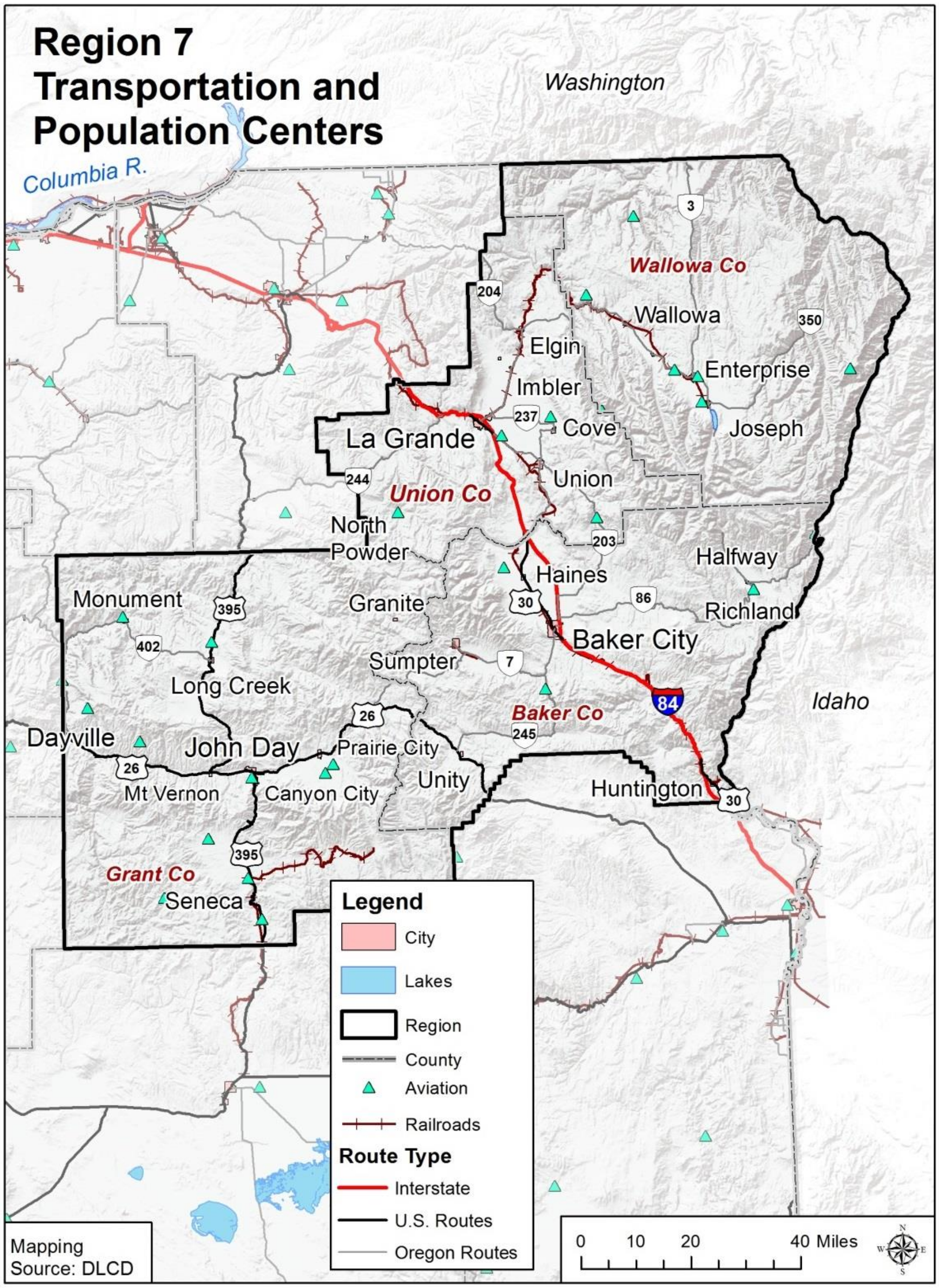
The largest population bases in Region 7 are located along the region's major freeways. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho. US-26, US-244, OR-245, and US-395 provide access west into Grant County. OR-82 provides access into Wallowa County. An additional north-south access is provided from Wallowa County to Washington via OR-3.

Region 7's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy. For information on ODOT's Seismic Lifeline Report findings for Region 7, see **Seismic Lifelines**.

Figure 2-204. Region 7 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 7, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 7, see **Seismic Lifelines**.

Table 2-438 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). In this region, 14% of bridges are distressed and/or deficient.

Table 2-438. Bridge Inventory for Region 7

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic Covered
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 7	36	212	17%	33	237	14%	3	33	9%	0	4	0%	72	499	14%	15
Baker	11	81	14%	10	79	13%	0	8	0%	0	0	-	21	165	13%	3
Grant	4	45	8%	10	38	26%	2	9	22%	0	1	0%	16	96	17%	1
Union	15	69	19%	5	61	8%	1	6	17%	0	1	0%	21	146	14%	6
Wallowa	6	17	29%	8	59	14%	0	10	0%	0	2	0%	14	92	15%	5

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 7 support cargo and trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The Class I rail line follows the I-84 corridor and another non-class I rail line provides access to the city of Enterprise (Wallowa County). There are no active rail lines in Grant County. There is one rail yard in the region (in La Grande, Union County) operated by UP (Cambridge Systematics, 2014).

There is no passenger rail available in Region 7.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and transport products from other states to and through Oregon (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 7. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region. There are several general aviation public airports including the Baker City and La Grande airports.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-439. Public and Private Airports in Region 7

	Number of Airports by FAA Designation				
	Public Airport	**Private Airport**	**Public Helipad**	**Private Helipad**	**Total**
Region 7	7	23	0	5	35
Baker	1	5	0	5	11
Grant	2	9	0	0	11
Union	1	3	0	0	4
Wallowa	3	6	0	0	9

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving Wallowa County. Idaho Power Company serves portions of Baker County. The region's electric cooperatives include: Oregon Trail Electric Cooperative (Baker, Grant, and Union), Central Electric Cooperative (Grant), Columbia Power Cooperative (Grant), and the Umatilla Electric Cooperative (Union). The Oregon Trail Electric Cooperative serves the major population centers in the region.

Table 2-440 lists electric power-generating facilities in Region 7. The region has a total of five power-generating facilities: three are hydroelectric power facilities, one is a wind power facility, and one is categorized as "other" (biomass). In total, the power-generating facilities have the ability to produce up to 1,277 megawatts (MW) of electricity.

Table 2-440. Power Plants in Region 7

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 7	3	0	1	0	1	5
Baker	2	0	0	0	0	2
Grant	0	0	0	0	1	1
Union	0	0	1	0	0	1
Wallowa	1	0	0	0	0	1
Energy Production (MW)	1,166	0	101	0	10	1,277

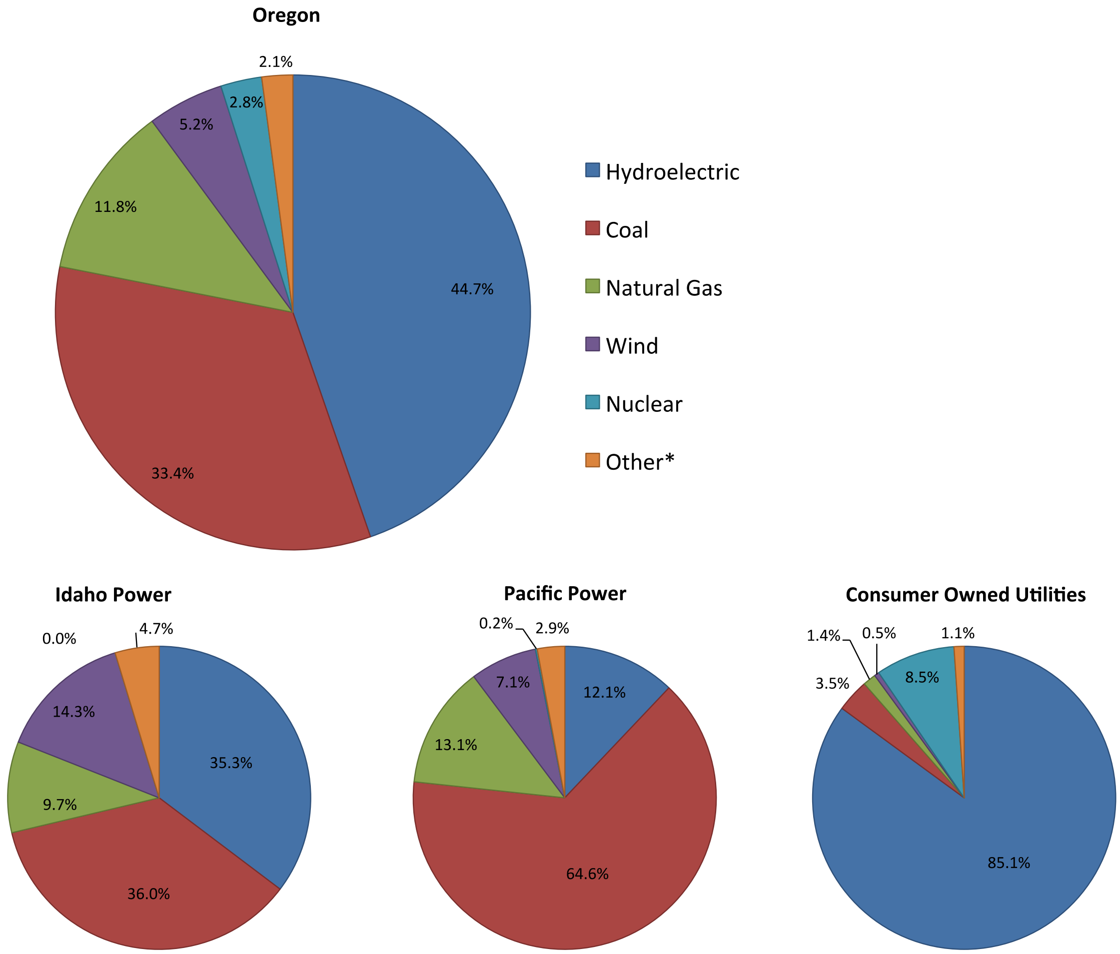
*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Oregon has a diverse energy portfolio (Figure 2-205) (Oregon Department of Energy, n.d.b). Consumer Owned Utilities provide for approximately 30% of the state's electricity consumption (largely through Bonneville Power Administration's electric generation facilities) while Pacific Power provides about 28% of the state's electricity need.

Pacific Power generates supply from a variety of sources including sites in Oregon and other western states. Transmission lines from the Rocky Mountain Region provide additional energy sources. Natural hazard events can create additional stresses to energy infrastructure that may lead to system damage or disruption in service. The redundancies and diversity in Pacific Power's energy generation portfolio and pipeline systems adds to the region's resilience in the face of power system damage or service disruption.

Figure 2-205. Oregon Energy Portfolio



Note: 3.9% of Oregon's electricity needs are met through Electric Service Suppliers that are not required to provide descriptions of their power sources to the State of Oregon.

*Other includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Oregon Department of Energy, 2014.

Hydropower

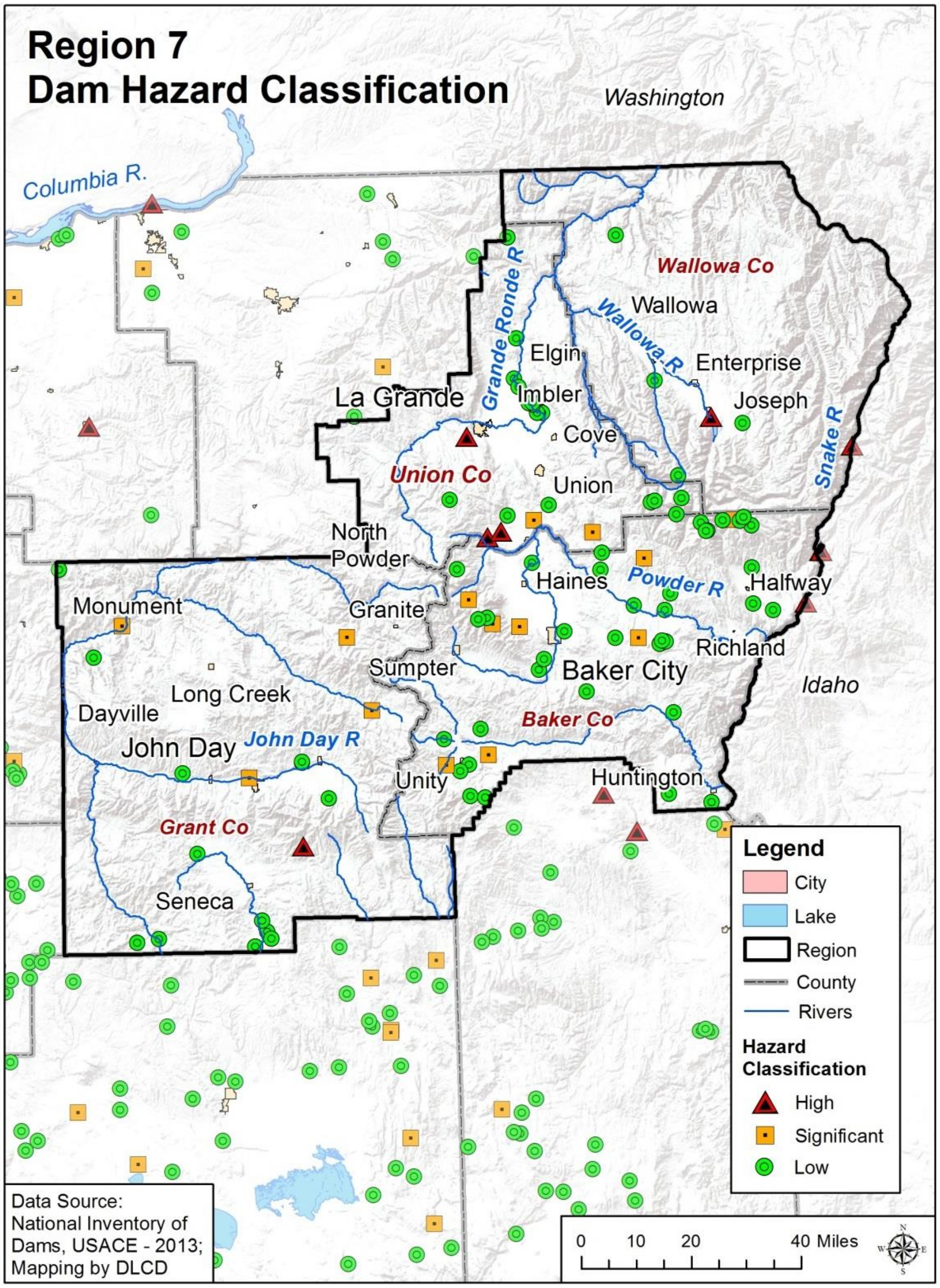
Major dams in the region are located on the Snake River (Brownlee, Oxbow, and Hells Canyon). Dam failures can occur at any time. Most result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does. The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). Most dams in the region are located in Baker County (70). There are 11 High Threat Potential dams and 10 Significant Threat Potential dams in the region.

Table 2-441. Threat Potential of Dams in Region 7

	Threat Potential			Total Dams
	High	Significant	Low	
Region 7	11	10	117	138
Baker	5	8	57	70
Grant	1	0	27	28
Union	3	2	26	31
Wallowa	2	0	7	9

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-206. Region 7 Dam Hazard Classification

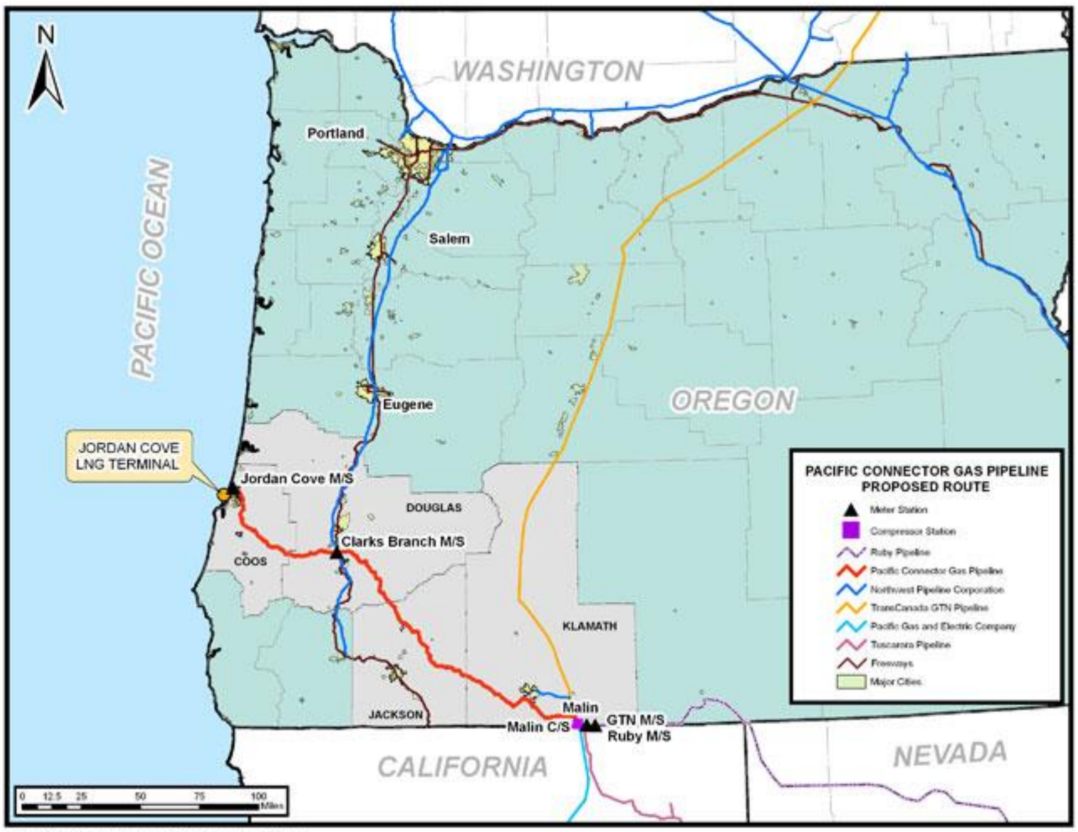


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-207** shows the Northwest Pipeline, which runs through Union and Baker Counties (in blue) (*Northwest Pipeline* Retrieved from http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-207. Liquefied Natural Gas Pipelines in Region 7



Source: Williams Corporation

Utility Lifelines

Northeast Oregon is an important throughway for oil and gas pipelines and electrical transmission lines, connecting Oregon to Idaho and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Region 7 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 7 is operated primarily by Pacific Power and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in northeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 7 is part of the Eastern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages. However, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI-TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 7. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 7 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Due to the remote nature and sparse population Region 7 lacks a station that would serve the Eastern Oregon Operational Area. ,Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Stations:

- KCMB-FM, 104.7 MHZ (Baker City, Baker, Morrow, Umatilla, and Union Counties);
- KJDY-FM, 94.5 MHZ (John Day, Grant County); and
- WVR-FM, 92.1 MHZ (Enterprise, Wallowa County).

State Primary Stations:

- KOBK-FM, 104.7 MHZ, Baker City (OPB Radio Network, also monitors KBOI-AM 690, Boise, PEP station)
- KOJD-FM, 89.7 MHZ, John Day (OPB Radio Network);
- KTVR-FM, 90.3 MHZ, La Grande (OPB Radio Network); and
- KETP-FM, 88.7 MHZ, Enterprise (OPB Radio Network).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 3 (Union, Wallowa) and 6 (Baker, Grant) provide service to Region 7. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). Union County is the only county in the region with an active ham emergency station. Calls for Region 7 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Baker County: Vacant;
- Grant County: Vacant;
- Union County: KE7QYU; and
- Wallowa County: Vacant.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 7 municipal drinking water supply is obtained from both surface and ground sources. In Wallowa and Grant Counties, the majority of municipal drinking water is from wells drawing from the aquifer with cities having water rights for surface water sources as backup sources in late summer. In Grant County, cities draw drinking water equally from a combination of surface and ground sources. Baker City draws its water from mountain springs and is unique in the state because it uses only ultraviolet water treatment without any filtration. Other cities in Baker County depend primarily on groundwater wells for municipal drinking water. Rural residents also obtain water primarily from both surface sources and groundwater wells.

Region 7 is impacted by several threats to water quality and quantity. Low levels of snowpack can lead to severe surface water shortages in a region that is already subject to annual shortages. Low water levels in surface sources can cause stagnation, low flows, and increased mineralization downstream, which negatively impacts water quality. Effluent runoff from feedlots is a lower priority concern for the region's water quality; however, other agricultural products such as pesticides and herbicides leeching into ground and surface water sources is a concern for water quality. High water temperatures are a concern in the region because of impacts to wildlife as well as increases in bacteria levels associated with high surface water temperatures. Riparian improvement projects are being implemented in Grant County to combat the issue of high surface water temperatures. Other concerns for water quality include industrial contamination, diesel spills, chromium, arsenic, iron and sulfur levels.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion and sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 7, most municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. In Region 7, only Baker City refers to LID techniques in its municipal code, requiring new surface parking areas are required to use LID strategies for stormwater runoff. Requiring decentralized LID stormwater management strategies in the other Region 7 counties could help reduce the burden of new development on storm sewer systems and increase the region's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 7 to the rest of the state. Fourteen percent of all bridges in Northeast Oregon are distressed or deficient. Railroads that run through Region 7 support cargo and trade flows, and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are five power-generating facilities located in this region: three hydroelectric, one wind, and one biomass facility. The area is the location of three large dams and hydroelectric projects on the Snake River. LNG is transported through the region via the Northwest Pipeline that runs through Union and Baker Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from I-84. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lacking system redundancies. Because most drinking water is sourced from surface water or wells, the region is at risk of high levels of pollutants entering waterways via stormwater runoff or combined sewer overflows (CSO) during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. Baker City is the only community Region 7 that requires low impact development (LID) stormwater management practices in its building code, and it is only required for new surface parking.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD website: http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition. Therefore even though both counties contain incorporated cities, the counties are considered 100% rural.

Statewide, Oregon counties added residents from 2000 to 2010, but several northeast counties lost population over the decade. Baker, Grant, and Wallowa Counties all decreased in population over the 10-year period, a combined population decrease of over 1,300 people. Union County increased by 5% and was the only county to experience growth in both urban and rural areas; however, its rate of urban growth was less than half of the state as a whole. At the city level, La Grande grew the most (+755). The region's population is clustered around the I-84 corridor and the cities of Baker City, La Grande, John Day, and Enterprise.

Table 2-442. Urban and Rural Populations in Region 7

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 7	23,883	24,427	2.3%	32,549	31,908	-2.0%
Baker	9,605	9,518	-0.9%	7,136	6,616	-7.3%
Grant	0	0	—	7,935	7,445	-6.2%
Union	14,278	14,909	4.4%	10,252	10,839	5.7%
Wallowa	0	0	0%	7,226	7,008	-3.0%

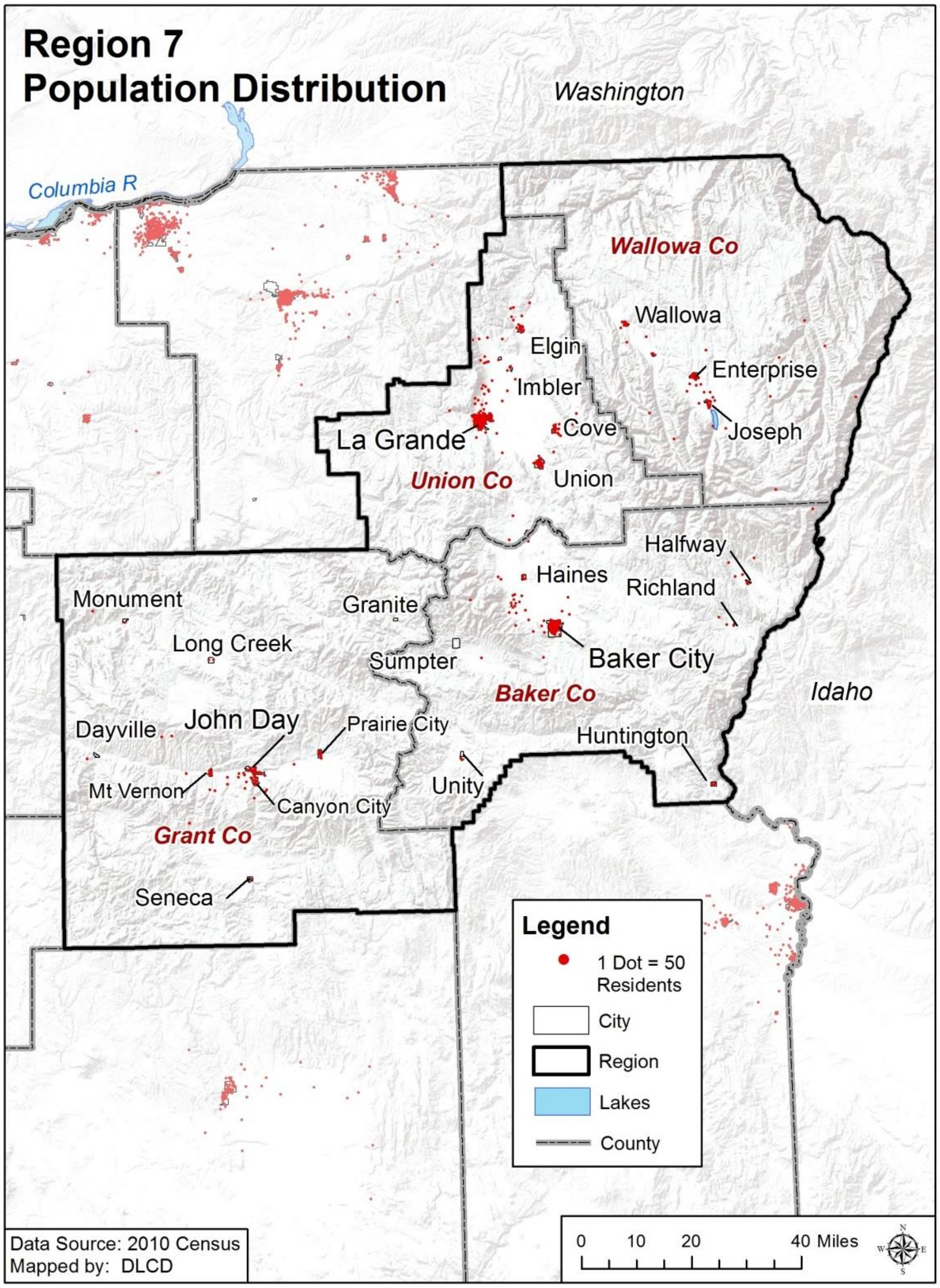
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

Table 2-443. Urban and Rural Housing Units in Region 7

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 7	10,552	11,039	4.6%	16,357	17,728	8.4%
Baker	4,342	4,498	3.6%	4,060	4,328	6.6%
Grant	0	0	—	4,004	4,344	8.5%
Union	6,210	6,541	5.3%	4,393	4,948	12.6%
Wallowa	0	0	0%	3,900	4,108	5.3%

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-208. Region 7 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

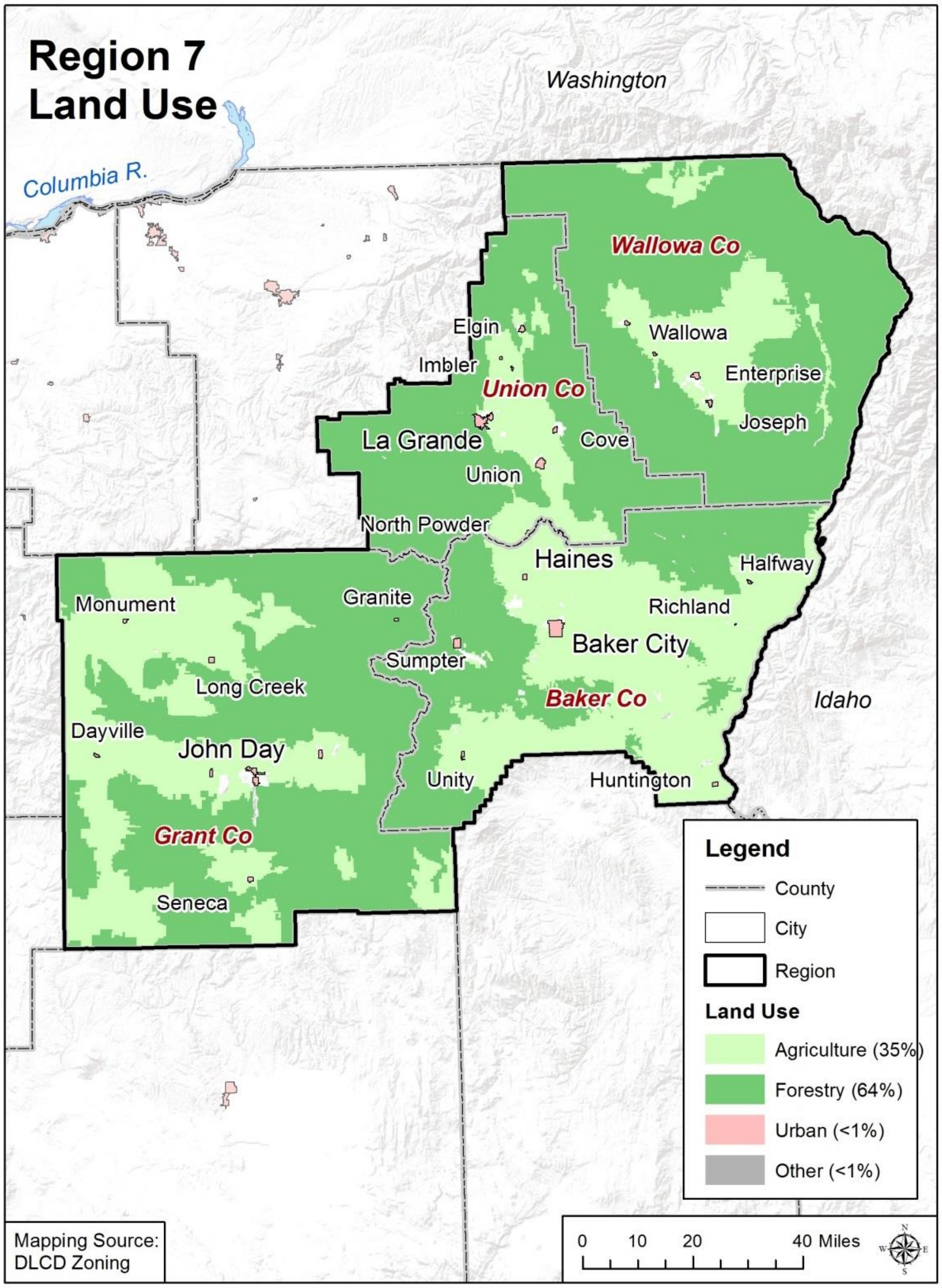
Private land generally has developed more slowly in Eastern Oregon than in Western Oregon between 1974 and 2009. State and local programs have been successful in limiting rural residential and urban development and maintaining large parcel sizes. Demand for large-scale development in this part of the state has historically been very low. Land ownership is almost completely split between federal (60%) and private (39+%) with less than 1% shared by state and local government.

To the extent it has occurred, development has generally been located along existing transportation corridors. Nearly half of the people in Region 7 reside in the cities of Baker City, John Day, La Grande, and Enterprise, and most unincorporated development in this region is located along the I-84 corridor.

As with other regions in the state this area has seen an upswing in building permits since the spring of 2012, although modest (U.S. Census Bureau, 2010). Any regional rate of growth is expected to be small. The Office of Economic Analysis projects that Region 7's population will increase by less than 1% over a 30-year period.

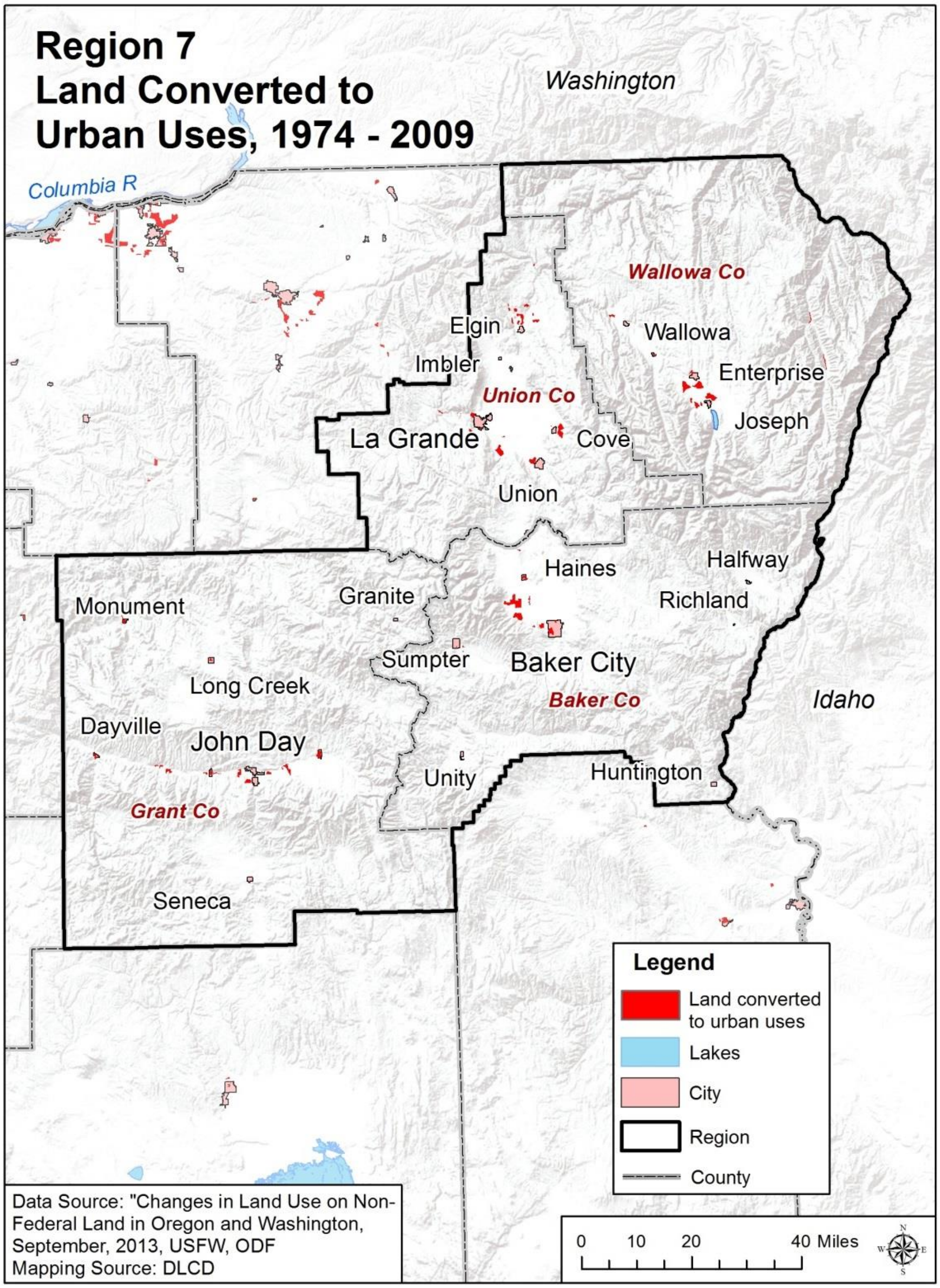
All the cities within the four counties of the region have acknowledged comprehensive land use plans that are periodically reviewed and updated. In 2013, the City of La Grande's Urban Growth Boundary (UGB) was extended, adding over 250 acres of vacant industrial land to the available land inventory.

Figure 2-209. Region 7 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-210. Region 7 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost 71% of the region's housing stock is single-family homes. The region's share of multi-family units is less than half that of the state, and almost two thirds of those units are in Union County. The region has twice the percentage of mobile homes as the state, comprising one quarter of all homes in Grant County. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-444. Housing Profile for Region 7, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 7	28,698	20,361	70.9%	3,668	12.8%	4,637	16.2%
Baker	8,826	6,509	73.7%	1,023	11.6%	1,274	14.4%
Grant	4,327	3,079	71.2%	200	4.6%	1,048	24.2%
Union	11,444	7,618	66.6%	2,104	18.4%	1,710	14.9%
Wallowa	4,101	3,155	76.9%	341	8.3%	605	14.8%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas, or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-445) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (State of Oregon Building Codes Division, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as a part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally about one half of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 80% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-445. Age of Housing Stock in Region 7, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 7	28,698	14,574	50.8%	8,691	30.3%	5,433	18.9%
Baker	8,826	4,987	56.5%	2,150	24.4%	1,689	19.1%
Grant	4,327	2,249	52.0%	1,443	33.3%	635	14.7%
Union	11,444	5,326	46.5%	3,913	34.2%	2,205	19.3%
Wallowa	4,101	2,012	49.1%	1,185	28.9%	904	22.0%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. Table 2-446 shows the initial and current FIRM effective dates for Region 7 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, Flood section.

Table 2-446. Community Flood Map History in Region 7

	Initial FIRM	Current FIRM
Baker County	Feb. 28, 1978	June 3, 1988
Baker City	Apr.17, 1984	June 3, 1988
Haines	June 3, 1988	June 3, 1988
Halfway	Sep. 24, 1984	June 3, 1988
Huntington	Sep 24, 1984	June 3, 1988
Sumpter	Sep 24, 1984	June 3, 1988
Grant County	Feb. 15, 1979	May 18, 1982
Canyon City	Sep 18, 1987	Sep 18, 1987
Dayville	Sep 24, 1984	Sep 24, 1984 (M)
John Day	Sep 15, 1977	Feb. 23, 1982
Long Creek	Sep 24, 1984	Sep 24, 1984 (M)
Monument	Sep 24, 1984	Sep 24, 1984 (M)
Mt. Vernon	Sep 18, 1987	Sep 18, 1987
Prairie City	Feb. 17, 1988	Feb. 17, 1988
Seneca	Sep 24, 1984	Sep 24, 1984 (M)
Spray	Aug. 16, 1988	Aug. 16, 1988 (M)
Union County	May 15, 1980	Apr. 3, 1996
Elgin	Nov. 15, 1978	Nov. 15, 1978
Island City	Nov. 15, 1978	Sep 30, 1987
La Grande	Sep 30, 1980	Apr.3, 1996
North Powder	Sep 29, 1978	Sep 29, 1987
Summerville	Jan. 15, 1980	Jan. 15, 1980 (M)
Union City	Dec.15, 1978	Dec. 15, 1978
Wallowa County	June 28, 1977	Feb. 17, 1988
Enterprise	Jan. 23, 1976	Feb. 17, 1988
Joseph	Dec. 5, 1975	Feb. 17, 1988
Lostine	Nov. 8, 1975	Feb. 17, 1988
Wallowa City	April 23, 1976	Feb. 17, 1988

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 7 can be found in **Table 2-447**. The region contains 1.9% of the total value of state-owned/leased critical/essential facilities.

Table 2-447. Value of State-Owned/Leased Critical/Essential Facilities in Region 7

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 7	$139,508,917	1.9%
Baker	$35,831,967	0.5%
Grant	$17,494,768	0.2%
Union	$71,475,427	1.0%
Wallowa	$14,706,756	0.2%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 7 is largely a rural county with urban development focused along I-84 and around the population centers of Baker City, Enterprise, John Day, and La Grande. Union County has the only growing urban and rural populations in the region. All counties in the region have higher percentages of mobile homes compared to statewide numbers. Notably, about one quarter of all housing units in Grant County are mobile structures. Almost half the homes were built before 1970 and floodplain management standards, and 80% were built before 1990 and current seismic building standards. None of the region’s FIRMs have been modernized or updated. The region’s share of state-owned facilities are mostly within Union County.

2.3.7.3 Hazards and Vulnerability

Droughts

Characteristics

Drought is a common occurrence in the northeastern portion of the state. Every county in Region 7 has been impacted by drought on several occasions during the last 20 years. Together, winter snowpack and spring rains provide water for meeting a variety of needs. Extended drought conditions in this region can result in significant losses for the agriculture and tourism industries as well as increased fire danger.

Historic Drought Events

Table 2-448. Historic Droughts in Region 7

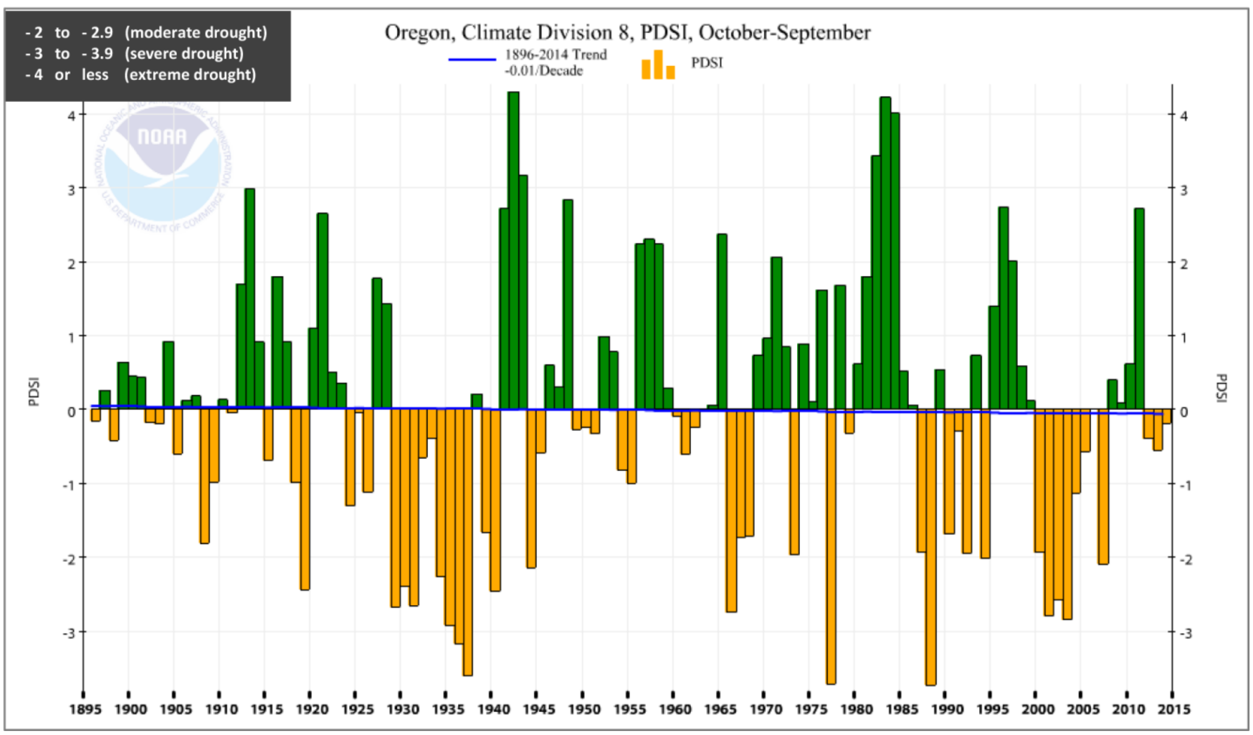
Year	Location	Description
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N & S central Oregon; eastern Oregon	a severe drought for northeast Oregon
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2002	southern and eastern Oregon	2001 drought declarations remain in effect for all counties, including Region 7's Baker, Union, and Wallowa Counties; Governor adds Grant County in 2002, along with five additional counties, bringing statewide total to 23 counties under a drought emergency.
2003	southern and eastern Oregon	Grant County 2002 declaration remains in effect through June 2003; Governor issues new declarations for Baker, Union, and Wallowa Counties, which are in effect through December 2003
2004	Region 5–8	Baker County receives Governor-declared drought emergency on June 2004, along with three other counties in neighboring regions
2005	Regions 5–7; 13 counties affected	Baker and Wallowa County receive a Governor drought declaration; all Region 5 counties affected, and most of Region 6 affected
2007	Regions 6–8	Grant, Baker, and Union Counties receive a Governor drought declaration; three other counties affected in neighboring regions
2013	Regions 5-8	Baker County receives a drought declaration, as well as four other counties in neighboring regions
2014	Regions 4, 6–8	Grant and Baker County receive drought declarations, including eight other counties in other regions

Sources: Taylor and Hatton (September 1999). The Oregon Weather Book: State of Extremes, and the Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historic drought information can be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The Palmer Index is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term record. **Figure 2-211** shows years where drought or dry conditions affected the north eastern area of Oregon (Climate Division 8).

Based on this index, 1936, 1937, 1977, and 1988 were severe drought years, while more than a dozen years in this record were moderate drought years.

Figure 2-211. Palmer Drought Severity Index for Region 7



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 7 will experience drought is shown in **Table 2-449**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-449. Local Probability Assessment of Drought in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis, to determine probability or vulnerability for a given community. Considering historical statewide droughts and the number of drought declarations made in recent years, it is reasonable to assume that it is very likely that Region 7 will experience drought in the near future.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-450**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-450. Local Vulnerability Assessment of Drought in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	H	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Baker County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Baker County has been under an emergency drought declaration on eight different occasions: 1992, 2001 (remained in effect during 2002), 2003, 2004, 2005, 2007, and 2013. This is only second to Klamath County in Region 6.

Dust Storms

Characteristics

The characteristics of dust storms in Region 7 are well described in the State Risk Assessment, **Dust Storms** section. There is little about the dust storms in this region that differs from the general description, except to note that agricultural practices likely play less of a role here than in Region 5. There are six examples of significant dust storms in this region that impacted Baker and Union Counties (**Table 2-451**).

Historic Drought Events

Table 2-451. Historic Dust Storms in Region 7

Date	Location	Description
Aug. 1905	Wallowa County	a dust storm described as "without a doubt the worst ever known in the history of the county" was said to be "the natural result of the long dry spell… there having been no rain since June" (Wallowa County Chieftain [Enterprise, Oregon], August 31, 1905)
May 1997	Union County	"blowing dust caused a three-car accident on Highway 82 between Island City and Imbler" (https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5597949)
Mar. 2004	Union County	"Sustained wind speeds between 20 and 30 mph kicked up blowing dust in the Grande Ronde Valley. Hunter Road and Booth Lane were closed due to low visibility caused by the dust storm." (https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=5388550)
Jan. 2008	Baker and Union Counties	ODOT closed the freeway's westbound lanes between Baker City and La Grande about noon because of blowing snow, dust, and debris that created near-zero visibility in the Ladd Canyon area east of La Grande, leading to motor vehicle crashes
Dec. 2012	Union County	"The winds kicked up a dust storm in the Grande Ronde Valley near La Grande that was moderated slightly by patches of snow." (Plus Media Solutions, December 21, 2012)
Sept. 2013	Baker County	dust storm occurred in and near Baker City

Source: Daily Mail, September 16, 2013; YouTube, Fredrik Anderson, September 12, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk

Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 7 will experience dust storms is shown in **Table 2-452**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-452. Local Probability Assessment of Dust Storms in Region 7

	Baker	Grant	Wallowa	Union
Probability	M	—	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The fact that three of the six storms noted occurred within the most recent 10 years of record suggests that the probability of these events may be increasing in Region 7. This hypothesis would benefit from more research.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-453**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration, noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-453. Local Vulnerability Assessment of Dust Storms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	—	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Of all four counties in the region, Baker County is most vulnerable to dust storms. Union County is also vulnerable.

Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: (a) shallow crustal events within the North America Plate, and (b) volcanic-earthquakes.

Region 7 contains high mountains and broad valleys. Although there is abundant evidence of faulting, seismic activity is low when compared with other areas of the state. Baker County probably has the most recorded seismic activity in the region. Not surprisingly, it appears to occur in the vicinity of Hells Canyon, an area with a complex geologic history. Several significant earthquakes have occurred in the region: the 1913 Hells Canyon; the 1927 and 1942 Pine Valley – Mountain; the 1965 John Day (M4.4); and the 1965 and 1966 Halfway (M4.3 and 4.2) (**Table 2-454**).

There are also a few identified faults in Union County that have been active in the last 20,000 years. The region has also been shaken historically by crustal earthquakes and prehistorically by subduction zone earthquakes centered outside the area (**Table 2-454**). All considered, there is good reason to believe that the most devastating future earthquakes in Region 7 would probably originate along shallow crustal faults.

Historic Earthquake Events

Table 2-454. Significant Earthquakes Affecting Region 7

Date	Location	Magnitude	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Oct. 1913	Hells Canyon, Oregon	VI	damage unknown
Apr. 1927	Pine Valley-Cuddy Mountain, Oregon	V	damage unknown
June 1942	Pine Valley-Cuddy Mountain, Oregon	V	damage minor
Aug. 1965	John Day, Oregon	4.4	damage unknown
Nov. 1965	Halfway, Oregon	4.3	damage unknown
Dec. 1966	Halfway, Oregon	4.2	damage unknown

*BCE: Before Common Era.

Sources: University of Washington. List of Magnitude 4.0 or Larger Earthquakes in Washington and Oregon 1872-2002; and Wong and Bott, November 1995, A Look Back at Oregon's Earthquake History, 1841-1994, *Oregon Geology*.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region7 will experience earthquakes is depicted **Table 2-455**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-455. Local Probability Assessment of Earthquakes in Region 7

	Baker	Grant	Wallowa	Union
Probability	M	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

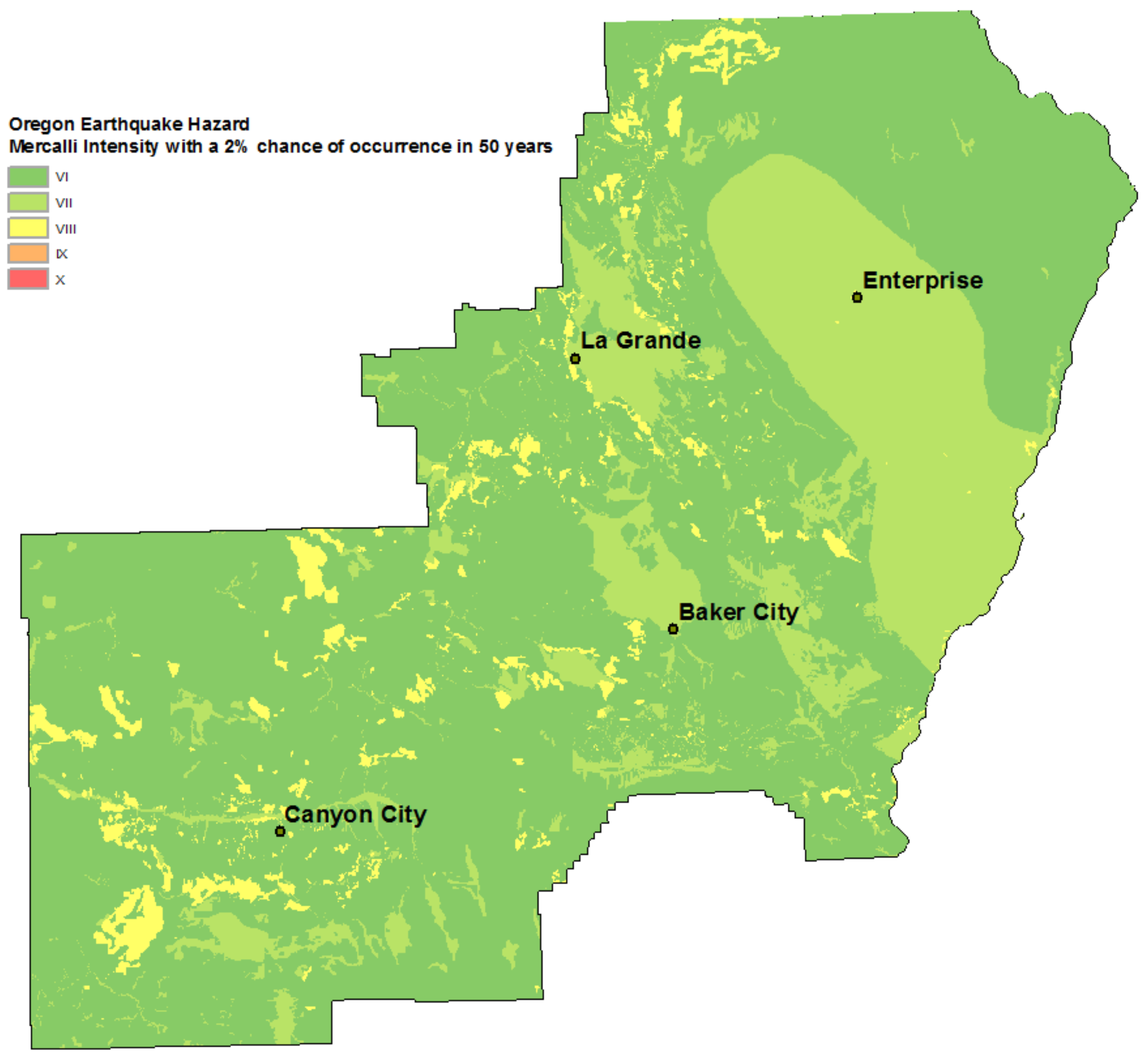
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 7, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 7 is depicted in **Figure 2-212**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. This map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-212**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-212. Probabilistic Earthquake Hazard in Region 7



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is shown in **Table 2-456**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-456. Local Vulnerability Assessment of Earthquakes in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	M	L	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 7 is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking.

In 2007, DOGAMI (Lewis, 2007) completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI surveyed a total of 3,349 buildings, giving each a 'low,' 'moderate,' 'high,' or 'very high' potential of collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore *approximate* rankings (Lewis, 2007). To fully assess a building's potential of collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help prioritize buildings for further study. Results are found in **Table 2-457**, **Table 2-458**, and **Table 2-459**.

Table 2-457 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-457. Buildings with Their Collapse Potential in Region 7

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Baker	4	15	6	8
Grant	12	2	15	17
Union	10	6	14	24
Wallowa	10	2	10	3

Source: Lewis (2007)

Table 2-458. Projected Dollar Losses in Region 7, Based on an M8.5 Subduction Event and a 500-Year Model

	Economic Bae in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from a (M) 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year Event
Baker County	$943,000	Less than $1,000	$13,000
Grant County	$415,000	Less than $1,000	$3,000
Union County	$1,237,000	Less than $1,000	$9,000
Wallowa County	$444,000	Less than $1,000	$8,000

Source: Wang and Clark (1999)

Table 2-459. Estimated Losses in Region 7 Associated with a 500-Year Model

	Baker	Grant	Union	Wallowa	Remarks
Injuries	3	0	1	1	
Deaths	0	0	0	0	
Displaced households	10	0	1	1	
Operational the day after the quake[1]:					
Fire stations	N/A	N/A	N/A	N/A	
Police stations	N/A	N/A	N/A	N/A	
Bridges	N/A	N/A	N/A	N/A	
Economic losses to:					
Highways	$5 mil	$3 mil	$1 mil	0	
Airports	$2 mil	$2 mil	$618,000	$3 mil	
Communications	$1,000	$469,900	$$479,000	$116,000	
Debris generated (thousands of tons)	8	1	5	4	

The Hazus run that produced the data in this table did not account for unreinforced masonry buildings.

[1]The 500-year model includes several earthquakes; the number of facilities operational the day after the earthquake cannot be calculated.

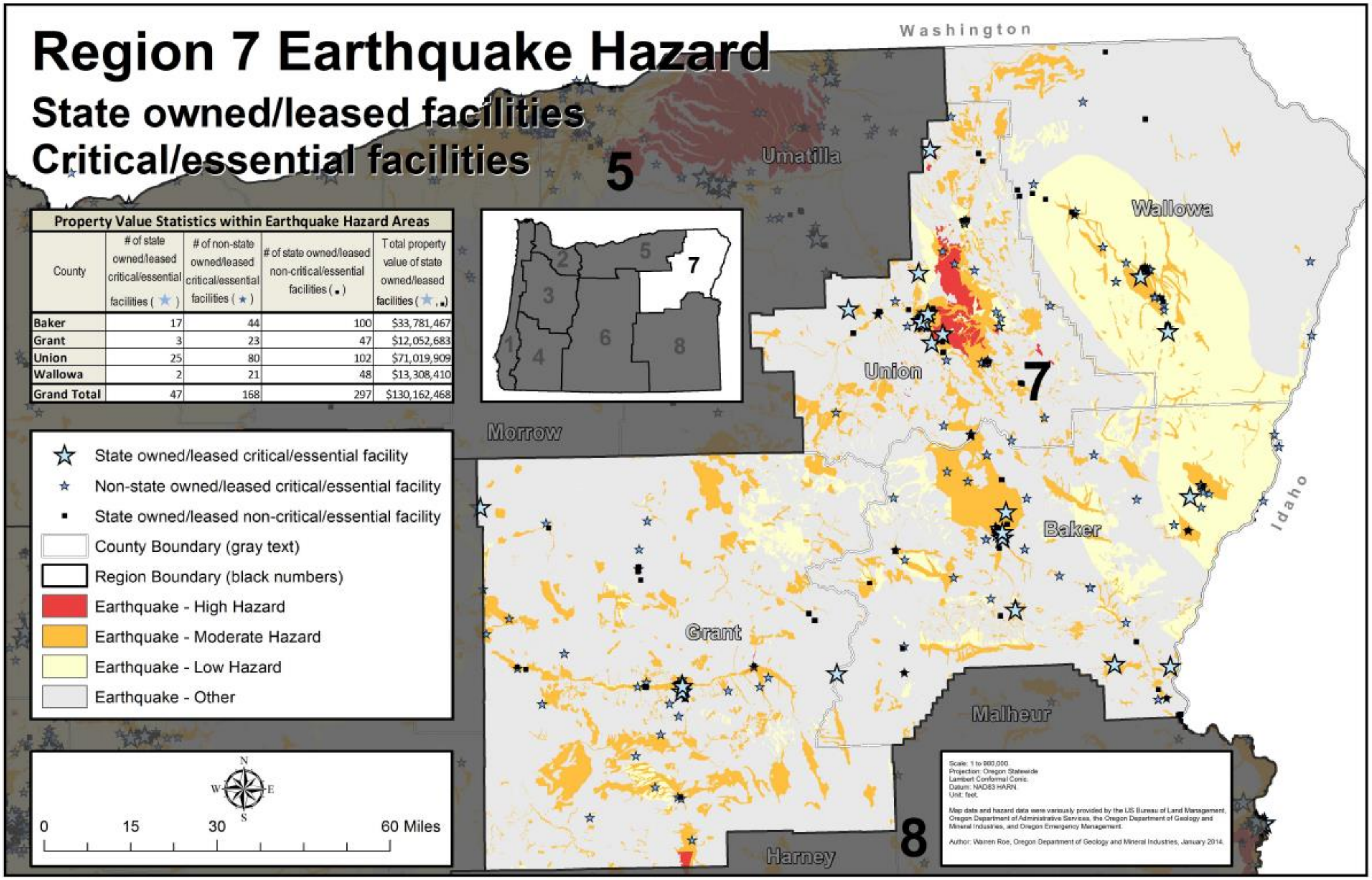
Source: Wang and Clark (1999)

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 344 totaling $130 million fall into an earthquake hazard zone in Region 7 (**Figure 2-213**). Among the 1,141 critical/essential state facilities, 47 are in an earthquake hazard zone in Region 7. Additionally, 168 non-state critical/essential facilities in Region 7 are located in an earthquake hazard zone.

Figure 2-213. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 7



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	17	44	100	$33,781,467
Grant	3	23	47	$12,052,683
Union	25	80	102	$71,019,909
Wallowa	2	21	48	$13,308,410
Grand Total	47	168	297	$130,162,468

Source: DOGAMI

SEISMIC LIFELINES

According to the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; see **Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. Therefore, this region was not part of the OSLR study. However, ODOT did provide the following descriptions of general impacts a CSZ would have on Region 8's seismic lifelines, and the region's overall vulnerability.

Regional Impact. Within this region, adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction, etc.) are not anticipated, but damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy.

Regional Loss Estimates. Losses in this region are expected to be nonexistent to low locally. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

Most Vulnerable Jurisdictions. Vulnerability of this whole region to a CSZ event is low. Loss of life, property, and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Floods

Characteristics

The Blue Mountain area of northeastern Oregon is quite distinct from the rest of the state in landform and climate. Nevertheless, its principal flood problems are similar to those found elsewhere in Oregon. The most damaging floods have occurred during the winter months, when warm rains from tropical latitudes melt mountain snow packs. Such conditions were especially noteworthy in February 1957, February 1963, December 1964, and January 1965. Somewhat lesser flooding has been associated with ice jams, normal spring runoff, and summer thunderstorms. Heavily vegetated stream banks, low stream gradients (e.g., Grande Ronde Valley), and breeched dikes have contributed to past flooding at considerable economic cost. Region 7 counties also have experienced flooding associated with low bridge clearances, over-topped irrigation ditches, and natural stream constrictions such as Rhinehart Gorge between Elgin and Imbler in Union County.

Historic Flood Events

Table 2-460. Significant Historic Floods Affecting Region 7

Date	Location	Description	Type of Flood
1894*	NE Oregon	widespread flooding	not recorded
1910*	NE Oregon	widespread flooding	not recorded
1917*	NE Oregon	widespread flooding	not recorded
1932*	NE Oregon	widespread flooding	not recorded
1935*	NE Oregon	widespread flooding	not recorded
May 1948	Columbia Basin / NE Oregon	unusually large mountain snow melt produced widespread flooding	snow melt
Dec. 1955 – Jan. 1956	Snake and Columbia basins	warm rain melted snow; runoff on frozen ground	rain on snow
Dec. 1964	entire state	widespread, very destructive flooding; warm rain, melted snow; runoff on frozen ground	rain on snow
Jan. 1974	much of state	warm rain / melted snow / runoff on frozen ground	rain on snow
Feb. 1986	entire state	warm rain / melted snow / runoff on frozen ground	rain on snow
June 1986	Wallowa County	severe thunderstorm / rain and hail / flash flooding	thunderstorm
May 1991	Union and Baker Counties	warm rain / melted snow; considerable damage to cropland and highways; a number of bridges destroyed	rain on snow
May 1998	eastern and central Oregon	persistent rains; widespread damage	rain on snow
July 2004	Union	$5,000 in property damage	
May 2008	Union and Wallowa Counties	flooding along Catherine Creek and Grande Ronde River damaged roads in Union County, causing $30,000 in damages; in Wallowa County the Imnaha River crested above flood stage	rain on snow
May 2011	Grant and Union Counties	heavy rainfall on above-average snowpack caused flooding to low lying areas of Grant and Union Counties; over $2.6 in property damage	rain on snow

Source: Taylor and Hatton (1999)

Source: Taylor and Hannan, 1999, The Oregon Weather Book, pp. 96-103; and FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88.

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Source: U.S. Department of Commerce. National Climatic Data Center. Available from http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms

Table 2-461. Principal Flood Sources by County in Region 7

Baker County	Grant County	Union County	Wallowa County
Powder River	North Fork John Day River	Grande Ronde River	Wallowa River
Old Settler's Slough	South Fork John Day River	Catherine Creek	Minam River
Pine Creek	Middle Fork John Day River	North Powder River	Lostine River
Eagle Creek	Canyon Creek	Little Creek	Grande Ronde River
Summit Creek	Cottonwood Creek	Gekeler Slough	Wenaha River
Rock Creek	Prairie Creek	Taylor Creek	Imnaha River
Mill Creek		Fresno Creek	Hurricane Creek
Marble Creek		Clark Creek	Prairie Creek
Stices Gulch		Indian Creek	
Snake River		Wolf Creek	
Burnt River			

Sources: FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience flooding is shown in **Table 2-462**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-462. Local Probability Assessment of Flooding in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon's most severe flooding occurs between November and February and most floods are associated with a period of intense warm rain on a heavy mountain snow pack. These periods of flooding coincide with La Niña conditions during the winter months when very moist subtropical air follows a heavy, wet snowfall. Climate records indicate that La Niña conditions occur on average about every 3 to 6 years. Climatologists speculate that Oregon has moved from a long-term El Niño period (1975–1994) with milder, drier air, to a long-term La Niña period, characterized by cool, wet weather, abundant snow, and floods. A historical overview of flooding is shown in **Table 2-460**.

All of the Region 7 counties have Flood Insurance Rate (FIRM) maps; however, old maps do not reflect present flood conditions. The most recent FIRM maps are as follows:

- Baker, June 3, 1988;
- Grant, May 18, 1982;
- Union, April 3, 1996; and
- Wallowa, February 17, 1988.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in **Table 2-463**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-463. Local Vulnerability Assessment of Floods in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to **Table 2-464**.

Table 2-464. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

The counties in this region all received a flood vulnerability score of 5. These are all very low population counties, so the low vulnerability score may be misleading with respect to a flood's effect on the population centers in the region.

FEMA has identified two Repetitive Loss properties in Region 7, neither of which is a Severe Repetitive Loss property (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

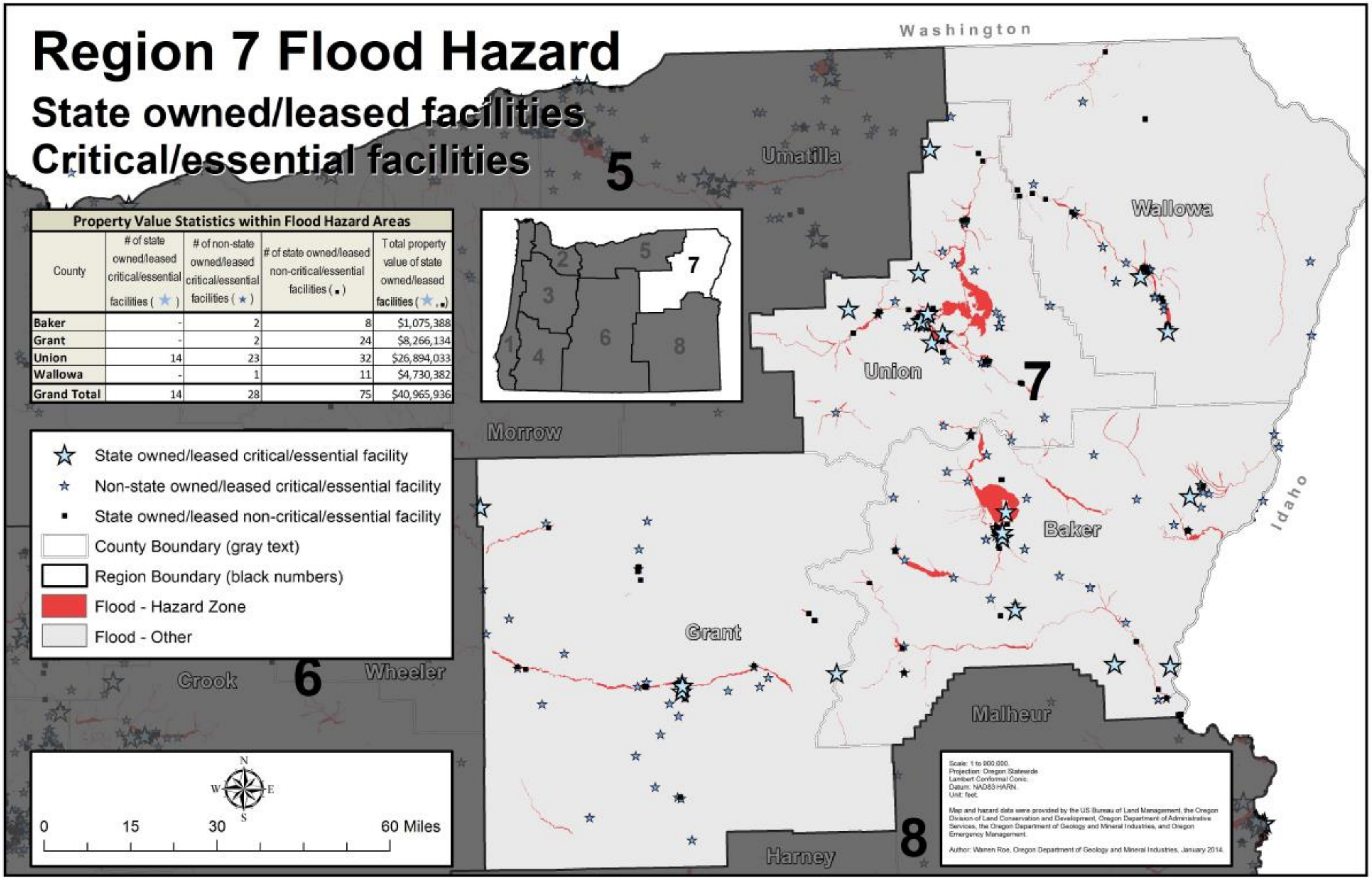
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 7 communities participate in the CRS Program.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 89 are currently located within a flood hazard zone in Region 7 and have an estimated total value of $41 million (**Figure 2-214**). Of these, 14 are identified as a critical or essential facility. An additional 28 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 7.

Figure 2-214. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Area in Region 7



Property Value Statistics within Flood Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	-	2	8	$1,075,388
Grant	-	2	24	$8,266,134
Union	14	23	32	$26,894,033
Wallowa	-	1	11	$4,730,382
Grand Total	14	28	75	$40,965,936

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Blue Mountains and Wallowa Mountains have a moderate to high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Landslides occur throughout Region 7 but to a much lesser extent than in western Oregon. In general, northeastern Oregon soil profiles are shallow and rainfall is less frequent and intense than in the western portion of the state. Most Region 7 landslides occur within the I-84 corridor, OR-82 (Union County), OR-86 (Baker County), OR-19 (Grant County), and OR-3 (Wallowa County). Notable slides include the 1984 Hole-in-the-Wall slide, which dammed the Powder River in Baker County, and the often-troublesome Whopper Slide near Elgin in Union County. In 1928, two people were killed in a landslide while working on a railroad near Baker City.

Historic Landslide Events

Table 2-465. Significant Landslides in Region 7

Date	Location	Description
May 2003	Grant County, Oregon	Property damage: $1,000

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience landslides is shown in **Table 2-466**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-466. Local Probability Assessment of Landslides in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	M	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-467**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-467. Local Vulnerability Assessment of Landslides in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	M	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

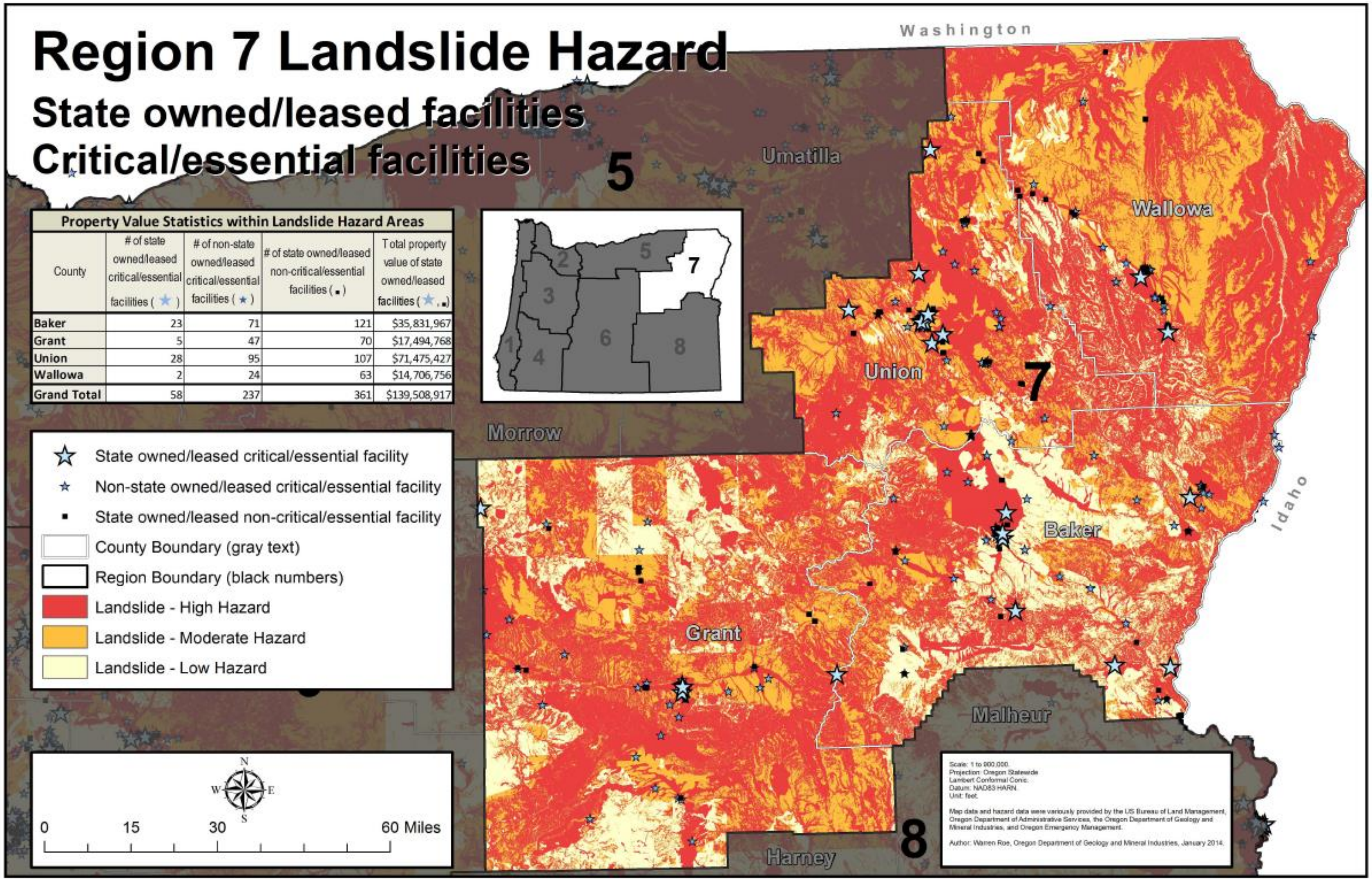
Although there are fewer historic landslides in this region than most others, the SLIDO-2 landslide inventory indicates a moderate to high hazard. Baker, Union, and Grant Counties all have approximately 500 mapped landslides in SLIDO-2. The communities located in areas of steeper slopes will likely have the highest vulnerability.

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 419 are located within landslide hazard areas in Region 7, and are valued at $139.5 million (**Figure 2-215**). This includes 58 critical or essential facilities. An additional 237 critical/essential facilities, not owned/leased by the state, are also located within a landslide hazard zone in Region 7.

Figure 2-215. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 7



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	23	71	121	$35,831,967
Grant	5	47	70	$17,494,768
Union	28	95	107	$71,475,427
Wallowa	2	24	63	$14,706,756
Grand Total	58	237	361	$139,508,917

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 7 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is considered nil. However, there is some risk from volcanic ash. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is from west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes.

Historic Volcanic Events

Table 2-468. Historic Volcanic Events in Region 7

Date	Location	Description
May 1980	northeast Oregon	trace amounts of ashfall from Mount St. Helens

Source: Reports of local geologists present in northeast Oregon in May of 1980.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience volcanic hazards is shown in **Table 2-469**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-469. Local Probability Assessment of Volcanic Activity in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	L	L	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of airborne ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington during the 1980 eruption and again in 2004.

The eruptive history of the Cascade volcanoes can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's recent history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction. Because wind direction and velocity vary with both time and altitude, it is impossible to predict the direction and speed of ash transport more than a few hours in advance (Walder et al., 1999). Mount St. Helens is about 250 air miles from the City of Enterprise (Wallowa County), consequently placing that community at risk. Mount Jefferson, located about 150 miles west of the City of John Day, is a possible but unlikely source. The annual probability of 1 cm or more of ash accumulation within the Region 7 counties, from any Cascade volcano, is about 1 in 5,000 (Sherrod et al., 1997).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic activity is shown in **Table 2-470**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-470. Local Vulnerability Assessment of Volcanic Activity in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	L	H	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The region's vulnerability to the effects of volcanic eruptions is low. Areas in Region 7 could be affected by ashfall from Cascade volcanic eruptions. Most of the region's people and infrastructure are located in the major cities along I-84, US-26, and US-395. The communities most vulnerable to volcano-related hazards in the region are La Grande, Baker City, and John Day.

Wildfires

Characteristics

The area has a significant history of human-caused fires in the Region 7. In addition, the prevalence of summer thunderstorms in the mountainous and timbered regions of eastern Oregon suggests the potential for lightning-caused fires. Most areas do not have structural fire protection available and some areas do not even have wildland fire protection.

While the rates of urban and rural residential development have declined statewide, they have increased in Eastern Oregon's non-federal forests, potentially impacting fire protection capability. There are now 3 times as many dwellings on non-federal wildland forest in Eastern Oregon as in 1975. Dwelling density is increasing at a faster rate in Eastern Oregon's fire-prone forests than in western Oregon's. Development ranges from homes with city services to seasonal-use recreational cabins. Many isolated clusters of private timberland have been bought and developed into home sites and recreational communities.

Historic Wildfire Events

Table 2-471. Significant Wildfires in Region 7

Year	Name of Fire	Location	Acres Burned	Remarks
1986	Clear	Baker, Grant, Union	6,000	lightning caused (?)
1988	Turner	Baker, Union, Grant	8,000	
1989	Dooley Mountain	Baker		
1989	Stices Gulch	Baker		
1996	Sloan's Ridge	Baker, Grant	10,000	
1996	Wildcat	Grant	10,303	
1999	Cummings Creek	Grant		
2000	Carrol Creek	Grant	3,197	
2000	Thorn	Wallowa	4035	
2001	Monument Complex	Grant		
2001	Horse Creek	Wallowa	16,309	
2002	Malheur Complex/Flagtail	Grant	21,641	
2003	Lightning Creek Complex	Wallowa	16,028	1 structure was lost
2007	Battle Creek Complex	Wallowa	79,299	
2007	Cottonwood Creek	Wallowa	8,100	
2013	Grouse Mountain	Grant	12,076	threatened the town of John Day

Sources: Wallowa-Whitman National Forest (Baker City), 2002; Oregon Department of Forestry, 2013

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on an analysis of risk conducted by county emergency program managers, the probability that Region 7 will experience wildfires is shown in **Table 2-472**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-472. Local Probability Assessment of Wildfire in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

A combination of climate, fuels, and terrain make this region prone to wildfire. The poor ecological health of the forested ecosystem, particularly in the greater Blue Mountains area, is well documented in federal and scientific reports. Past timber management practices, fire exclusion, and the subsequent buildup of forest fuels have significantly changed the vegetation composition in this region over time. The simplification of stand structure (unnaturally dense) and shift in species composition over time, combined with low precipitation and competition for limited water and nutrients, increases the probability of insect, disease epidemics, and large-scale fire.

A significant number of lightning storms pass through during the summer and fall months, starting many fires that can easily strain wildland firefighting resources. With fuels and low relative humidity, the probability for large fires can significantly increase during lightning events. The number of days per season that these conditions exist is also important to consider.

Over three quarters of all fire starts are attributed to lightning, with a higher percentage of lightning starts on public lands than on private lands. ODF reports a slightly higher percentage of human-caused fires where human activity is more prevalent.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-473**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-473. Local Vulnerability Assessment of Wildfire in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

State Assessment

Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 7, Grant, Union and Wallowa Counties have high percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface areas), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and are listed in **Table 2-474**.

A large wildfire could eliminate valuable timber or rangeland for grazing, which might affect local businesses and industry. Recreational areas that draw tourists would also be impacted. Wildlife habitat and diversity, as well as threatened and endangered species of fish, wildlife, and plant life could be annihilated or severely harmed in the long-term depending on the intensity of the wildfire. Water quality could be impacted if a moderate to high intensity wildfire burned through watersheds, affecting the health of fish and wildlife as well as domestic water supplies for residents.

Many communities in this area are located a long distance from fire stations, which will result in longer response times. There are areas with a single access road that could impair ingress and egress during emergencies. Many homes do not have defensible space and would be difficult to protect from and oncoming fire. Response efforts are further hindered by the lack of water resources in the most vulnerable locations.

Region 7 is characterized as having heavy fuel loading on forestlands with a high potential for crown fires, which are very difficult to extinguish. The slopes are steep and carry fire quickly to upland flashy fuels and crowns. Ignition potential is also high, as many people visit the area.

Table 2-474. Wildland-Urban Interface Communities by County in Region 7

Baker	Grant	Union	Wallowa
Anthony Lakes Resort	Austin	Camp Elkanah	Alder
Baker Valley	Bates	Cove	Eden
Bourne	Canyon City	Elgin	Enterprise
Cornucopia	Dayville	Hilgard	Flora
Durkee	Granite	Kamela	Freezeout Creek
Greenhorn	John Day	Medical Springs	Grouse
Halfway / Pine Valley	Long Creek	Morgan Lake	Hurricane Grange
Keating	Monument	Mt. Emily	Imnaha River Woods
Powder River	Mount Vernon	Palmer Junction	Imnaha
Rattlesnake Estates	Prairie City	Perry	Joseph
Richland	Seneca	South Fork Catherine Creek	Lostine
Sparta		Starkey	Minam
Stices Gulch		Union	Prairie Creek
Sumpter / Sumpter Valley			Promise
			South Fork Lostine River Subdivision
			Ski Run / Ski Run Road
			Troy
			Wallowa Lake Basin
			Wallowa Slope / Canyon

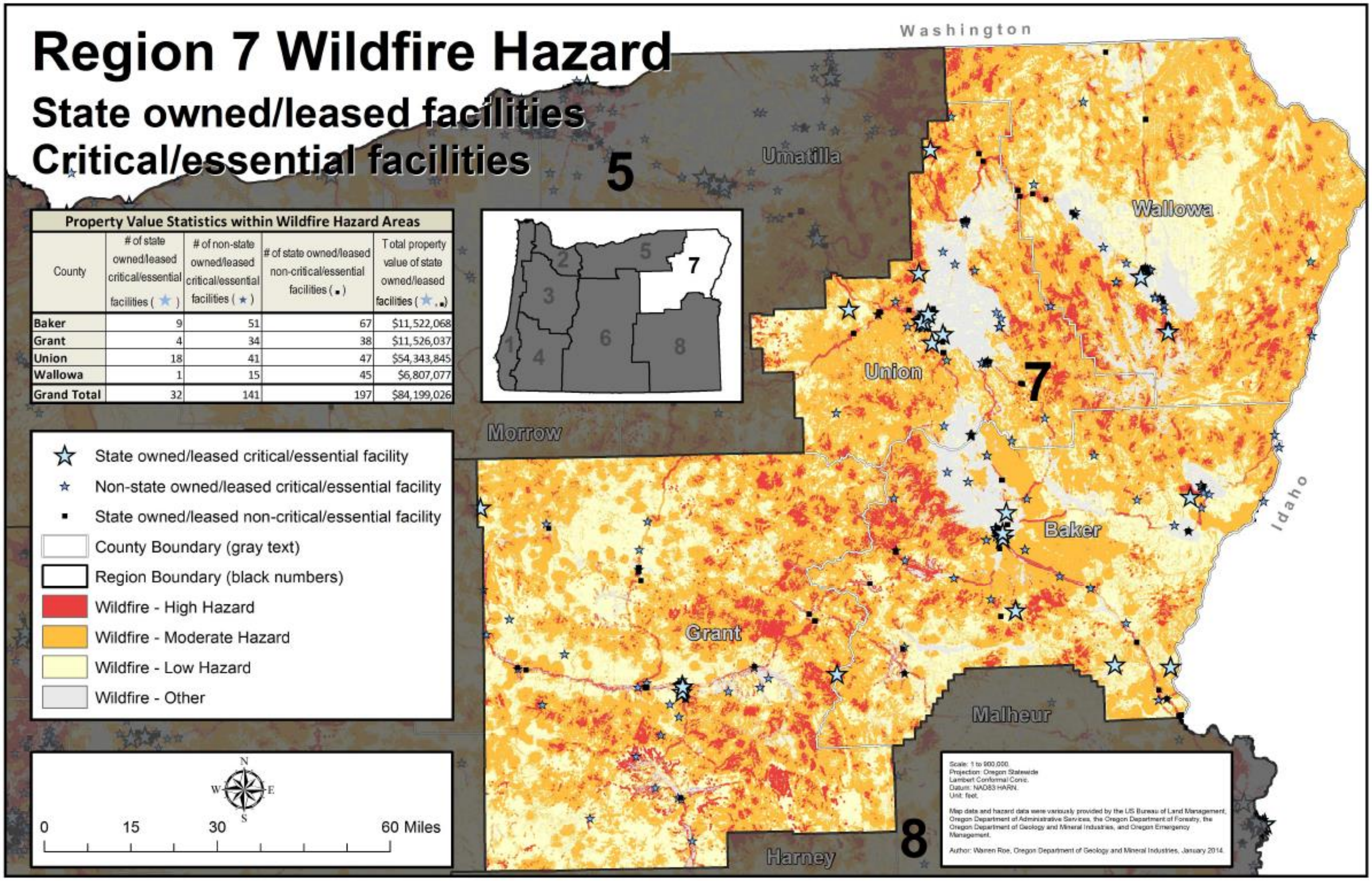
Source: Oregon Department of Forestry Statewide Forest Assessment, September 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 229 are within a wildfire hazard zone in Region 7 and total roughly $84 million in value (**Figure 2-216**). Among those, 32 are state critical/essential facilities. An additional 141 non-state critical/essential facilities are also located in Region 7.

Figure 2-216. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 7



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Baker	9	51	67	$11,522,068
Grant	4	34	38	$11,526,037
Union	18	41	47	$54,343,845
Wallowa	1	15	45	$6,807,077
Grand Total	32	141	197	$84,199,026

Source: DOGAMI

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge, so much so that these areas have special building code standards. This is not the case in the Blue Mountains, although high winds in the valleys are not uncommon. For example, the residents of Union County's Grande Ronde Valley caution newcomers about living in the vicinity of Ladd Canyon, known for its high winds.

Historic Windstorm Events

Table 2-475. Historic Windstorms in Region 7

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 7-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Jan. 1986	northeast Oregon	wind gusts 80–90 mph; heavy drifting snow in Ladd Canyon (Union County)
Dec. 1990	Wallowa County	severe wind storm
Mar. 1991	northeast Oregon	severe wind storm
Dec. 1991	northeast Oregon	severe wind storm
Dec. 1992	northeastern mtns., Oregon	severe wind storm
May 2003	Union County	$1,000 in property damage
June 2003	Wallowa County	$1,000 in property damage
July 2003	Union County	$30,000 in property damage
Oct. 2003	Wallowa County	$1,000 in property damage
Oct. 2003	Union County	$2,000 in property damage
Jan. 2004	Grant and Wallowa Counties	$500 in property damage
Feb. 2004	Union	$1,000 in property damage
Mar. 2004	Union County	$200 in property damage
July 2004	Union County	$300,000 in property damage
Nov. 2004	Union County	$1,000 in property damage
Jan. 2005	Union County	$10,000 in property damage
Nov. 2005	Union County	$100 in damages from a strong wind storm
Nov. 2006	Union and Wallowa Counties	$35,000 in damages from a wind storm with wind speeds measured at 80 mph; Morrow and Umatilla Counties also affected, causing a total storm damage of $70,000
Nov. 2007	Wallowa County	$500,000 in damages from a windstorm near Wallowa Lake State Park
July 2011	Union County	$2,000 in property damage

Sources: Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, *Severe Windstorm in Western Oregon*, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007), The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database], Columbia, SC: University of South Carolina, http://hvri.geog.sc.edu/SHELDUS/.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience windstorms is shown in **Table 2-476**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-476. Local Probability Assessment of Windstorms in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in Region 7 is defined as one-minute average winds of 90 mph. A 50 year storm is one-minute average winds of 80 mph. The 25-year event consists of average winds of 70 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-477**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-477. Local Vulnerability Assessment of Windstorms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 7 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed when uprooted trees growing next to a house fall during a windstorm. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establishing a tree maintenance and removal program.

Winter Storms

Characteristics

Severe winter weather in Region 7 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 7 with an average of 24 inches of snow; most communities are prepared for them. In the elevated areas of the Wallowa Mountains severe winter storms are more frequent and the snowfall is much heavier. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region. Heavier snowfall is expected and planned for in the areas of the Wallowa Mountains of the region as the elevation gets higher.

Historic Winter Storm Events

Table 2-478. Severe Winter Storms in Region 7

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state.
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire State	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	northeast mountains, Oregon	heavy snow; school closures; traffic accidents; broken power lines
Dec. 1988	northeast mountains, Oregon	three blizzards in a 4-week period; 15-foot drifts; wind over 60 mph
Feb. 1990	entire state	heavy snow throughout state
Jan. 1994	northeast mountains, Oregon	heavy snow throughout region
Jan. 1998	northeast Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Jan. 2004	Union County	one fatality

Source: Taylor and Hatton (1999).

Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 7 will experience winter storms is shown in **Table 2-479**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-479. Local Probability Assessment of Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Winter storms occur annually in Region 7. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-480**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-480. Local Vulnerability Assessment of Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

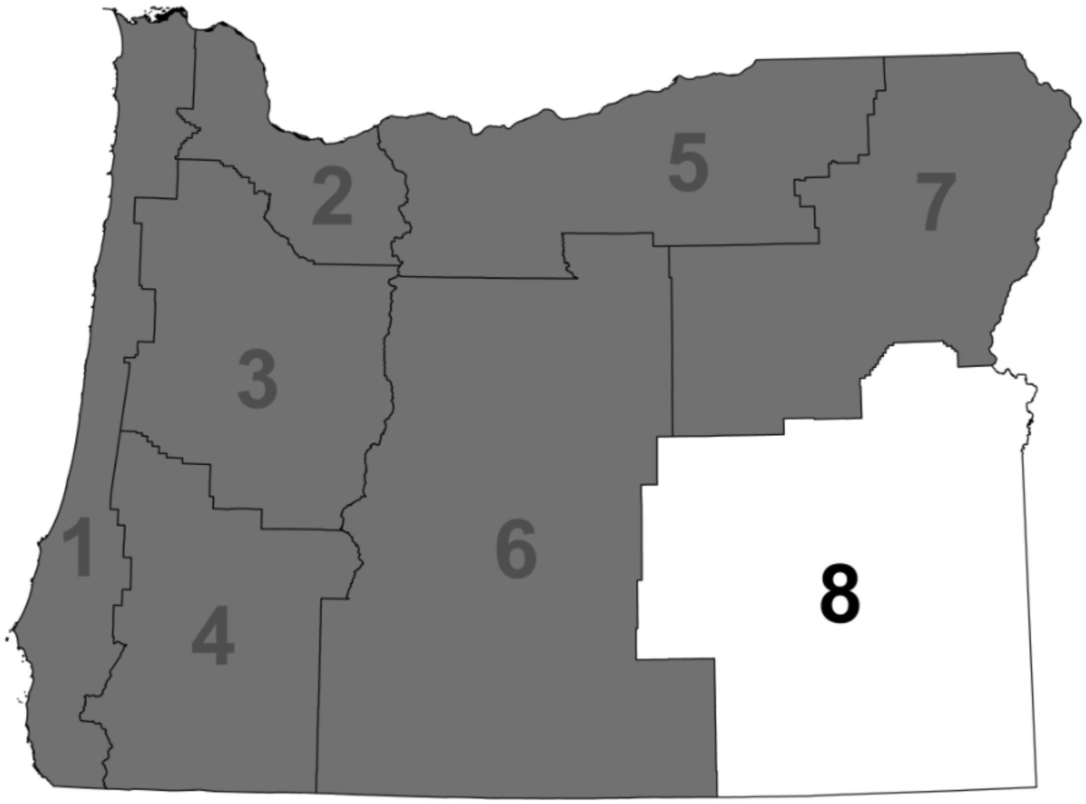
Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 7 counties are known for cold, snowy winters. This region is a gateway for neighboring states Washington and Idaho and for the commodity flow to those states. In general, the region is prepared for winter storm events, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

2.3.8 Region 8: Southeast Oregon

Harney and Malheur Counties



2.3.8.1 Summary

Profile

Region 8's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 8 is driven by a declining population, low median household incomes, and high levels of poverty. In Harney County there are also a high percentages of seniors and people with disabilities. In Malheur County there are more tourists, higher percentages of people who do not speak English very well, a significant drop in already low incomes, and more family households with children.

This region is still recovering from the financial crisis that began in 2007. There are few key industries and employment sectors in Region 8. Regional wages remain below the state average. Harney County continues to suffer from high unemployment. Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Roads and railways are susceptible to winter storms and flooding. Many of the bridges in the area are distressed or deficient.

Wells and rivers are primary sources of drinking water for the region. The quality of these water bodies can be threatened by regional agricultural practices that use pesticides and herbicides and by naturally occurring minerals in the soil. Malheur Lake is especially vulnerable to high mineral content.

Southeast Oregon has two power-generating facilities: one hydroelectric facility and one geothermal facility. Oil and natural gas pipelines and electrical transmission lines running through this region support the regional economy and are vulnerable to disruptions and damage from natural hazard events.

Region 8 is largely rural and is losing population. The region has a high percentages of mobile homes and homes built before floodplain management and seismic building standards. This coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increases the vulnerability of development in Region 8.

Hazards and Vulnerability

Region 8 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in Region 8 and have a significant economic impact on agricultural, livestock, and natural resources. The U.S. Department of Agriculture designated droughts in Malheur and Harney County as primary natural disasters in May and June of 2013. Malheur County is considered one of the counties most vulnerable to drought in Oregon.

Dust Storms: Dust storms occur when strong winds carry fine silt, sand, and clay particles into the air. These storms can travel hundreds of miles at speeds of at least 25 miles per hour and can reach heights of over 10,000 feet. Dust storms are most common over the areas of dry land that are prevalent within this region. Malheur County is considered one of the counties most vulnerable to dust storms in the state.

Earthquakes: Two types of earthquakes affect Region 8: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Region 8 is moderately vulnerable to earthquake-induced landslides, liquefaction, and ground shaking. There are 211 state-owned/leased facilities, valued at over $284.5 million, in this region. Of these, 53 are critical/essential facilities. An additional 153 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Floods affect Southeast Oregon in the form of riverine flooding often preceded by rapid snowmelt during unseasonably warm winters, ice jams, and closed basin playa flooding. Flash floods and associated summer thunderstorms are also possible. Both counties are considered to have a moderately low vulnerability to the flood hazard. However, the City of Burns has a high ratio of special flood hazard area to city area. There are 36 state-owned/leased facilities, valued at approximately $14.7 million, located in the region's flood hazard zone. Of these, six are considered critical/essential facilities. An additional 48 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. In general, landslide vulnerability for Region 8 is low to moderate. However, there are some areas that have very high landslide risk: the Summer Lake area along OR-31, around Lakeview, and along US-395. There are 266 state-owned/leased facilities in this region, valued at over $303 million. Of these, 64 are critical/essential facilities. An additional 192 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Though the volcanic Cascade Range is not in Region 8 and vulnerability to effects of volcanic eruptions is low, there is some threat of ashfall from Cascade volcanic eruptions. More locally, the region is also vulnerable to small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. The communities in Southeast Oregon most vulnerable to volcanic activity are the Cities of Burns, Ontario, and Jordan Valley.

Wildfires: The region's arid climate, frequent lightning strikes, large tracts of ponderosa pine forests (primarily in the northern part of Harney County), and grasslands all contribute to Region 8's vulnerability to wildfire. Past management practices that suppressed all wildfires and favored growth of a brushy understory and accumulation of dead or dying trees have led to devastating fires today. State and federal agencies seek to alleviate the problem through a controlled burning program. Areas of higher vulnerability are within wildland-urban interface communities. There are 117 state-owned/leased facilities located in this region's wildfire hazard zone with a value of approximately $41 million. Of these, 19 are identified as critical/essential facilities. An additional 135 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms in Region 8 are commonly associated with thunderstorms. Wind storms can be especially problematic in burned areas, where dust becomes airborne reducing visibility and causing localized damage. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland. Small tornadoes also have the potential to impact this region.

Winter Storms: This region is known for winter storms that bring cold weather and 24 inches of snow annually. Moderate to heavy snowfall is expected in this region, and residents and tourists are usually prepared for them.

Climate Change

The most reliable information on climate change to date is at the state level. The state information indicates that hazards projected to be impacted by climate change in Region 8 include drought and wildfire. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. An increase in drought could result in the increase incidence of dust storms, though no current research is available on the direct effects of future climate conditions on the incidence of dust storms. Areas that have historically been both hotter and drier than the statewide average — such as Eastern Oregon counties — are at somewhat higher risk of increased drought and wildfire than the state overall. While winter storms and windstorms affect Region 8, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the section **Introduction to Climate Change**.

2.3.8.2 Profile

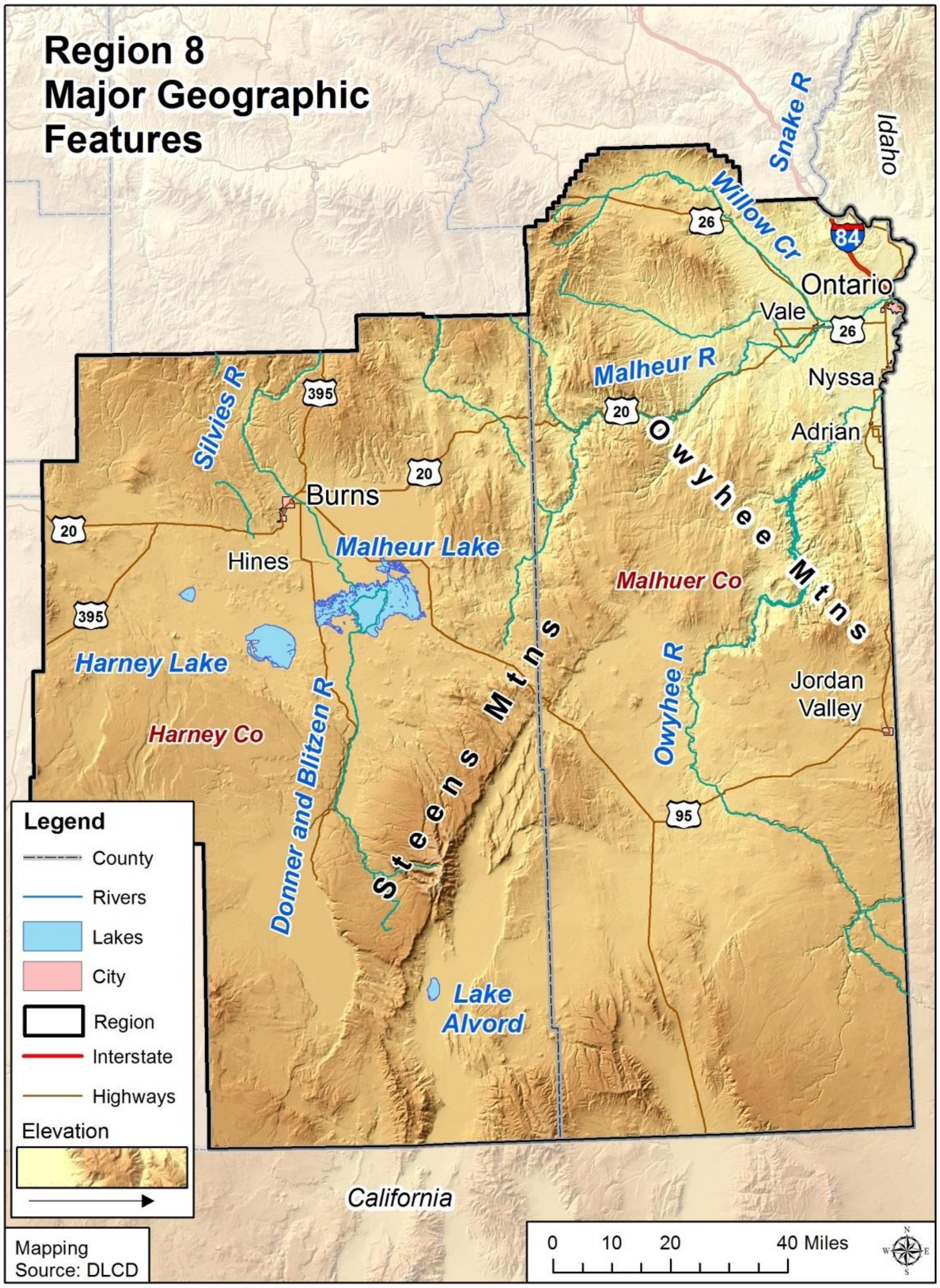
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Region 8 is approximately 20,023 square miles in size and contains Harney and Malheur Counties. The region is bordered to the east by Idaho and to the south by Nevada and California. The Blue Mountains lie in the northern part of the region. Steens Mountain is a prominent landmass in the region and major rivers in the region include the Malheur and Owyhee.

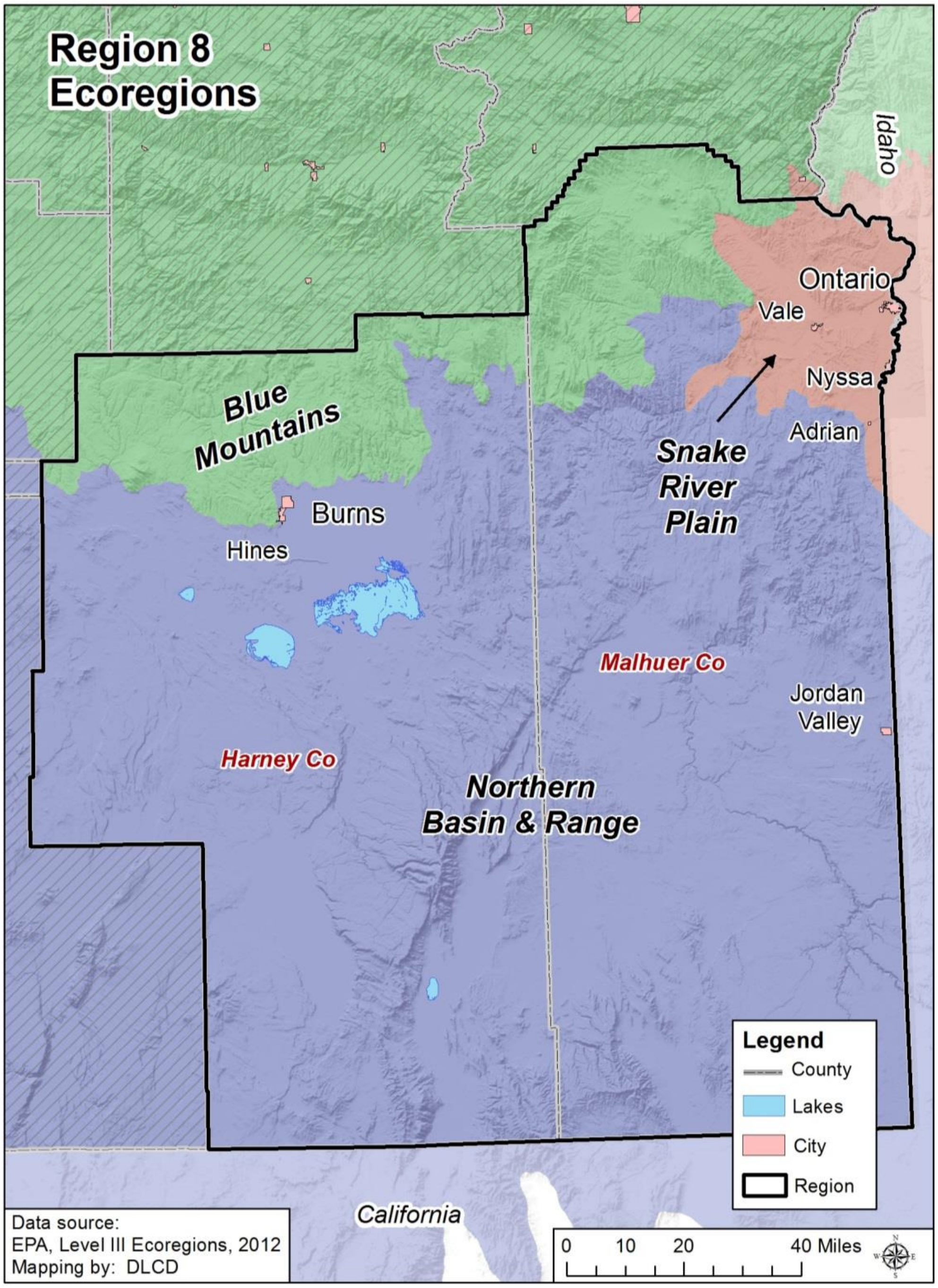
Figure 2-217. Region 8 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 8 is composed of three ecoregions: Northern Basin and Range, Blue Mountains, and Snake River Plain (**Figure 2-218**).

Figure 2-218. Region 8 Ecoregions



Blue Mountains: The Region 8 section of this ecoregion is complex and diverse having many sub-ecoregions with unique conditions. The landscape varies between steep sloped mountains of volcanic origin, scattered cinder cones, foothills, scattered buttes, and the Cold Basins, which contain cold, wet valleys, and basins. Forested areas may have ponderosa pine, mixed fir, or juniper canopies. Unforested areas are generally sagebrush steppes or wetlands with vegetation such as sedges and associated grasses. Land uses in the area are primarily livestock grazing and wildlife habitat (Thorson et al., 2003).

Northern Basin and Range: This ecoregion dominates Region 8 with dissected lava plains, rolling hills, alluvial fans, valleys, deep river canyons, and scattered mountains. Because of the ecoregion's location in the rain shadow of the Cascades and Blue Mountains, most areas are arid or semi-arid. Basaltic rock, tuffaceous rock, or volcanic ash are dominant rock types, while soil generally varies between sediments, alluvial, colluvial and fluvial deposits, and rock outcrops. Land cover varies between sagebrush steppe, grasslands, rare wetlands, aspen stands in riparian meadows, and unvegetated deserts. Land uses in this ecoregion include recreation, wildlife habitat including federal wildlife refuges, and limited livestock grazing (Thorson et al., 2003).

Snake River Plan: The Region 8 portion of the Snake River Plain ecoregion is classified as the "Unwooded Alkaline Foothills" and "Treasure Valley," which are underlain by volcanic and sedimentary rocks with alkaline lacustrine sediments and alluvium, loess, lacustrine and alluvial fan deposits at the surface. The landscape includes valleys, incised rivers, canals, rolling foothills, hills, benches, alluvial fans, and badlands. The land cover is dominated by sagebrush steppe with Wyoming big sagebrush, basin big sagebrush and associated grasses. Land uses in this ecoregion include croplands (potatoes, onions, beets, alfalfa, hay, wheat and sugar) as well as pastureland and wildlife habitat (Thorson et al., 2003).

Climate

Climate refers to the temperatures, weather patterns, and precipitation in the region. This section covers historic climate information. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Region 8 has diverse ecoregions with varying climatic conditions. The majority of the region's land is in the Northern Basin and Range ecoregion. The region's predominantly arid climate supports limited agricultural activities, primarily livestock grazing. The region is subject to droughts, floods, landslides, and wildfires. When considering the climate, snowfall should also be taken into account. Flooding can be a direct result of rain-on-snow events. Likewise, the amount of snowpack in a region can also impact the ability of communities to cope with drought. **Table 2-481** shows mean annual precipitation and temperatures for the three ecoregions in Region 8. Temperature and precipitation vary widely by sub-ecoregion and microclimates. For more detailed and locally relevant climate data refer to the Oregon Climate Service.

Table 2-481. Average Precipitation and Temperature Ranges in Region 8 Ecoregions

Ecoregion	Mean Annual Precipitation Range (inches)	Mean Temperature Range (°F) January min/max	Mean Temperature Range (°F) July min/max
Northern Basin and Range*	6–45	17/42	42/88
Blue Mountains*	9–35	16/39	43/84
Snake River Plain*	8–12	19/35	57/96

*Data have been generalized from all the sub-ecoregions of the ecoregion in Region 8.

Source: Thorson et al. (2003)

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter et al., 2003). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Overall, between 2000 and 2013, Region 8 lost population. Harney County lost a greater share of its population than Malheur County. By 2020, the region is expected to grow at about half the rate of the state with Malheur County projected to grow at a higher rate than Harney.

Table 2-482. Population Estimate and Forecast for Region 8

	2000	2013	Percent Change (2000 to 2013)	2020 Projected	Percent Change (2013 to 2020)
Oregon	3,421,399	3,919,020	14.5%	4,252,100	8.5%
Region 8	39,224	38,700	-1.3%	40,127	3.7%
Harney	7,609	7,260	-4.6%	7,404	2.0%
Malheur	31,615	31,440	-0.6%	32,723	4.1%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2000 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 8 are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history and culture), and special events (such as fairs, festivals or sporting events) (Longwoods Travel USA., 2011d). Note that the Longwoods Travel Report includes all of the Region 8 counties; Baker, Grant, Union, and Wallowa (Region 7); and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region. Approximately 8% (2.2 million) of all overnight visitor trips to Oregon included time within Region 8. Three fourths of all trips to the region occur between April and September, and the average travel party contains 3.8 persons. The average trip length is 4.3 nights (Longwoods Travel USA., 2011d).

Annually there are about twice as many tourists in Malheur County than Harney County. Visitors to Malheur County are more likely to stay in hotels, motels, or private homes. In Harney County visitors are just as likely to be lodged in hotels, motels, private homes, or other accommodations.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-483. Annual Visitor Estimates in Person Nights in Region 8

	2011		2012		2013	
	Number	Percent	Number	Percent	Number	Percent
Region 8	874	—	892	—	866	—
Harney	249	100%	259	100%	251	100%
Hotel/Motel	84	33.7%	93	35.9%	87	34.7%
Private Home	74	29.7%	74	28.6%	70	27.9%
Other	91	36.5%	92	35.5%	94	37.5%
Malheur	625	100%	633	100%	615	100%
Hotel/Motel	221	35.4%	228	36.0%	214	34.8%
Private Home	307	49.1%	308	48.7%	303	49.3%
Other	97	15.5%	97	15.3%	98	15.9%

Source: Oregon Travel Impacts: 1991–2013, April 2014. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations, while difficult to identify and measure, are disproportionately affected during disasters (Cutter et al., 2003). More people in Region 8 identify as having a disability than do people throughout the state. Most of the region's people with disabilities, both children (under 18) and seniors (65 and older), reside in Harney County. More than half of Harney County's seniors report a disability, and over 40% of Malheur County's do as well. Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events.

Table 2-484. People with a Disability by Age Groups in Region 8, 2012

	Total Population*	With a Disability		Under 18 Years with a Disability		65 Years and Over with a Disability	
	Estimate	Estimate	Percent	Estimate	Percent**	Estimate	Percent**
Oregon	3,796,881	511,297	13.5%	39,439	4.6%	200,374	37.8%
Region 8	35,427	5,991	16.9%	411	4.3%	2,694	46.2%
Harney	7,219	1,532	21.2%	120	7.4%	736	54.2%
Malheur	28,208	4,459	15.8%	291	3.7%	1,958	43.7%

*Total population does not include institutionalized population

**Percent of age group

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

Population estimates of the homeless in Oregon are performed each January. These are rough estimates and can fluctuate with many factors, including the economy or season. The overwhelming majority of homeless are either single adult males or families with children. Communities located along major transportation corridors, such as I-84, tend to have higher concentrations of homeless populations (Thomas et al., 2008). The numbers of homeless people in Region 8 increased from 2009 to 2010, and then decreased by 2011. Almost all homeless persons in the region live in Malheur County.

Extra attention is needed to care for and serve homeless communities. Some homeless people choose to remain hidden or anonymous, making it especially difficult to mitigate harm to them from natural hazard events. Accessible shelter and social services are key emergency considerations for the homeless community.

Table 2-485. Homeless Population Estimate for Region 8

	2009	2010	2011	3-Year Average
Oregon	17,122	19,208	22,116	19,482
Region 8	205	124	56	128
Harney	3	16	3	7
Malheur	202	108	53	121

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services. http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx

Gender

There are 8% more males than females in Region 8 (U.S. Census Bureau; n.d.). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities (Cutter et al., 2003).

Age

The senior population in Malheur County is similar to that of the state. A 5% greater share of the population in Harney County is 65 years and older. Senior citizens may require special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, the elderly may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to the elderly (Morrow, 1999).

Similar to the state, about one quarter of the region's population are children. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents may lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter et al., 2003).

Table 2-486. Population by Vulnerable Age Groups, in Region 8, 2012

	Total Population	Under 18 Years Old		65 Years and Older	
	Estimate	Estimate	Percent	Estimate	Percent
Oregon	3,836,628	864,243	22.5%	540,527	14.1%
Region 8	38,416	9,543	24.8%	6,085	15.8%
Harney	7,359	1,646	22.4%	1,404	19.1%
Malheur	31,057	7,897	25.4%	4,681	15.1%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP05

Language

Almost 11% of the people in Malheur County do not speak English “very well.” The number of people in Harney County who do not speak English “very well” is negligible. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

Table 2-487. English Usage in Region 8, 2012

	Speak English "Very Well"		Speak English Less Than "Very Well"	
	Estimate	**Percent**	**Estimate**	**Percent**
Oregon	3,376,744	93.8%	224,905	6.2%
Region 8	32,743	91.5%	3,055	8.5%
Harney	6,925	99.4%	40	0.6%
Malheur	25,818	89.5%	3,015	10.5%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Income

The impact of a disaster in terms of loss and the ability to recover varies among population groups. “The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event” (Cutter, 2006, p. 76). Historically, 80% of the disaster burden falls on the public. Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

Median household incomes in Malheur County have been particularly impacted since the financial crisis that began in 2007 — a 12% decrease between 2009 and 2012. Harney County’s decrease in median household income over the same period is about the same as the state’s.

Table 2-488. Median Household Income in Region 8

	2009	2012	Percent Change
Oregon	$52,474	$50,036	-4.6%
Region 8	N/A	N/A	N/A
Harney	$41,506	$39,674	-4.4%
Malheur	$42,260	$37,191	-12.0%

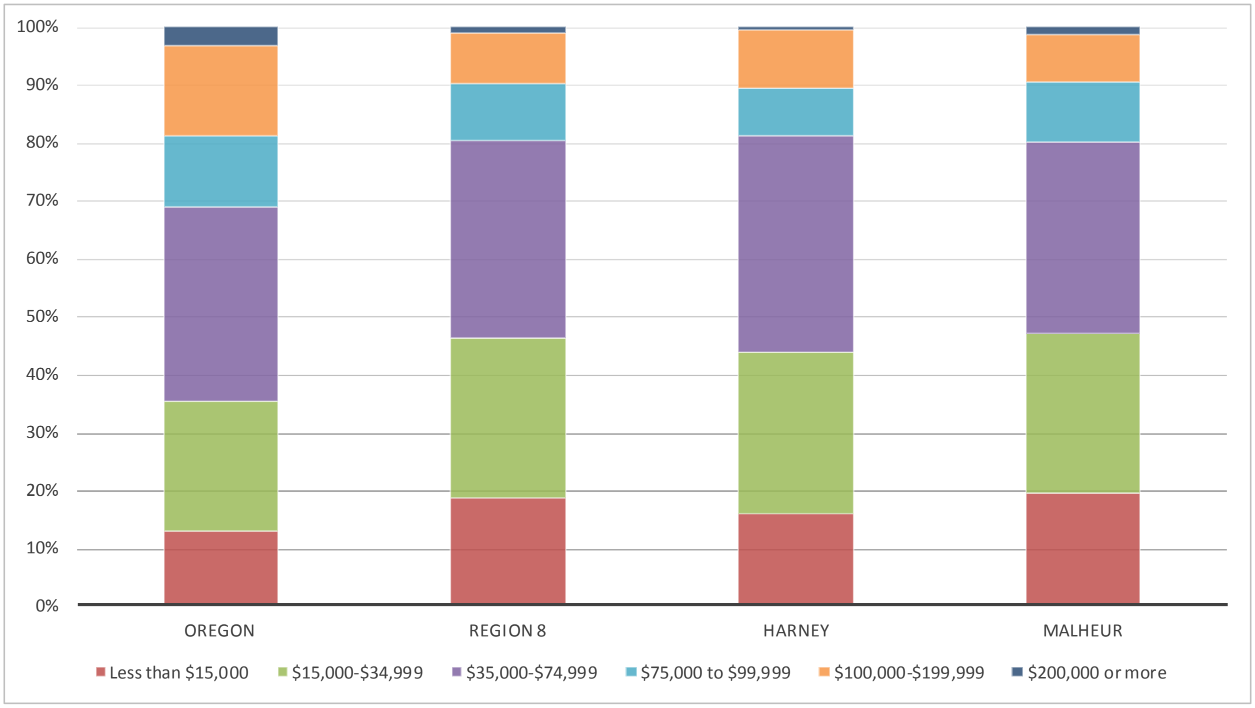
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics’ Consumer Price Index Inflation Calculator.

N/A = data not aggregated at the regional level.

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates. Table DP03.

Eleven percent more of Region 8’s households earn less than $35,000 annually compared to households statewide. Also compared to the state, 22% fewer of the region’s households are in upper income brackets, earning more than $75,000.

Figure 2-219. Median Household Income Distribution in Region 8, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

Eight percent more individuals and about 12% more children in Region 8 live in poverty than the state overall. One quarter of Malheur County's population lives in poverty. Child poverty increased by more than 56% in Harney County between 2009 and 2012. Overall, the poverty rate in both counties increased more than twice as fast as the state's.

Table 2-489. Poverty Rates in Region 8, 2012

	Total Population in Poverty			Children Under 18 in Poverty		
	Number	Percent	Percent Change*	Number	Percent	Percent Change*
Oregon	584,059	15.5%	17.7%	175,303	20.6%	17.6%
Region 8	8,372	23.8%	44.8%	3,024	32.3%	31.8%
Harney	1,379	19.1%	39.0%	467	29.0%	56.7%
Malheur	6,993	25.0%	46.1%	2,557	33.0%	28.1%

Percent change since 2009

Source: U.S. Census Bureau. 2005–2009 and 2008–2012. American Community Survey – 5-Year Estimates, Table S1701

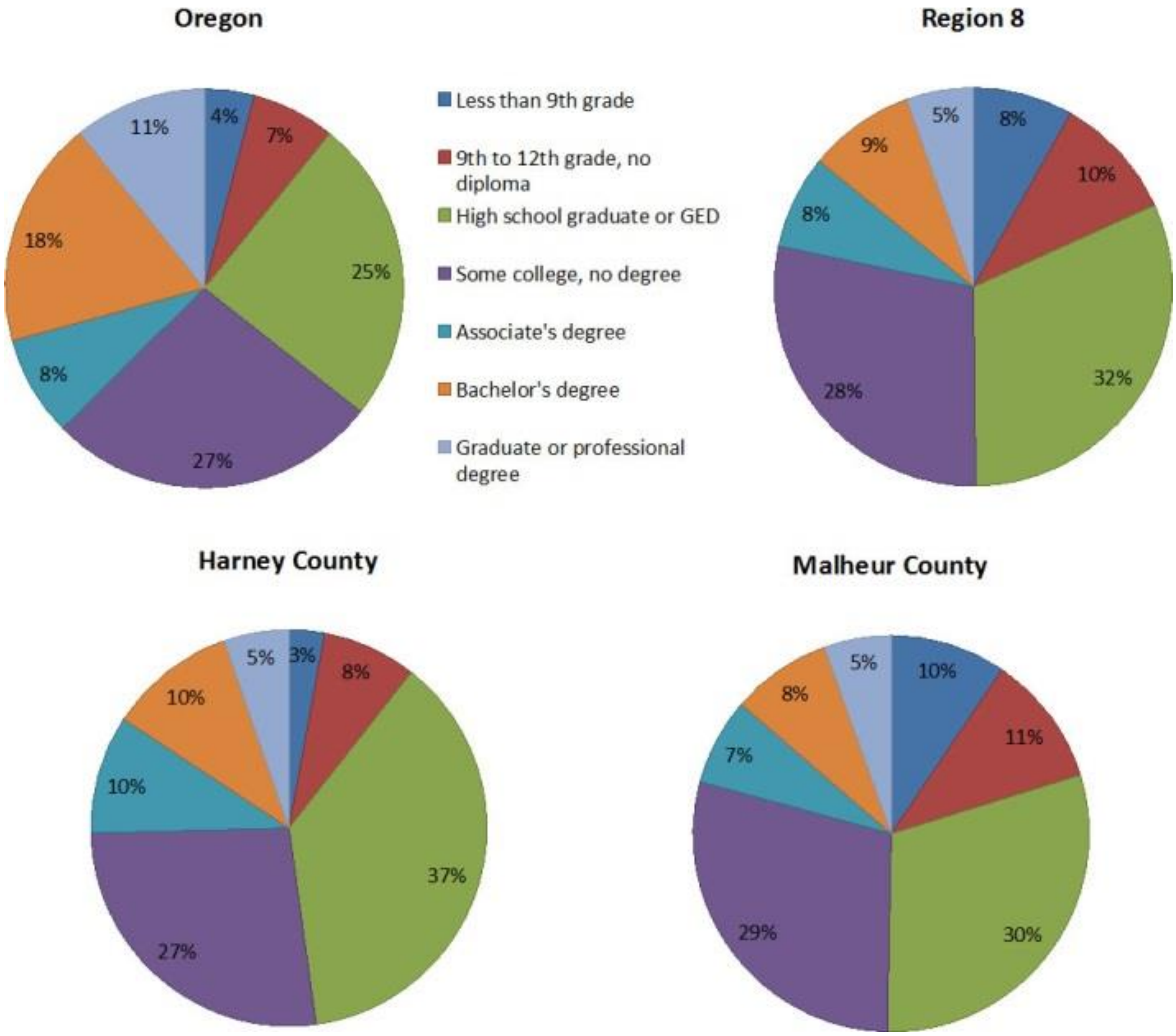
Low-income populations require special consideration when mitigating loss from a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter et al., 2003).

Education Level

Studies (Cutter et al., 2003) show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings. The region has a 7% higher share of high school graduates (including GEDs) and a 15% lower share of persons with a college degree compared to state percentages.

Education can influence the ability to access resources, while lack of resources may constrain the ability to understand warning information (Cutter et al., 2003). Therefore, levels of education within the region should be considered when designing hazard outreach materials to local communities.

Figure 2-220. Educational Attainment in Region 8, 2012



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

Housing Tenure

Wealth can increase the ability to recover following a natural disaster (Cutter et al., 2003), and homeownership, versus renting, is often linked to having more wealth. Renters often do not have personal financial resources or insurance to help recover post-disaster. On the other hand, renters tend to be more mobile and have fewer assets at risk. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable or unaffordable due to natural disaster events.

Similar to statewide numbers, about 36% of housing units in the region are rentals. The share of vacant units in Malheur County is almost double the share statewide vacancies state. Harney County has a greater share of seasonal and recreational homes (U.S. Census Bureau, 2008–2012 American Community Survey, Table DP04 and Table B25004).

Table 2-490. Housing Tenure in Region 8, 2012

	Total Occupied Units	Owner Occupied		Renter Occupied		Vacant*	
		Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	945,824	62.5%	566,894	37.5%	105,417	6.3%
Region 8	13,320	8,567	64.3%	4,753	35.7%	1,654	10.7%
Harney	3,186	2,045	64.2%	1,141	35.8%	350	9.2%
Malheur	10,134	6,522	64.4%	3,612	35.6%	1,304	11.2%

*Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04 and Table B25004.

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Region 8 is predominantly composed of family households. Roughly one third of households in Malheur County have families with children. Similar to statewide numbers, there are about twice as many single-parent households headed by females than by males.

Table 2-491. Family vs. Non-family Households in Region 8, 2012

	Total Households	Family Households		Nonfamily Households		Householder Living Alone	
	Estimate	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	1,512,718	964,274	63.7%	548,444	36.3%	421,620	27.9%
Region 8	13,320	9,090	68.2%	4,230	31.8%	3,637	27.3%
Harney	3,186	2,119	66.5%	1,067	33.5%	877	27.5%
Malheur	10,134	6,971	68.8%	3,163	31.2%	2,760	27.2%

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Table 2-492. Family Households with Children by Head of Household in Region 8, 2012

	Family Households with Children		Single Parent (Male)		Single Parent (Female)		Married Couple with Children	
	Estimate	Percent	Estimate	Percent	Estimate	Percent	Estimate	Percent
Oregon	415,538	27.5%	35,855	2.4%	93,575	6.2%	415,538	27.5%
Region 8	4,018	30.2%	400	3.0%	853	6.4%	4,018	30.2%
Harney	784	24.6%	83	2.6%	171	5.4%	784	24.6%
Malheur	3,234	31.9%	317	3.1%	682	6.7%	3,234	31.9%

Note: The table shows the percent of total households represented by each family household structure category.

Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP04

Social and Demographic Trends

This analysis shows that Region 8 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event, because:

- Population is declining, with marginal growth expected by 2020.
- Less than 20% of the population reports a disability, but of these over 50% are children and seniors.
- In Malheur County a high percentage of the population does not speak English "very well."
- Region 8 has low median household incomes overall; Malheur County has suffered a significant drop.
- The region has high poverty levels.
- Malheur County has a higher percentage of family households with children than the state overall.

Economy

Employment

Employment status and salary level may impact the resilience of individuals and families in the face of disasters as well as their ability to mitigate against natural hazards (Cutter et al., 2003). "The potential loss of employment following a disaster exacerbates the number of unemployed workers in a community, contributing to a slower recovery from the disaster" (Cutter et al., 2003). The region is still recovering from the financial crisis that began in 2007. Recent statistics show that nonfarm job counts are down in the region's counties (Tauer, 2014). Harney County's unemployment rate is 5% higher than the state's. Salaries are only 72% of the state average.

Table 2-493. Unemployment Rates in Region 8, 2009–2013

	2009	2010	2011	2012	2013	Change (2009–2013)
Oregon	11.1%	10.8%	9.7%	8.8%	7.7%	-3.4%
Region 8	11.9%	11.7%	11.1%	10.5%	9.4%	-2.5%
Harney	16.1%	15.7%	14.7%	12.8%	12.3%	-3.8%
Malheur	10.7%	10.7%	10.2%	9.9%	8.7%	-2.0%

Source: Oregon Employment Department, 2014

Table 2-494. Employment and Unemployment Rates in Region 8, 2013

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	1,924,604	1,775,890	92.3%	148,714	7.7%
Region 8	15,727	14,245	90.6%	1,482	9.4%
Harney	3,129	2,743	87.7%	386	12.3%
Malheur	12,598	11,502	91.3%	1,096	8.7%

Source: Oregon Employment Department, 2014

Table 2-495. Employment and Payroll in Region 8, 2013

	Employees	Average Pay	Percent State Average
Oregon	1,679,364	$45,010	100%
Region 8	14,572	$32,171	71.5%
Harney	2,175	$32,786	72.8%
Malheur	12,397	$32,063	71.2%

Source: Oregon Employment Department, 2014

Employment Sectors and Key Industries

In 2013 the five major employment sectors in Region 8 were: (a) Government; (b) Trade, Transportation, and Utilities; (c) Education and Health Services; (d) Natural Resources and Mining; and (e) Leisure and Hospitality. Table 2-496 shows the distribution of total employment across all sectors. Region 8 is composed of Oregon Employment Department Region 14 (Southeast Oregon). The Southeast Oregon Region (Grant, Harney, Malheur) is expected to have a 9% increase in employment between 2012 and 2022 (Oregon Employment Department, n.d.b).

Table 2-496. Covered Employment by Sector in Region 8, 2013

		Harney		Malheur	
Industry	**Region 8**	**Employment**	**Percent**	**Employment**	**Percent**
Total All Ownerships	14,572	2,175	100%	12,397	100%
Total Private Coverage	71.3%	1,184	54.4%	9,200	74.2%
Natural Resources & Mining	9.2%	166	7.6%	1,172	9.5%
Construction	1.8%	66	3.0%	202	1.6%
Manufacturing	6.2%	(c)	-	897	7.2%
Trade, Transportation & Utilities	22.5%	352	16.2%	2,932	23.7%
Information	1.4%	13	0.6%	186	1.5%
Financial Activities	2.4%	56	2.6%	297	2.4%
Professional & Business Services	3.7%	82	3.8%	454	3.7%
Education & Health Services	12.7%	178	8.2%	1,672	13.5%
Leisure & Hospitality	9.0%	222	10.2%	1,096	8.8%
Other Services	2.3%	44	2.0%	291	2.3%
Private Non-Classified	0.0%	(c)	-	(c)	-
Total All Government	28.7%	991	45.6%	3,197	25.8%
Federal Government	3.1%	243	11.2%	216	1.7%
State Government	9.2%	130	6.0%	1,215	9.8%
Local Government	16.4%	618	28.4%	1,767	14.3%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department, 2013

Each industry faces distinct vulnerabilities to natural hazards. Identifying key industries in the region enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment sectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

Natural Resources and Mining: The primary industries within this sector regionally are largely crop and animal production. These industries tend to fluctuate seasonally and are vulnerable to a variety of natural hazard (winter storms, floods, etc.). Further, to the loss of farm production, wages could be lost due to natural disasters. In addition, these industries are dependent upon transportation systems that are vulnerable to disasters.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Revenue by Sector

In 2007 Trade (Retail and Wholesale), Manufacturing, and Healthcare and Social Assistance were the highest revenue grossing industries in Region 8. (Note that revenue data from the 2012 Economic Census will not be released prior to the publication of this Plan.) Combined, these three industries generated over $691 million (89% of total revenue) for the region. Trade (Retail and Wholesale) is the largest grossing reported sector in the region. Note: Due to the small size and few industries in the region the collected data are withheld in several categories to avoid disclosing data for individual companies. Data are aggregated to the county level.

Table 2-497. Revenue of Top Industries (in Thousands of Dollars) in Region 8, 2007

	Total Revenue (in Thousands)	Trade (Retail and Wholesale)	Manufacturing	Health Care and Social Assistance
Oregon	$277,017,733	44.4%	24.1%	7.3%
Region 8	$778,079	73.9%	—	14.9%
Harney	$114,461	79.1%	—	D
Malheur	$663,618	73.0%	D	17.5%

Source: U.S. Census, Economic Census. 2007, Table ECO700A1. Notes: D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals, and "-" = data not provided.

Sectors that are anticipated to be major employers in the future warrant special attention, especially in the hazard mitigation planning process so the workforce and employers can be more prepared to respond and adapt to needs that arise after a natural hazard event. Between 2012 and 2022, the largest job growth in Region 8 is expected to occur in the following sectors: (a) Natural Resources and Mining; (b) Education and Health Services; (c) Trade, Transportation, and Utilities (including retail trade); (d) Government; and (e) Leisure and Hospitality (Oregon Employment Department, 2014).

Identifying sectors with a large number of businesses and targeting mitigation strategies to support those sectors can help the region's resiliency. The Trade, Transportation, and Utilities sector includes the most businesses in Region, 20.2% of all businesses. Government (particularly local government) has the second most number of businesses. Natural Resources and Mining, Education and Health Services, and the Leisure and Hospitality round out the top five sectors in the region (Oregon Employment Department, 2012). While many of these are small businesses, employing fewer than 20 employees, collectively they represent almost two thirds of the businesses in the region. Due to their small size and large collective share of the economy, these businesses are particularly sensitive to temporary decreases in demand, such as may occur following a natural hazard event.

Economic Trends and Issues

Current and anticipated financial conditions of a community are strong determinants of community resilience, since a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly. The economic analysis shows that Region 8 is particularly vulnerable during a hazard event due to the following characteristics:

- Consistently higher unemployment in Harney County, and
- Lower regional wages.

Region 8 is still recovering from the financial crisis that began in 2007. The health care industry sector and the region's service and professional occupations sectors spur much of the growth in employment within the region. Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

Roads

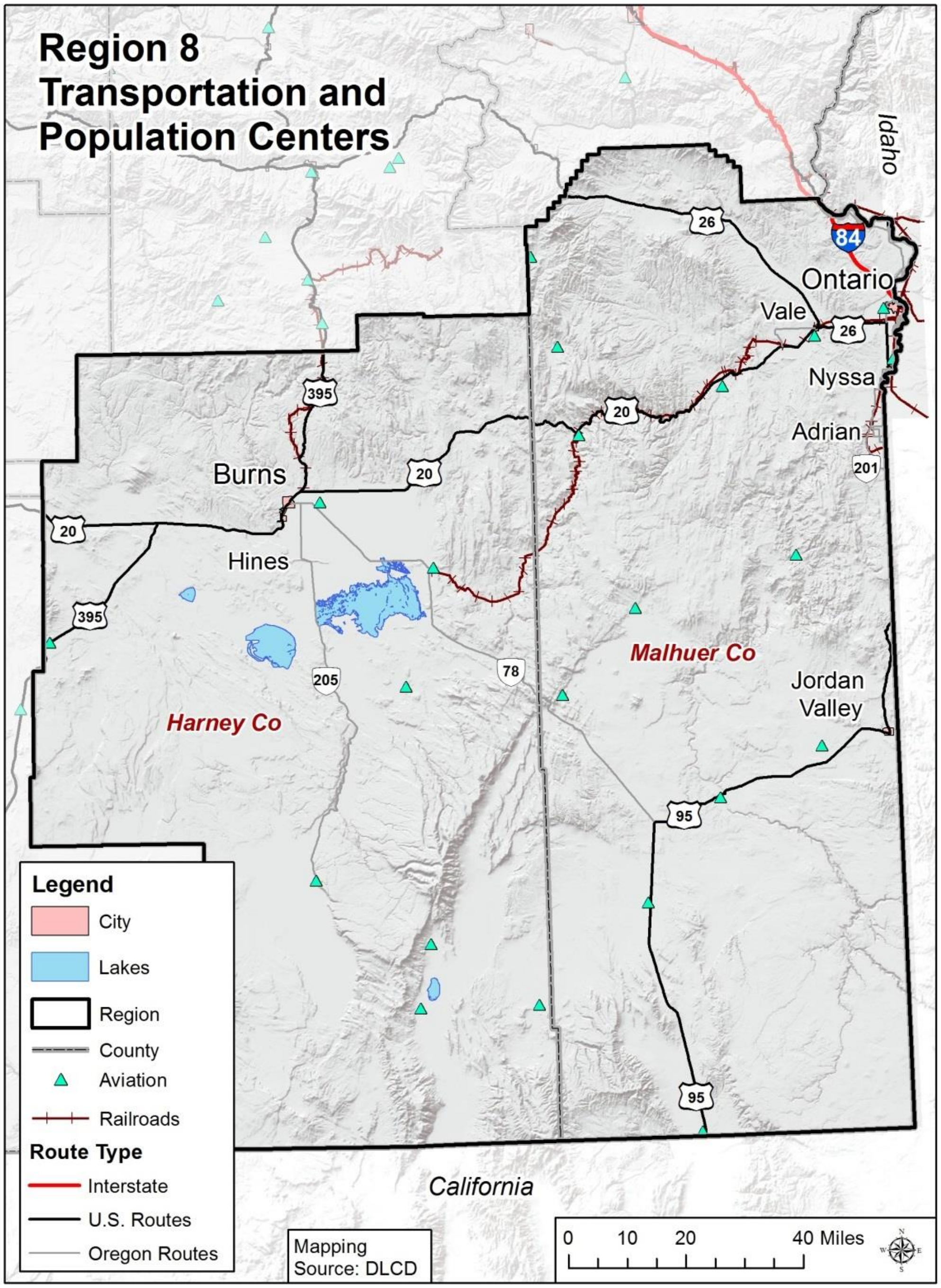
The largest population bases in Region 8 are located along the region's major highways: I-84, US-20, US-26, and US-95. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho. **Figure 2-221** shows Region 8's highways and population centers. US-20, US-26, and US-95 provide access east and west into Idaho and central Oregon counties. US-395 provides access into Lake County. Additional access is provided within Idaho to adjacent counties via US-30 and US-95.

Region 8's growing population centers bring more workers, automobiles, and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) Seismic Lifeline Report (**Appendix 9.1.13**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, economic disruption from major losses in the larger markets of the state will affect the economy in this region. For information on ODOT's Seismic Lifeline Report findings for Region 8, see **Seismic Lifelines**.

Figure 2-221. Region 8 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

Because of earthquake risk in Region 8, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities. For information on ODOT's Seismic Lifeline Report findings for Region 8, see **Seismic Lifelines**.

A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2012, 2013). The region has a lower percentage of bridges that are distressed and/or deficient than the state overall

Table 2-498. Bridge Inventory for Region 8

	State Owned			County Owned			City Owned			Other Owned			Area Total			Historic
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D	Covered
Oregon	610	2,718	22%	633	3,420	19%	160	614	26%	40	115	35%	1,443	6,769	21%	334
Region 8	7	111	6%	17	176	10%	0	0	0%	0	0	0%	24	287	8%	3
Harney	2	37	5%	9	71	13%	0	0	0%	0	0	0%	11	110	10%	0
Malheur	5	74	7%	8	105	8%	0	0	0%	0	0	0%	13	177	7%	3

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 8 support cargo and trade flows. The region's major freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The rail line follows the I-84 corridor and another non-Class I rail line provides access to the City of Vale. There are no active rail lines in Harney County. There are two rail yards in the region — in Ontario and Nyssa — operated by UP (Cambridge Systematics, 2014). There is no passenger rail available in Region 8.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 8. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region, however. There are several general aviation public airports including the Burns and Ontario Municipal airports.

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-499. Public and Private Airports in Region 8

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 8	6	17	0	1	24
Harney	1	8	0	0	9
Malheur	5	9	0	1	15

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Idaho Power is the primary investor-owned utility company serving Harney and Malheur Counties. The region's electric cooperatives include the Harney Electric Cooperative (Harney, Malheur), and the Oregon Trail Electric Cooperative (Harney).

Table 2-500 lists electric power-generating facilities that are within Region 8. The region has two power-generating facilities: one hydroelectric power facility and one geothermal facility. There is no power-generating facilities in Harney County. In total the power-generating facilities have the ability to produce up to 40 megawatts (MW) of electricity.

Table 2-500. Power Plants in Region 8

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 8	1	0	0	0	1	2
Harney	0	0	0	0	0	0
Malheur	1	0	0	0	1	2
Energy Production (MW)	35	0	0	0	5	40

*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

Hydropower

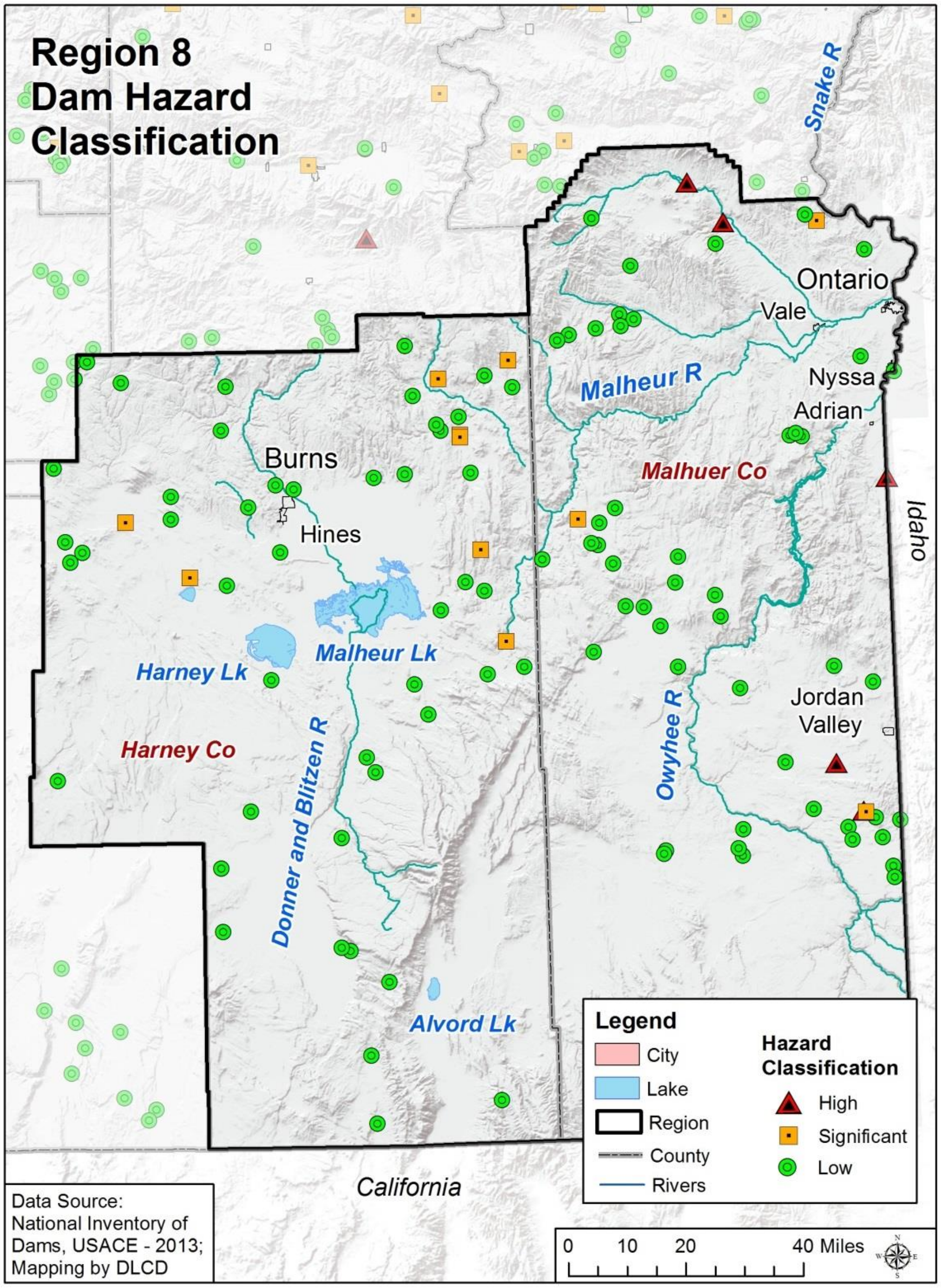
There are several major dams owned by Idaho Power along the Lower Snake River just north of the Region 8, which produce a significant amount of hydropower. Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist. The Oregon Water Resources Department maintains an inventory of all large dams located in Oregon (using the National Inventory of Dams (NID) threat potential methodology). **Table 2-501** lists the number of dams included in the inventory. Most dams in the region are located in Malheur County (146). All 10 of the High Threat Potential dams are within Malheur County. There are also 13 Significant Threat Potential dams in the region.

Table 2-501. Threat Potential of Dams in Region 8

	Threat Potential			Total Dams
	High	Significant	Low	
Region 8	10	13	216	239
Harney	0	9	84	93
Malheur	10	4	132	146

Source: Oregon Water Resources Department, Dam Inventory Query, 2014

Figure 2-222. Region 8 Dam Hazard Classification

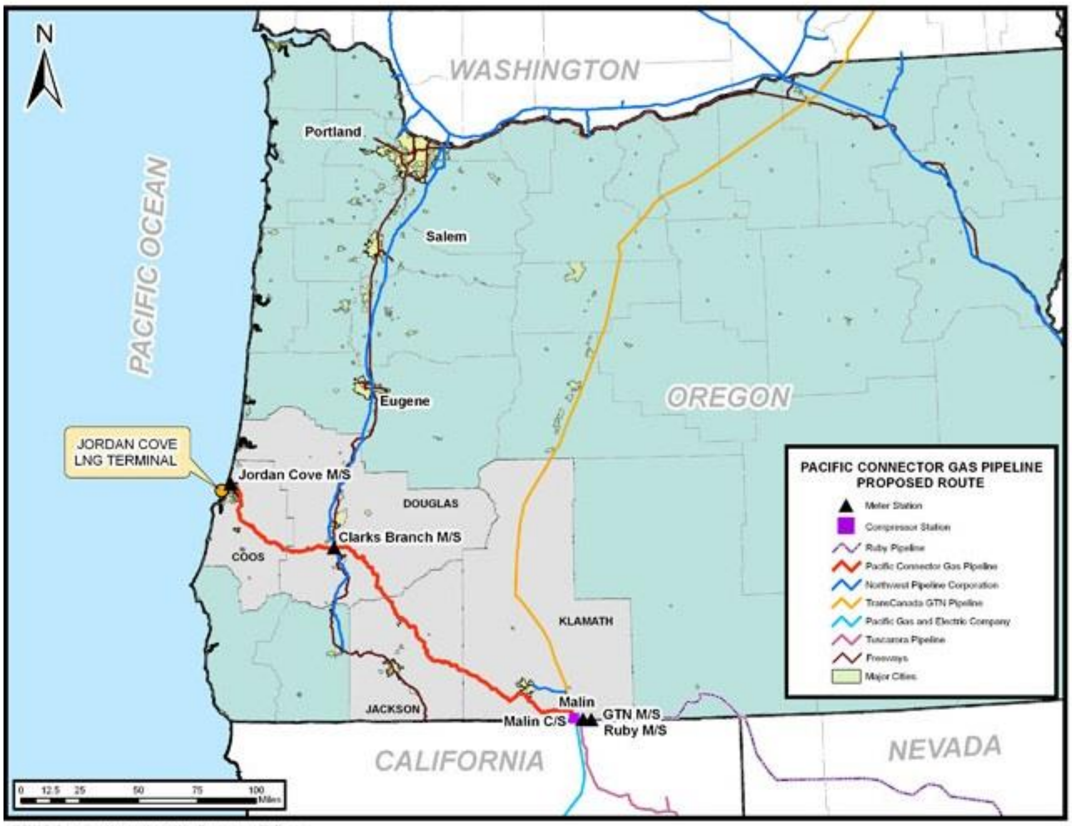


Source: National Inventory of Dams, USACE, 2013

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to the region's energy portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. **Figure 2-223** shows the Northwest Pipeline, which runs through Malheur County (near Ontario, shown in blue). (http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-223. Liquefied Natural Gas Pipelines in Region 8



Source: Williams Corporation

Utility Lifelines

The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes.

Region 8 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the region are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 8 is operated primarily by Idaho Power, Pacific Power, and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in southeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 8 is part of the Lake-Harney Operational Area under The Oregon State Emergency Alert System Plan (Oregon OEM, 2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages; however, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 8. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 8 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Station:

- KBHN-FM, 1230 KHZ (Burns); and

State Primary Station:

- KOBN-FM, 90.1 MHZ (Burns).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES District 6 provides service to Region 8. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 8 are (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Harney County: KF7CIS; and
- Malheur County: K&RHB.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In southeastern Oregon, the majority of municipal drinking water is supplied from groundwater wells, including in the cities of Burns and Hines. The City of Ontario primarily draws its drinking water from the Snake River. The City of Nyssa also has water rights for municipal water on the Snake River as a secondary water source. The City of Vale primarily relies on the Malheur River for drinking water and has groundwater wells as a backup water source. Rural areas in Malheur County draw drinking water from the Owyhee River, Beulah Reservoir, and Billy Creek. In Harney County, rural drinking water is drawn primarily from groundwater wells.

Irrigation water is generally pulled from surface sources and distributed through established irrigation districts in Malheur County. In Harney County, irrigation water is drawn from a combination of groundwater wells and surface sources including the Silvies, Donner und Blitzen River, and smaller tributary creeks.

There are several threats to the region’s water quality and quantity. In Malheur County agricultural products such as pesticides and herbicides leech nitrates into ground and surface water. Other concerns for water quality in Malheur County include naturally occurring arsenic and phosphorus in the soil and bacterial contaminants such as *Escherichia coli* (*E. coli*). Naturally occurring arsenic and other minerals threatens water quality in Harney County. Mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality threats in Harney County.

Water shortages have become common in Region 8. 2011 was the last year with a predictable water supply. The region had drought declarations for three consecutive years, from 2012 to 2014.

Low levels of snowpack can lead to severe shortages in a region that is already subject to annual shortages. Low precipitation levels can lead to low levels of groundwater recharge, which could impact both agricultural and municipal supplies. Additionally, no new water rights are available for surface water, although groundwater rights are still available in Malheur County.

At the time of this writing, water supply in irrigation districts is not meeting demand to sustain local agricultural operations. In 2014, irrigation water supplies are expected to be unavailable two and a half months less than usual. This is compounded by the fact that Harney County currently has no above-ground reservoir for municipalities or rural residents.

Underground water supplies and aging or outdated infrastructure such as reservoirs, treatment facilities, and pump stations can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 8, county and building codes (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so it enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. LID strategies are not required any community in Region 8. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Damage or service interruption to roads, bridges, and rail systems can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 8 to the rest of the state and neighboring states. Eight percent of all bridges in Region 8 are distressed or deficient. In Malheur County there are two rail yards, and rails that support cargo and trade flows and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Two power-generating facilities are located here, a hydroelectric and a geothermal facility. The majority of the region's dams are located in Malheur County. Ten have High Threat Potential dams and 13 have Significant Threat Potential. The northeast corner of Malheur County is an important throughway for oil and gas pipelines and electrical transmission lines. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover areas that are distant from major transportation routes. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Drinking water is primarily sourced from groundwater wells, the Snake River, Malheur River Owyhee River, Beulah Reservoir, and Billy Creek. These water bodies are vulnerable to pollution from agricultural pesticides and herbicides. Naturally occurring mineral concentrations become higher in proximity to Malheur Lake and during drought seasons, increasing water quality vulnerability in Harney County. No communities in the region require low impact development (LID) regulations.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Contrary to statewide patterns of urban growth and rural decline between 2000 and 2010, Region 8's urban populations shrank by about 13% and rural populations grew by roughly 15%. Harney County experienced a greater increase in housing units in both urban and rural communities. The region's population is clustered around the I-84 corridor and the cities of Burns, Hines, Ontario, and Vale.

Table 2-502. Urban and Rural Populations in Region 8

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 8	23,194	20,283	-12.6%	16,030	18,452	15.1%
Harney	4,330	4,131	-4.6%	3,279	3,291	0.4%
Malheur	18,864	16,152	-14.4%	12,751	15,161	18.9%

Note: The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition, therefore all of their populations are considered rural even though the counties include incorporated cities.

Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

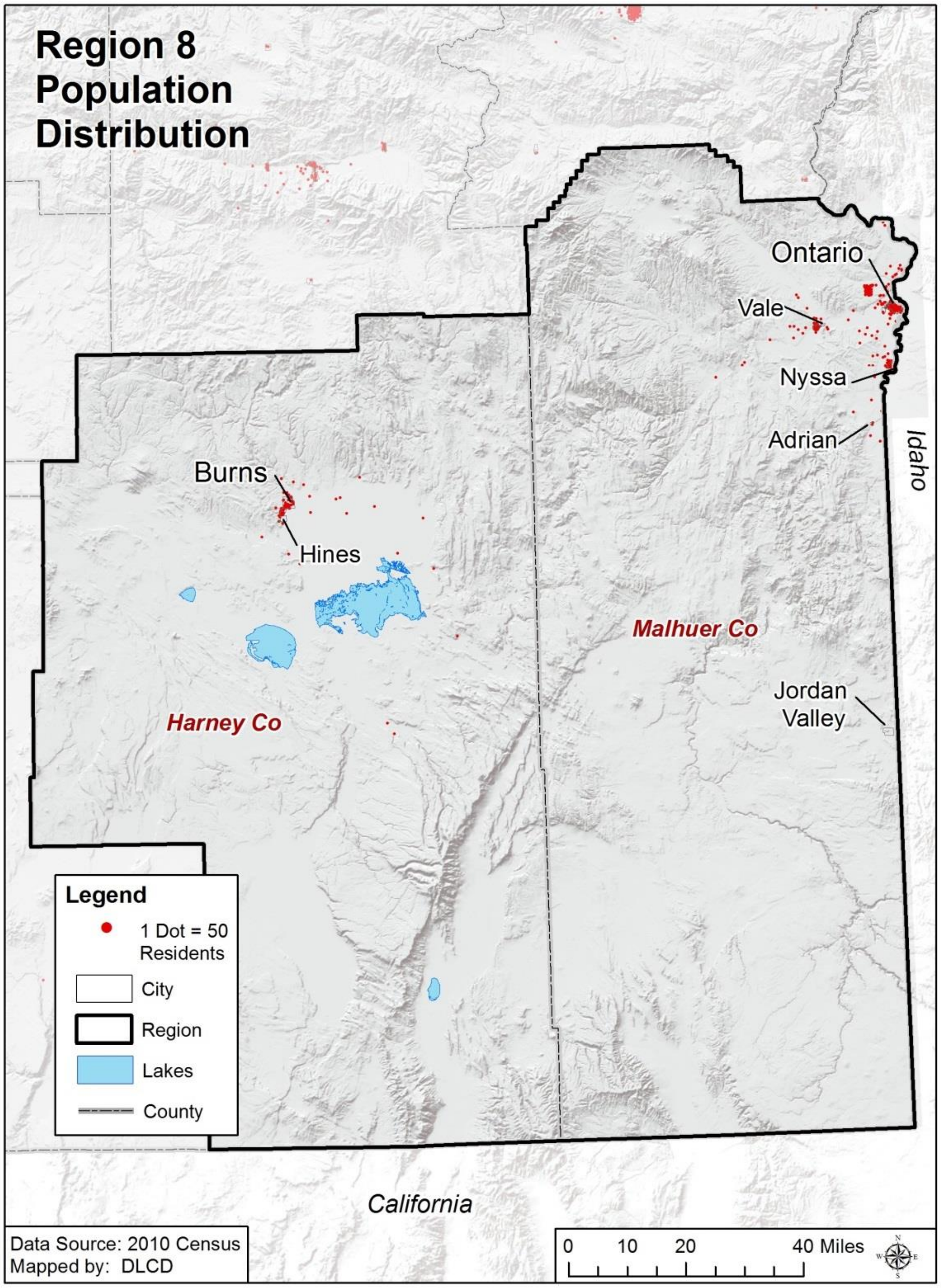
Table 2-503. Urban and Rural Housing Units in Region 8

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 8	8,186	8,453	3.3%	6,580	7,074	7.5%
Harney	1,990	2,111	6.1%	1,543	1,724	11.7%
Malheur	6,196	6,342	2.4%	5,037	5,350	6.2%

Note: The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition, therefore all of their populations are considered rural even though the counties include incorporated cities.

Source: U.S. Census Bureau. 2000 Decennial Census, Table H002 and 2010 Decennial Census, Table H2

Figure 2-224. Region 8 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

Similar to Region 7, the past 40 years have seen a slower pace of development of private land in Region 8 than in western Oregon. In this time period very little loss of private land in forest, agriculture, and range uses occurred. Land use programs have limited rural residential and urban development and have maintained large parcel sizes. Demand for large-scale development has historically been very low. To the extent it has occurred, it has generally been located along existing transportation corridors (DLCD, internal communications, 2014).

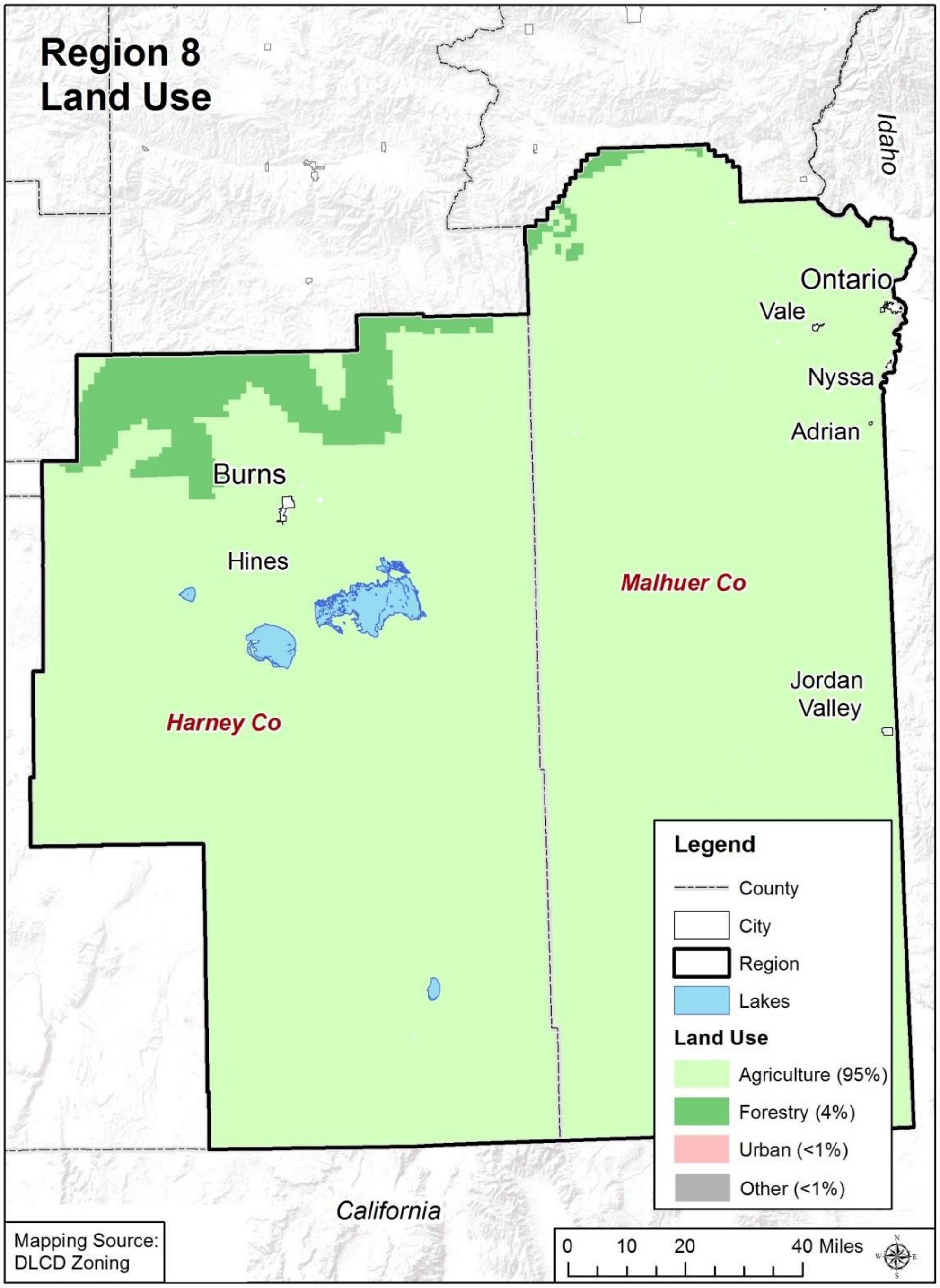
Malheur County's land ownership is just more than one fifth privately owned (22% private land) and a little less than four fifths publically owned (73% federal land and 4.5% state land). Harney County is similar, with 72% federal land, 25% private, and 3% state land.

Overall, Region 8 is overwhelmingly rangeland, with the Bureau of Land Management (BLM) controlling over 70% of the land. The land cover is largely grasslands and shrubs. Irrigated fields in the county's northeast corner, known as Western Treasure Valley, are the center of intensive and diversified farming.

The region's wide-open spaces have a total of only seven incorporated cities. Ontario, relatively close to the Boise, Idaho, metropolitan area is economically active. Burns-Hines is an important center for commerce as well as tourism. Timber and logging remained important to that local economy until the 1990s, when the area's last lumber mill closed for lack of timber.

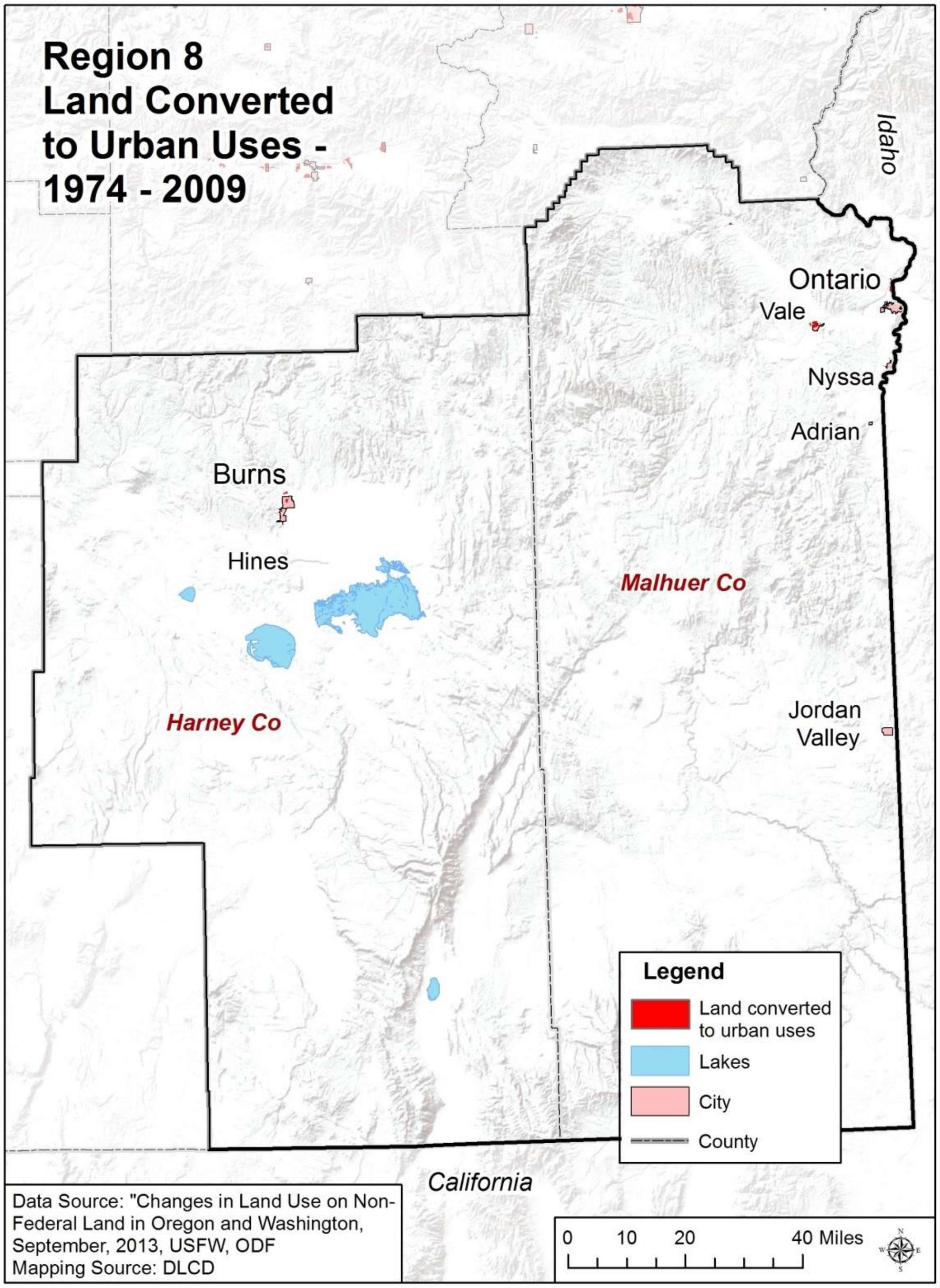
The Bureau of Land Management is considering a management plan designed protect the habitat of the sage grouse, possibly tightening uses of its land and capping how much human disturbance is allowed on the bird's core habitat. A number of stakeholders are working together to address loss of habitat while hoping to minimize potential impact on rangeland users.

Figure 2-225. Region 8 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-226. Region 8 Land Converted to Urban Uses, 1974–2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Similar to the state, about two thirds of the region's housing stock is single-family homes. In contrast to overall state numbers, the region has about half the percentage of multi-family homes and more than double the percentage of mobile homes. Notably, 30% of homes in Harney County are mobile units. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-504. Housing Profile for Region 8, 2012

	Total Housing Units	Single Family		Multi-Family		Mobile Homes	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	1,140,319	68.1%	460,852	27.5%	139,768	8.4%
Region 8	15,490	10,423	67.3%	1,968	12.7%	3,094	20.0%
Harney	3,815	2,324	60.9%	346	9.1%	1,145	30.0%
Malheur	11,675	8,099	69.4%	1,622	13.9%	1,949	16.7%

Note: The percentages listed above do not reflect the number of structures that are built within special flood hazard areas, or that are at risk of seismic damage.

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25024

Aside from location and type of housing, the year structures were built (Table 2-505) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally, about 45% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 80% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-505. Age of Housing Stock in Region 8, 2012

	Total Housing Units	Pre 1970		1970 to 1989		1990 or later	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Oregon	1,673,593	609,062	36.4%	518,569	31.0%	545,962	32.6%
Region 8	15,490	6,784	43.8%	5,491	35.4%	3,215	20.8%
Harney	3,815	1,682	44.1%	1,139	29.9%	994	26.1%
Malheur	11,675	5,102	43.7%	4,352	37.3%	2,221	19.0%

Source: U.S. Census Bureau. 2008–2012, American Community Survey 5-Year Estimates, Table B25034

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. **Table 2-506** shows the initial and current FIRM effective dates for Region 8 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-506. Community Flood Map History in Region 8

	Initial FIRM	Current FIRM
Harney County	Apr. 17, 1984	Apr. 17, 1984
Burns	Aug.15, 1984	Dec. 22, 1998
Hines	Sep. 28, 1984	Nov. 3, 1989
Burns-Paiute Reservation	Sep. 28, 1984	Sep. 28, 1984
Malheur County	Sep. 29, 1986	Sep. 29, 1986
Adrian	Sep. 19, 1984	Sep. 19, 1984
Jordan Valley	Sep. 19, 1984	Sep. 19, 1984
Nyssa	Dec. 14, 1982	Dec.14, 1982 (M)
Ontario	Apr. 17, 1984	Apr. 17, 1984
Vale	Sep. 4, 1987	Sep. 4, 1987

(M) = no elevation determined; all Zone A, C and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 8 can be found in **Table 2-507**. The region contains 4.1% of the total value of state-owned/leased facilities and critical/essential facilities.

Table 2-507. Value of State-Owned/Leased Critical and Essential Facilities in Region 8

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 8	$302,954,349	4.1%
Harney	$25,925,826	0.4%
Malheur	$277,028,523	3.8%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 8 is largely a rural county with urban development focused along I-84 and around the population centers of Burns, Hines, Ontario, and Vale. The region is losing population and most new population is in the smaller rural communities. The region’s housing stock is largely single-family homes, with only about one half the state’s percentage of multi-family homes. The region has more than double the state’s percentage of mobile homes — Harney County has almost 4 times statewide numbers. About 45% of the homes were built before 1970 and floodplain management standards; 80% were built before 1990 seismic standards. None of the region’s FIRMs has been modernized or updated. The region’s share of state-owned facilities is mostly within Malheur County.

2.3.8.3 Hazards and Vulnerability

Droughts

Characteristics

Droughts are a common occurrence in Region 8 and can have a significant economic impact on agricultural, livestock, and natural resources. In 2013, for example, most irrigation reservoirs started the season at a third of capacity, with some irrigation districts running out of water by mid to late June. The Governor has declared a drought emergency in Region 8 numerous times since 1992. In May and June of 2013, the U.S. Department of Agriculture designated Malheur and Harney Counties as primary natural disaster areas due to damages and losses caused by drought.

Because of late winter 2014 reservoir storage levels and predicted streamflow forecasts, the Natural Resources Conservation Service predicted water shortages for the summer of 2014. Governor Kitzhaber issued drought emergencies for both Malheur and Harney Counties. Owyhee Reservoir peaked at 197,000 acre-feet in 2014. In December, the Capitol Press reported that irrigation water supplies for Malheur County farms that rely on water from the Owyhee Project began to run out in July and were completely shut off by August, two months earlier than normal (http://infoweb.newsbank.com/resources/openurl?ctx_ver=z39.88-2004&rft_dat=news/1522AB0187C74988&rft_id=info:sid/infoweb.newsbank.com&rft_val_format=info:ofi/fmt:kev:mtx:ctx&svc_dat=NewsBank&req_dat=0DC38C612B5C2835).

Historic Drought Events

Table 2-508. Historic Droughts in Region 8

Year	Location	Description
1930s	statewide	generally, a very dry period for much of Oregon; Malheur County experiences its most extreme drought years in 1931, 1934, and 1935
1988	Regions 7, 8	extreme drought for Malheur County (PDSI value of -4.14); this was also a severe drought year for northeast Oregon
1992	statewide	Governor declared drought emergency for all 36 counties in Oregon. 1992 was a severe drought year for Malheur County.
1994	Regions 4–8	in 1994, Malheur County received a Governor drought declaration, along with 10 other counties located within regions 4, 5, 6, and 7
2001	eastern and southern Oregon	Governor-declared drought emergency for Harney County and 17 other counties throughout the state
2002	eastern and southern Oregon	Governor-declared drought emergency for Malheur and Harney Counties; total of 23 counties under a drought emergency during 2002
2003	eastern and southern Oregon	Governor-declared drought emergency issued for Malheur and Harney Counties; most counties remain under a drought emergency from the 2001 and 2002 declarations through June 2003
2004	Regions 5–8	Governor-declared drought emergency issued for Malheur County, along with three counties from neighboring regions
2007	Regions 6–8	Governor-declared drought emergency issued for Malheur and Harney County, along with four other counties in Region 6 and 7
2013	Region 5–8	Governor-declared drought emergency issued for Malheur County, along with four other counties in neighboring regions
2014	Regions 4, 6–8	Governor-declared drought emergency issued for Malheur and Harney Counties, along with eight other counties in other regions

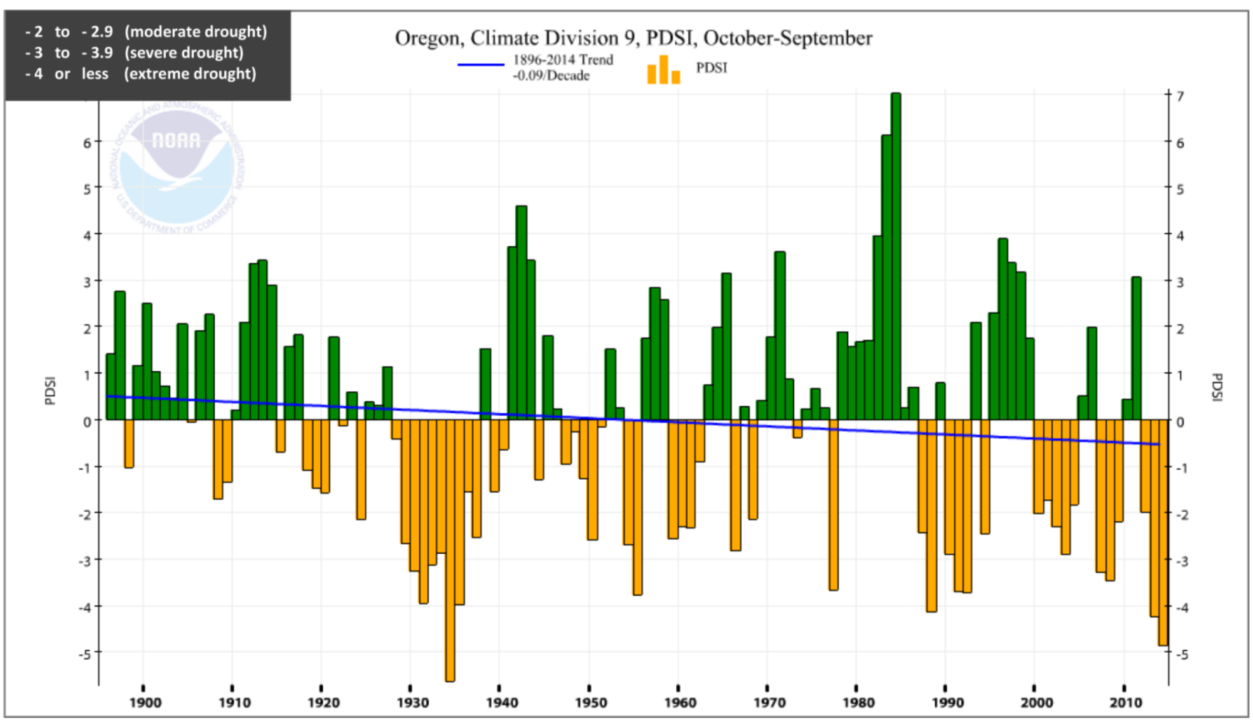
Sources: Taylor and Hatton (1999); and the Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historical drought information can also be obtained from the National Climatic Data Center, which provides historical climate data showing wet and dry conditions, using the Palmer Drought Severity Index (PDSI) that dates back to 1895. The PDSI is not the best indicator of water availability for Oregon as it does not account for snow or ice (delayed runoff), but it has the advantage of providing the most complete, long-term drought record.

Figure 2-227 shows years where drought or dry conditions affected the south eastern area of Oregon, known as Climate Division 9, which encompasses Malheur County only.

Based on this index, 1934 was a very extreme drought year for Malheur County (PDSI: -5.63). Water Years 1931, 1935, 1988, and 2013 were also extreme drought years. Malheur County has experienced a combined total of 31 years of moderate, severe, or extreme drought conditions during this period of record, more than any other climate region in the state.

Figure 2-227. Palmer Drought Severity Index for Region 8



Source: National Climatic Data Center, http://www.ncdc.noaa.gov/cag/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 8 will experience drought is shown in **Table 2-509**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-509. Local Probability Assessment of Drought for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis to determine probability or vulnerability for a given community.

With that said, the likelihood that Malheur and Harney County will experience drought conditions in the near future is very likely. As mentioned, the Governor has declared drought in both counties on several occasions since 1992. During the 100-year period of 1895-1995, both counties experienced severe or extreme drought conditions 10–15% of the time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to drought is shown in **Table 2-510**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-510. Local Vulnerability Assessment of Drought for Region 8

	Harney	Malheur
Vulnerability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, based on a review of drought declarations issued by the Governor, Malheur County could be considered one of the communities most vulnerable to drought and its related impacts. Since 1992, Malheur County has been under an emergency drought declaration on eight different occasions: 1992, 1994, 2002, 2003, 2004, 2007, 2013, and most recently, in February 2014. Harney County shares a similar recurrent pattern of drought emergencies: 1992, 2001, 2002, 2003, 2007, and 2014, and can also be considered vulnerable to drought-related impacts.

Ranching, farming, and other agricultural activities greatly contribute to the economy of both counties. Malheur County ranks fourth in the state for agricultural sales, with $373 million in gross farm and ranch sales in 2012. Drought can have a significant impact on the agricultural community and associated businesses that rely on this industry.

Dust Storms

Characteristics

There is little about the dust storms in this region that differs from the description in the State Risk Assessment, **Dust Storms** section, except to note that agricultural practices likely play less of a role here than in Region 5. All the same, Region 8 farmers, ranchers, homeowners, resort properties, and wildlife sometimes find themselves vying for limited water. This competition for scarce water can affect the locations and amounts of dust lifted into the atmosphere, and blown on the wind.

Historic Dust Storm Events

Table 2-511. Historic Dust Storms in Region 8

Date	Location	Description
Aug. 2012[1]	Harney and Malheur Counties	a massive dust storm due to 50–60 mph winds produced by thunderstorms eventually blew on into Idaho; some media reports indicate this event darkened the skies in some areas for more than 2 hours
Mar. 2013[2]	Malheur County	dust from this storm is reported to have accelerated snowmelt in a Southwestern Idaho mountain range; "Nobody on our staff has ever witnessed anything similar," said Adam Winstral, Research Hydrologist with the U.S. Department of Agriculture

Sources:

(1) Dust, an emerging problem in the Great Basin: insights from 2012, January 23, 2013; YouTube, Brenda Burns, published August 6, 2012 and Zeronieo, published August 14, 2012; Mother Recounts Her Encounter with an Oregon Dust Storm, Yahoo Voices, August 8, 2012

(2) The Oregonian (oregonlive.com) and Associated Press, March 29, 2013; Idaho Statesman (Rocky Barker), March 28, 2013

Brenda Burns and her family were traveling through Malheur County around 4:30 p.m. on August 5, 2012 when they noticed something ominous in the distance. What they saw was a massive wall of dust heading in their direction. According to ktvb.com, the massive dust storm that started in Eastern Oregon packed winds between 50 to 60 miles an hour, and carried the debris into Idaho. "It took about 27 minutes to totally overtake our position," said Mrs. Burns. "It was so wide… that it cut us off from returning the way we came… We really had no direction to go… The initial cloud blackout lasted about 30 minutes, but we were inside the dust storm for over two and a half hours… At one point my husband and I thought maybe it was some kind of pyroclastic cloud. It really looked that ominous. It was very frightening…"

"Mother Recounts Her Encounter with an Oregon Dust Storm," *Yahoo Voices*, August 8, 2012

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the probability that Region 8 will experience dust storms is shown in **Table 2-512**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-512. Local Probability Assessment of Dust Storms for Region 8

	Harney	Malheur
Probability	—	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The fact that the two storms noted in the Historic Events table (**Table 2-511**) both occurred within the most recent few years of record suggests that the probability of these events may be increasing in Region 8. This hypothesis would benefit from more research.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to dust storms is shown in **Table 2-513**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-513. Local Vulnerability Assessment of Dust Storms for Region 8

	Harney	Malheur
Vulnerability	—	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

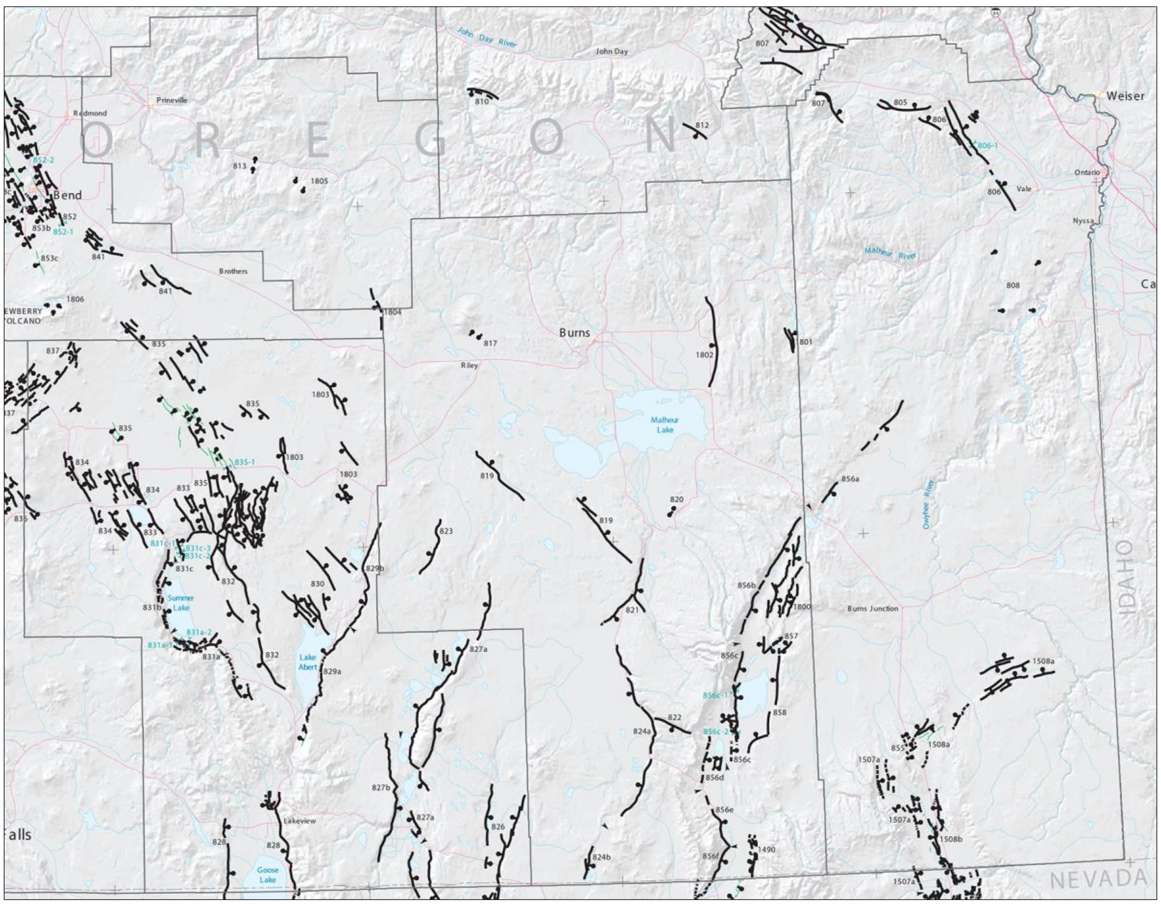
Malheur County is most vulnerable to dust storms in this region. Harney County is also vulnerable. Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment loading of creeks and rivers.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: crustal events and volcanic-earthquakes. Generally, crustal faults can produce earthquakes with magnitudes up to roughly M7.0. Because only certain faults have been studied in detail and determined to be active, there may be many more crustal faults in the region capable of producing earthquakes which have not yet been identified. Figure 2-228 shows the locations of faults in Region 8.

Figure 2-228. Quaternary Faults and Folds in Region 8

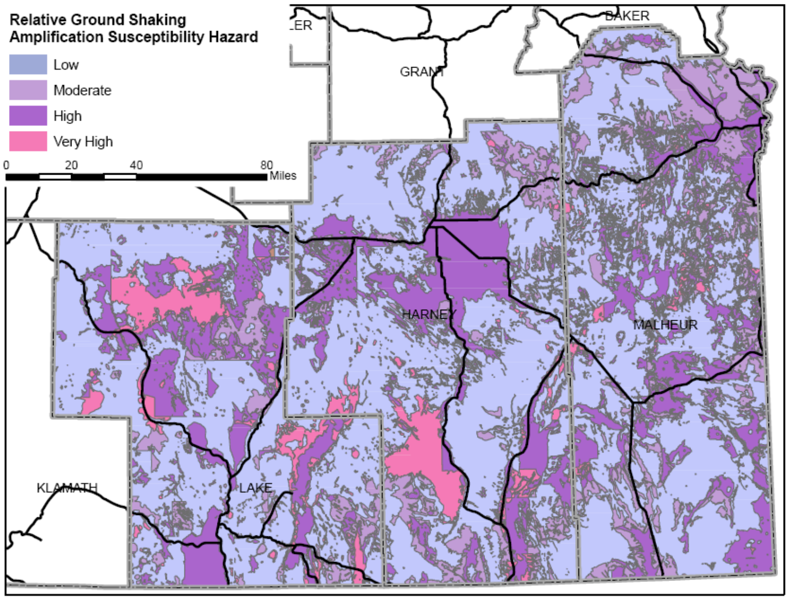


Source: Modified from Personius et al. (2003)

When all of these earthquake sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relatively moderate seismicity area.

Figure 2-229 displays the relative ground shaking amplification hazard throughout Region 8.

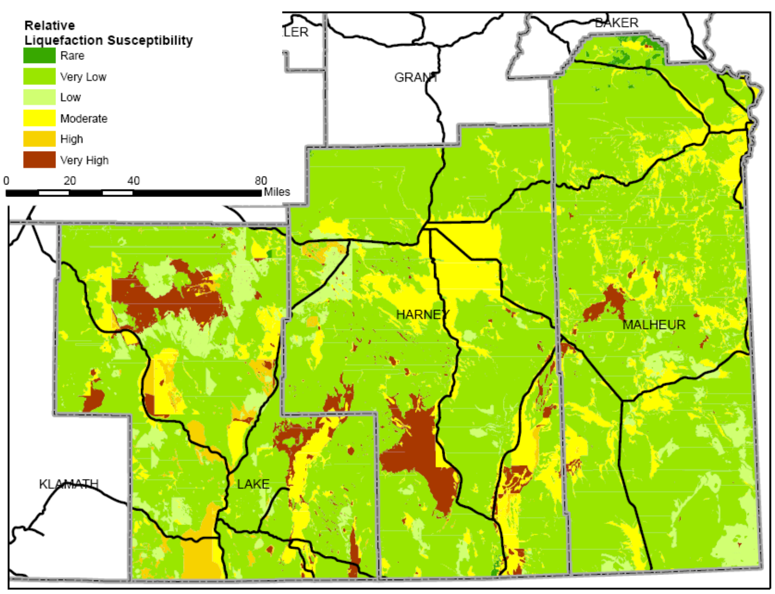
Figure 2-229. Relative Ground Shaking Amplification Hazard in Region 8



Source: Burns (2007)

During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes "liquefied," losing its strength and its ability to support loads. Figure 2-230 displays the relative liquefaction hazard throughout Region 8.

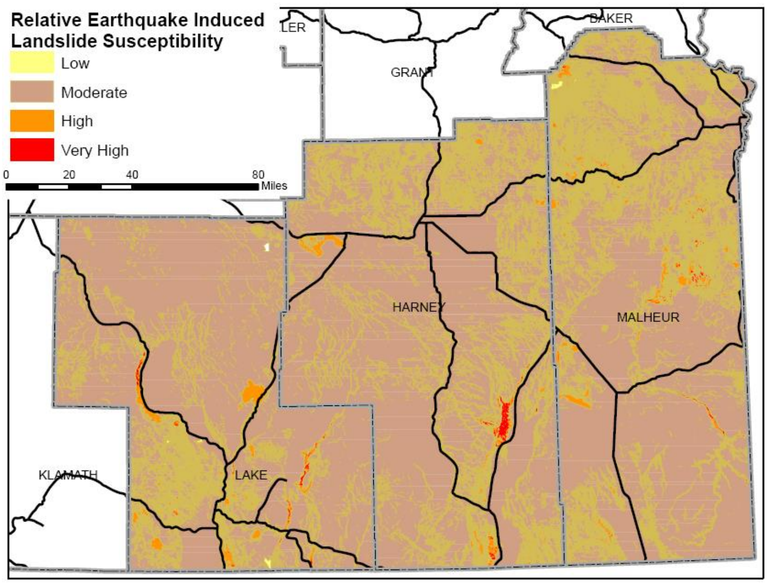
Figure 2-230. Relative Liquefaction Susceptibility Hazard in Region 8



Source: Burns (2007)

Strong ground shaking can also cause landslides and reactivate dormant landslides. Commonly, slopes that are marginally stable prior to an earthquake become unstable and fail. Some landslides result from liquefaction that causes lateral movement of soil, or lateral spread. Figure 2-231 displays the relative earthquake induced landslide hazard throughout Region 8.

Figure 2-231. Relative Earthquake Induced Landslide Susceptibility Hazard in Region 8



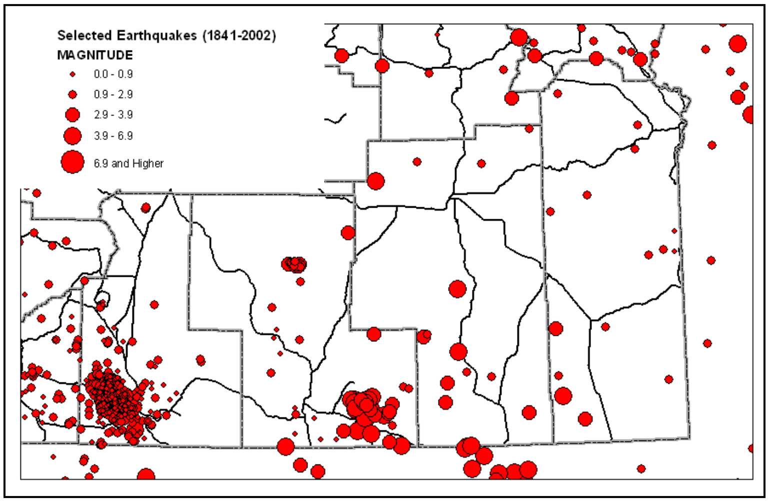
Source: Burns (2007)

Region 8 has experienced many earthquakes. Several earthquake sequences (swarms) have occurred in the region within the last 20 years. There are also identified faults in the region that have been active in the last 20,000 years. The region has also been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. Figure 2-232 maps earthquakes in the region from 1841 to 2002, and Table 2-514 provides a general history of earthquakes in Oregon.

When all of these earthquakes sources are added together, the general earthquake hazard in the region can be displayed as a whole and is reflected in the USGS national seismic hazard maps. When compared to the rest of the United States, most of the region is within a relative moderate seismicity area.

Figure 2-232 displays over 1,000 earthquakes that have been recorded in the region during the last century. Because the instrument network in the region was very sparse until the mid-2000s, it is likely that thousands of earthquakes have occurred in the region but were not recorded.

Figure 2-232. Selected Earthquakes in Region 8, 1841–2002



Source: Niewendorp and Neuhaus (2003)

Historic Earthquake Events

Table 2-514. Significant Earthquakes Affecting Region 8

Date	Location	Magnitude	Comments
Approximate years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the midpoints of the age ranges for these six events
Jan. 26, 1700	offshore, Cascadia Subduction Zone	about 9	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 23, 1873	near Brookings, Oregon at the Oregon-California border	6.8	may have been an intraplate event because of lack of aftershocks; felt as far away as Portland and San Francisco
Mar. 1893	Umatilla	VI-VII (Modified Mercalli Intensity)	damage: unknown
July 15, 1936	Milton-Freewater	6.4	damage: $100,000 damage (in 1936 dollars); two foreshocks and many aftershocks felt
Apr. 13, 1949	Olympia, Washington	7.1	fatalities: eight; damage: $25 million damage (in 1949 dollars); cracked plaster, other minor damage in northwest Oregon
Jan. 1951	Hermiston	V (Modified Mercalli Intensity)	damage: unknown
Nov. 5, 1962	Portland/ Vancouver	5.5	shaking up to 30 seconds; damage: chimneys cracked, windows broken, furniture moved
Apr. 12, 1976	near Maupin	4.8	sounds described as distant thunder, sonic booms, and strong wind
Apr. 25, 1992	Cape Mendocino, California	7.0	subduction earthquake at the triple-junction of the Cascadia Subduction Zone and the San Andreas and Mendocino faults
Mar. 25, 1993	Scotts Mill	5.6	center: Mount Angel-Gates Creek fault; damage: $30 million, including Molalla High School and Mount Angel church
Sep. 20, 1993	Klamath Falls	5.9 and 6.0	fatalities: two; damage: $10 million, including county courthouse; rockfalls

*BCE: Before Common Era.

Sources: Wong and Bolt (1995); Pacific Northwest Seismic Network

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience earthquakes is shown in **Table 2-515**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-515. Local Probability Assessment of Earthquakes for Region 8

	Harney	Malheur
Probability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

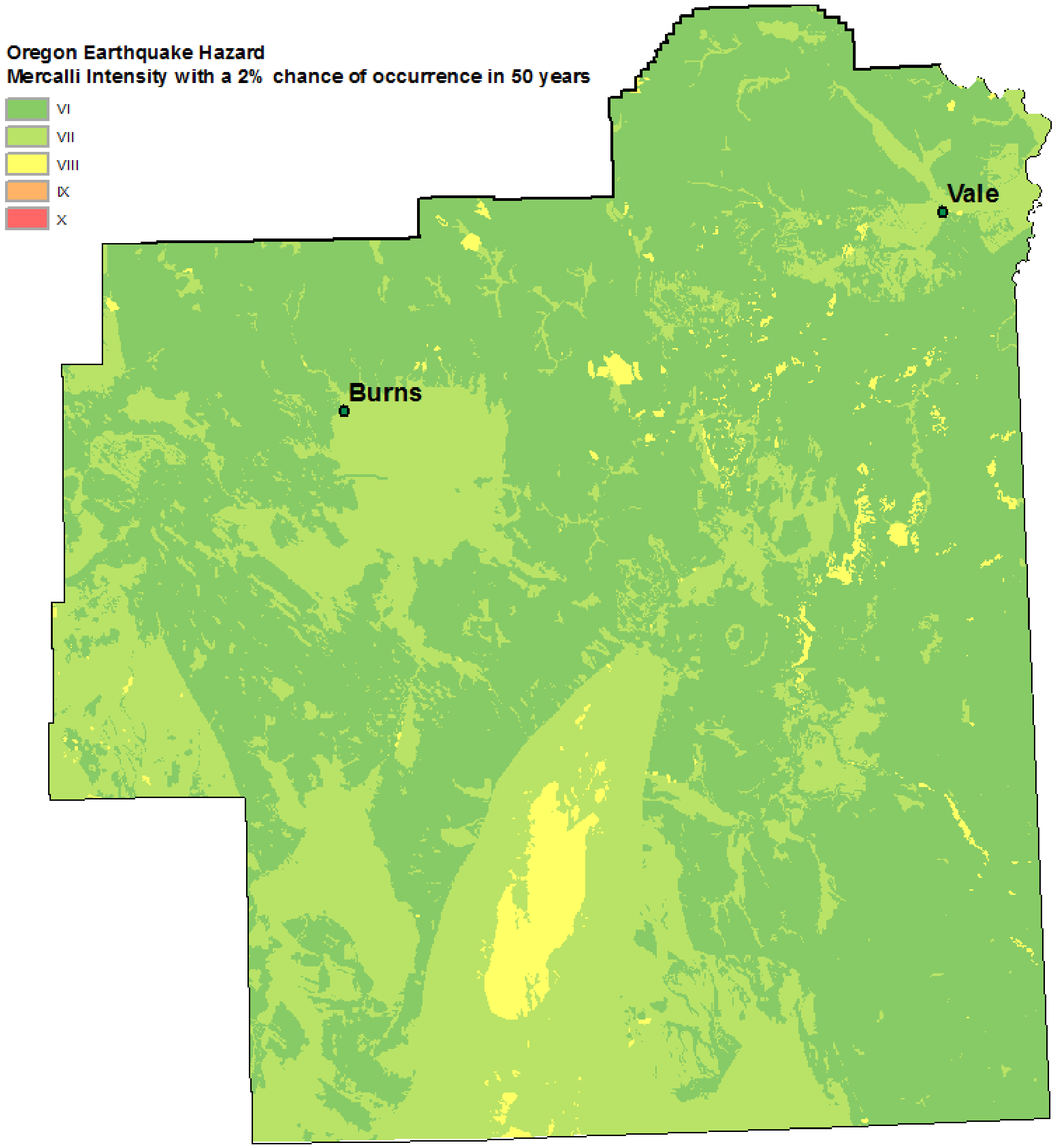
State Assessment

The probability of damaging earthquakes varies widely across the state. In Region 8, the hazard is dominated by local faults and background seismicity.

The probabilistic earthquake hazard for Region 8 is depicted in **Figure 2-233**. This map shows the expected level of earthquake damage that has a 2% chance of occurring in the next 50 years. The map is based on the 2008 USGS National Seismic Hazard Map and has been adjusted to account for the effects of soils following the methods of Madin and Burns (2013). In this case, the strength of shaking calculated as peak ground acceleration and peak ground velocity is expressed as Mercalli intensity, which describes the effects of shaking on people and structures. This map incorporates all that is known about the probabilities of earthquake on all Oregon faults, including the Cascadia Subduction Zone.

The Cascadia subduction zone is responsible for most of the hazard shown in **Figure 2-233**. The paleoseismic record includes 18 M8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller M8.3–8.5 earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Figure 2-233. Probabilistic Earthquake Hazard in Region 8



Color zones show the maximum level of earthquake shaking and damage (Mercalli Intensity Scale) expected with a 2% chance of occurrence in the next 50 years. A simplified explanation of the Mercalli levels is:

VI	Felt by all, weak buildings cracked;
VII	Chimneys break, weak buildings damaged, better buildings cracked;
VIII	Partial collapse of weak buildings, unsecured wood frame houses move;
IX	Collapse and severe damage to weak buildings, damage to wood-frame structures; and
X	Poorly built structures destroyed, heavy damage in well-built structures.

Source: Madin and Burns (2013)

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to earthquakes is depicted Table 2-516. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-516. Local Vulnerability Assessment of Earthquakes for Region 8

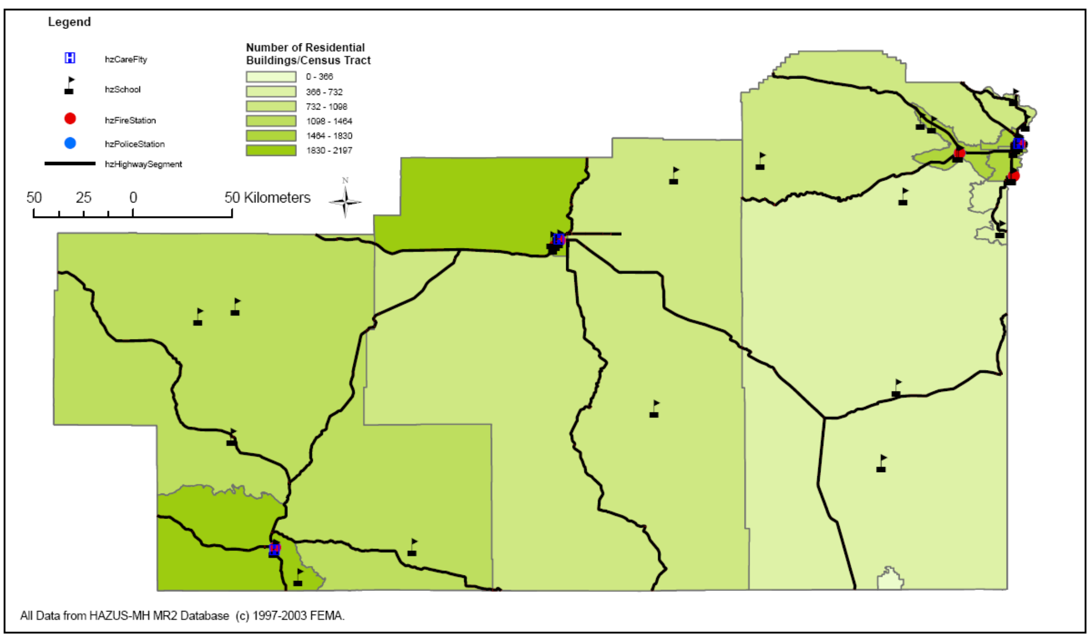
	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Region 8 is moderately vulnerable to earthquake hazards from earthquake-induced landslides, liquefaction, and ground shaking. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. Figure 2-234 shows a map of the generalized exposure of buildings to earthquakes in Region 8.

Figure 2-234. Region 8 Generalized Earthquake Exposure



Source: Hazus-MH MR2 database, Burns, 2007.

The Oregon Department of Geology and Mineral Industries (DOGAMI) has developed two earthquake loss models for Oregon based on the two sources of seismic events: (a) a M6.9 arbitrary crustal event, and (b) 2,500 year probabilistic driving earthquake scenario. Both models are based on Hazus-MH, a computer program used by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The arbitrary crustal event is based on a potential M6.9 earthquake generated from an arbitrarily chosen fault using the Hazus software, and assuming a worst-case scenario. The 2,500-year probabilistic driving earthquake does not look at a single earthquake; instead, it encompasses many faults and potential earthquake sources, each with a 2% chance of producing an earthquake in the next 50 years. The analysis assumes that each fault will produce a single "average" earthquake during this time.

DOGAMI investigators caution that the analysis contains a high degree of uncertainty and should be used only for general planning purposes. Despite their limitations, the analysis does provide some approximate estimates of damage. Results are found in Table 2-517, Table 2-518, Table 2-519, Table 2-520, Table 2-521, and Table 2-522.

Table 2-517. School and Emergency Response Buildings' Collapse Potential in Region 8

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Harney	5	3	7	3
Malheur	16	6	5	23

Source: Lewis (2007)

Table 2-518. Building, Transportation, and Utility Exposure in Region 8

County	Building Exposure	Transportation Exposure	Utility Exposure	Total Exposure
Harney	$448,000,000	$2,281,900,000	$733,200,000	$3,463,100,000
Malheur	$1,441,000,000	$4,396,900,000	$810,300,000	$6,648,200,000
Region Total	$1,889,000,000	$6,678,800,000	$1,543,500,000	$10,111,300,000

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-519. Building, Transportation, and Utility Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$9,260,000	$21,600,000	$2,000,000	$32,860,000	0.9%
Malheur	$143,370,000	$47,000,000	$19,680,000	$210,050,000	3.2%
Region Total	$152,630,000	$68,600,000	$21,680,000	$264,590,000	2.6%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-520. Building, Transportation, and Utility Losses in Region 8 Associated with a (M) 6.9 Arbitrary Crustal Earthquake Event

REGION 8 County	Building Losses	Transportation Losses	Utility Losses	Total Losses	Loss Percent of Total
Harney	$1,600,000	$39,200,000	$390,000	$41,191,000	1.1%
Malheur	$453,470,000	$114,100,000	$36,820,000	$604,390,000	9.0%
Region Total	$455,070,000	$153,300,000	$37,210,000	$645,581,000	6.4%

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-521. Estimated Losses in Region 8 Associated with a M6.9 Arbitrary Crustal Earthquake Event

Region 8 Counties	Harney	Malheur
Injuries (5 pm time frame)	3	444
Death (5 pm time frame)	0	28
Displaced households	0	1,224
Economic losses from buildings	$1.6 mil	$453.47 mil
Operational day after quake:		
Fire stations	0%	25%
Police stations	0%	50%
Schools	29%	48%
Bridges	98%	93%
Economic losses to:		
Highways	$29.8 mil	$107.10 mil
Airports	$8.6 mil	$4.8 mil
Communications	$0.04 mil	$0.03 mil
Debris generated (million tons)	0	0

Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

Table 2-522. Estimated Losses in Region 8 Associated with a 2,500-Year Probable M6.5 Driving Earthquake Scenario

Region 8 Counties:	Harney	Malheur
Injuries (5 pm time frame)	3	106
Deaths (5 pm time frame)	0	5
Displaced Households	2	357
Economic losses from buildings	$9.26 m	$143.37 m
Operational the day after the quake		
Fire stations	100%	100%
Police stations	100%	100%
Schools	100%	100%
Bridges	100%	100%
Economic Losses to /for:		
Highways	$14.3 m	$34.3 m
Airports	$6.9 m	$11.8 m
Communication systems	$ 0.01 m	$0.01 m
Debris generated (million tons)	0	0

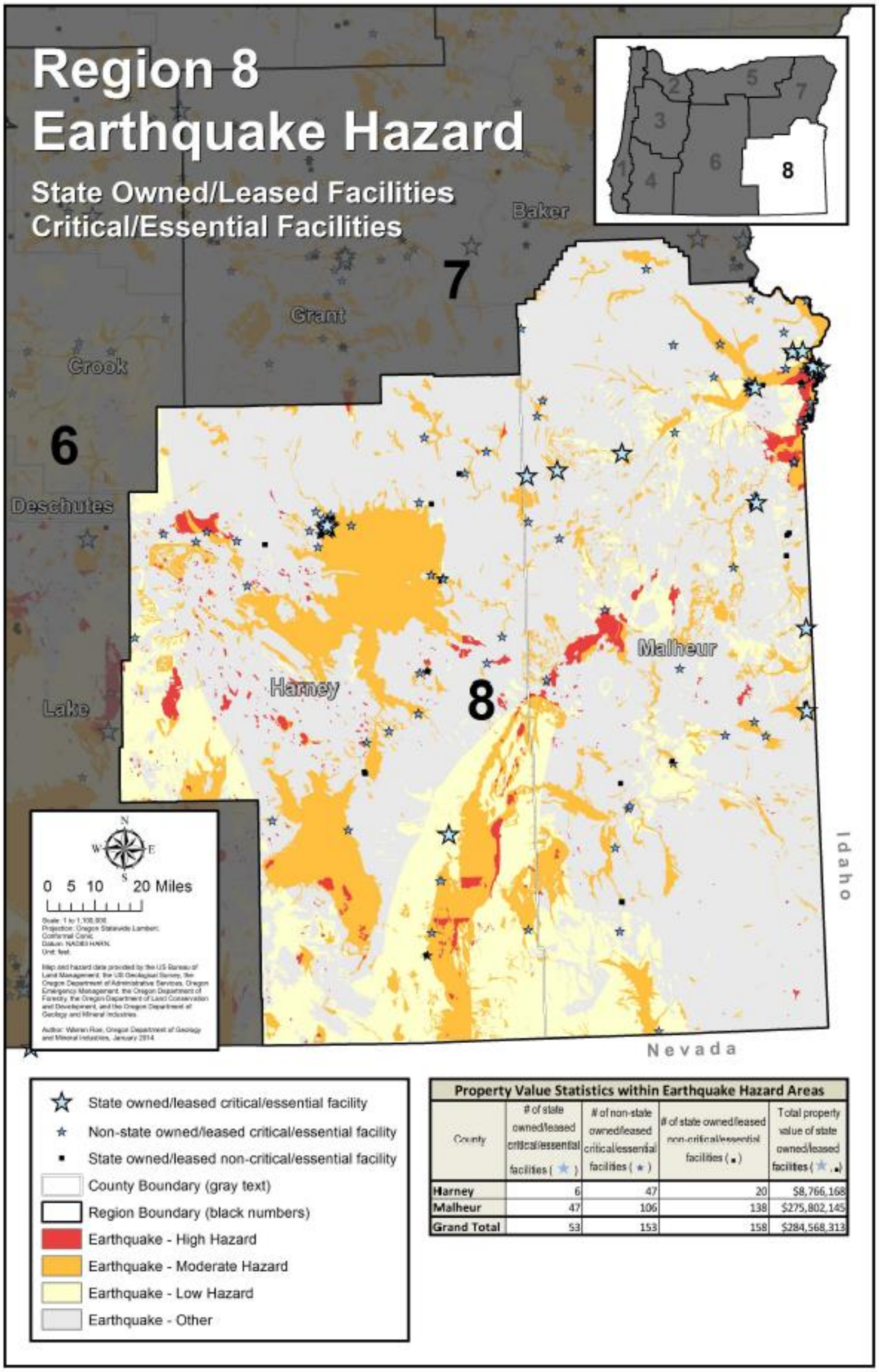
Source: W. J. Burns (DOGAMI), 2007 (unpublished), Geologic hazards of the southeast Oregon region

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of 5,693 state facilities evaluated, 211 valued at $284.5 million are located in an earthquake hazard zone in Region 8 (**Figure 2-235**). Among the 1,141 critical/essential state facilities, 53 are in an earthquake hazard zone in Region 9. Additionally, 153 non-state critical/essential facilities in the region are located in an earthquake hazard zone.

Figure 2-235. State-Owned/Leased Facilities and Critical/Essential Facilities in an Earthquake Zone in Region 8



Property Value Statistics within Earthquake Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilites (★, ▪)
Harney	6	47	20	$8,766,168
Malheur	47	106	138	$275,802,145
Grand Total	53	153	158	$284,568,313

Source: DOGAMI

SEISMIC LIFELINES

Because the projected impacts of a CSZ event are considered negligible in this part of the state, this region was not part of the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; **Appendix 9.1.13**).

REGIONAL IMPACT. Within this region, significant adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction etc.) are not anticipated.

REGIONAL LOSS ESTIMATES. Losses in this region are expected to be nonexistent to low. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

MOST VULNERABLE JURISDICTIONS. Vulnerability of this whole region to a CSZ event is low. Loss of life, property and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Floods

Characteristics

Although flooding occurs throughout Oregon, the climate, local geology and the relatively low population of Region 8 lessen its effects. Region 8 contains a variable landscape that greatly influences flood conditions. The region is subject to a variety of flood conditions, including: (a) spring runoff from rain and melting snow, (b) warming and rain during the winter months, (c) ice-jam flooding, (d) local flash flooding, and (e) closed basin playa flooding.

Most flooding throughout the region is linked to the spring cycle of melting snow. However, rain-on-snow events, associated with La Niña years in which cool, moist weather conditions are followed by a system of warm, moist air from tropical latitudes, can quickly melt foothill and mountain snow causing floods. Some of Oregon's most devastating floods are associated with these events.

Ice jams on the Snake and Malheur rivers have created flood conditions in the past. Ice jams happen during the winter and early spring, while the river is still frozen. Sudden warming of higher altitude snow and ice results in increased runoff and break-up of river ice. On the way downstream, floating ice can "jam" in a narrow reach of the drainage or against a road crossing, causing a dam. Subsequent breach of the dam releases a torrent of water.

Summer thunderstorms are common throughout the region. During these events, normally dry gulches quickly become raging torrents, a flash flood. Although flash flooding occurs throughout Oregon, local geology in the region can increase this hazard. Bedrock, composed mostly of igneous rocks, is exposed at the surface throughout much of the region. Consequently, runoff is increased significantly.

Many parts of Harney and Malheur Counties are characterized by interior drainage or closed basins called playas. Some playas contain lakes that grow and diminish with the seasons and from year to year. Harney and Malheur lakes are good examples. At times, they are almost dry, but conditions change with prolonged periods of rainfall or snowmelt. Since the water has nowhere to go except into the lakes, the lakes just keep filling up until they overflow. Evaporation is the primary way the water levels recede and it can take years to significantly reduce swollen lake levels through this slow process.

With some exceptions, Malheur County is physically different. This area contains the Owyhee uplands and the Snake River plains, whose streams flow into the Snake River, a tributary of the Columbia. Several reaches of the Snake River have flood control structures. Consequently, it is less of a problem than other rivers in the region.

The interior drainage or closed basin lakes and creeks and rivers in southeastern Oregon have a long history of flooding (**Table 2-523**). Most of the lake water originates from high mountain snowpack above the basin. Flooding follows winters with deep snow accumulation. Such was the case in 1982 and subsequent years, when high lake levels caused economic damage within the region (especially in Harney County). Farms, ranches, homesteads, utilities, highways, and a railroad branch line are at risk.

Unusually warm winter conditions, as in 1957 and 1964, produced severe flooding.

Historic Flood Events

Table 2-523. Significant Flood Events in Region 8

Date	Location	Description	Remarks
1897	Harney County	severe flooding on Silvies River	flood of record on the Silvies River (300-year flood)
1904	Harney and Malheur Counties	severe flooding on Silvies and Malheur Rivers	
1910	Malheur County	severe Malheur River flooding	flood of record on the Malheur River
1921	Harney County	severe flooding on Silvies River	
1943	Harney County	severe flooding on Silvies River	
1952	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	
Feb. 1957	Harney and Malheur Counties	severe flooding on Jordan Creek, the Silvies and Malheur rivers	warm rain on snow / frozen ground
Dec. 1964	entire state	severe flooding throughout region	warm rain on snow / frozen ground
1982	Harney County	severe flooding from Harney and Malheur lakes	Long history: not the first lake floods; others floods followed
Dec. 1985	Malheur County	ice jam flooding	40 miles of ice on Snake River between Farewell Bend and Ontario; at least 35 people evacuated
June 1989	Malheur County	flash flood; crops damaged; high winds	vicinity of Nyssa
Mar. 1993	Malheur and Harney Counties	widespread flooding in rural areas; highways closed	warm rain on heavy snow pack; flood of record on Owyhee River
May 1998	Malheur and Harney Counties	widespread flooding. Mudslides in Malheur County	persistent rain on mountain snow pack
May 2005	Harney County	$10,000 in property damage	
Apr. 2011	Harney County	widespread basin flooding	Oregon DOT closed and breached U.S. 20 at milepost 132.6 on April 8, 2011, for flood relief; the breach was done at the request of Harney County Emergency Operations Center to avoid damage to nearby residences; larger culverts were later installed

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; Harney County FIS, 12/22/98; Taylor and Hatton. (1999). The Oregon Weather Book, p. 96-103; Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-524. Principal Flood Sources in Region 8

Harney County	Malheur County
Silvies River	Snake River
Silver Creek	Malheur River
Silver Lake	Bully Creek
Cow Creek	Willow Creek
Donner und Blitzen River	Jordan Creek
McCoy Creek	Indian Creek
Trout Creek	Clover Creek
Whitehorse Creek	Owyhee River
Harney Lake	Cottonwood Creek
Malheur Lake	

Sources: FEMA, Malheur County Flood Insurance Study (FIS), 09/29/86; FEMA, Harney County FIS, 12/22/98

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience flooding is shown in **Table 2-525**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-525. Local Probability Assessment of Floods for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Table 2-523 provides some indication of flooding in Region 8 (not all flooding is shown). Significant flooding occurs regularly, at least once every 5-7 years.

In Region 8 counties, the Federal Emergency Management Agency (FEMA) has mapped the 10, 50, 100, and 500-year floodplains, corresponding to 10%, 2%, 1%, and 0.2% chance, respectively, of a certain magnitude flood in any given year. In addition, FEMA has mapped the 100-year floodplain (i.e., 1% flood) in the incorporated cities. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based.

All of the Region 8 counties have Flood Insurance Rate Maps (FIRM); however, the maps are old. The FIRM maps were issued at the following times:

- Harney: April 17, 1984, and
- Malheur: September 29, 1986.

A remapping initiative is underway in Harney County.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers the region's vulnerability to flooding is shown in Table 2-526. See the State Risk Assessment for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-526. Local Vulnerability Assessment of Floods for Region 8

	Harney	Malheur
Vulnerability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The Oregon Department of Land Conservation and Development (DLCD) created a countywide flood vulnerability index by compiling data from NOAA's Storm Events Database and from FEMA's National Flood Insurance Program. Data were calculated statewide for the period 1978 through 2013 for five input datasets: number of events, structure and crop damage estimates in dollars and NFIP claims number and dollar amounts. The mean and standard deviation were calculated for each input. Then, each county was assigned a score ranging from 0 to 3 for each of these inputs according to Table 2-527.

Table 2-527. Scoring for Vulnerability Index

Score	Description
3	county data point is greater than 2.5 times standard deviation for the input data set
2	county data point is greater than 1.5 times standard deviation for the input data set
1	county data point is within standard deviation
0	no data reported

Source: DLCD

DLCD summed the scores for each of the five inputs to create a county-by-county vulnerability index. The maximum possible score is 15. A score over 6 indicates that at least one variable significantly exceeds average values.

Both Harney and Malheur Counties received a flood vulnerability score of 5. This low score is likely misleading because flood risks do exist in the population centers located along US-20 and US-395. The City of Burns is one of the top 10 cities in terms of the ratio of Special Flood Hazard Area to city area.

FEMA has identified no Repetitive Loss properties in Region 8 (FEMA NFIP BureauNet, http://bsa.nfipstat.fema.gov/, accessed 12/1/2014).

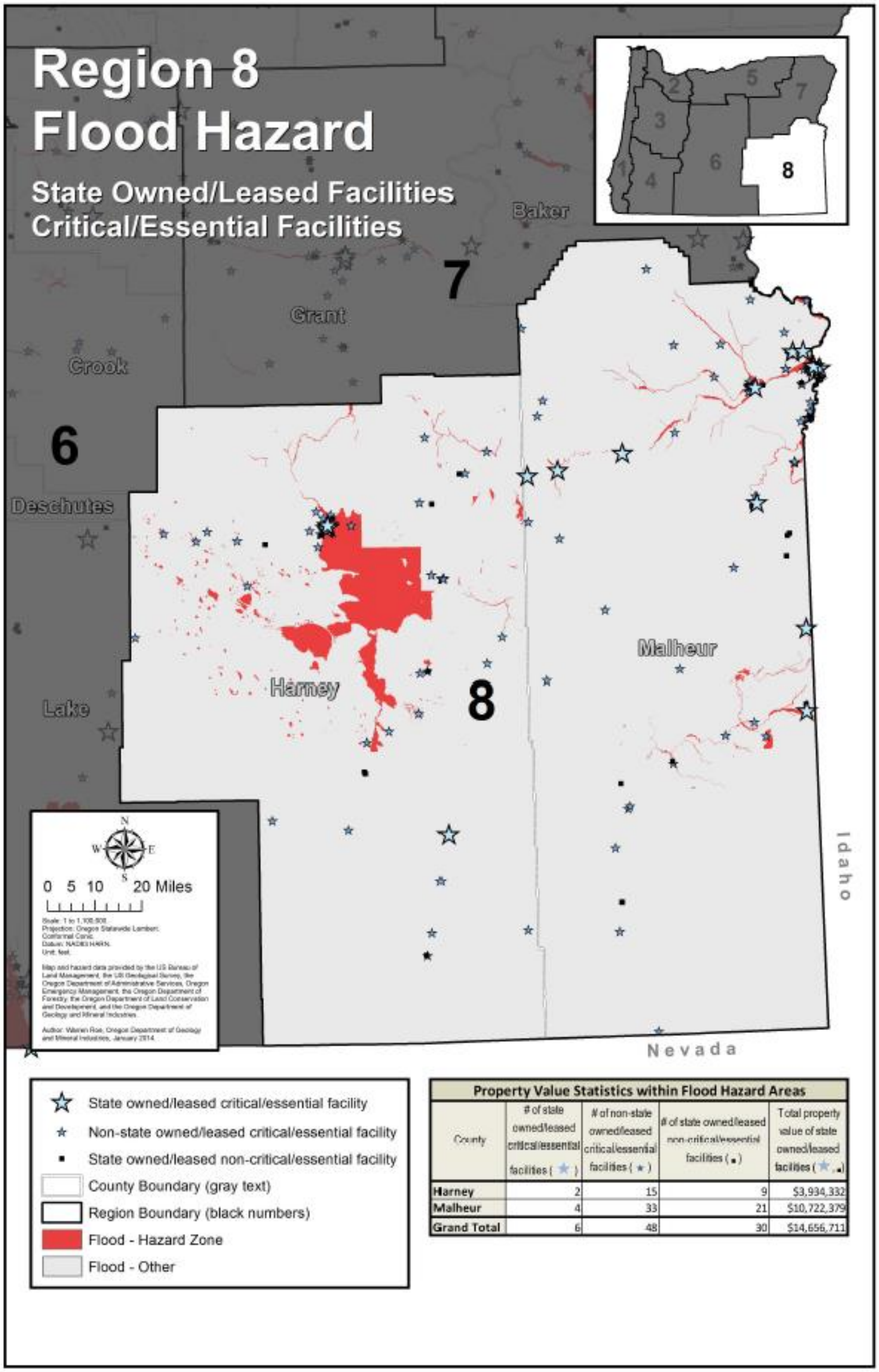
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 8 communities participate in the CRS Program

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** section for more information.

Of the 5,693 state facilities evaluated, 36 are currently located within a flood hazard zone in Region 8 and have an estimated total value of $14.7 million (**Figure 2-236**). Of these, 6 are identified as a critical or essential facility. An additional 48 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 8.

Figure 2-236. State-Owned/Leased Facilities and Critical/Essential Facilities in a Flood Hazard Zone in Region 8



Property Value Statistics within Flood Hazard Areas				
County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★ , ▪)
Harney	2	15	9	$3,934,332
Malheur	4	33	21	$10,722,379
Grand Total	6	48	30	$14,656,711

Source: DOGAMI

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Historic Landslide Events

There are no readily known significant landslides in this region.

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience landslides is shown in **Table 2-528**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-528. Local Probability Assessment of Landslides for Region 8

	Harney	Malheur
Probability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The probability of future landslides in the southeastern Oregon region is moderate. The probability of an area to have a landslide is increased depending on the factors that reduce the stability without causing failure. When several of these factors are combined, such as an area with steep slopes, weak geologic material, and previous landslide movement, the probability of future landsliding is increased. There is a strong correlation between intensive winter rainstorms and the occurrence of rapidly moving landslides (debris flows).

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to landslides is shown in **Table 2-529**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-529. Local Vulnerability Assessment of Landslides for Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

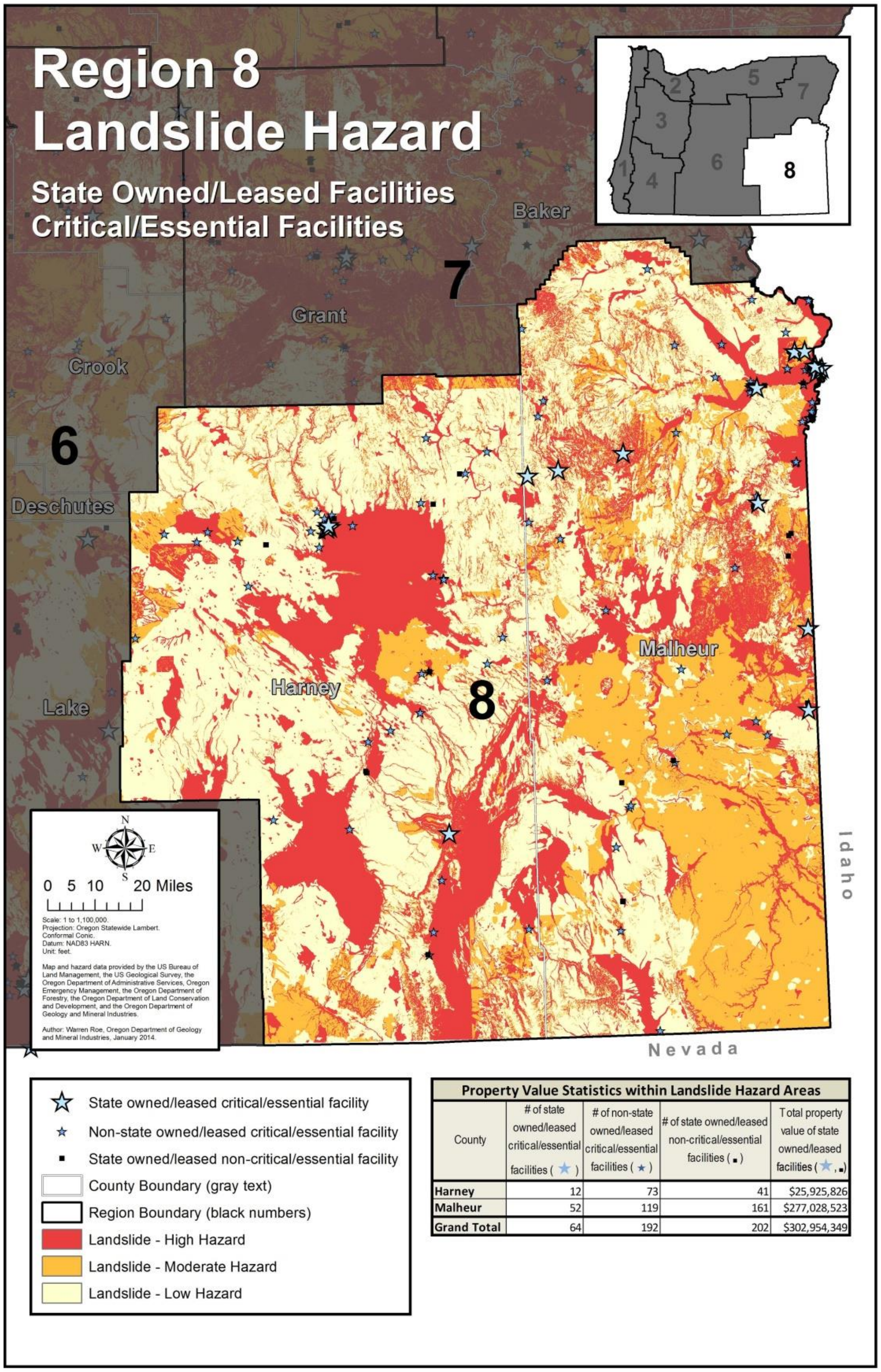
Landslides pose significant threats to people and infrastructure. Landslides have caused damage and loss in Region 8, and it is very likely that they will again. Most of the people and infrastructure in Region 8 are located in one of the major cities in the region which are located along highways. The generalized landslide hazard for the region is low to moderate; however, there are areas within the region that have very high hazard risk, such as the Summer Lake area along OR-31, around Lakeview, and along US-395.

STATE-OWNED/LEASED FACILITIES AND CRITICAL AND ESSENTIAL FACILITIES

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 266 are currently located within a landslide hazard zone in Region 8 and have an estimated total value of $303 million (**Figure 2-237**). Of these, 64 are identified as a critical or essential facility. An additional 192 non-state-owned/leased critical/essential facilities are located in a flood hazard zone in Region 8.

Figure 2-237. State-Owned/Leased Facilities and Critical/Essential Facilities in a Landslide Hazard Zone in Region 8



Property Value Statistics within Landslide Hazard Areas

County	# of state owned/leased critical/essential facilities (★)	# of non-state owned/leased critical/essential facilities (★)	# of state owned/leased non-critical/essential facilities (▪)	Total property value of state owned/leased facilities (★, ▪)
Harney	12	73	41	$25,925,826
Malheur	52	119	161	$277,028,523
Grand Total	64	192	202	$302,954,349

Source: DOGAMI

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 8 counties, but there is some risk from volcanic ash derived from these volcanoes. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes. Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the U.S. Geological Survey Volcano Hazards Program at the Cascade Volcano Observatory in Vancouver, Washington and are available at http://volcanoes.usgs.gov/observatories/cvo/.

Besides the distant Cascade volcanoes to the west, there are numerous examples of local volcanic activity throughout southeastern Oregon, such as the abundant thermal hot springs, and some large volcanic fields (e.g., Diamond and Jordan Craters), which attest to its not too distant volcanic past. Jordan Craters, located about 36 miles southwest of Adrian, is thought to have erupted lava roughly 3,200 years ago.

Historic Volcanic Events

Table 2-530. Historic Volcanic Events in Region 8

Date	Location	Description
< 7,000 YBP	Diamond Craters, eastern Oregon	lava flows and tephra in Diamond Craters field
< 3,200 YBP	Jordan Craters, eastern Oregon	lava flows and tephra in Jordan Craters field

Note: YBP is years before present.

Source: Source: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience volcanic hazards is shown in **Table 2-531**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-531. Local Probability Assessment of Volcanic Activity in Region 8

	Harney	Malheur
Probability	L	L

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Mount St. Helens remains a probable source of ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington, during the 1980 eruption and again in 2004. The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction.

The eruptive history of the nearby Cascade volcanoes to this region can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

Local eruptions within Region 8 occurred most recently at Diamond Craters about 6000 years ago and younger activity at Jordan Craters dates after 3,200 years ago. These events consisted of short-lived effusion of basaltic lava and blanketing of the surrounding landscape with basaltic ash. These volcanoes are now extinct, but future eruptions in Southeast Oregon will occur. However, neither the timing nor the location of such events can be forecast in the absence of volcanic unrest.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to volcanic hazards is shown in **Table 2-532**. In some cases, counties either did not rank a particular hazard or did not find it to be a significant consideration. These cases are noted with a dash (—). See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-532. Local Vulnerability Assessment of Volcanic Activity in Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The region's vulnerability to the effects of volcanic eruptions are low. Areas within Region 8 could be affected by ashfall from Cascade volcanic eruptions and more locally by small eruptions of lava from the numerous youthful volcanic cones scattered across Harney and Malheur Counties. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395. The most vulnerable communities are Burns, Ontario, and Jordan Valley. The region's total exposure for buildings and transportation systems alone is roughly $15 billion.

Wildfires

Characteristics

Southeastern Oregon contains large tracts of ponderosa pine forests, primarily in the northern part of Harney County. Less extensive forests occur in Malheur County near Ironside and in scattered mountain ranges throughout the region. These areas are highly vulnerable to wildfire because of natural aridity and the frequency of lightning strikes. Grasslands, which naturally cover most of the region, also are problematic. Wildfire always has been a part of these ecosystems. Past management practices, which included the suppression of all wildfires, has favored the growth of a brushy understory and the accumulation of dead or dying trees. This leads to devastating fires. State and federal agencies seek to alleviate the problem through a controlled (i.e., prescribed) burning program. **Table 2-533** lists some of the significant wildfires that have occurred in the region.

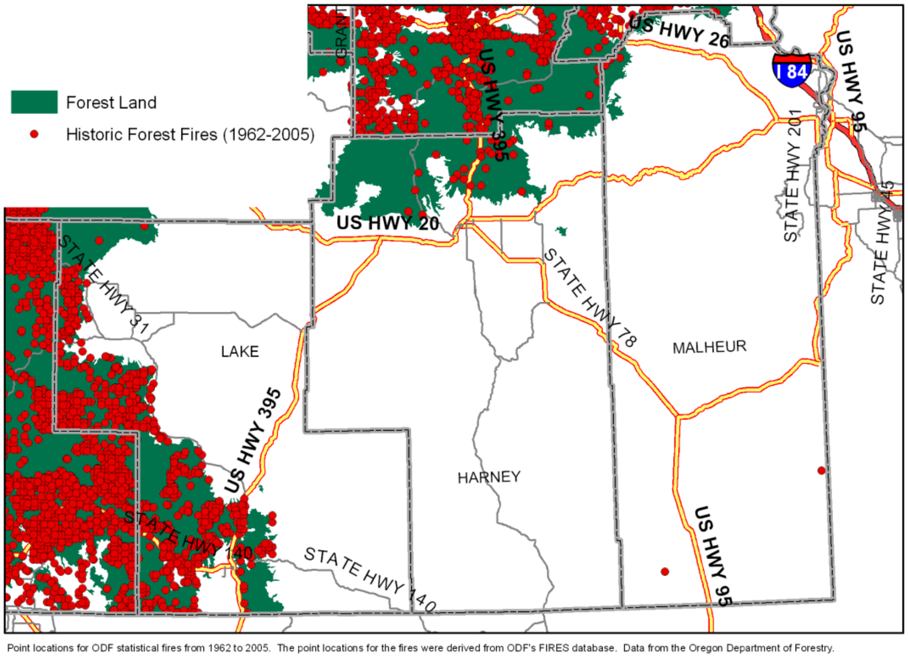
Historic Wildfire Events

Table 2-533. Significant Wildfires in Region 8

Date	Name of Fire	Location	Acres Burned
1998	Ontario	Malheur County	
2000	Jackson	Malheur County	79,875
2001	Sheepshead	Malheur County	51,452
2007	Egley	Harney	140,360

Source: Oregon Department of Forestry, 2013

Figure 2-238. Historic Forest Fires in Region 8



Source: The Oregon Department of Forestry Database and extent of forested land (http://egov.oregon.gov/ODF/GIS).

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience wildfire is shown in **Table 2-534**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-534. Local Probability Assessment of Wildfire for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The forests and grasslands of Region 8 are highly susceptible to wildfire and many of the cities and unincorporated communities, in addition to rangelands and agricultural lands, are vulnerable to its effects. Wildfires are an annual occurrence and have varied in size from under 10 acres to over 100,000 acres.

Most wildfires started by lightning. Human causes are mostly associated with abandoned campfires, debris burning, or fires started along the interstate and highways (faulty vehicle equipment, cigarettes tossed out of windows of vehicles, etc.).

Hilly or mountainous topography exacerbates wildfire hazards. These areas can cause a wildfire to spread rapidly and burn larger areas in a shorter period of time, especially as fires migrate uphill. Wildfire has been known to move at speeds of 30 mph or higher on grasslands.

Large fires have, at times, exceeded the capability of structural and wildland resources, not only calling for the declaration of the Conflagration Act, but also requiring National Incident Management Teams to manage fires at the project fire level.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to wildfire is shown in **Table 2-535**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-535. Local Vulnerability Assessment of Wildfire for Region 8

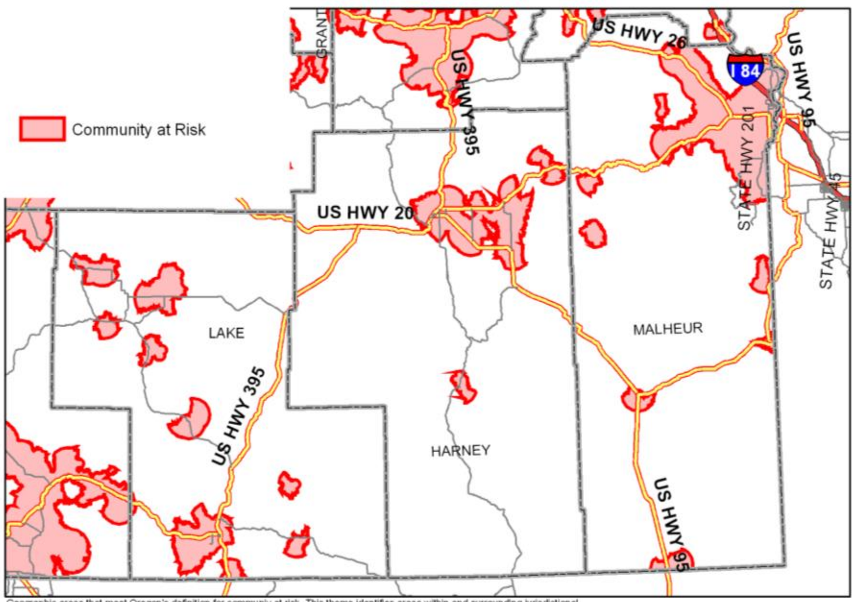
	Harney	Malheur
Vulnerability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The generalized wildfire hazard for the region is moderate to high; however, there are areas within the region that have a very high hazard. Most of the region's people and infrastructure are located in the major cities along I-84, US-20, and US-395 (**Figure 2-239**). The region's total exposure for buildings and transportation systems alone is roughly 11.5 billion dollars.

Figure 2-239. Region 8 Communities at Risk of Wildfire



Geographic areas that meet Oregon's definition for communiy at risk. This theme identifies areas within and surrounding jurisdictional populated areas that are considered part of the community. Data from the Oregon Communities At Risk assessment for 2004 for the National Fire Plan by Oregon Department of Forestry.

Source: ODF

Preliminary analyses indicate a high likelihood of damage and losses from future wildfire in the region. Threatened assets include businesses, farmland, ranchland, grazing land, and hunting and recreation land. Action should be taken to reduce the damage and losses through pre-disaster mitigation and prepare for effective emergency response after the disaster. Special action should be taken for critical facilities including schools and emergency facilities and infrastructure such as roadways.

Wildland fire protection in unincorporated areas is protected by Rangeland Fire Protection Associations or BLM. Where the majority of BLM land is leased for ranching operations, large wildfires can have significant economic impacts on ranchers' stock and range allotments, as burned land is unfit for grazing use for several years after a fire.

Known sage-grouse habitat is a top wildfire suppression priority in this region. Rangeland Protection Associations and Oregon Department of Forestry are planning to implement, prior to January 2015, conservation measures to reduce the negative impacts of wildland fire on sagebrush plant communities within the range of the sage-grouse.

The communities in Region 8 are particularly vulnerable because they are scattered throughout the landscape on large acreages with highly flammable vegetation. Many communities have no structural fire protection, and wildland agencies would have extended response times.

Table 2-536. Wildland-Urban Interface Communities in Region 8

Harney	Malheur
Andrews	Adrian
Blitzen	Arock
Burns-Hines	Brogan
Crane	Danner
Diamond	Harper
Drewsey	Jamieson
Fields	Jordan Valley
Frenchglen	Juntura
Narrows	McDermitt
Double O	Nyssa Heights
	Ontario Heights
	Oregon Slope
	Vale
	Ironside

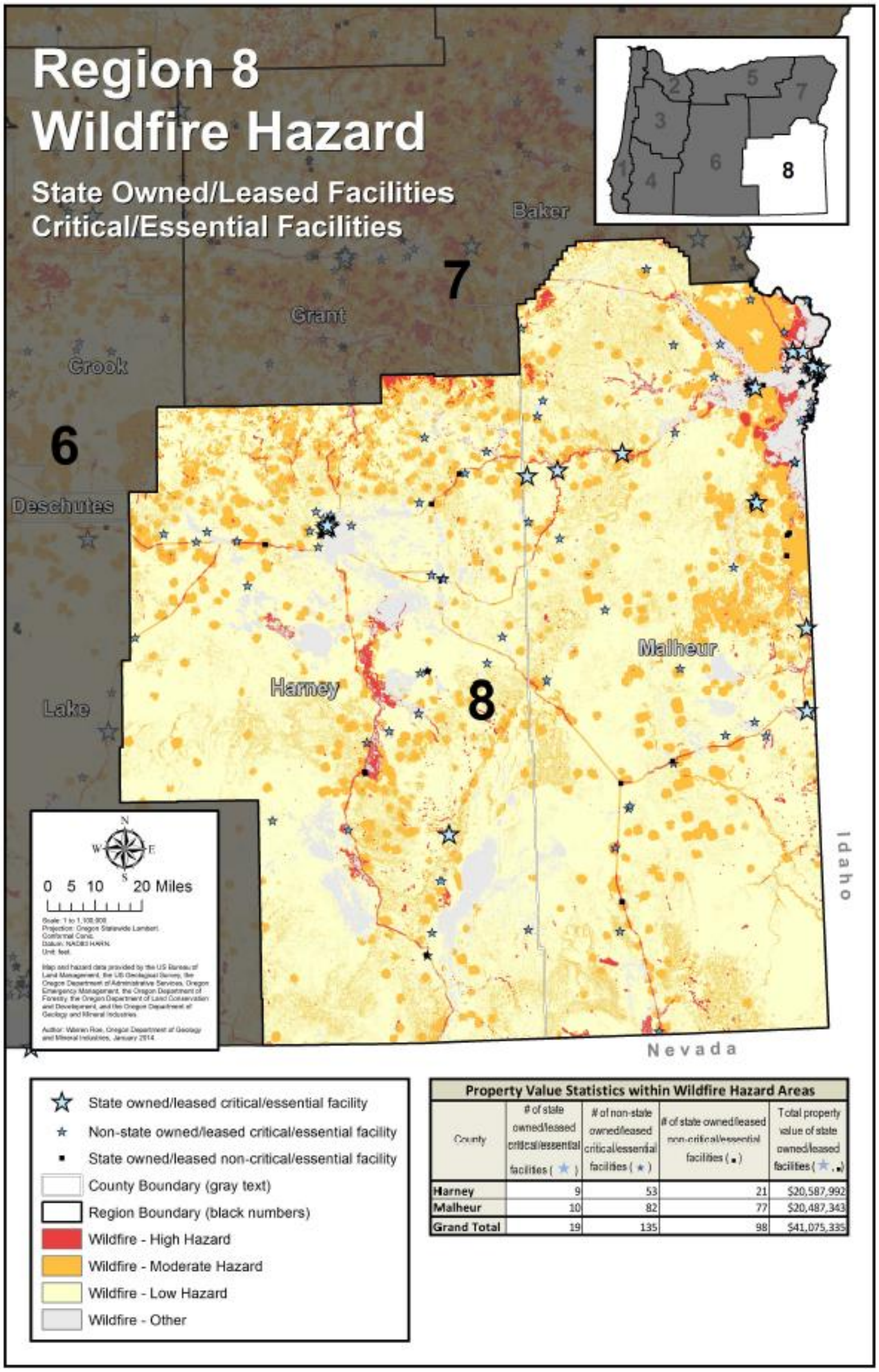
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Facilities and Critical and Essential Facilities

The following information is based on a state facility and critical/essential facility vulnerability assessment update completed by DOGAMI in 2014. See the State Risk Assessment, **Oregon Vulnerabilities** for more information.

Of the 5,693 state facilities evaluated, 117 are within a wildfire hazard zone in Region 8 and total roughly $41 million in property value (**Figure 2-240**). Among those, 19 are state critical/essential facilities. An additional 135 non-state critical/essential facilities are also located in Region 8.

Figure 2-240. State-Owned/Leased Facilities and Critical/Essential Facilities in a Wildfire Hazard Zone in Region 8



Property Value Statistics within Wildfire Hazard Areas

County	# of state owned/leased critical/essential facilities	# of non-state owned/leased critical/essential facilities	# of state owned/leased non-critical/essential facilities	Total property value of state owned/leased facilities
Harney	9	53	21	$20,587,992
Malheur	10	82	77	$20,487,343
Grand Total	19	135	98	$41,075,335

Source: DOGAMI

Windstorms

Characteristics

High winds in the intermountain areas of Region 8 are not uncommon. There is little in the way of mountain protection for much of these counties; the landscape is flat and open with the exception of a few areas. Winds in Harney and Malheur Counties are often associated with thunderstorms, which have strong outflow and coincidentally strong surface winds. Windstorms can be problematic in burned areas, where dust may be lifted and transported across the landscape, causing reductions in visibility and localized damage.

Tornadoes

Small to moderate sized tornadoes have been recorded in virtually every area of Oregon. Six have been recorded in Region 8 (**Table 2-537**), but others probably have occurred. Wind speeds have varied; estimates are somewhere between 40 to 112 mph, corresponding to “gale” (F0 on the Fujita Scale of Tornado Intensity) and “moderate” (F1 on the Fujita Scale) tornadoes. Damage was estimated to be an amount between $5,000 and $50,000 (Taylor and Hatton 1999).

Historic Windstorm Events

Table 2-537. Historic Windstorms in Region 8

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; Wind speed 40–60 mph; Gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69 mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71 mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon’s most destructive storm to date.; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Aug. 1966	Malheur County	tornado between Nyssa and Ontario; telephone poles and some farm buildings destroyed
June 1967	Malheur County	two tornadoes reported; some damage
June 1969	Malheur County	tornado reported 40-60 miles south of Jordan Valley (Malheur County)
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Apr. 1974	Malheur County	tornado path parallel to Oregon- Idaho border; farm building destroyed
Nov. 1981	statewide	60-mph winds common throughout state
Jan. 1990	statewide	severe wind storm
Jan. 1991	most of Oregon	severe wind storm
Dec. 1991	NE and central Oregon	severe wind storm
Dec. 1992	northeastern mountains, Oregon	severe wind storm
May 1994	eastern Oregon	strong winds in Treasure Valley area (Ontario); blowing dust caused many car accidents
May 2005	Malheur County	hail storm causes $3,000 in crop damage
July 2006	Harney County	wind storm produces winds of 75 mph
Aug. 2006	Harney County	three high wind storms in Harney County with winds measured at 67, 58 and 58 mph, respectively
Aug. 2007	Harney County	high wind storm produces winds of 58 mph
Apr. 2010	Harney County	75-mph winds caused $200,000 in property damage, including 52 downed power poles

Source: Taylor and Hannan, 1999, *The Oregon Weather book;* The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org

Table 2-538. Tornadoes Recorded in Region 8

County	Date	Location	Damage
Malheur	Aug. 1966	Adrian to Oregon border just north of Ontario, Oregon	several farm buildings destroyed; trees uprooted; telephone poles displaced
Malheur	June 1967	13 miles west of Sheaville, Oregon	two tornadoes; limited in extent and duration; one damaging; the other, no damage
Malheur	June 1967	remote	some damage
Malheur	June 1969	40–60 miles west of Jordan Valley, Oregon	grain fields damaged
Malheur	Apr. 1974	10 miles SW of Nyssa, Oregon	farm buildings destroyed

Source: Taylor and Hatton, 1999, pp. 123-137

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete “OEM Hazard Analysis Methodology” is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience windstorms is shown in **Table 2-539**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-539. Local Probability Assessment of Windstorms for Region 8

	Harney	Malheur
Probability	M	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

The 100-year storm in this region is defined as one-minute average winds of 75 mph. A 50-year storm includes winds of 65 mph. A 25-year storm has winds of up to 55 mph.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to windstorm is shown in **Table 2-540**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-540. Local Vulnerability Assessment of Windstorms for Region 8

	Harney	Malheur
Vulnerability	L	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Many buildings, utilities, and transportation systems within Region 7 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed when uprooted trees growing next to a house fall during a windstorm. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establishing a tree maintenance and removal program.

Winter Storms

Characteristics

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. Winter weather in Region 8 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 8 with an average of 24 inches of snow; most communities are prepared for them. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region.

Historic Winter Storm Events

Table 2-541. Significant Winter Storms in Region 8

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire state	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	central /eastern Oregon	heavy snow; traffic accidents; broken power lines
Mar. 1988	entire state	strong winds; heavy snow
Feb. 1990	entire state	heavy snow throughout state
Nov. 1993	Cascade Mountains, Oregon	heavy snow throughout region
Feb. 1994	southeastern Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)

Source: Taylor and Hatton, 1999, p. 118–122

Probability and Vulnerability

As stated in the State Risk Assessment, **Section 2.2.2.4, Local and State Vulnerability Assessment Comparison**, different methods are used to assess risk at local and state levels. All methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. The state recognizes these inconsistencies and has prioritized the analysis of local and state probability and vulnerability scores during the next plan update. A description of how the High (H), Moderate (M), and Low (L) scores in the local

probability and vulnerability tables in this section were determined is provided in the State Risk Assessment **Section 2.2.2.2, Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.16**.

Probability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the probability that Region 8 will experience winter storms is shown in **Table 2-542**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-542. Local Probability Assessment of Winter Storms for Region 8

	Harney	Malheur
Probability	H	H

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by county emergency program managers, the region's vulnerability to winter storms is shown in **Table 2-543**. See the **State Risk Assessment** for background information on the OEM Hazard Analysis and scoring methodology.

Table 2-543. Local Vulnerability Assessment of Winter Storms for Region 8

	Harney	Malheur
Vulnerability	M	M

Source: Oregon Office of Emergency Management, 2013 County Hazard Analysis Scores

State Assessment

Within the State of Oregon, Region 8 communities are known for cold, snowy winters. This is advantageous in at least one respect: in general, the region is prepared, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. Local residents also experience problems. During the winter, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers. Road closures due to winter weather are more common in this region. In general, the impacts of winter storms to southeastern Oregon communities are less significant because communities are prepared for long winters.