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.

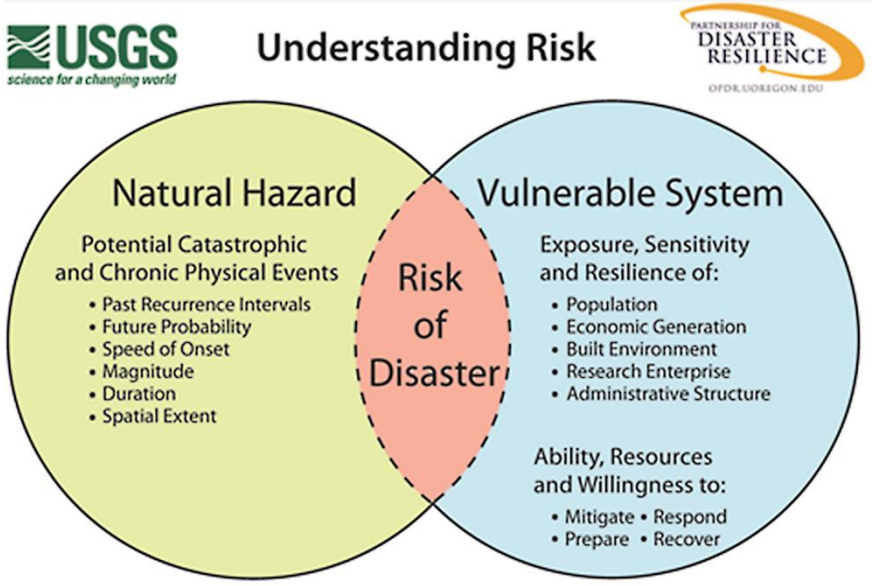
2.1 Introduction

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.

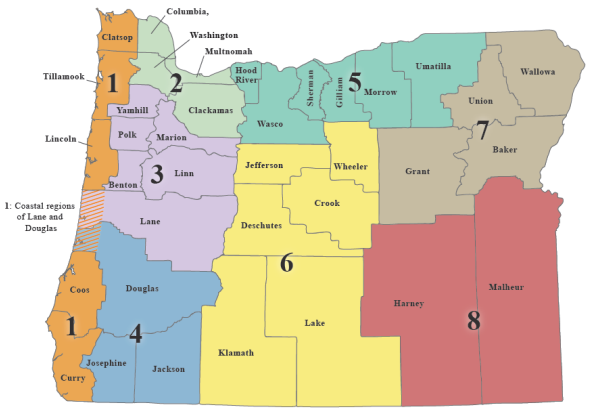
A vulnerability assessment combines information from the hazard characterization with an inventory of the existing (or planned) property and population exposed to a hazard and attempts to predict how different types of property and population groups will be affected by each hazard. Vulnerability is determined 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.

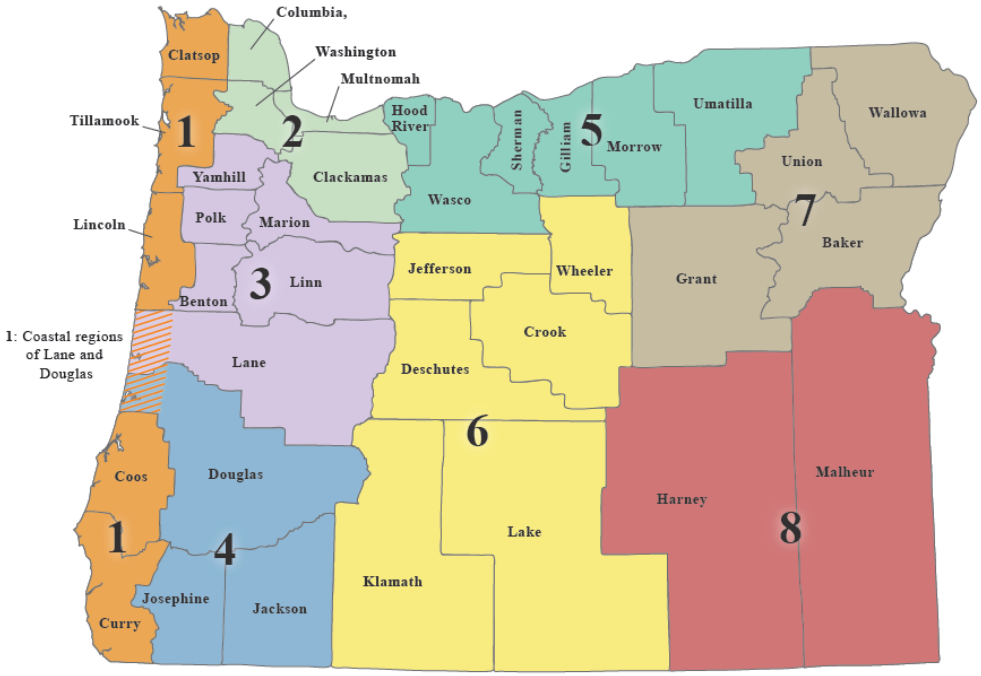
Figure 2-2. Oregon NHMP Natural Hazards Regions



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.

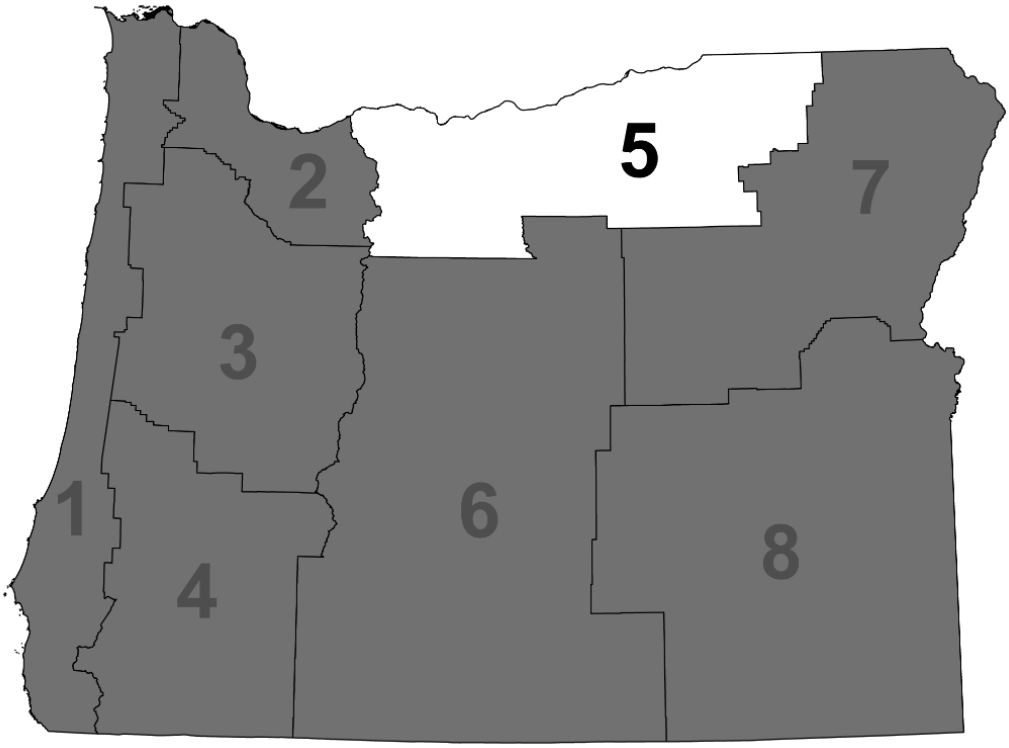
   The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability 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.

2.3.5 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

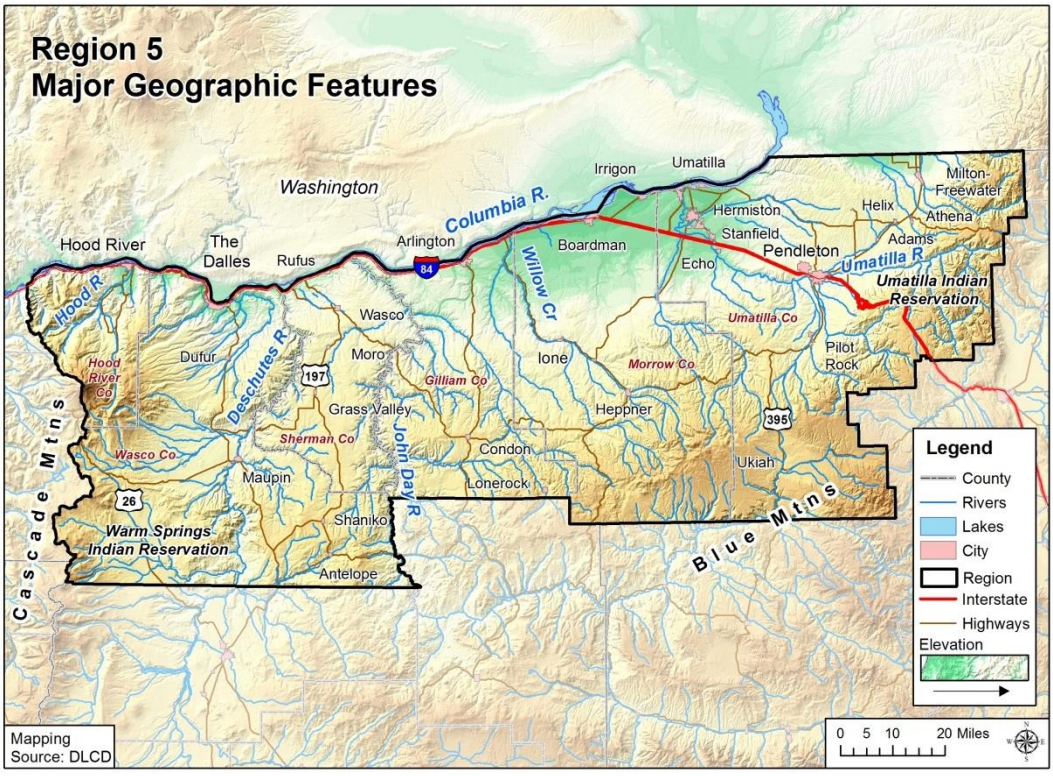
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

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.

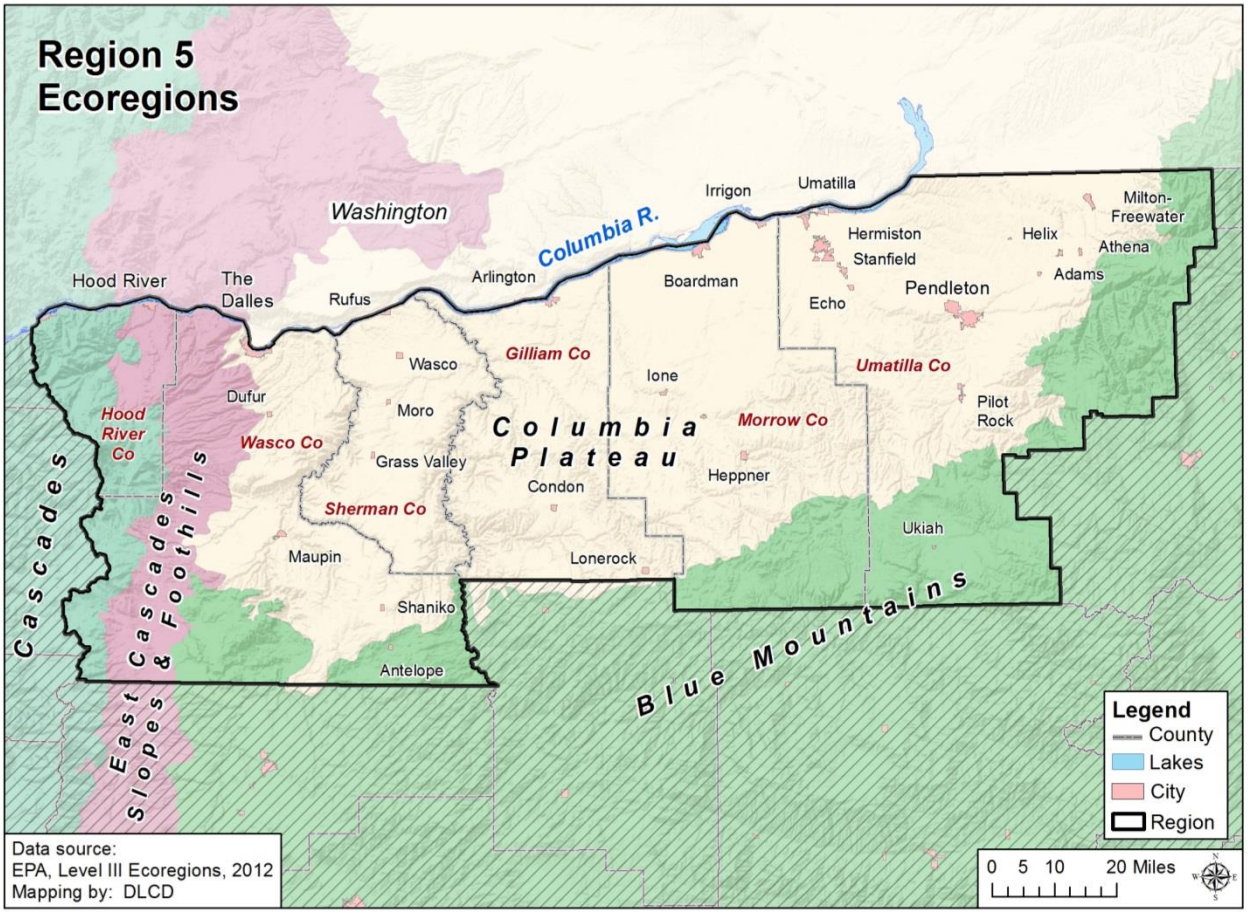
Figure 2-157. Region 5 Major Geographic Features



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%

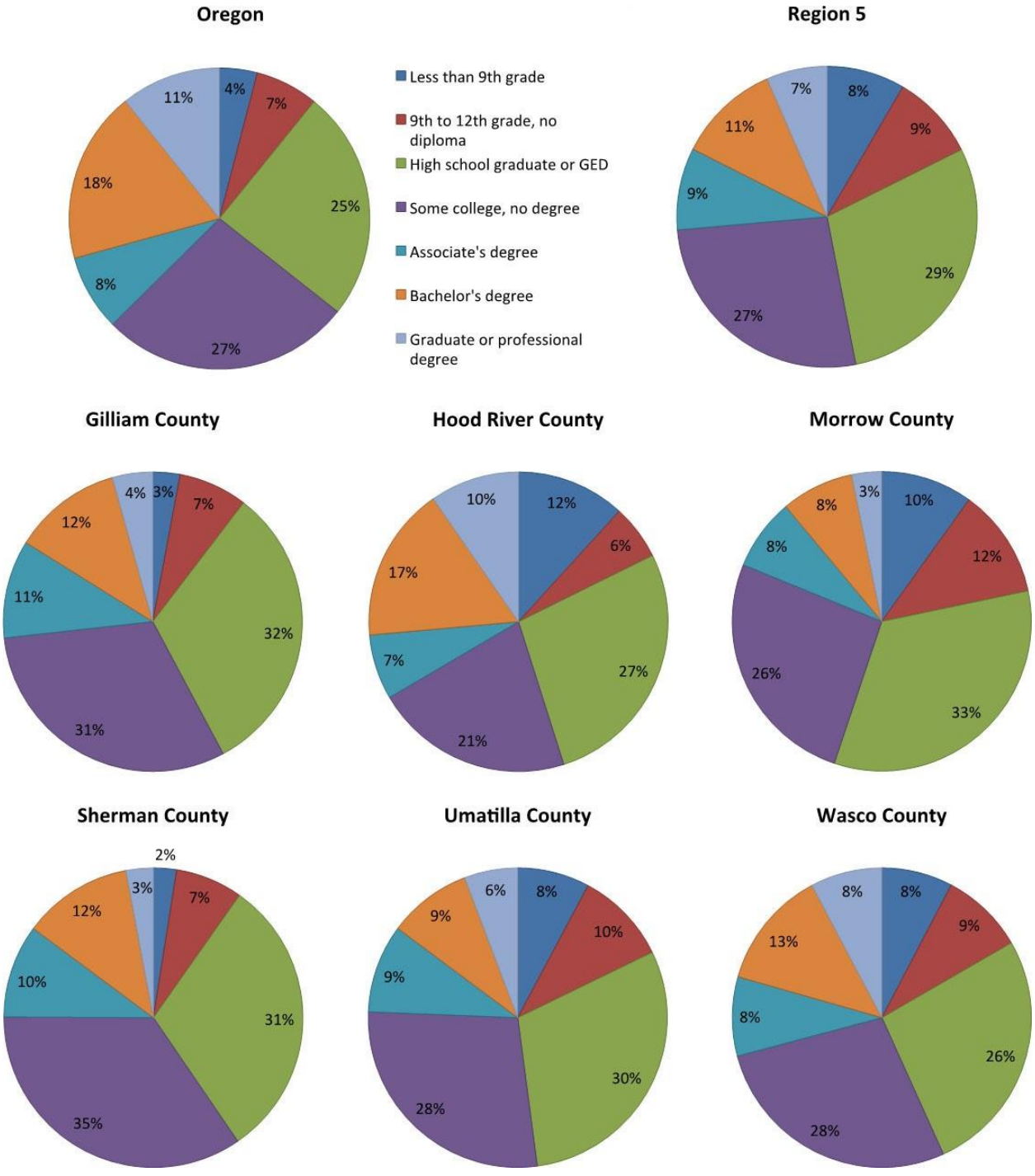
Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

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%

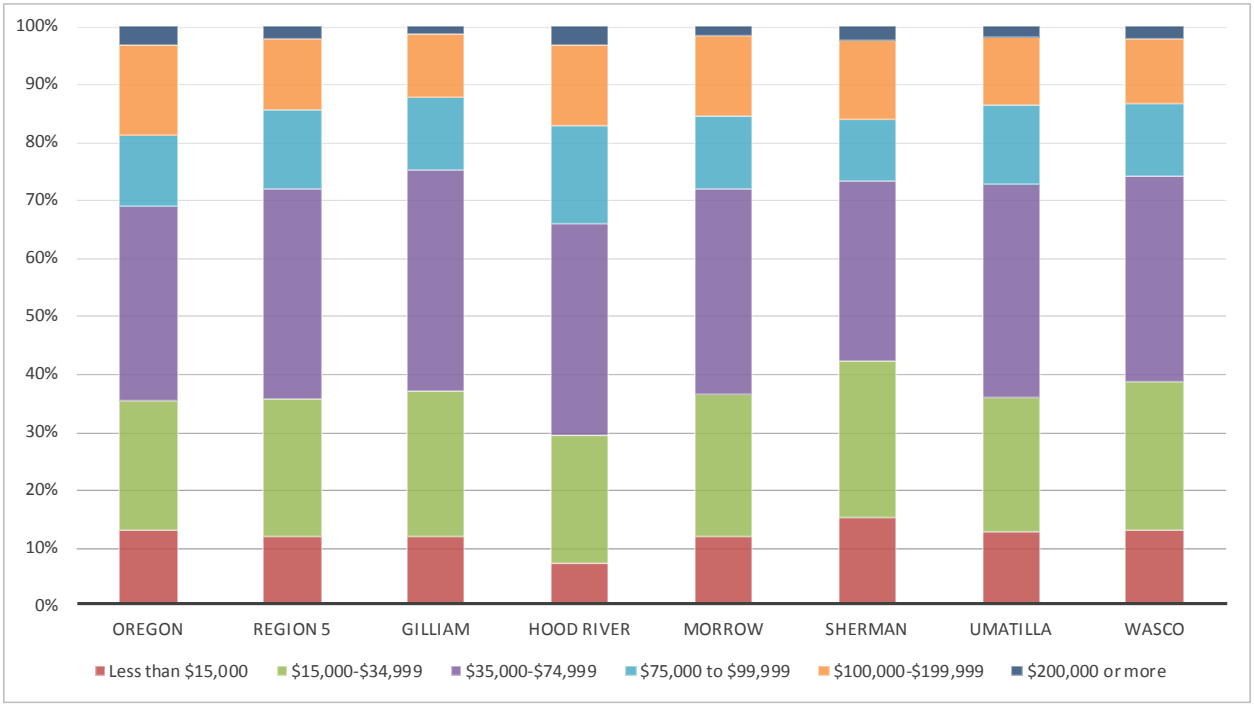
Note: 2009 dollars are adjusted for 2012 using Bureau of Labor Statistics' Consumer Price Index Inflation Calculator.

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

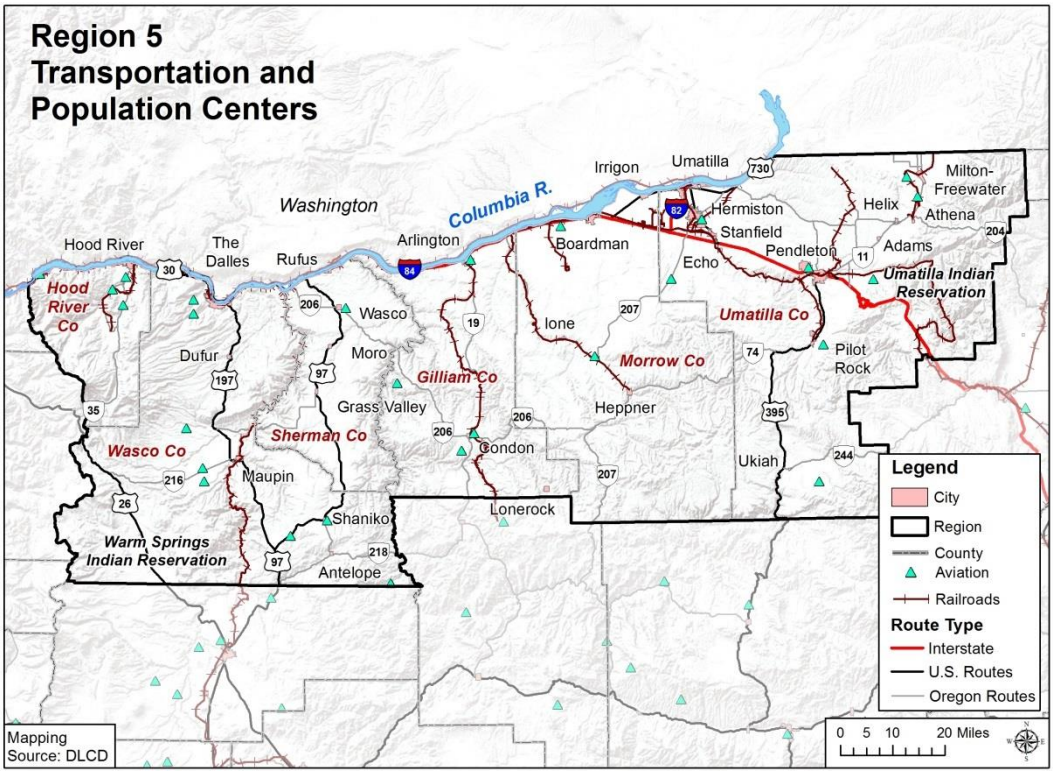
The largest population bases in Region 5 are located along the region's major freeways, I-84. I-84 is the main east-west passage for automobiles and trucks traveling between the northwest and states to the east.

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.

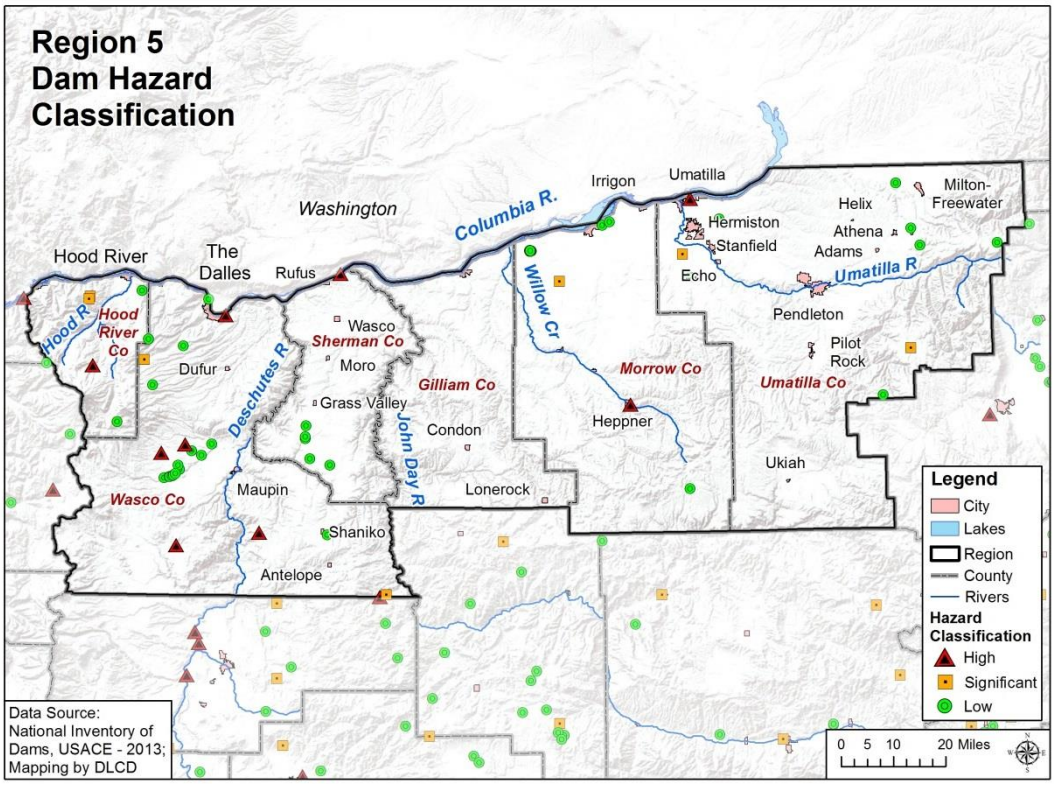
Minor dam failures can occur at any time. Most dam failures result in minor damage to structures and pose little or no risk to life safety. However, the potential for severe damage and fatalities does exist (major dam failures have occurred most recently near Hermiston, 2005, and Klamath Lake, 2006) (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 Dams
	High	Significant	Low	
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

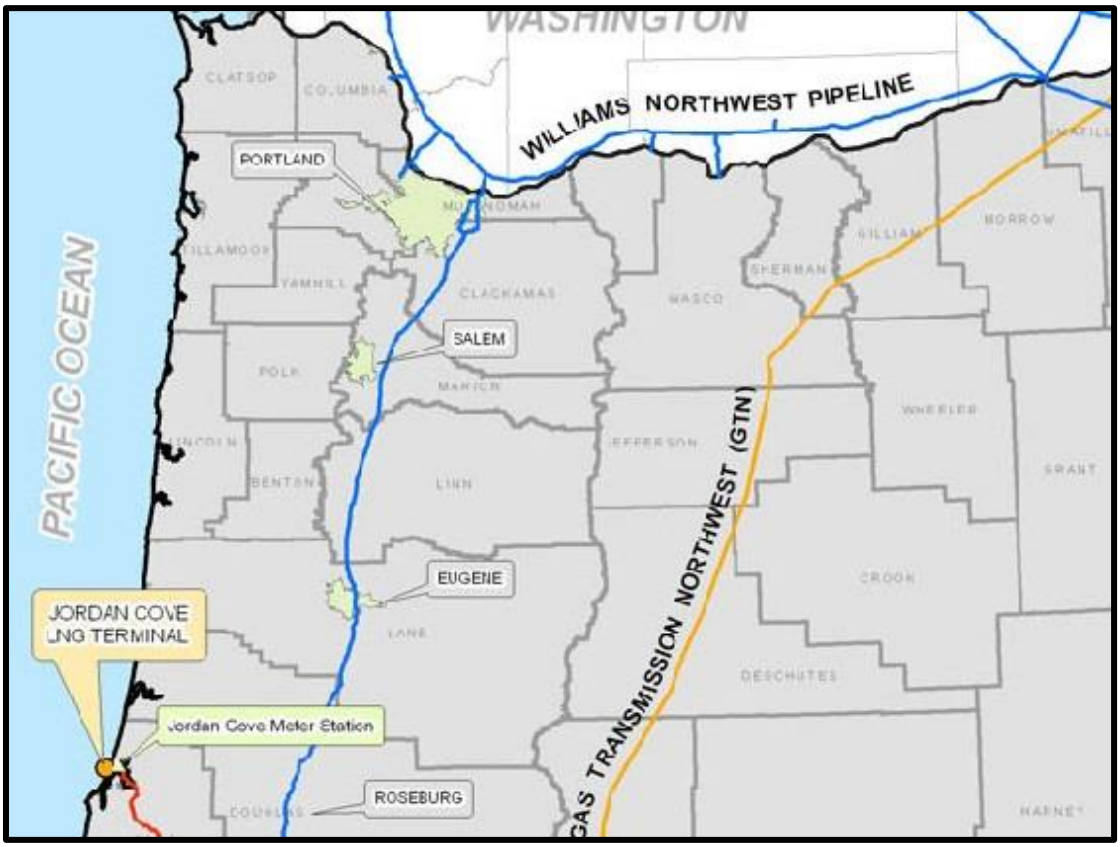


Source: National Inventory of Dams, USACE, 2013

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%

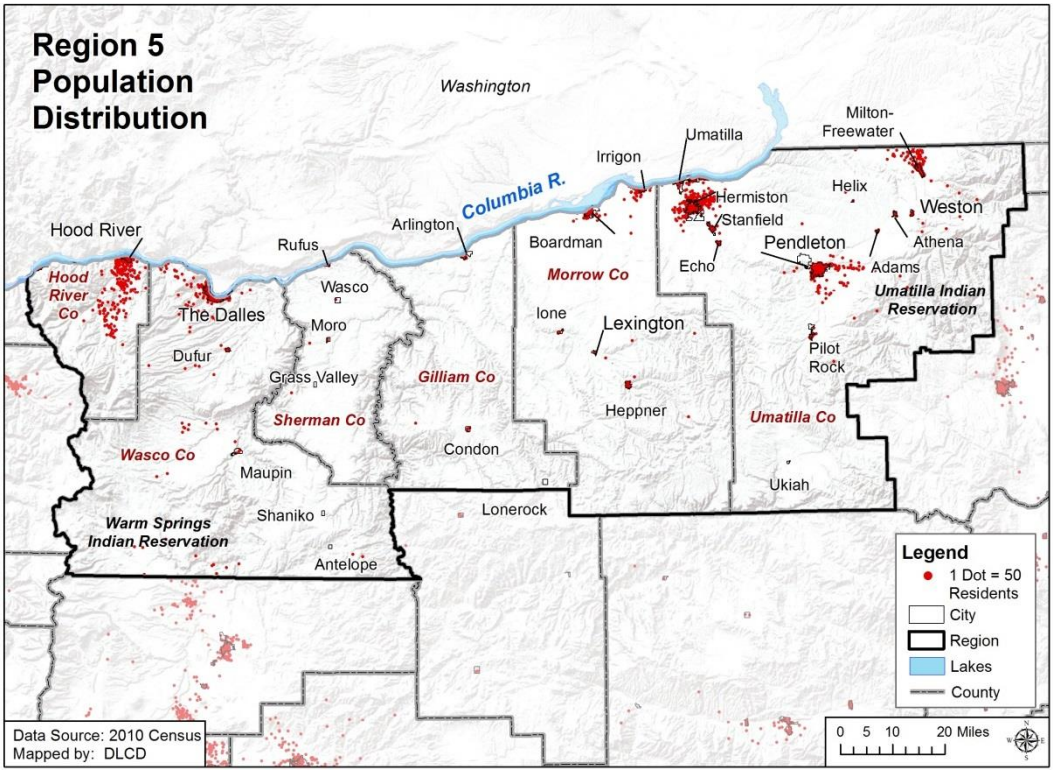
Source: U.S. Census Bureau. 2000 Decennial Census, Table P002 and 2010 Decennial Census, Table P2

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).

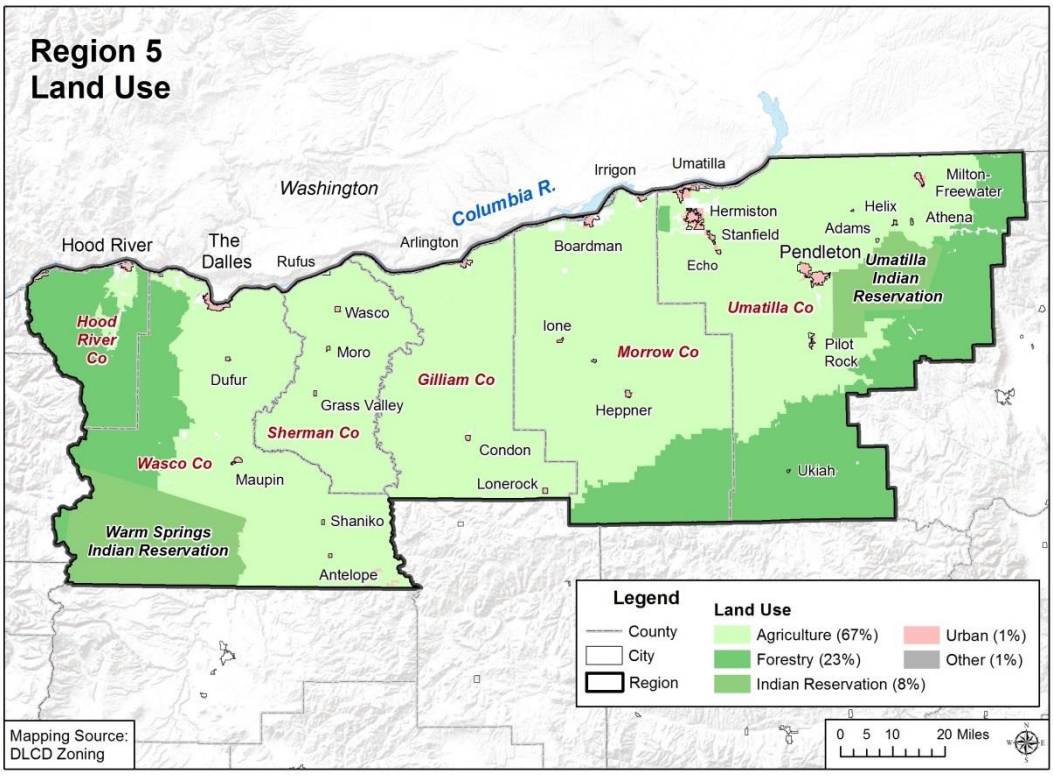
The community of Arlington (Gilliam County) has maintained a steady growth rate, and the Port of Morrow, 25 miles to the east in Umatilla County, remains the second busiest port in Oregon. Development can be limited in Region 5 along the Columbia River partly due to the geography. For example, buildable 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.

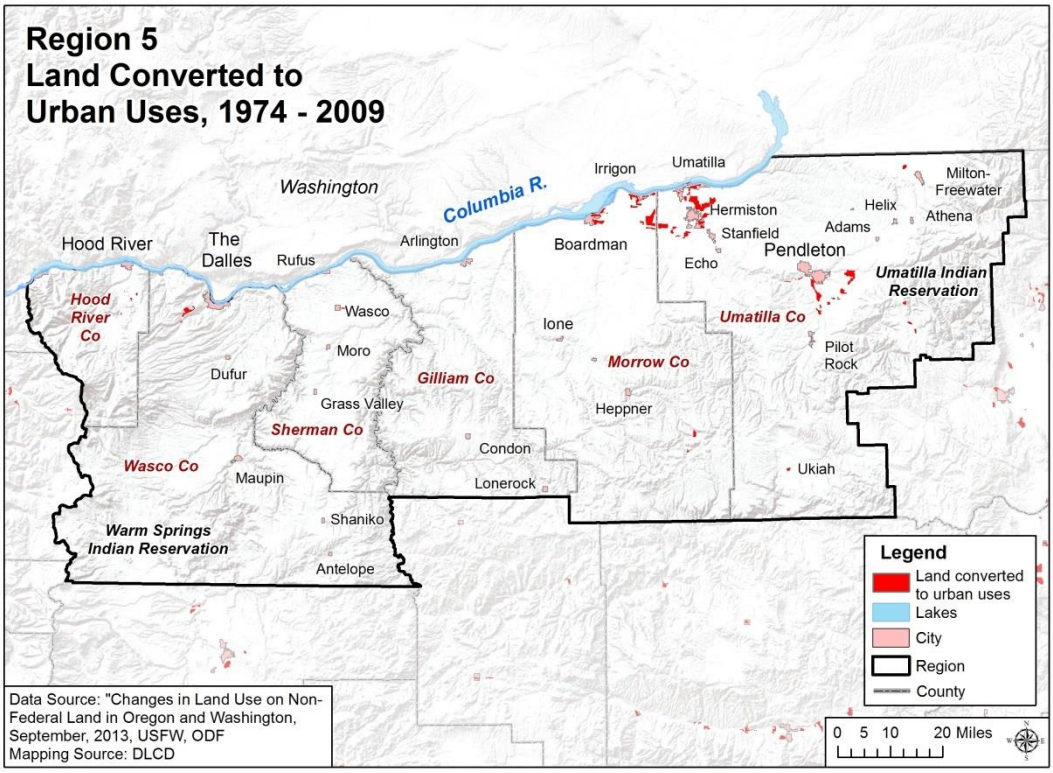
New FEMA floodplain mapping in Umatilla County in 2010 brought significant changes for the community of Milton-Freewater: the major levee along the Walla Walla River providing protection for much of the community was de-certified, effectively moving three quarters of the population into the NFIP regulatory 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

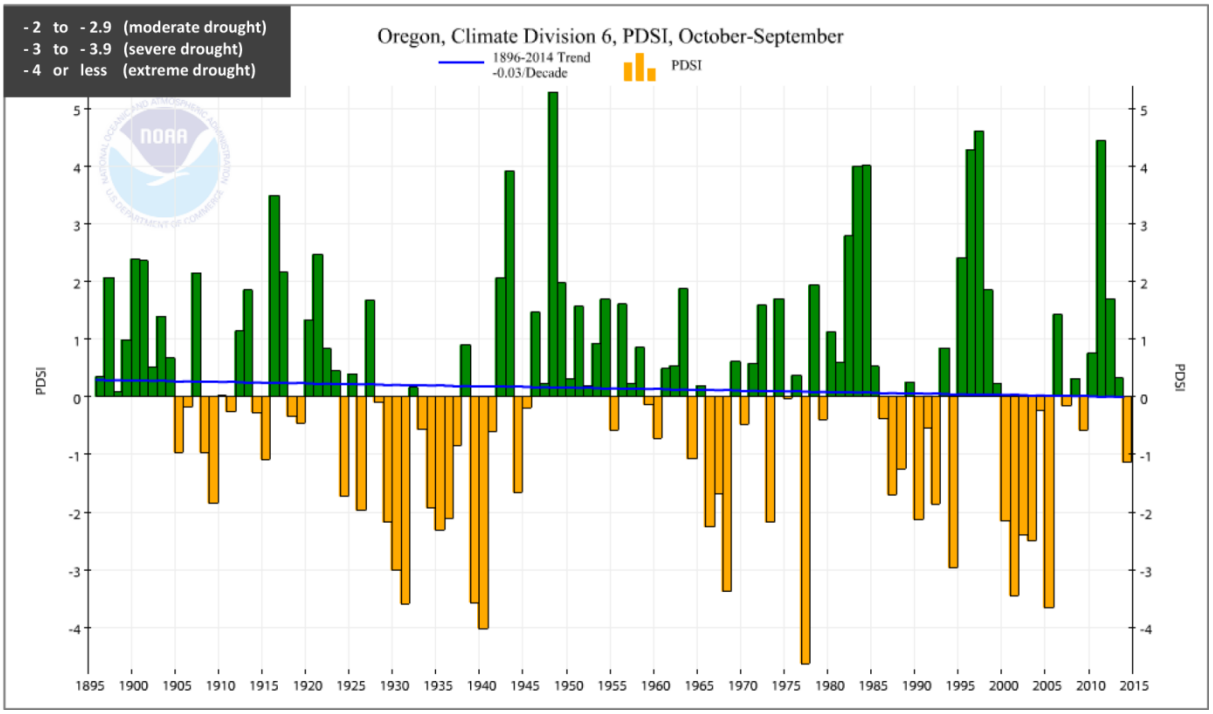
Water Year	Location	Description
1939	statewide 1938-1939, extreme drought in Region 5 in 1939-1940	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	Regions 4–8	the 1976-1977 drought was 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.

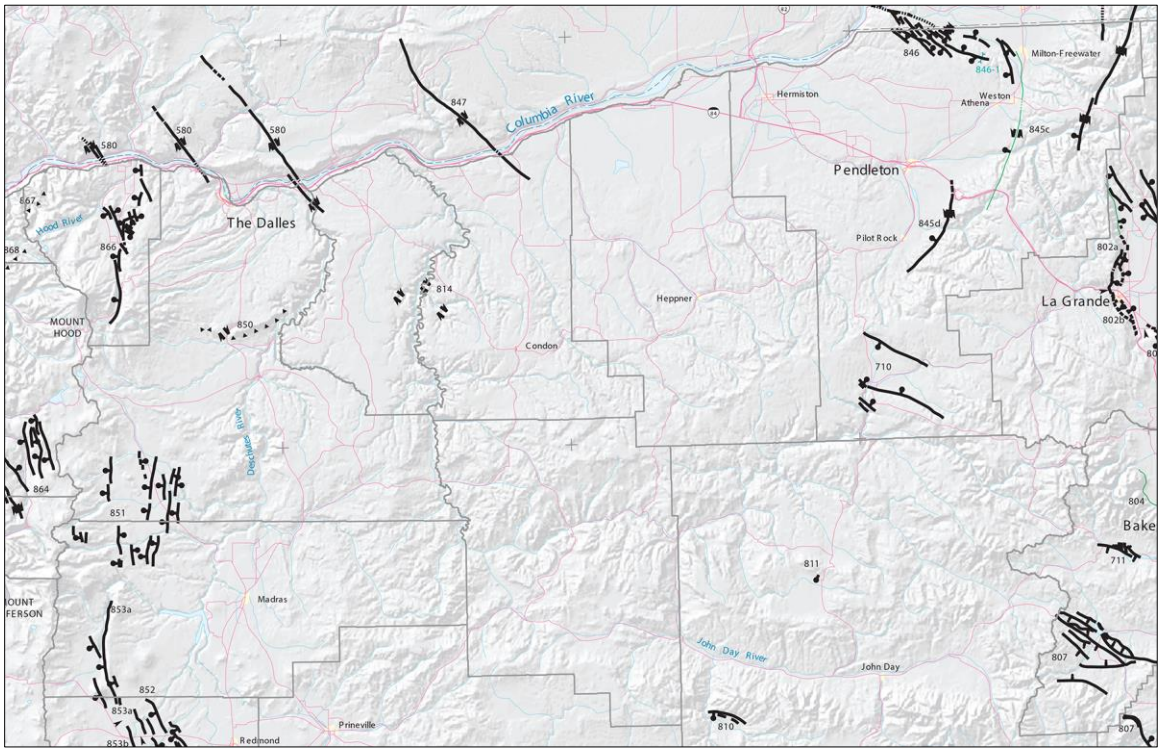
Poor visibility leading to motor vehicle crashes is the worst potential impact of these storms; often these crashes result in fatalities and major injuries. Other impacts include poor air quality, including dust infiltration of equipment and engines, loss of productive soil, and an increase in fine sediment 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

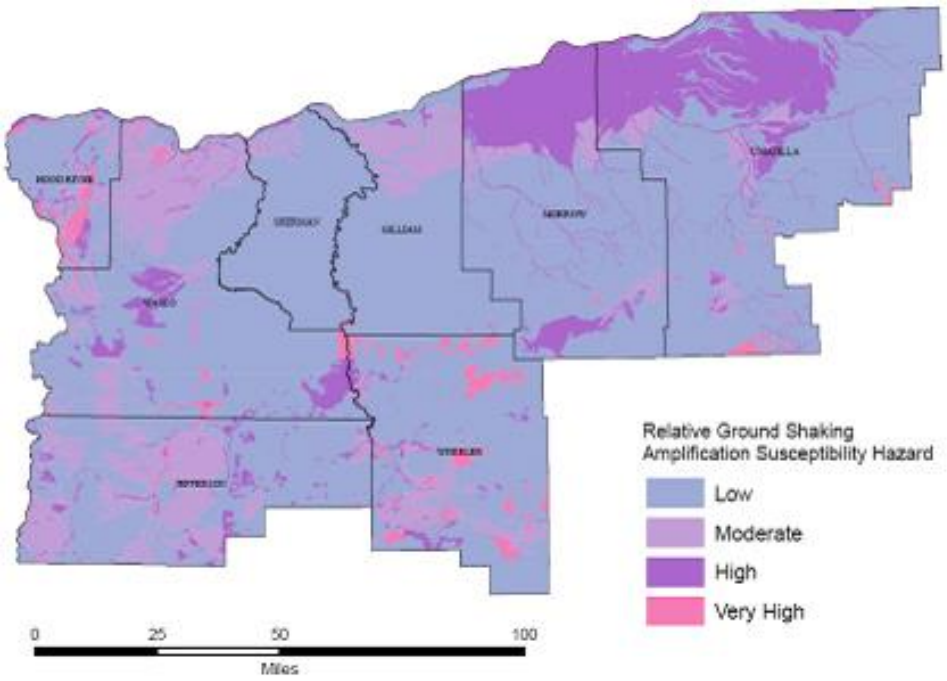


Source: Modified from Personius et al., 2003

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.

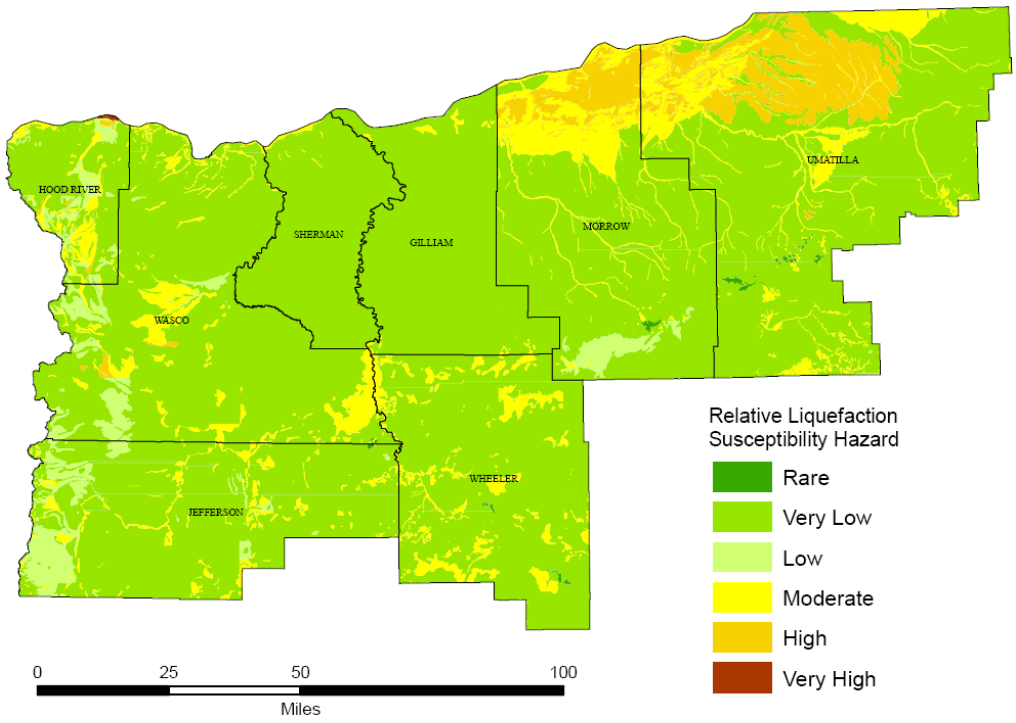
Figure 2-169. Relative Ground Shaking Amplification Hazard in Region 5



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.

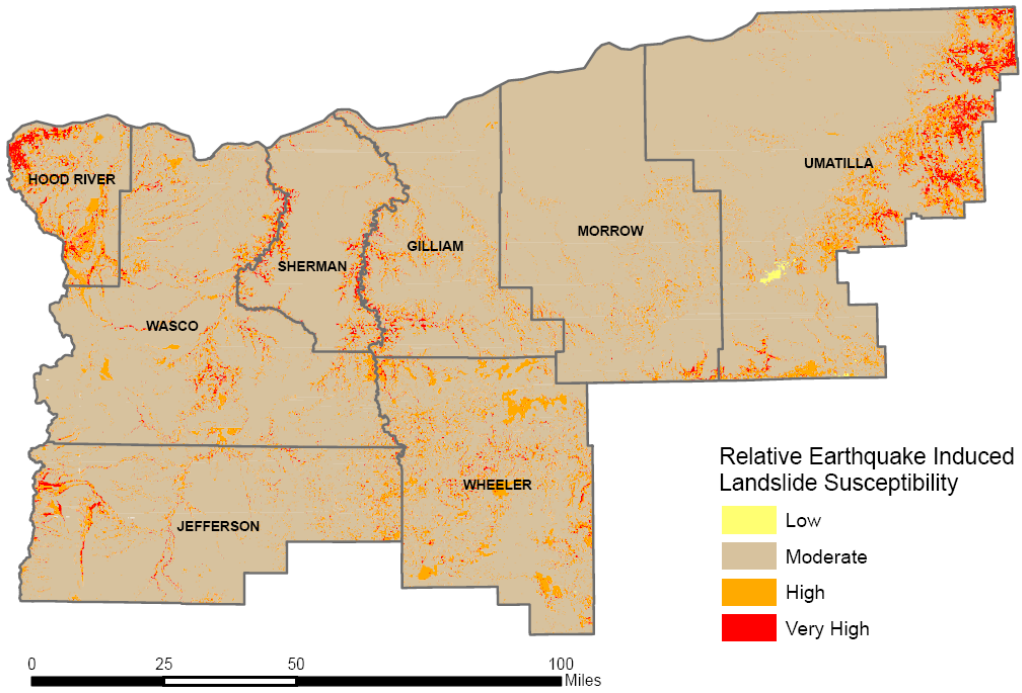
Figure 2-170. Relative Liquefaction Susceptibility Hazard in Region 5



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

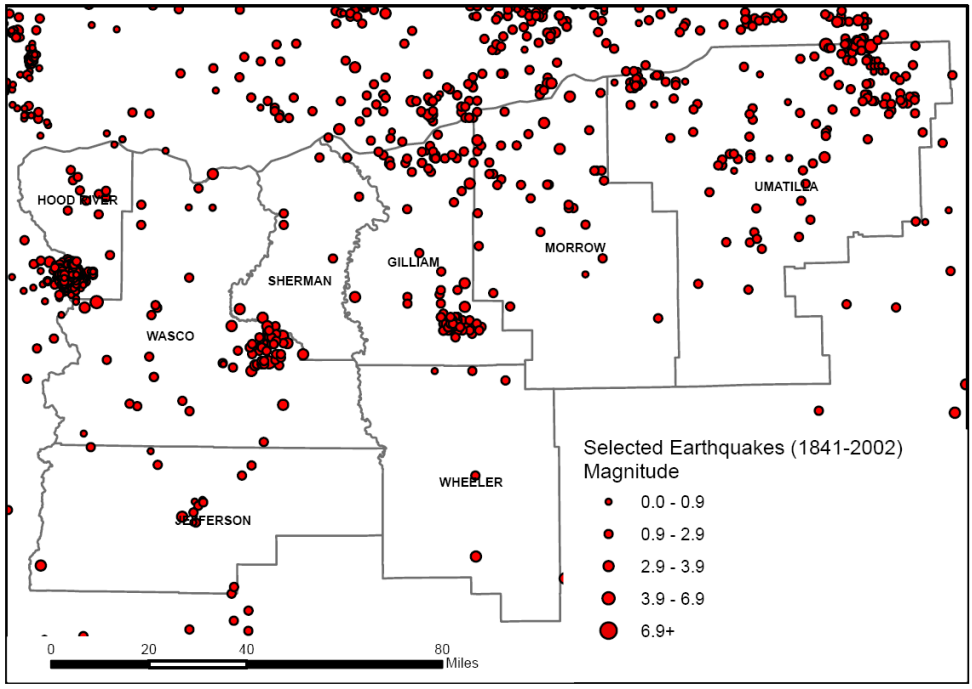


Source: Burns, 2007

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

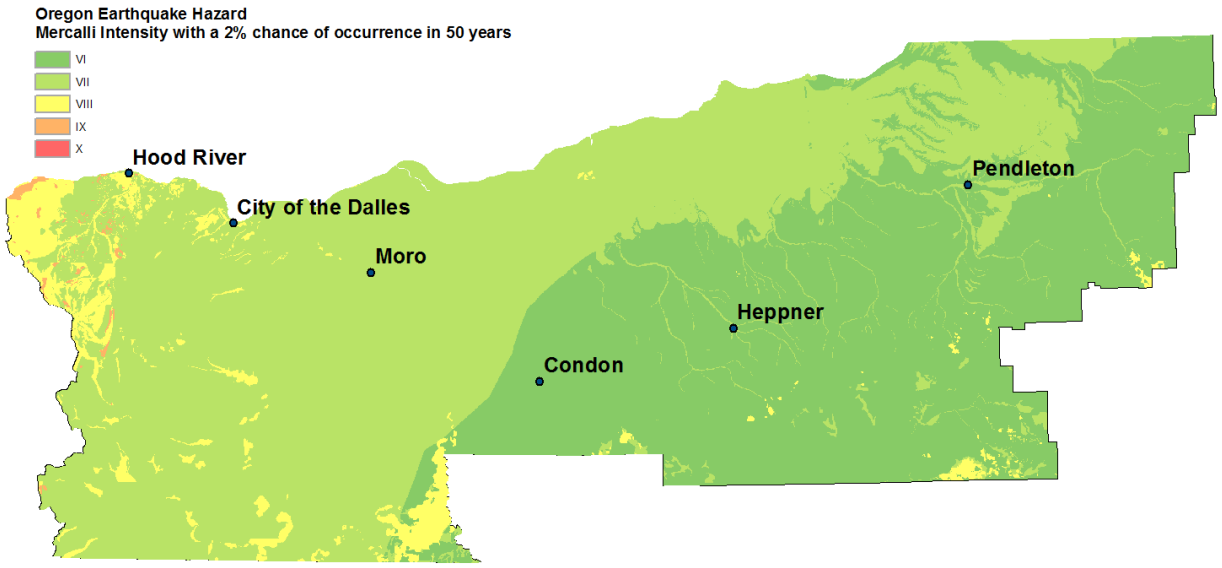
The probability of damaging earthquakes varies widely across the state. In Region 5, the hazard is dominated by local faults and background seismicity.

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

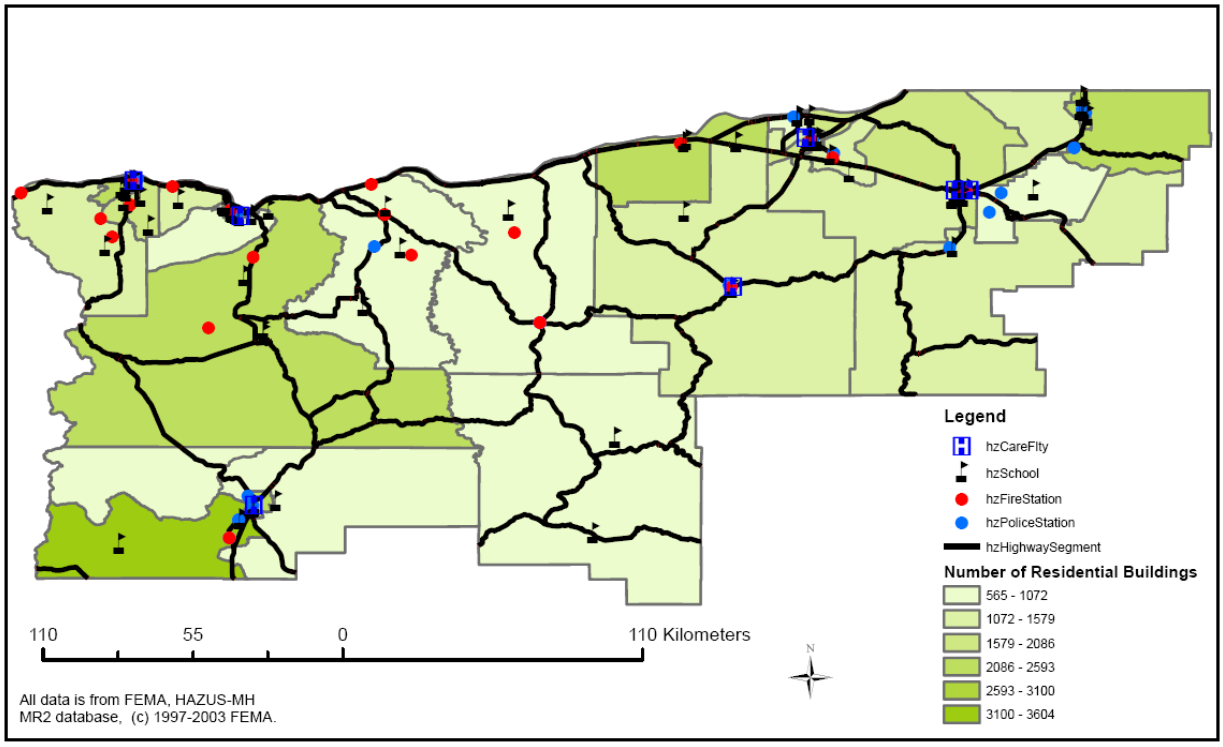
	Gilliam	Hood River	Morrow	Sherman	Umatilla	Wasco
Vulnerability	M	M	H	L	M	M

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

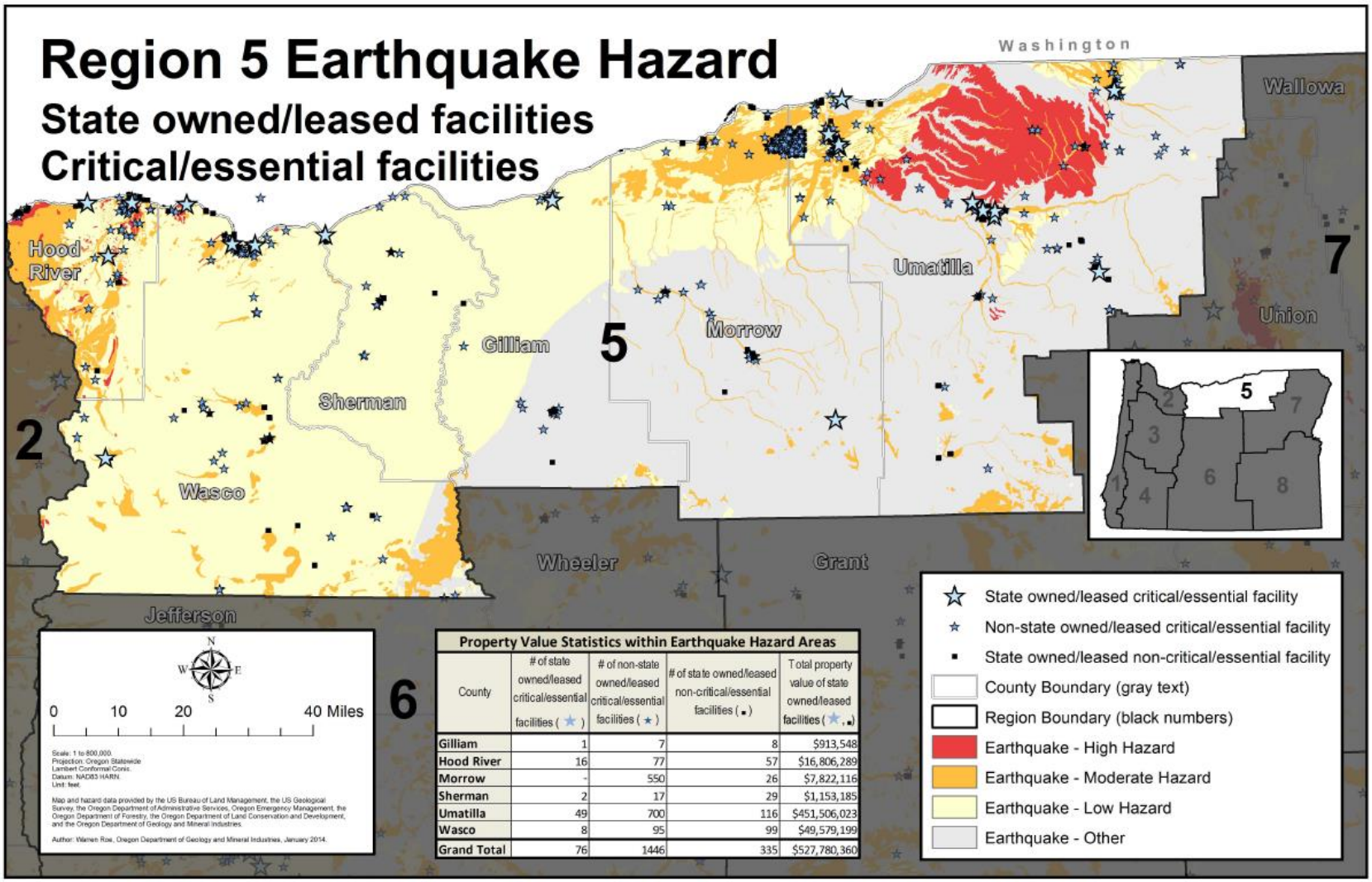
Source: W. J. Burns, 2007, DOGAMI unpublished report: Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage and loss estimates for seven counties in the Mid-Columbia River Gorge Region including Hood River, Wasco, Sherman, Gilliam, Morrow, Umatilla, Jefferson, and Wheeler

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).

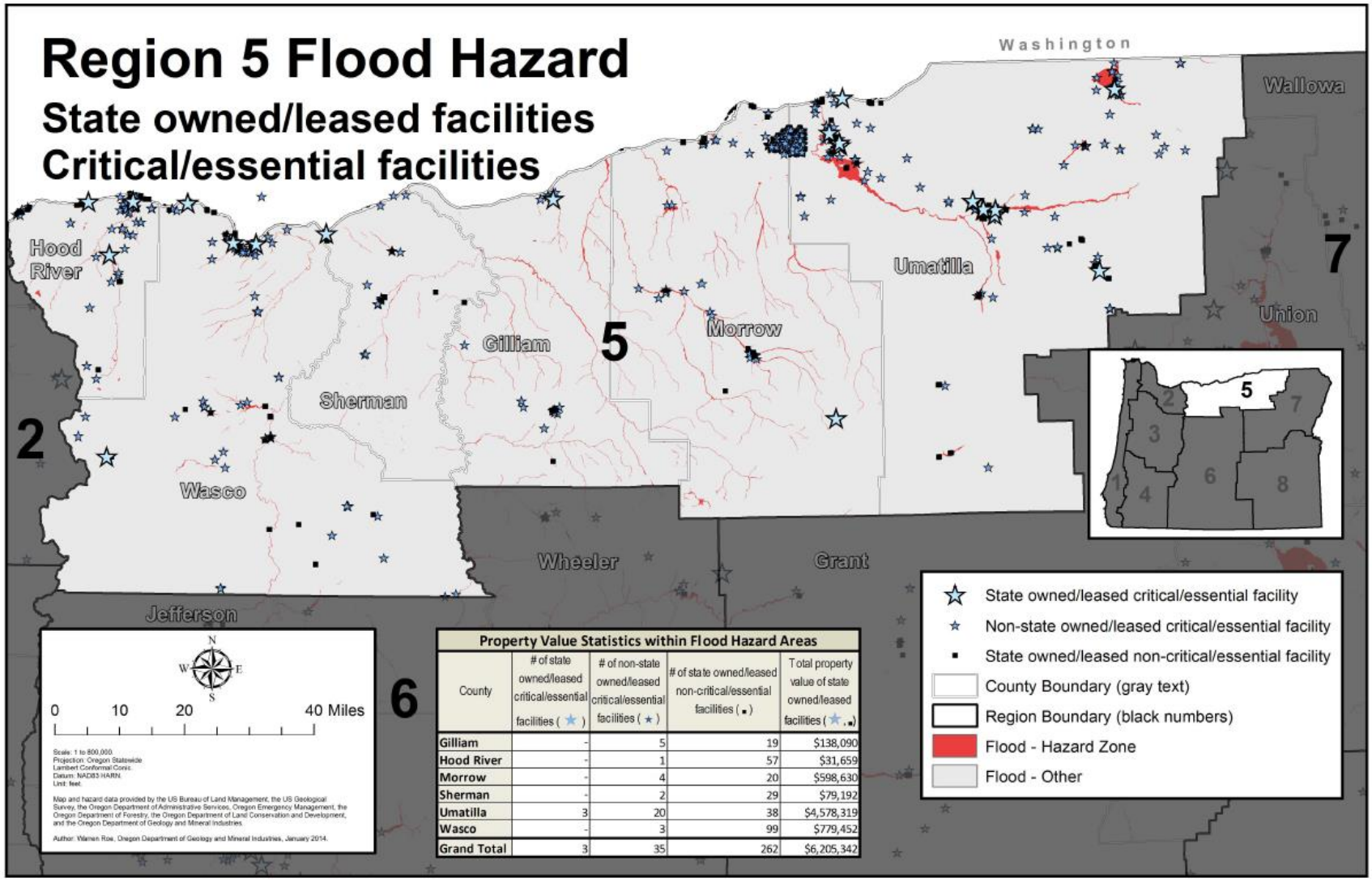
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. The cities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

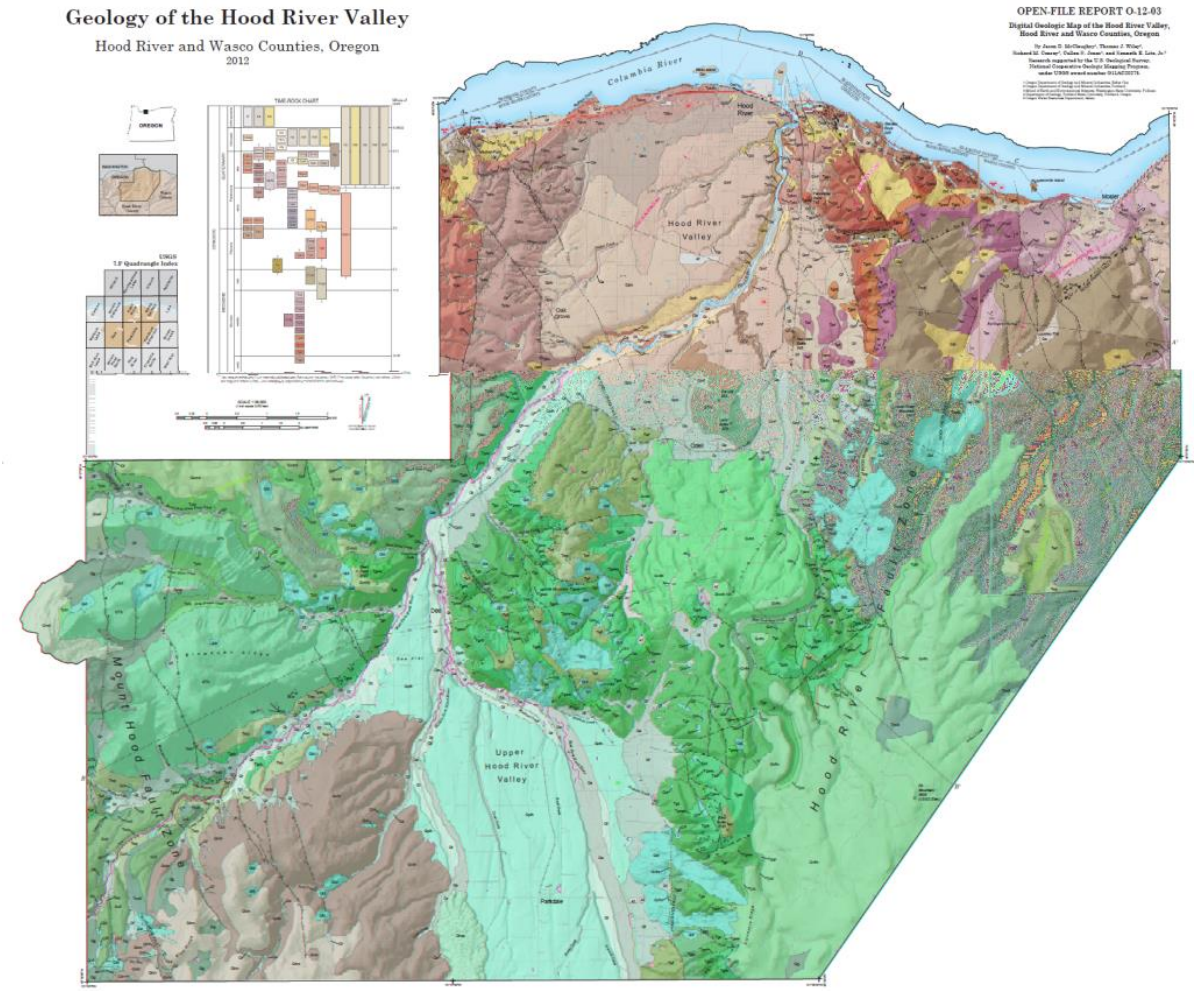
Landslides

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

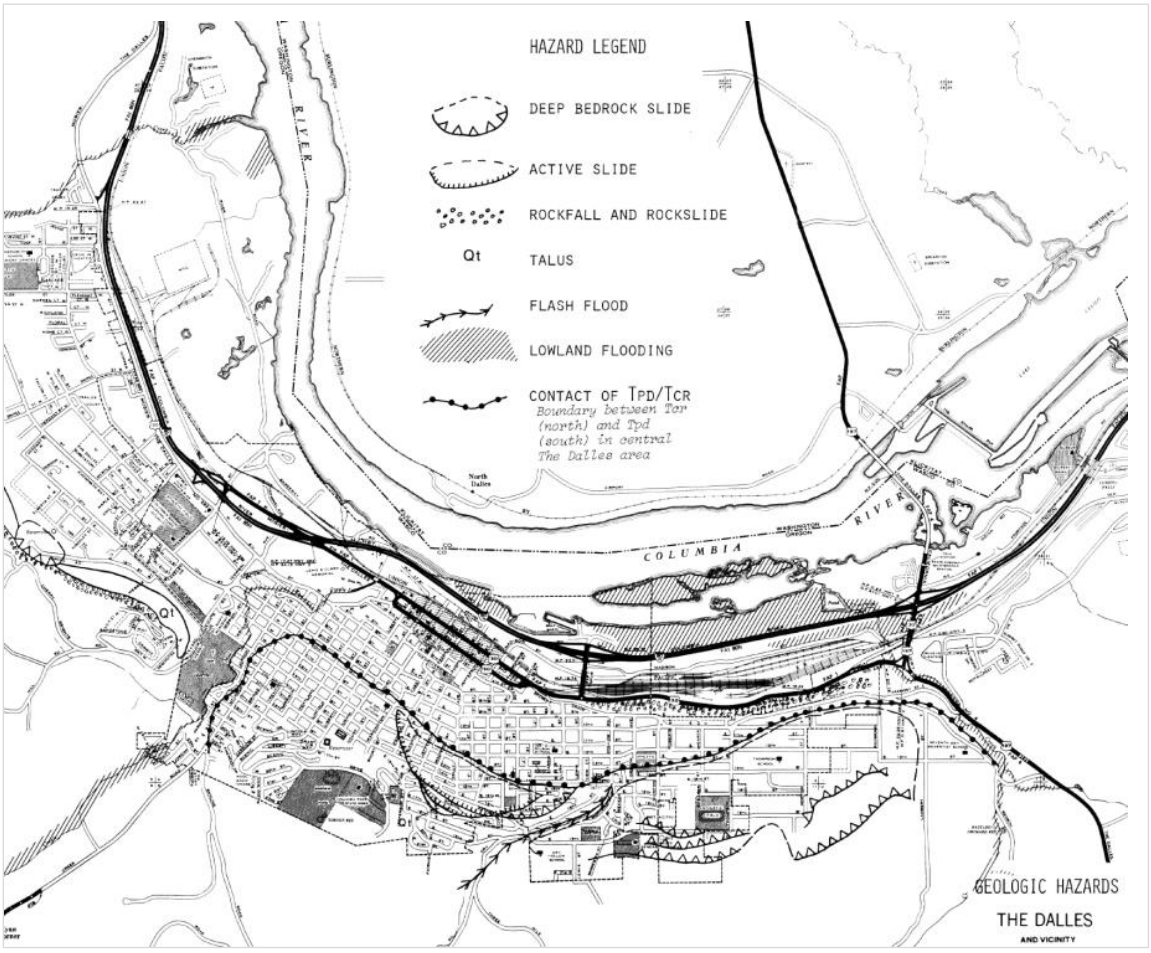
Table 2-341. Historic Landslides in Region 5

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

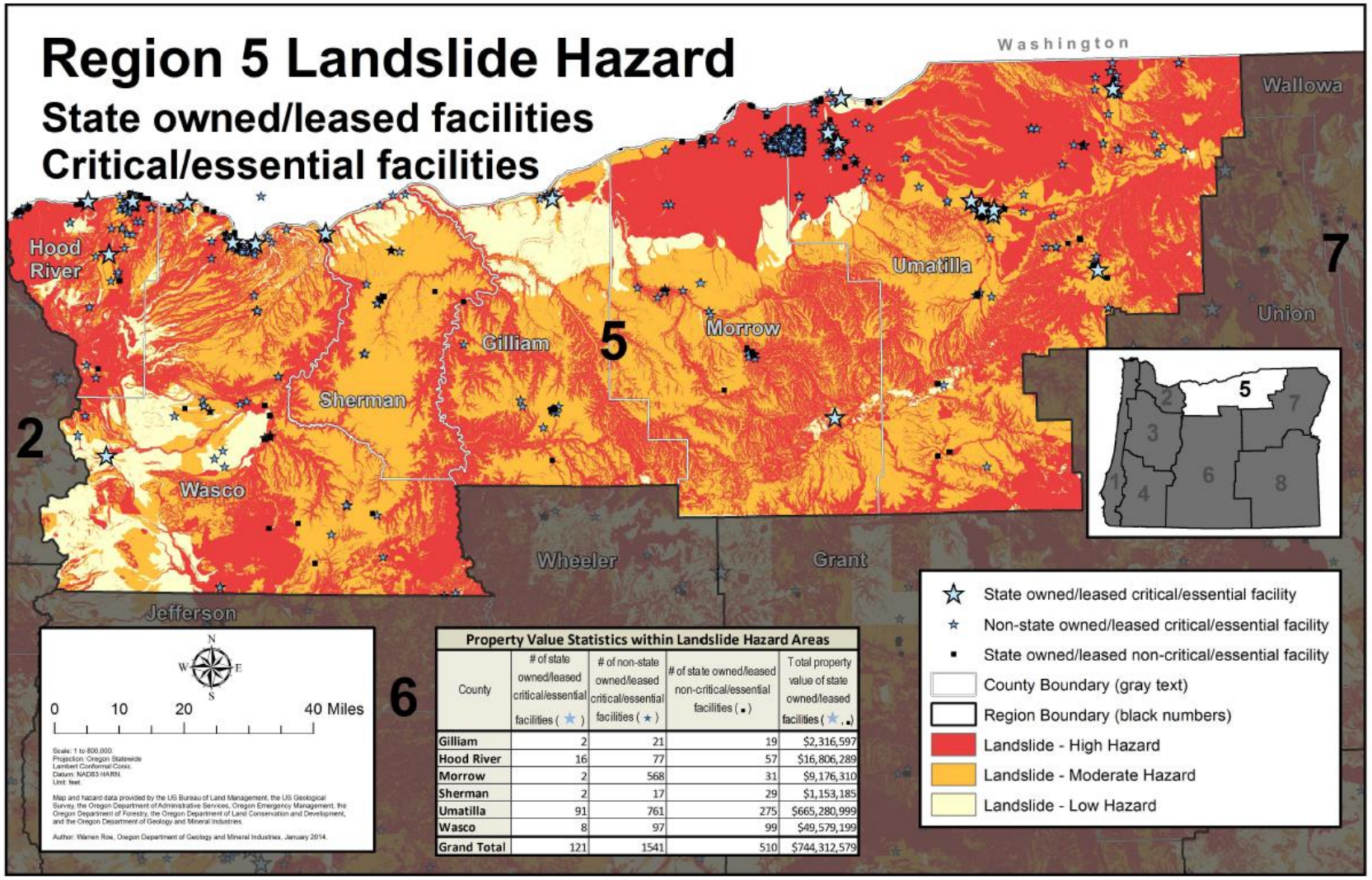
The Mid-Columbia Region is moderate to highly vulnerable to landslide hazards. Most of the people and infrastructure are along the I-84 corridor which runs along the northern portion of the region. This multimodal transportation corridor is vital to Oregon's economy and includes a major interstate highway (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



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 (★,▪)
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

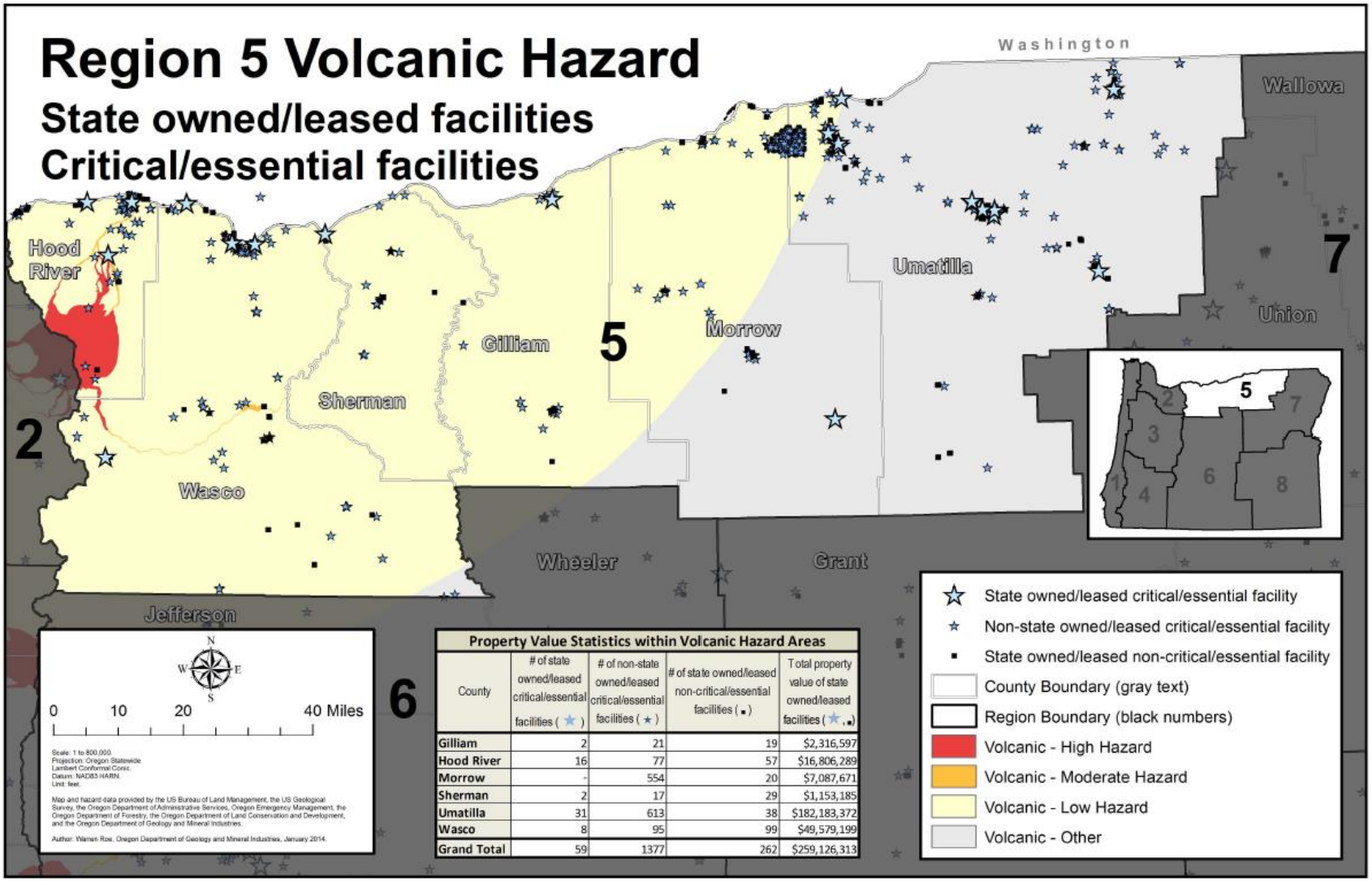
The U.S. Geological Survey has addressed volcanic hazards at Mount Hood (Scott et al., 1997). This report includes maps depicting the areas at greatest risk. The communities which are closer to Mount Hood, such as the Parkdale and the City of Hood River in Hood River County, are at risk from proximal 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	

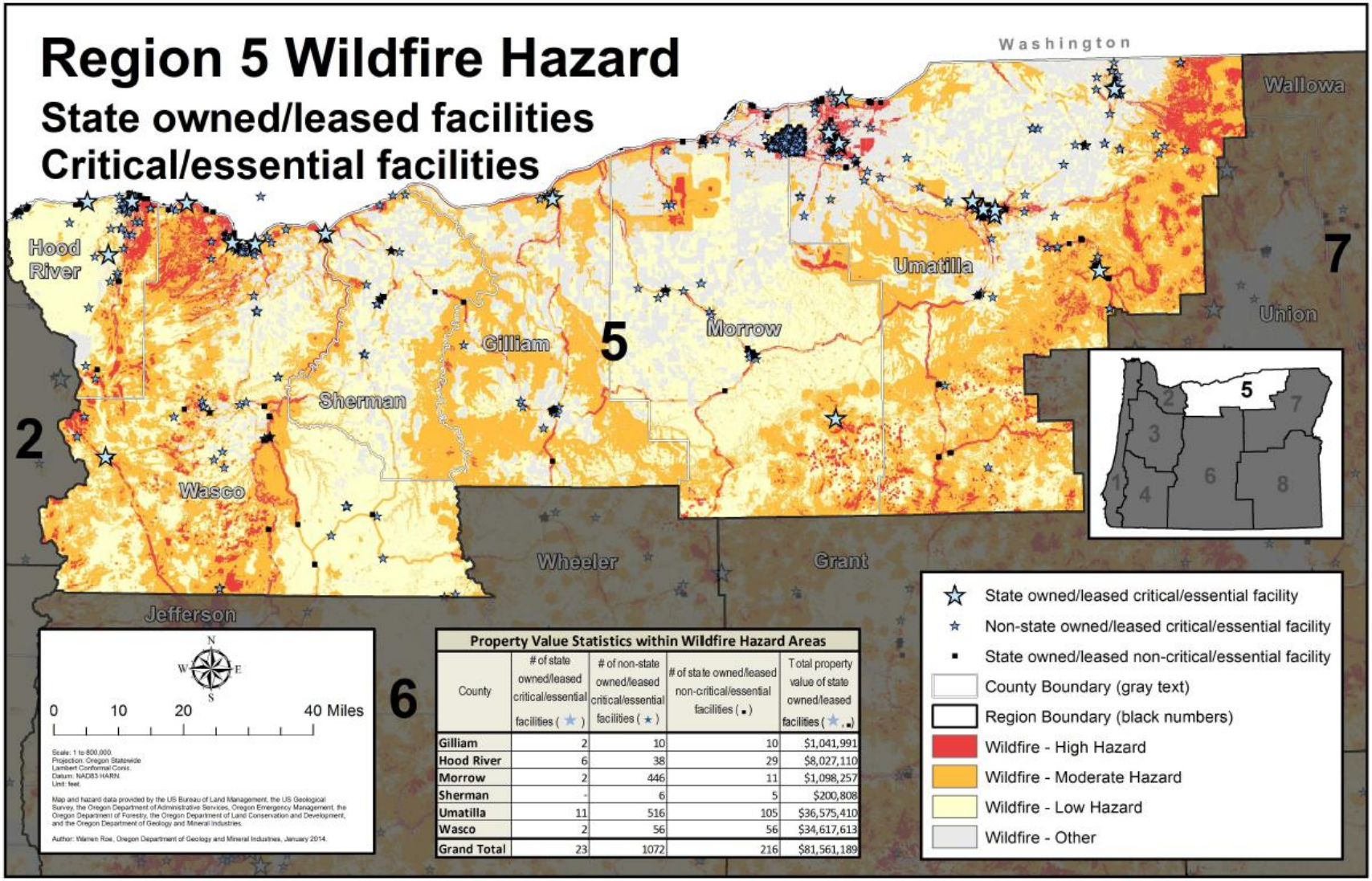
Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

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.