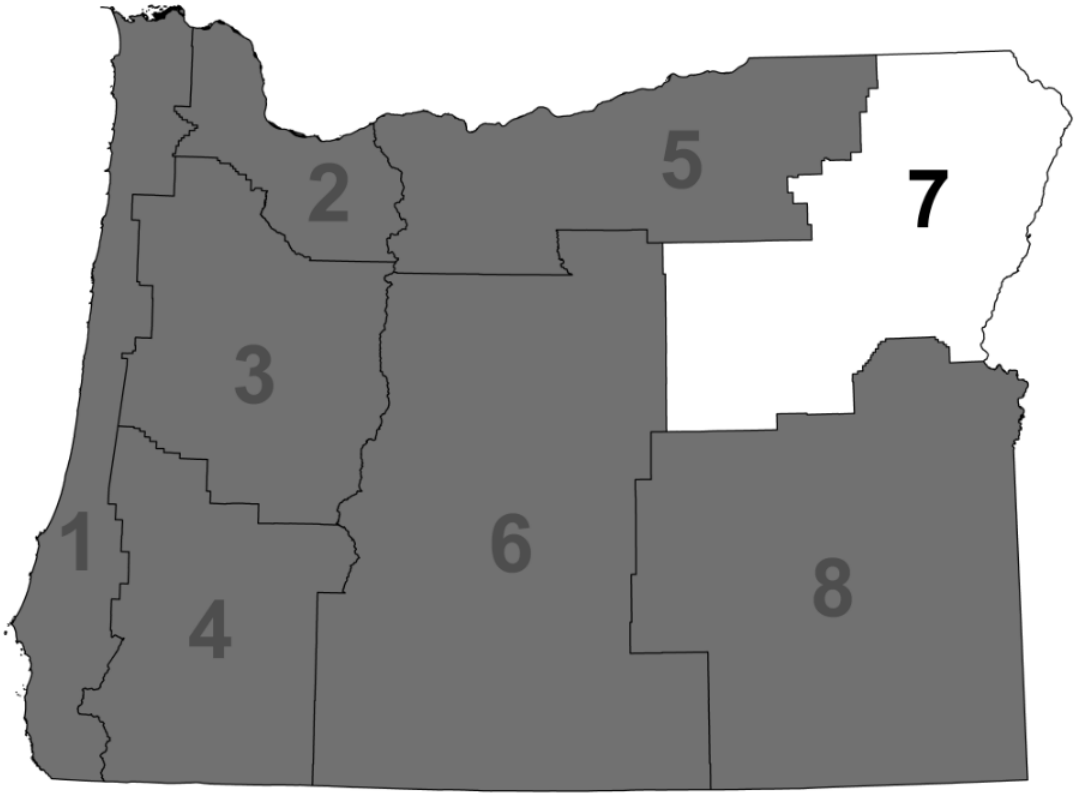
2.3.7 Region 7: Northeast Oregon

Baker, Grant, Wallowa, and Union Counties



2.3.7.1 Summary

Profile

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

Social vulnerability in Region 7 is driven by a declining population; high numbers of senior citizens, many of whom have disabilities; low rates of college degrees; child poverty; and low median household incomes. Additional vulnerabilities at the county level include high numbers of children in Baker and Wallowa Counties and vacant homes in Grant and Wallowa Counties.

Though Region 7 has been recovering jobs lost during the financial crisis that began in 2007, the area lags behind the state overall with fewer jobs and lower wages. Unemployment remains greater than statewide. Regionally, wages remain low, averaging only 75% of the state median wage.

Roads and railways are susceptible to winter storms and flooding. Damage or service interruption to the region's transportation systems can have devastating effects on the region's economy. In addition, many of the bridges in the area are distressed or deficient.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for human health and water quality. Drinking water is sourced from surface water or wells and is susceptible to pollution from stormwater runoff and combined sewer overflows (CSO) during high-water events. Only Baker City employs low impact development (LID) standards in its building regulations.

Northeast Oregon's energy facilities and conveyance system infrastructure support the regional economy and are susceptible to damage and disruptions due to natural hazards. The region has five power-generating facilities (hydroelectric, wind, and biomass). Liquid natural gas pipelines run through Union and Baker Counties. However, diversity of the region's energy sources boosts its ability to provide power should service be disrupted.

The region's limited growth is occurring within Union County and some other areas along I-84. A high share of mobile homes and homes built before floodplain management and seismic building standards coupled with the lack of modernized Flood Insurance Rate Maps (FIRMs) increase the vulnerability of development in Region 7.

Hazards and Vulnerability

Region 7 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts are common in all Northeast Oregon counties, particularly within Lake and Klamath Counties. Drought conditions can result in limited water supplies, losses in agriculture, increased fire risk, and adverse impacts to tourism and therefore to the local economy. Baker County has been under an emergency drought declaration eight times and is considered one of the communities most vulnerable to drought conditions.

Earthquakes: Two types of earthquakes affect Region 7: (a) shallow crustal events and (b) earthquakes associated with volcanic activity. Northeast Oregon is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking. The region's seismic lifelines have low vulnerability to a Cascadia Subduction Zone (CSZ) event as most of the region's impact will be secondary, due to disruptions to markets to the west. This region has 344 state-owned/leased facilities, valued at over $130 million, within an earthquake hazard zone. Of these, 47 are critical/essential facilities. An additional 168 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: In this region, the most damaging floods have been rain-on-snow events in the mountains during the winter. Other forms of flooding here have been associated with ice jams, normal spring runoff, and summer thunderstorms. Flooding has also been associated with heavily vegetated stream banks, low stream gradients, breeched dikes, low bridge clearances, over-topped irrigation ditches, and natural stream constrictions. All of the region's counties are considered moderately vulnerable to the flood hazard. There are 89 state-owned/leased facilities, valued at approximately $41 million, located in this region's flood hazard zone. Of these, 14 are considered critical/essential facilities. An additional 28 non-state-owned/leased critical/essential facilities are located in this hazard zone.

Landslides: Landslides can occur throughout the region, though to a lesser extent than in parts of western Oregon. In general, areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. Rain-induced landslides can occur during winter months. Earthquakes can also trigger landslides. The Blue and Wallowa Mountains have a moderate to high incidence of landslides. Landslides can also sever transportation routes along highways and rail lines, which can impact the region's economy. There are 419 state-owned/leased facilities, valued at over $139.5 million, in this region's landslide hazard zone. Of these, 58 are critical/essential facilities. An additional 237 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Though volcanic activity does not occur within this region, ashfall can travel many miles and may affect the region. Communities potentially vulnerable to ashfall are Baker City, La Grande, and John Day. There are no state-owned/leased facilities located in a volcanic hazard zone. Similarly, there are no non-state-owned/leased critical/essential facilities located in this hazard zone.

Wildfires: Though population and development has declined in this region overall, development has increased in this region's non-federal forests and may impact fire protection capability. Summertime lightning-caused fires are prevalent in the mountainous and timbered regions of

eastern Oregon. Wildfire in this region can adversely impact timber and rangeland, recreation and tourism, wildlife habitat and diversity including endangered species, and water quality and supply. Vulnerability is further heightened where fire stations are located far distances from many communities, resulting in longer response times. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 7, Grant and Union Counties have high percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 229 state-owned/leased facilities located in a wildfire hazard zone in Region 7, with a value of approximately $84 million. Of these, 32 are identified as critical/essential facilities. An additional 141 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Inter-mountain valley regions of Northeast Oregon are known for high winds. Windstorms generally affect the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Winter storms bring colder weather and higher precipitation to this region annually. These storms average 24 inches of snow per year. Moderate to heavy snowfall is prepared for and expected. Heavier snowfall is expected and planned for in higher elevation of the Wallowa Mountains.

Climate Change

The hazards faced by Region 7 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat.

Climate models project warmer, drier summers for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, Region 7 is expected to be affected by an increased incidence of drought and wildfire. In Region 7, climate change would result in increased frequency of drought due to low spring snowpack (*very likely*, >90%), low summer runoff (*likely*, >66%), and low summer precipitation and low summer soil moisture (*more likely than not*, >50%). It is *very likely* (>90%) that Region 7 will experience increasing wildfire frequency and intensity due to warmer, drier summers coupled with warmer winters that facilitate greater cold-season growth.

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*).

Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (*high confidence*) that is *more likely than not* (>50%) to lead to an increase in the incidence and magnitude of damaging floods (*low confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

While winter storms and windstorms affect Region 7, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see Section 2.2.1.2, **Introduction to Climate Change**.

2.3.7.2 Profile

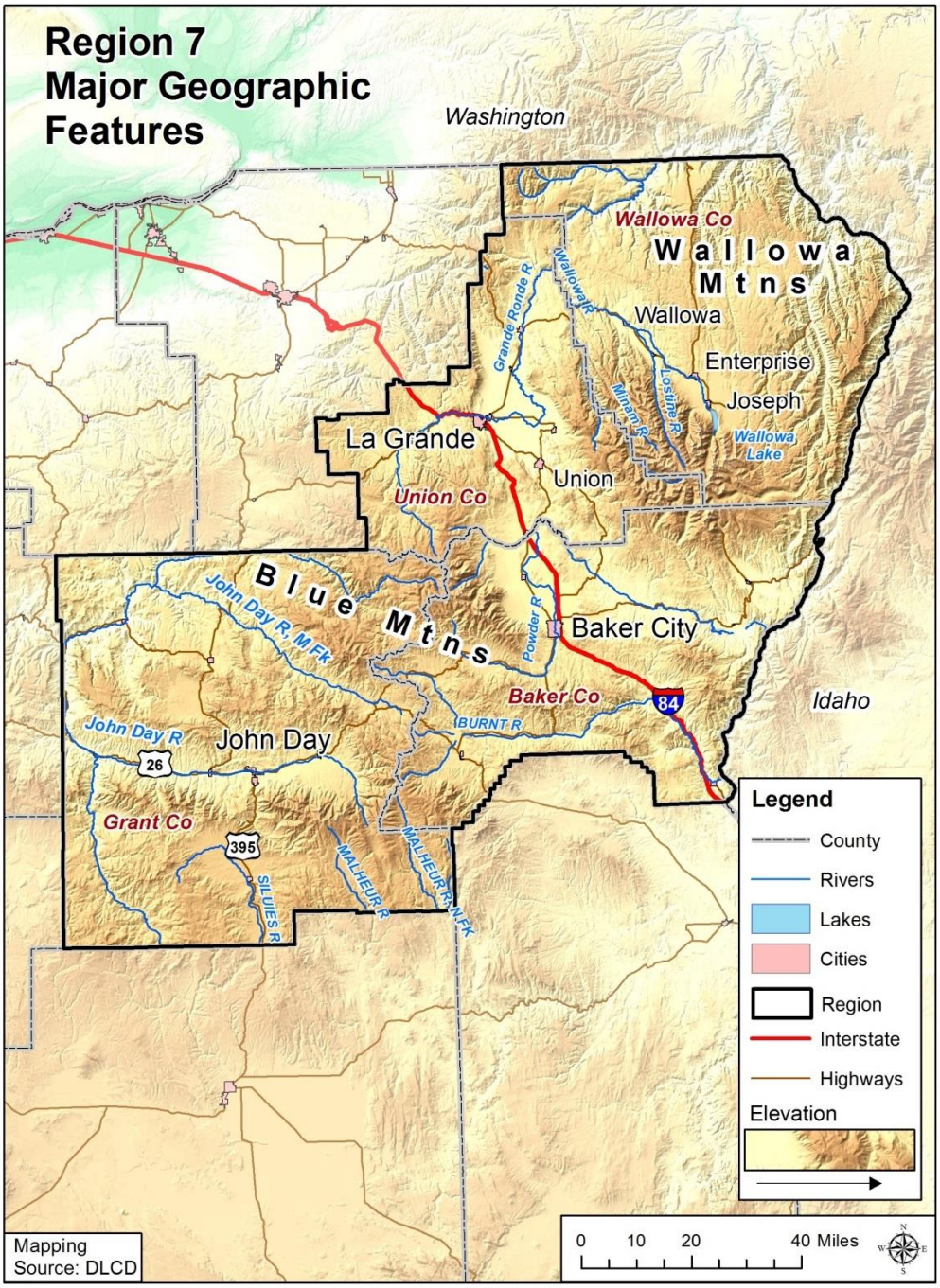
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Northeastern Oregon is approximately 12,765 square miles in size, and includes Baker, Grant, Union, and Wallowa Counties. The region is bordered by the Snake River to the east and the Columbia River to the north. Columbia River Basalt lava flows formed the high plateaus of the region, and the Blue and Wallowa Mountains are included in the region. Major rivers in the region include the John Day, Grande Ronde, and the Snake.

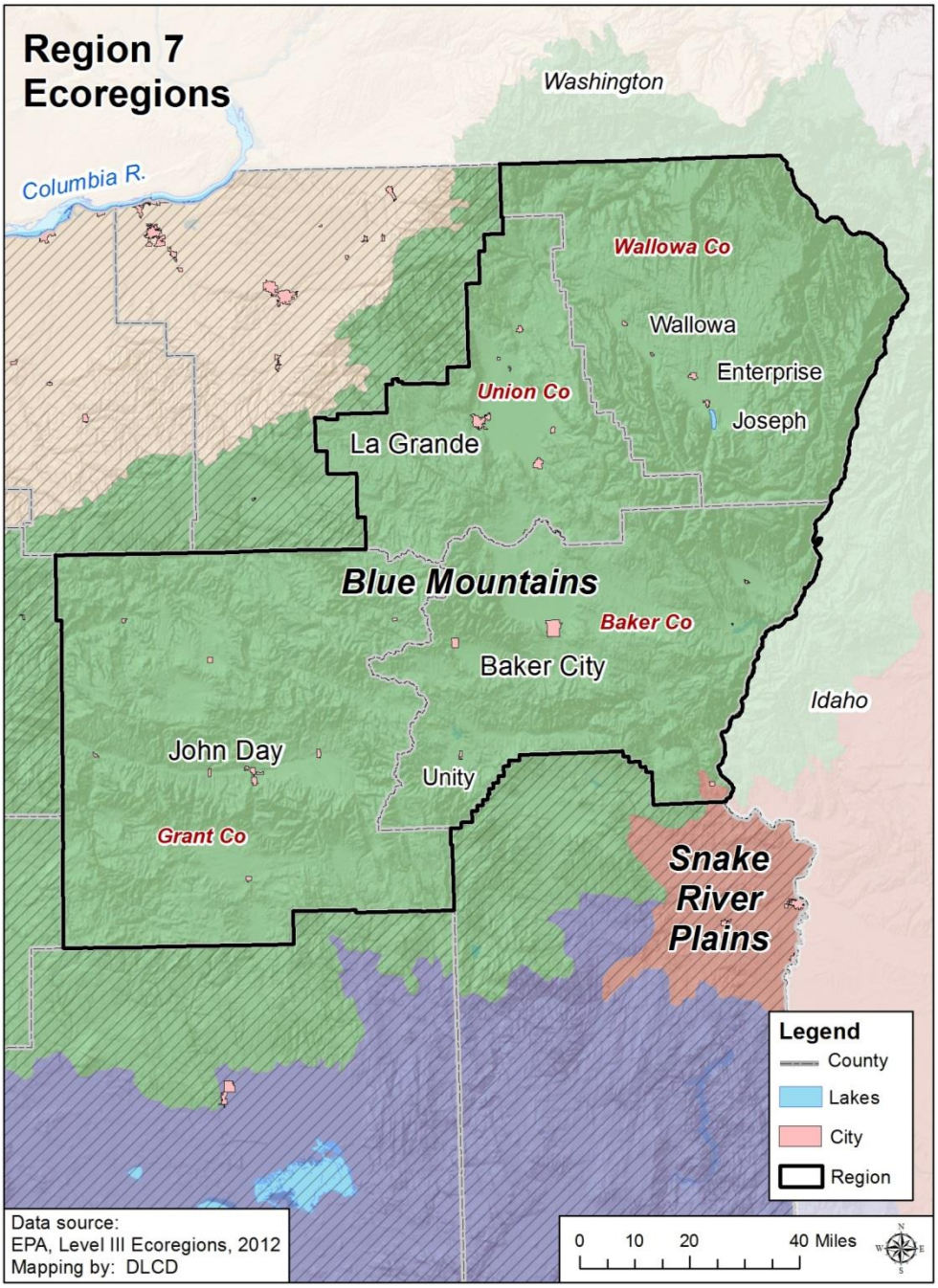
Figure 2-263. Region 7 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 7 is composed of two ecoregions: the Blue Mountains and very small area of the Snake River Plain ecoregion (**Figure 2-264**).

Figure 2-264. Region 7 Ecoregions



Blue Mountains: This ecoregion is complex and diverse, with many sub-ecoregions having unique conditions. In general, the Blue Mountains areas of Region 7 have dry continental climate with marine intrusions because of proximity to the Columbia Gorge. While much of the Blue Mountains are flat with arid climates, the highly dissected John Day / Clarno Highlands

contain the John Day and Crooked Rivers that provide more abundant water than other parts of the Blue Mountains ecoregion, which leads to higher levels of human settlement in proximity to the rivers. Much of the Blue Mountains are underlain with volcanic rock although land in the Wallowa and Elkhorn Mountain ranges is composed of granitic intrusives, deep sea sediments, and metamorphic rocks. Grazing, logging, and fire suppression regimes have altered land cover throughout the region where juniper woodlands have given way to sagebrush grasslands and grand fir forests have given way to spruce fir forests. Other forests in the region predominantly have either a Douglas fir or ponderosa pine canopy. Ponderosa forests tend toward sparsely vegetated understories the ecoregion's Douglas fir forests tend toward dense shrub understories, making them more difficult to log. Some wet, high meadows also exist within Cold Basins of the Blue Mountains in Region 7 and unchannelized streams tend toward a meandering nature within wide floodplains, moving dynamically through the landscape. Riparian areas of the region have a diverse palette of understory shrubs with black cottonwoods, grand firs, and alders in the canopy layer.

Snake River Plain: The Region 7 portion of the Snake River Plain ecoregion is classified as the "Unwooded Alkaline Foothills," which is underlain by alkaline lacustrine deposits. The landscape includes rolling foothills, hills, benches, alluvial fans, and badlands. Wyoming sagebrush and associated grasses are the dominant vegetation with salt-tolerant shrubs found on alkaline outcrops. The land is high value rangeland and wildlife habitat.

Climate

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

The climate of Northeast Oregon is semi-arid supporting primarily livestock grazing. More precipitation occurs in the higher elevations in the Blue and Wallowa Mountains. The region is subject to droughts and wildfires, particularly during dry summers and years with low snowpack. Despite its relative dryness, the region is also subject to floods and landslides. Flooding can be a direct result of rain-on-snow events. Localized variations in temperature and precipitation exist across the region's microclimates. **Table 2-515** displays 1981–2010 average precipitation and temperature for counties and climate divisions within Region 7 based on data from the NOAA National Centers for Environmental Information.

Table 2-595. Average Precipitation and Temperature in Region 7 Counties and Climate Divisions

Sub-Region	Annual Precipitation Mean & Range (1981–2010)	January & July Mean Precipitation (1981–2010)	Annual Mean Temperature (1981–2010)	January & July Average Min/Max Temperature (1981–2010)
Baker County	21.69" (15.28"–29.86")	Jan: 2.74" Jul: 0.71"	45.2°F	Jan: 19.3°F /33.9°F Jul: 51.1°F /82.3°F
Grant County	21.6" (13.85"–30.56")	Jan: 2.55" Jul: 0.63"	44.2°F	Jan: 20.4°F /36.8°F Jul: 47.3°F /80.4°F
Union County	28.56" (19.8"–38.4")	Jan: 3.58" Jul: 0.79"	44.3°F	Jan: 22.0°F /35.1°F Jul: 48.5°F /78.4°F
Wallowa County	26.86" (20.03"–34.89")	Jan: 2.94" Jul: 1.05"	43.5°F	Jan: 20.0°F /34.2°F Jul: 48.4°F /77.9°F
Climate Division 8 "Northeast"	24.93" (18.34"–32.23")	Jan: 2.99" Jul: 0.79"	44.3°F	Jan: 0.6°F/35.1°F Jul: 48.8°F/79.5°F

Source: NOAA National Centers for Environmental Information, Climate at a Glance: County & Divisional Time Series, published August 2019, retrieved on August 22, 2019 from https://www.ncdc.noaa.gov/cag/.

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, Boruff, & Shirley, 2003). Population change includes two major components: natural increase (births minus deaths) and net migration (in-migrants minus out-migrants) (USDA, 2020). 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.

The population in Region 7 has remained relatively constant since 2010. The population in Baker County grew slowly during this period; that growth was entirely a result of sporadic net in-migration and was undercut by natural decrease (Population Research Center, Portland State University, 2019). The trend is expected to continue and the region is projected to lose population over the next decade. A large number of deaths relative to births caused natural decrease in Grant County since 2010, resulting in a slight population decline (Population Research Center, Portland State University, 2019). The population in Union County has increased steadily since 2010, driven both by net in-migration and natural increase (Population Research Center, Portland State University, 2019). Slow growth is projected to continue through 2030, with slowing natural increase undercutting net in-migration. Net in-migration in Wallowa County outpaced natural decrease from 2010 to 2018, resulting in very slow population growth. Over the next decade, natural decrease is projected to lead to population decline (Population Research Center, Portland State University, 2019).

Table 2-596. Population Estimate and Forecast for Region 7

	2010	2018	Percent Change (2010 to 2018)	2030 Projected	Percent Change (2018 to 2030)
Oregon	3,831,074	4,195,300	9.5%	4,694,000	11.9%
Region 7	56,335	58,225	3.4%	55,851	−4.1%
Baker	16,134	16,765	3.9%	15,404	−8.1%
Grant	7,445	7,400	-0.6%	6,771	−8.5%
Union	25,748	26,885	4.4%	26,981	0.4%
Wallowa	7,008	7,175	2.4%	6,695	−6.7%

Source: Population Research Center, Portland State University (2018), Certified Population Estimates; Population Research Center, Portland State University (2019), Current Forecast Summaries for All Areas & Oregon Final Forecast Table by Age (2019); U.S. Census Bureau, 2010 Decennial Census. Table DP-1

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 7 (Longwoods Travel USA, 2011d) are largely centered on outdoor activities (hiking/backpacking, visiting national/state parks etc.), touring (traveling to experience scenic beauty, history, and culture), and special events (such as fairs, festivals, or sporting events) (Longwoods International, 2017). Approximately 62% of all trips to the region occur between April and September and the average travel party contains three to four persons (Longwoods International, 2017). The average trip length is between two and three nights (Longwoods International, 2017). The Longwoods Travel Report includes all of the Region 7 counties, Harney and Malheur Counties (Region 8), and Morrow, Umatilla, and parts of Gilliam Counties within the Eastern Region.

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

Table 2-597. Annual Visitor Estimates in Person Nights in Region 7

	2016		2017		2018	
	Number	Percent	Number	Percent	Number	Percent
Region 7	1,624	—	1,642	—	1,658	—
Baker	651	100%	656	100%	662	100%
Hotel/Motel	166	25.5%	173	26.4%	174	26.3%
Private Home	206	31.6%	207	31.6%	208	31.4%
Other	278	42.7%	275	41.9%	280	42.3%
Grant	222	100%	223	100%	225	100%
Hotel/Motel	38	17.1%	40	17.9%	40	17.8%
Private Home	72	32.4%	73	32.7%	73	32.4%
Other	112	50.5%	111	49.8%	112	49.8%
Union	560	100%	568	100%	575	100%
Hotel/Motel	138	24.6%	144	25.4%	147	25.6%
Private Home	260	46.4%	264	46.5%	266	46.3%
Other	162	28.9%	159	28.0%	162	28.2%
Wallowa	191	100%	195	100%	196	100%
Hotel/Motel	85	44.5%	89	45.6%	90	45.9%
Private Home	27	14.1%	28	14.4%	28	14.3%
Other	78	40.8%	78	40.0%	79	40.3%

Source: Dean Runyan Associates (2019, March). Oregon Travel Impacts Statewide Estimates: 1992-2018p. Retrieved from 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 are disproportionately affected during disasters and can be difficult to identify and measure (Cutter, Boruff, & Shirley, 2003). A higher percentage of the population in Region 7 has a disability than statewide. The percentage with a disability is also higher in each county than in the state as a whole. In Baker, Grant, and Wallowa Counties, approximately one-fifth of all residents have a disability. The share is comparatively smaller in Union County, but still higher than the statewide estimate.

Accurately measuring the number of children with a disability is challenging, especially in counties with a smaller overall population. Consequently, the estimate of young people (< 18) with a disability for each county should be used with caution or not used at all. The percentage of older adults with a disability slightly higher in the region than in the state as a whole. Considering the margins of error, all counties within the region have a similar share of older adults living with a disability.

Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events. Planning professionals might take a number of steps to mitigate risk for disabled community members. Inaccessible shelter facilities can pose challenges in a disaster event. Local officials should also strengthen partnerships with the disability community, and work with local media organizations to ensure emergency preparedness and response communications are accessible for all.

Table 2-598. People with a Disability by Age Group in Region 7

	With a Disability			Under 18 Years with a Disability			65 Years and Over with a Disability		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	14.6%	☑	0.1%	4.6%	☑	0.2%	37.1%	☑	0.4%
Region 7	18.8%	☑	0.9%	3.0%	⊙	0.8%	40.0%	☑	2.3%
Baker	21.2%	☑	1.6%	3.6%	⊗	1.8%	42.7%	☑	4.0%
Grant	22.1%	☑	2.4%	3.8%	⊗	2.8%	40.2%	☑	5.3%
Union	15.9%	☑	1.3%	2.5%	⊙	1.0%	38.1%	☑	4.1%
Wallowa	21.2%	☑	2.7%	3.5%	⊗	2.7%	39.2%	☑	4.9%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

Homeless Population

The U.S Department of Housing and Urban Development requires Continuums of Care to conduct the Point-in-Time Count, a biennial count of sheltered and unsheltered people experiencing homelessness. These are rough estimates and can fluctuate with many factors. They should be understood as the absolute minimum number of people experiencing homelessness in the area (Oregon Housing & Community Services, 2019). Moreover, the PIT does not fully depict the extent of housing insecurity, as it excludes families or individuals that might be staying with friends or family due to economic hardship. The count also obscures the demographic composition of the houseless population, frequently undercounting people of color, for example (Oregon Housing & Community Services, 2019).

According to the PIT, between 2015 and 2019 the region experienced a 39% decrease in the number of people experiencing homelessness. Union and Wallowa Counties both reported decreases in homelessness, while Baker County reported no change. Grant County was the only county within the region to report an increase.

People experiencing homelessness are typically more physically and psychologically vulnerable compared to the general population and natural hazard events exacerbate vulnerability conditions. Disasters that result in damage to the built environment can place additional stress on temporary shelters (Peacock , Dash, Zhang, & Van Zandt, 2017). Local emergency management professionals should take a trauma-informed approach to providing services and include people with expertise in providing support to people experiencing homelessness in planning for natural hazard events (U.S. Department of Housing and Urban Development, 2016). Additionally, it is important to plan for episodic natural hazards as well as chronic events. For example, year-around access to shelter is becoming increasingly important as wildfire smoke becomes more common across the state.

Table 2-599. Homeless Population Estimate for Region 7

	2015	2017	2019	Period Average
Oregon	13,077	13,953	15,800	14,277
Region 7	120	62	73	85
Baker	14	7	14	12
Grant	7	4	11	7
Union	75	43	32	50
Wallowa	24	8	16	16

Source: Oregon Housing and Community Services (n.d.). Oregon Point in Time Homeless Counts. Retrieved from https://public.tableau.com/profile/oregon.housing.and.community.services#!/vizhome/2019Point-in-TimeDashboard/Story1

Biological Sex and Gender

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture (U.S. Census Bureau, 2019). Moreover, the two may or may not correspond (U.S. Census Bureau, 2019).

The American Community Survey question was specifically designed to capture biological sex and there are no questions on the survey about gender (U.S. Census Bureau, 2019). According to the survey, there is an equal ratio of men to women in the region (100.8 men to every 100 women) (U.S. Census Bureau, 2019).

Primarily empirical research has begun to emerge about the ways in which gender influences resilience to disasters. It indicates that gender influence is much more pervasive and expressed differently among men, women, LGBTQ+, and non-binary populations than has generally been recognize (Enarson, 2017). This is an area deserving of more attention as the field develops.

Age

Older adults, persons aged 65 and older, comprise a larger share of the population in Region 7 than they do in the state as a whole. In Baker, Grant, and Wallowa, approximately one-quarter of all residents are older adults. Older adults require special consideration in the planning process. They are more likely to have a disability and require assistance from others to complete routine tasks. Family or neighbors who might ordinarily assist them might be unable to help during a disaster event (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Moreover, an older population requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, older people 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 all ages and abilities (Morrow, 1999).

The percentage of children in the region—and in three of the four regional counties—is slightly smaller than the statewide estimate. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access

medical facilities. Parents might lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter, Boruff, & Shirley, 2003).

Table 2-600. Population by Vulnerable Age Group, in Region 7

	Total Population	Under 18 Years Old			65 and Older		
	Estimate	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	4,025,127	21.5%	☑	0.1%	16.3%	☑	0.1%
Region 7	55,863	20.4%	☑	0.1%	22.7%	☑	0.1%
Baker	15,980	19.6%	☑	0.3%	24.9%	☑	0.2%
Grant	7,209	18.3%	☑	0.2%	27.5%	☑	0.3%
Union	25,810	22.2%	☑	*	18.8%	☑	0.2%
Wallowa	6,864	17.9%	☑	0.3%	27.3%	☑	0.7%

* Indicates that the estimate has been controlled to be equal to a fixed value and so it has no sampling error.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP05: ACS Demographics and Housing Estimates, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. Compared to the statewide estimate, a very small share of the population does not speak English "very well" in Region 7. Still, communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-601. English Usage in Region 7

	Speak English Less Than "Very Well"				
	Estimate	CV **	MOE (+/−)	Percent	% MOE (+/−)
Oregon	222,428	☑	4,116	5.90%	0.1%
Region 7	747	☑	165	1.41%	0.3%
Baker	190	⊙	62	1.30%	0.4%
Grant	79	⊗	84	1.10%	1.2%
Union	418	⊙	125	1.70%	0.5%
Wallowa	60	⊙	27	0.90%	0.4%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

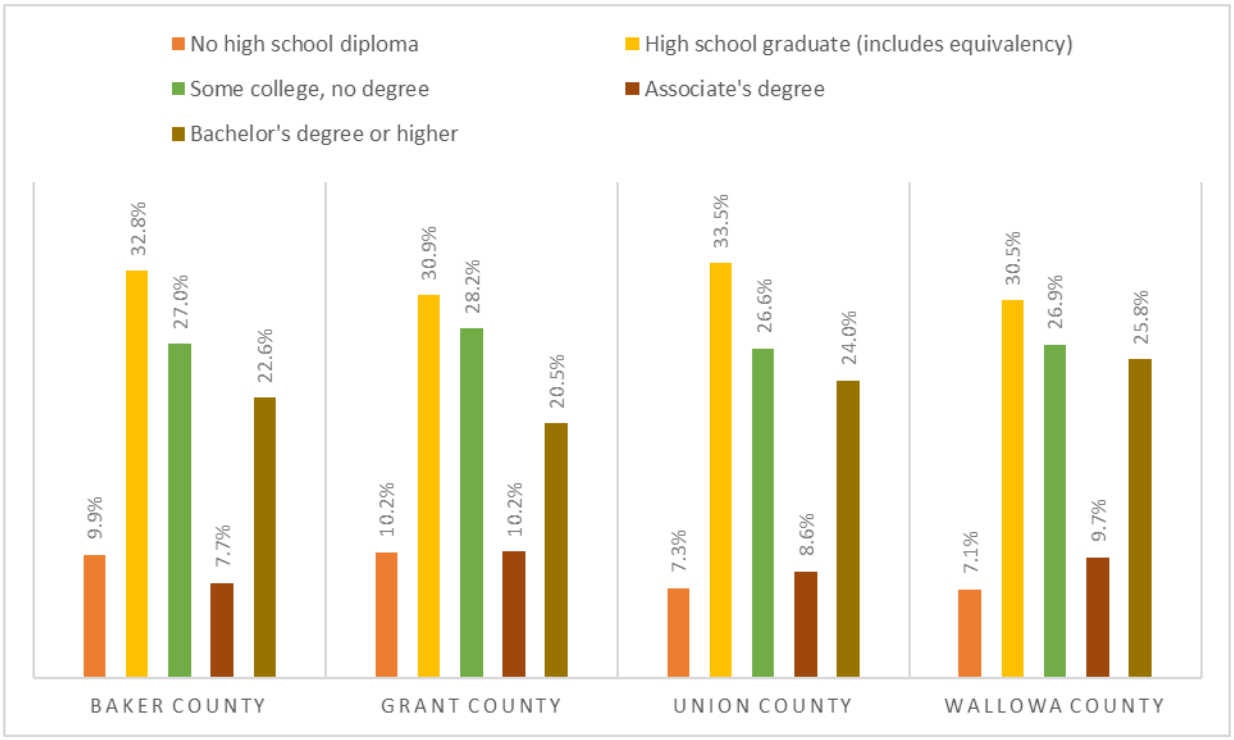
Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

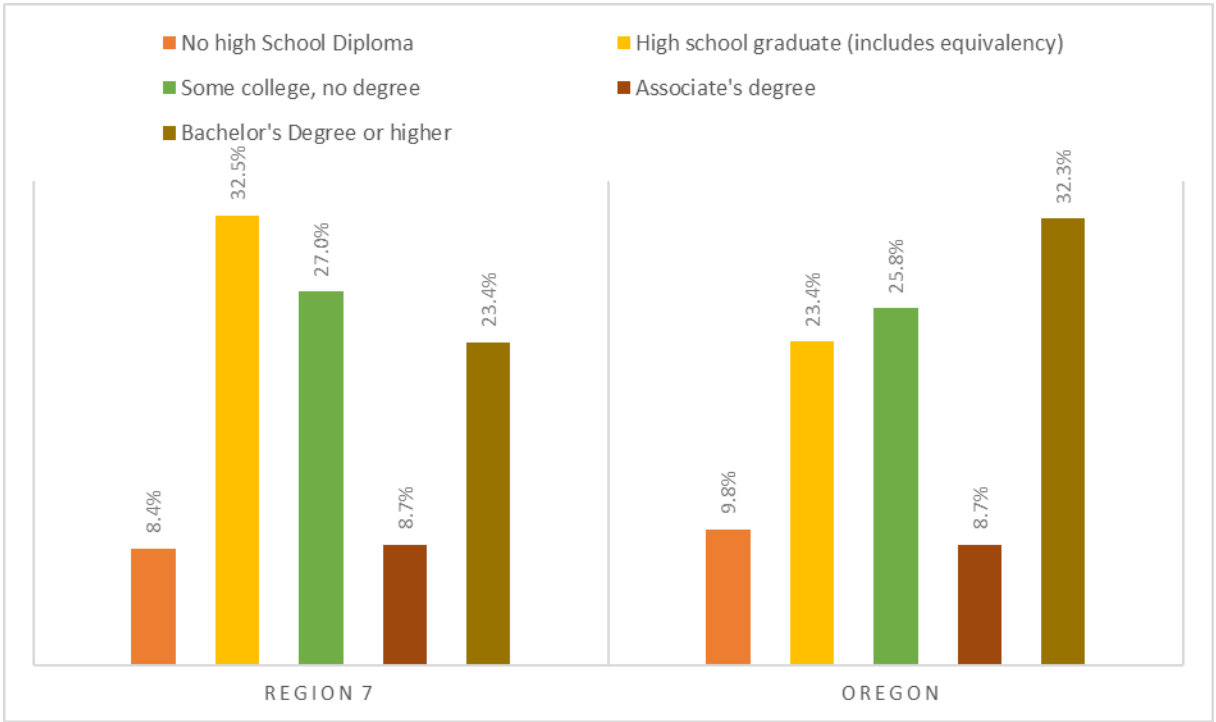
Education Level

Studies show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings (Cutter, Boruff, & Shirley, 2003). Furthermore, education can influence an individual's ability to understand and act on warning information, navigate bureaucratic systems, and to access resources before and after a natural disaster (Masozera, Bailey, & Kerchner, 2007).

A smaller share of residents in Region 7 have a bachelor's degree or higher compared to the state as a whole; the difference between the two estimates is approximately nine percentage points. Educational attainment is similar for all counties within the region and so the regional profile is fairly representative. Grant County has the highest share of residents without a high school diploma and the smallest share of residents who have a four-year degree or more.

Figure 2-265. Educational Attainment in Region 7: (top) by County, (bottom) Regional vs. Statewide





Source: U.S. Census Bureau (2018). Table DP02: Selected Social Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

Income and Poverty

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 S. L., 2006). Historically, 80% of the disaster burden falls on the public (Stahl, 2000). 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.

All counties in the region have lower median household incomes than the state average, ranging from $10,000-$12,000 below the state median. Grant County was the only county in the region to experience a statistically significant change in median household income between 2012 and 2017, although the margins of error indicate the increase might not be as high as the estimate shows.

Table 2-602. Median Household Income in Region 7

	2008-2012			2013-2017			Statistically Different*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	$53,427	☑	$338	$56,119	☑	$370.00	Yes
Region 7	—	—	—	—	—	—	—
Baker	$43,021	☑	$2,904	$43,765	☑	$3,354.00	No
Grant	$36,760	☑	$1,728	$44,826	☑	$5,576.00	Yes
Union	$44,850	☑	$2,023	$46,228	☑	$1,934.00	No
Wallowa	$43,259	☑	$4,205	$44,877	☑	$3,973.00	No

Notes: 2012 dollars are adjusted for 2017 dollars. Data not aggregated at the regional level.

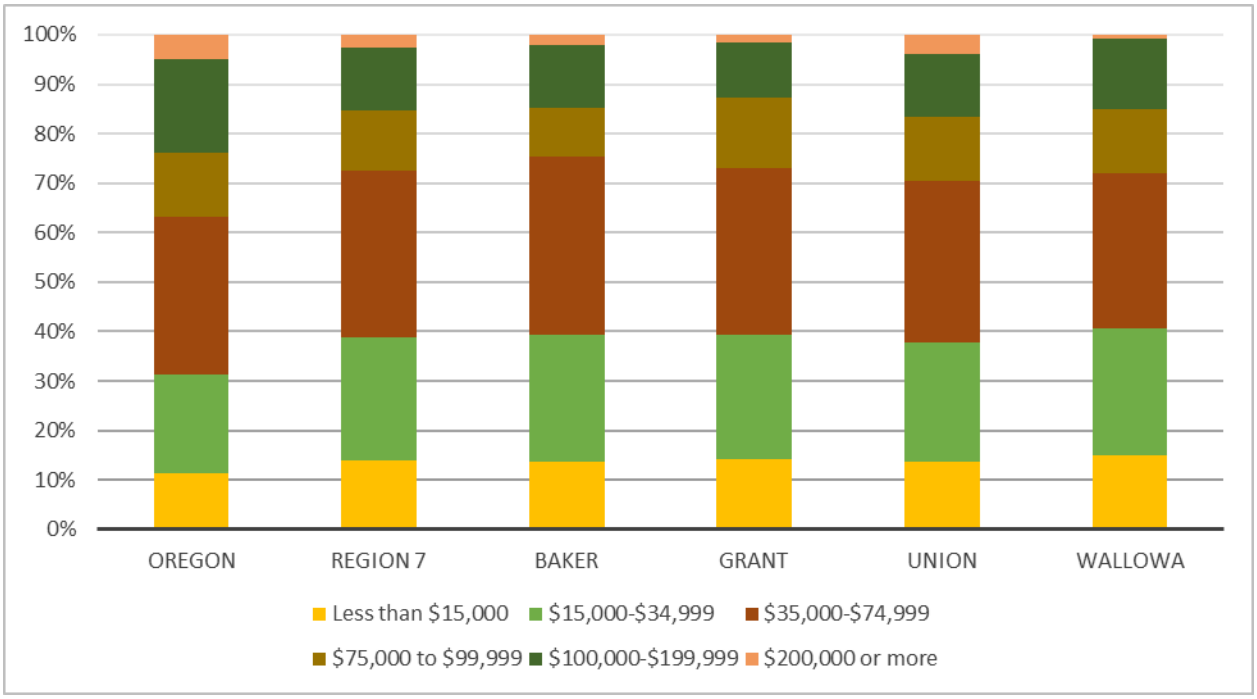
* Yes indicates that the 2013-2018 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates the two estimates are not statistically different.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2008-2002 and 2013-2017. American Community Survey – 5-Year Estimates. Table CP03.

Compared to statewide numbers, the region has a higher share of its households earning less than $35,000 per year. Within the region, the percentage is highest in Wallowa County, but only slightly .Just under one-third of the region's households earn between $35,000 and $75,000 per year, similar to the statewide share. More earners in the bottom brackets means fewer in the top; approximately 27% of household in Region 7 earn more than $75,000 annually, roughly nine percentage points lower than the statewide share.

Figure 2-266. Median Household Income Distribution in Region 7



Source: U.S. Census Bureau. Table DP03: Selected Economic Characteristics, American Community Survey, 2013-2017 American Community Survey 5-Year Estimates

The American Community Survey uses a set of dollar value thresholds that vary by family size and composition to determine who is in poverty (U.S. Census Bureau, 2018). Moreover, poverty thresholds for people living in nonfamily households vary by age—under 65 years or 65 years and older (U.S. Census Bureau, 2018). A greater share of the regional population overall is living in poverty compared to the state as a whole. Between 2012 and 2017, Baker County was the only county within the region to experience a statistically significant decrease in poverty.

A higher percentage of children in Region 4 are living in poverty compared to the statewide share. Baker County has the highest percentage of children living in poverty; however, as with its overall population, Baker County experienced a statistically significant decrease in the total number of children living in poverty from 2012 to 2017. The estimate in Baker County remains higher than its peers and the statewide estimate, but the margins of error are significant for all counties in the region.

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, Boruff, & Shirley, 2003).

Table 2-603. Poverty Rates in Region 7

	Total Population in Poverty						
	2008-2012			2013-2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	15.5%	☑	0.3%	14.9%	☑	0.3%	No
Region 7	17.3%	☑	1.4%	15.9%	☑	1.3%	No
Baker	19.6%	☑	2.7%	15.3%	☑	2.6%	Yes
Grant	15.7%	☑	3.9%	13.7%	☑	2.6%	No
Union	17.2%	☑	2.2%	17.4%	☑	2.1%	No
Wallowa	14.5%	☑	2.6%	13.7%	☑	2.8%	No

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Table 2-604. Child Poverty in Region 7

	Children Under 18 in Poverty						
	2008-2012			2013-2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	20.6%	☑	0.5%	19.0%	☑	0.6%	Yes
Region 7	24.0%	☑	3.5%	22.5%	☑	1.3%	No
Baker	33.3%	☑	6.5%	23.8%	⊙	6.1%	Yes
Grant	19.6%	⊙	8.7%	22.1%	⊙	6.9%	No
Union	21.6%	⊙	5.5%	22.1%	☑	4.8%	No
Wallowa	17.1%	⊙	5.5%	21.3%	⊙	8.3%	No

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Housing Tenure

Housing tenure, which captures whether someone owns or rents their home, has long been understood as a determinant of social vulnerability (Cutter, Boruff, & Shirley, 2003). Renters generally experience more housing challenges than homeowners; natural disasters frequently exacerbate those hardships (Lee & Van Zandt, 2019).

Homeownership is correlated with greater wealth, which can increase the ability to recover following a natural disaster (Cutter, Boruff, & Shirley, 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster; they also frequently cannot access the same federal monies homeowners typically leverage following a disaster. They also might lack social resources, such as the ability to influence neighborhood decisions (Lee & Van Zandt, 2019).

Renters tend to be more mobile and have fewer assets at risk, however those assets might be more difficult to replace due to insufficient income. Renters typically have fewer options in terms of temporary shelter following a disaster and are less likely to stay with a relative or friend than in a public or mass shelter (Lee & Van Zandt, 2019).

The quality of construction for multi-family housing—more often rental—tends to be lower and is therefore more vulnerable to destruction during a disaster (Lee & Van Zandt, 2019). Moreover, renters have less ability to make improvements or alterations to their dwellings to enhance durability and structural safety (Lee & Van Zandt, 2019). Following a disaster, rental housing—especially affordable and subsidized housing—is frequently rebuilt more slowly, if at all (Lee & Van Zandt, 2019).

Each county in Region 7 has a higher share of owner-occupied housing compared to the state as a whole.

Table 2-605. Housing Tenure in Region 7

	Total Occupied Units	Owner-Occupied			Renter-Occupied		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	61.7%	☑	0.3%	38.3%	☑	0.3%
Region 7	23,626	66.7%	☑	1.7%	33.3%	☑	1.8%
Baker	7,033	68.3%	☑	2.7%	31.7%	☑	2.7%
Grant	3,176	73.1%	☑	2.8%	26.9%	☑	2.8%
Union	10,291	63.3%	☑	2.8%	36.7%	☑	2.8%
Wallowa	3,126	67.9%	☑	3.7%	32.1%	☑	3.7%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP04: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Living alone can also be a risk factor—especially in poorer communities that lack adequate social infrastructure (Klinenberg, 2016). The American Community Survey defines a family household as one that contains a householder and one or more other people living in the same unit who are related by birth, marriage, or adoption. Conversely, a nonfamily household is one where someone is either living alone, or with nonrelatives only.

The share of family households in Region 7 is the same as the share in the state as a whole, however, the percentage of single-person households is slightly higher in the region than the statewide share. Wallowa County has the highest share of single-person households—approximately six percentage points higher than the statewide number. Compared to the statewide estimate, single-person households comprise a larger share of households in each county across the region, except for Union County. The region as a whole has a smaller share of households with children and a slightly smaller share of single-parent households vis-a-vis the state. Not factoring in margins of error, Union County has the highest percentage of households with children and the highest percentage of single-parent households within the region.

Table 2-606. Family vs. Non-family Households in Region 7

	Total Households	Family Households			Nonfamily Households			Householder Living Alone		
	Estimate	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	63.3%	☑	0.2%	36.7%	☑	0.2%	27.7%	☑	0.2%
Region 7	23,626	63.3%	☑	0.2%	36.7%	☑	0.2%	29.9%	☑	0.2%
Baker	7,033	62.9%	☑	0.3%	37.1%	☑	0.2%	32.9%	☑	0.0%
Grant	3,176	63.0%	☑	0.2%	37.0%	☑	0.0%	30.6%	☑	0.2%
Union	10,291	63.7%	☑	0.1%	36.3%	☑	0.2%	26.5%	☑	0.1%
Wallowa	3,126	62.6%	☑	0.1%	37.4%	☑	0.1%	33.5%	☑	0.0%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from http://factfinder2.census.gov/

Table 2-607. Family Households with Children by Head of Household in Region 7

	Family Households with Children			Single Parent (Male or Female)		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	26.2%	☑	0.2%	8.1%	☑	0.2%
Region 7	22.6%	☑	1.3%	7.7%	☑	1.2%
Baker	21.2%	☑	2.1%	6.3%	⊙	1.6%
Grant	19.5%	☑	2.5%	7.0%	⊙	2.1%
Union	25.6%	☑	2.1%	9.0%	☑	1.4%
Wallowa	19.1%	☑	2.3%	7.3%	⊙	2.2%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from http://factfinder2.census.gov/

Social and Demographic Trends and Issues

This analysis shows that Region 7 has a greater number of people than the state average who are predisposed to be particularly vulnerable during a hazard event:

- The regional population is projected to decline. An aging population is expected to lead to a natural decrease (more deaths than births). Moreover, this trend is expected to outpace net in-migration.
- A higher percentage of the population in Region 7 has a disability than statewide. The percentage with a disability is also higher in each county than in the state as a whole. The percentage of older adults with a disability is also slightly higher in the region than in the state as a whole, and there is insufficient data to know the share of children with a disability.
- Older adults, persons aged 65 and older, comprise a larger share of the population in Region 7 than they do in the state as a whole.
- Fewer residents in Region 7 have a bachelor's degree or higher compared to the state as a whole; the difference between the two estimates is approximately nine percentage points.
- All counties in the region have lower median household incomes than the state average, ranging from $10,000-$12,000 below the state median. Moreover, the region has a higher share of its households earning less than $35,000 per year, and a smaller in the top income brackets.
- A greater share of the regional population overall and a higher share of children in the region are living in poverty compared to the state as a whole.

- Compared to the statewide estimate, single-person households comprise a larger share of households in each county across the region, except for Union County.

Economy

The impact of natural hazards on economic conditions depends on many variables. For example the vulnerability of businesses' labor, capital, suppliers, and customers are all relevant factors (Zhang , Lindell, & Prater, 2009). Some industries rebound quickly and even thrive following a disaster, manufacturing and construction, for example. Others, like wholesale and retail, rebound more slowly or never recover (Zhang , Lindell, & Prater, 2009). 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 participants, financial and natural resources, and critical infrastructure are interconnected and interdependent.

Employment and Unemployment

Natural disasters do not impact all labor market participants equally. Unemployed and underemployed populations are disproportionately affected by disaster events. Research shows that employment outcomes can be especially bad for people physically displaced by a disaster (Karoly & Zissimopoulos, 2010). Moreover, those who are unemployed and many employed in low-wage positions lack access to employee benefit plans that provide income and healthcare supports (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Income deprivation and inaccessible healthcare, ruinous in the best of times, are felt more severely following a disaster. It is important for local policy makers to understand existing labor force characteristics and existing market trends to build a resilient workforce and mitigate the scope and intensity of disruptions and economic pain.

Unemployment rates across Region 7 have been steadily declining since they peaked during the Great Recession. From 2014-2018, unemployment rates were consistently higher in all counties vis-à-vis the state as a whole. Throughout the four-year period, unemployment in Grant and Wallowa Counties tended to be higher than rates in Baker and Union Counties.

Table 2-608. Civilian Labor Force in Region 7, 2018

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	2,104,516	2,017,155	95.8%	87,361	4.2%
Region 7	25,328	23,873	94.3%	1,455	5.7%
Baker	6,976	6,593	94.5%	383	5.5%
Grant	3,099	2,874	92.7%	225	7.3%
Union	11,935	11,291	94.6%	644	5.4%
Wallowa	3,318	3,115	93.9%	203	6.1%

Source: Oregon Employment Department, 2019

Table 2-609. Civilian Unemployment Rates in Region 7, 2014-2018

	2014	2015	2016	2017	2018	Change (2014–2018)
Oregon	6.8%	5.6%	4.8%	4.1%	4.2%	−2.6%
Region 7	8.3%	6.9%	6.3%	5.6%	5.7%	−2.6%
Baker	8.3%	6.8%	6.3%	5.5%	5.5%	−2.8%
Grant	10.5%	8.7%	7.6%	6.9%	7.3%	−3.2%
Union	7.2%	6.2%	5.9%	5.3%	5.4%	−1.8%
Wallowa	10.0%	7.8%	6.7%	5.7%	6.1%	−3.9%

Source: Oregon Employment Department, 2019

Supersectors and Subsectors

The North American Industry Classification System (NAICS) is a framework used by the United States, Canada, and Mexico to collect, analyze, and publish data about the North American economy. The classification system groups "economic units that have similar production processes" according to a six-digit hierarchical structure (Office of Management and Budget , 2020). "The first two digits of the code designate the sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry" (Office of Management and Budget , 2020). The U.S. Bureau of Labor Statistics through its Quarterly Census of Employment and Wages program adds to the NAICS hierarchy by grouping NAICS sectors into supersectors (U.S. Bureau of Labor Statistics, 2019). This plan looks at regional economic activity through these supersectors and then through three-digit NIAICS subsectors.

In 2018 the five major supersectors by share of employment in Region 7 were:

1. Trade, Transportation and Utilities
2. Education and Health Services
3. Local Government
4. Manufacturing
5. Leisure and Hospitality

Identifying supersectors with a large number of business establishments and targeting mitigation strategies to support them can help the region's resiliency. In Region 7, the following supersectors comprise a significant share of all business establishments.

- The Other Services supersector includes the highest number of establishments in Region 7, 16.3% of all businesses (QCEW, 2018).
- Trade, Transportation, and Utilities is second largest with 16.1% of all business establishments (QCEW, 2018).
- The Construction supersector has the third largest number of establishments, with 10.6% of the regional share (QCEW, 2018).
- Leisure and Hospitality is fourth, with 9.2% of business establishments (QCEW, 2018).
- Professional and Business Services is fifth, with 8.9% of all businesses (QCEW, 2018).

While supersectors are useful abstractions, it's important to remember that within are many small businesses employing fewer than 20 employees (Valdovinos, 2020). Due to their small size, these businesses are particularly sensitive to disruptions that may occur following a natural hazard event.

Table 2-610. Covered Employment by Sector in Region 7, 2019

Industry	Region 7	Baker		Grant	
	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	100.0%	5,544	100.0%	2,482	100.0%
Total Private Coverage	76.8%	4,424	79.8%	1,466	59.1%
Natural Resources & Mining	5.1%	220	4.0%	283	11.4%
Construction	4.6%	270	4.9%	64	2.6%
Manufacturing	10.4%	560	10.1%	119	4.8%
Trade, Transportation & Utilities	18.0%	1,084	19.6%	297	12.0%
Information	1.1%	43	0.8%	53	2.1%
Financial Activities	2.8%	137	2.5%	54	2.2%
Professional & Business Services	4.7%	290	5.2%	101	4.1%
Education & Health Services	15.6%	945	17.0%	189	7.6%
Leisure & Hospitality	10.2%	583	10.5%	214	8.6%
Other Services	4.3%	290	5.2%	91	3.7%
Unclassified	0.0%	(c)	(c)	(c)	(c)
Total All Government	23.2%	1,120	20.2%	1,016	40.9%
Total Federal Government	3.8%	201	3.6%	268	10.8%
Total State Government	3.7%	207	3.7%	135	5.4%
Total Local Government	15.6%	712	12.8%	613	24.7%

Industry	Region 7	Union		Wallowa	
	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	100.0%	10,173	100.0%	2,572	100.0%
Total Private Coverage	76.8%	8,115	79.8%	1,952	75.9%
Natural Resources & Mining	5.1%	379	3.7%	177	6.9%
Construction	4.6%	468	4.6%	156	6.1%
Manufacturing	10.4%	1,327	13.0%	157	6.1%
Trade, Transportation & Utilities	18.0%	1,916	18.8%	440	17.1%
Information	1.1%	108	1.1%	18	0.7%
Financial Activities	2.8%	264	2.6%	122	4.7%
Professional & Business Services	4.7%	454	4.5%	121	4.7%
Education & Health Services	15.6%	1,743	17.1%	371	14.4%
Leisure & Hospitality	10.2%	1,051	10.3%	273	10.6%
Other Services	4.3%	402	4.0%	118	4.6%
Unclassified	0.0%	(c)	(c)	(c)	(c)
Total All Government	23.2%	2,058	20.2%	620	24.1%
Total Federal Government	3.8%	236	2.3%	88	3.4%
Total State Government	3.7%	364	3.6%	72	2.8%
Total Local Government	15.6%	1,458	14.3%	460	17.9%

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

Source: Oregon Employment Department. (2019). Quarterly Census of Employment and Wages. Retrieved from Qualityinfo.org

Each supersector faces distinct vulnerabilities to natural hazards. Identifying a region's dominant supersectors and the underlying industries enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment supersectors has sensitivity to natural hazards, as follows.

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

Education and Health Services: The industries in these sectors play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an increasing distribution of businesses primarily serving a local and aging population.

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

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Looking at industrial subsectors (three-digit NAICS) provides greater detail about the regional economy while maintaining a level of aggregation useful for analysis. The table below shows the top ten industries by share of employment within the region. Many of the top employment subsectors are similar across regions. For example, Food Services and Drinking Places and Educational Services are the two largest employment subsectors in Region 7. These subsectors also rank highly in other regions. Ambulatory Health Care Services—also known as outpatient services—and Hospitals are also major employers in Region 7 and across the state. Conversely, other subsectors, such as Wood Product Manufacturing, are more unique to the region.

Table 2-611. Industries with Greatest Share of Employment in Region 7, 2018

Industry	Employment Share	Employment (2018)
Educational Services	10.0%	2,261
Food Services and Drinking Places	9.4%	2,118
Ambulatory Health Care Services	4.8%	1,073
Food and Beverage Stores	4.6%	1,043
Wood Product Manufacturing	4.5%	1,025
Nursing and Residential Care Facilities	3.8%	863
Social Assistance	3.7%	837
Executive, Legislative, and Other General Government Support	3.4%	763
Transportation Equipment Manufacturing	2.8%	638
Professional, Scientific, and Technical Services	2.7%	613

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for employment share and average employment by DLCD

Industry Concentration and Employment Change

A location quotient (LQ) is a metric used to identify a region's area of industrial specialization. It is calculated by comparing an industry's share of regional employment with its share of employment in a reference economy (Quinterno, 2014). If a LQ is higher than 1.0, employment in that industry is more concentrated in that region than in the reference economy. In this case, the reference economy is the United States as a whole. Industries with a high LQ indicate the region might have a competitive advantage and that the industry is potentially—but not always—exporting goods and services. Understanding regional competitiveness and targeting mitigation strategies that make exporting industries less vulnerable can help the region's resiliency. Location quotients, however, require careful interpretation; analysis of employment data should be paired with local knowledge of regional business dynamics.

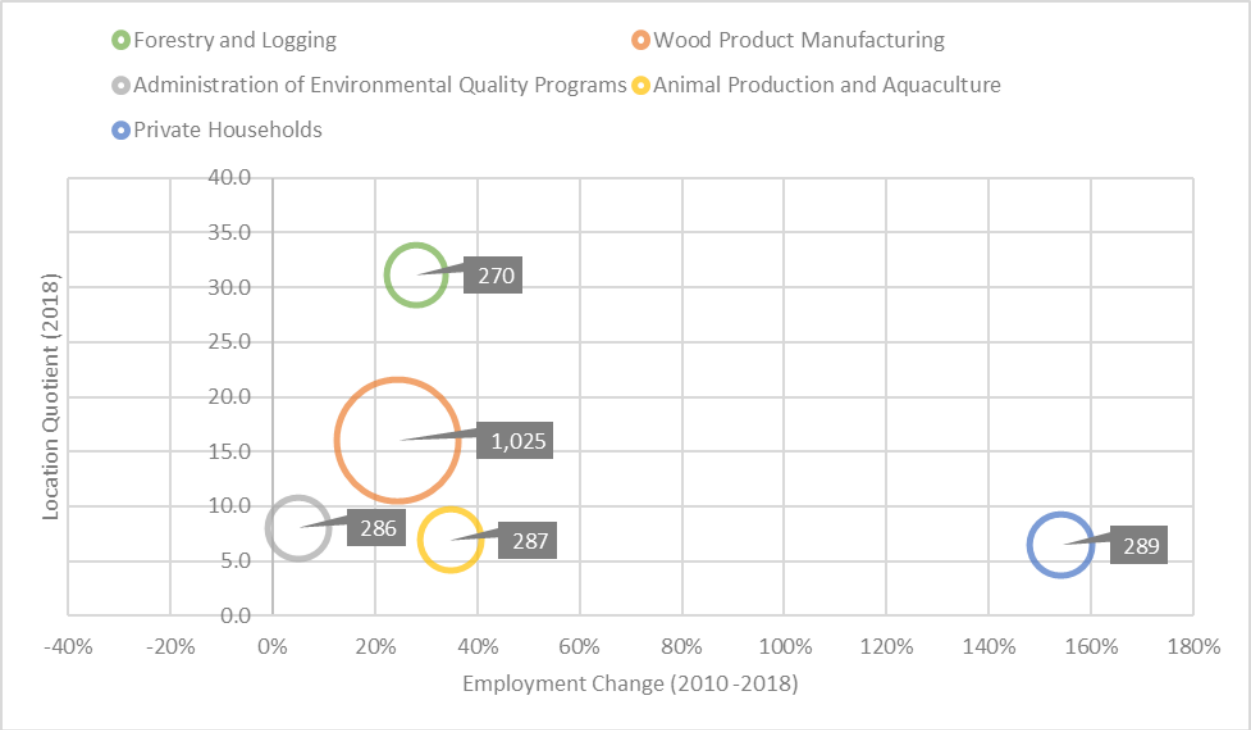
Table 2-612. Most Concentrated Industries and Employment Change in Region 7, 2018

Industry	Location Quotient	Employment (2018)	Employment Change (2010–2018)
Forestry and Logging	31.1	270	28%
Wood Product Manufacturing	16.0	1,025	24%
Admin. of Environmental Quality Programs	8.0	286	5%
Animal Production and Aquaculture	6.9	287	35%
Private Households	6.5	289	154%

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

In addition to an industry's LQ value, it is important to consider the number of jobs and whether the industry is growing or declining. The scatter plot below presents this information for the five industries in Region 7 with the highest LQ values. It shows the percent change in employment over the last eight years, the total number of employees in the industry, and the LQ value.

Figure 2-267. Location Quotients, Employment Change, and Total Employment in Region 7, 2018



APA Citation: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retreived from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD staff

Four of the region's five most concentrated industries are natural resource based. Similar to other regions, Region 7 has significant employment concentrations in timber related industries. Forestry and Logging and Wood Product Manufacturing both have a location quotient over fifteen—suggesting the industry presence is rather unique within the United States. All subsectors experienced growth during the eight-year period, with Administration of Environmental Quality Programs experiencing the least and Private Household experiencing the most. Mirroring conditions in other regions with a timber industry, manufacturing goods from wood requires more employment than harvesting timber.

Fastest Growing and Declining Industries

Empirical analysis suggests that natural disasters can accelerate preexisting economic trends (Zhang , Lindell, & Prater, 2009). Therefore, it is important for local planners to understand their region's existing economic context, which industries are growing and which are declining.

Employment change can be caused by internal and external factors. The shift-share analysis helps us understand and separate regional and national influences on a local industry. There are three separate elements to the analysis that attempt to account for local and national forces. The national-share controls for the broad growth of the national economy; the industry-mix controls for broad national changes within an industry being analyzed; and the local-factor tries

to explain what portion of employment change can be attributed to local factors. The bar chart below depicts a shift-share analysis for Region 7's fastest growing and declining industries

Table 2-613. Fastest Growing and Declining Industries in Region 7, 2010-2018

Industry	Employment Change	Employment (2010)	Employment (2018)
Fastest Growing			
Food Manufacturing	548%	10	65
Private Households	154%	114	289
Couriers and Messengers	116%	39	85
Waste Management and Remediation Services	89%	37	70
Amusement, Gambling, and Recreation Industries	71%	195	334
Fastest Declining			
Motion Picture and Sound Recording Industries	−100%	16	0
Primary Metal Manufacturing	−100%	45	0
Rental and Leasing Services	−100%	89	0
Transit and Ground Passenger Transportation	−100%	63	0
Clothing and Clothing Accessories Stores	−66%	87	29

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for average annual employment, and employment change by DLCD

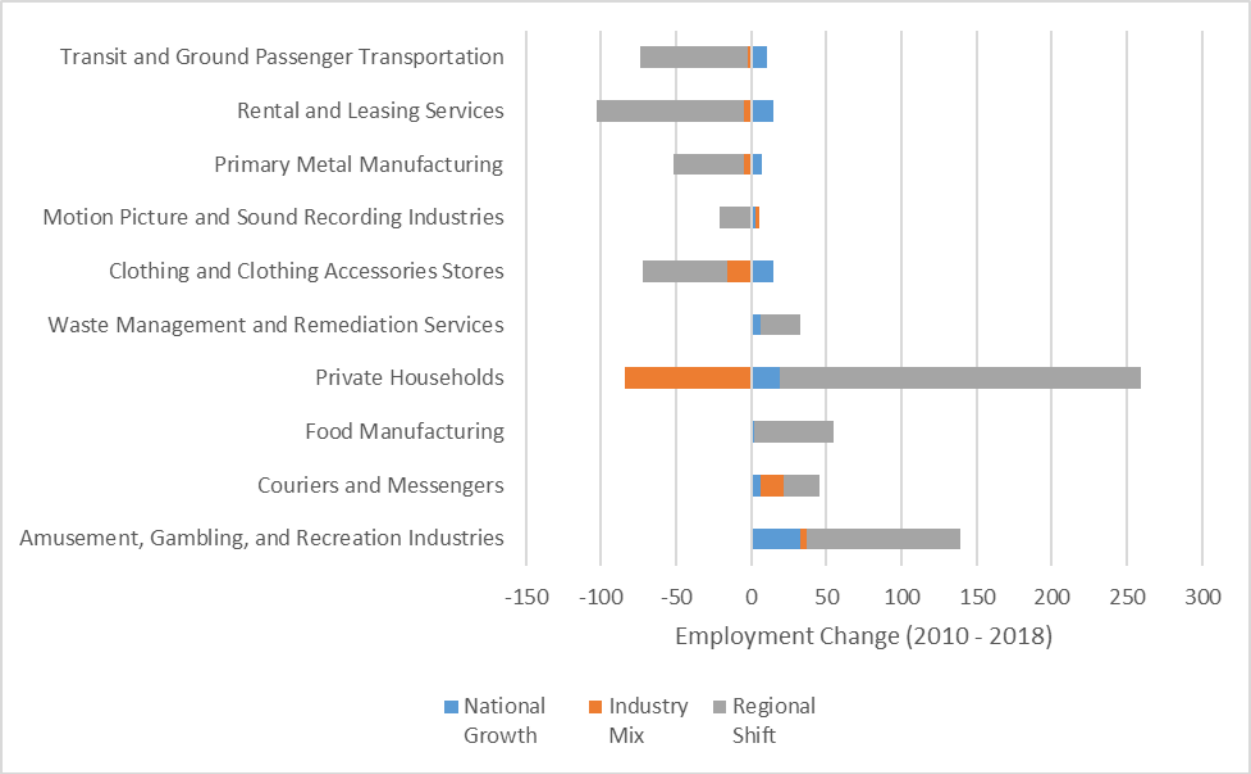
Due to a smaller population, the fastest growing industries started with meager employment in 2010—each under two-hundred. Consequently, small changes in absolute terms equate to significant percent increases. According to the shift share analysis, growth in all five subsectors was driven by largely by regional factors.

All five of the fastest declining subsectors in Region 7 started with under one-hundred employees in 2010. Four of the five collapsed entirely during the eight-year period. According to the shift-share analysis, this collapse was driven by regional factors. It should be noted that with such small numbers, subsector decline potentially represents the closure of one or two establishments, rather than larger industry trends.

The Private Households subsector more than doubled from 2010-2018. This sector employs workers "that work on or about the household premises…such as cooks, maids, butlers, gardeners, personal caretakers, and other maintenance workers" (Wallis, 2019). The increase in employment in the Private Households industry mirrors a statewide trend (Wallis, 2019). Demand is driven in part by an aging population's need for in-home care workers (Wallis, 2019).

Employment in the Couriers and Messengers subsector is likely a reflection of the global revolution in retail sales. With an increased share of retail shopping occurring online, growth in transportation, storage, and distribution infrastructure and employment has been increasing nationally. Although the character of work is quite different, new employment in this in the subsector has helped to offset job loss in traditional "Brick and Mortar" retail (Lehner, Oregon's Shifting Retail Landscape , 2017). For example, Clothing and Clothing Accessories Store in the region shed more than half of all jobs from 2010-2018. Companies employing couriers include names like Federal Express, FedEx Ground, and United Parcel Service (Wallis, Couriers and Messengers: From Pony Express to Future Drones, 2018).

Figure 2-268. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 7, 2010-2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by

Table 2-614. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 7, 2010-2018

Industry	Employment Change	National Growth	Industry Mix	Regional Shift
Fastest Growing				
Amusement, Gambling, and Recreation Industries	139	32	4	103
Couriers and Messengers	46	7	15	24
Food Manufacturing	55	2	0	53
Private Households	175	19	−84	240
Waste Management and Remediation Services	33	6	0	27
Fastest Declining				
Clothing and Clothing Accessories Stores	−58	14	−16	−56
Motion Picture and Sound Recording Industries	−16	3	2	−21
Primary Metal Manufacturing	−45	7	−5	−47
Rental and Leasing Services	−89	15	−5	−98
Transit and Ground Passenger Transportation	−63	10	−2	−71

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by DLCD

Economic Trends and Issues

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

- The region generally lacks a diversity of traded sector industries. Many of the region's most concentrated industries are natural resource-based or depend on natural resource industries. These sectors are especially vulnerable to the impacts of climate change;
- Unemployment rates across the region were higher than in the state as a whole from 2014-2018;
- The regional economy has fewer opportunities for highly-skilled employees, limiting the income potential of regional residents.

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

Infrastructure

Transportation

Roads

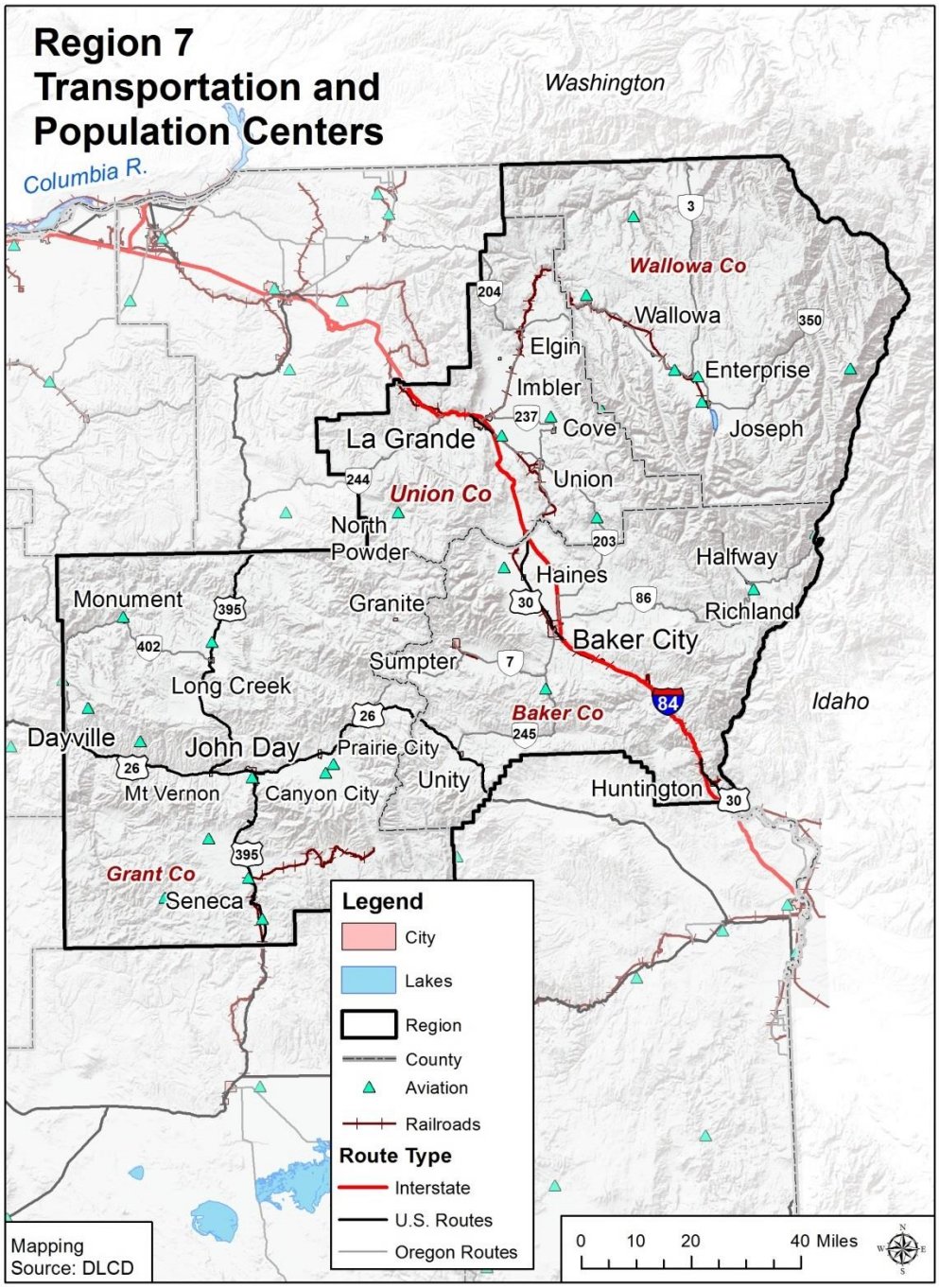
The largest population bases in Region 7 are located along the region's major freeways. I-84 runs north-south and is the main passage for automobiles and trucks traveling east of the Cascade Range between Portland and Idaho. US-26, US-244, OR-245, and US-395 provide access west into Grant County. OR-82 provides access into Wallowa County. An additional north-south access is provided from Wallowa County to Washington via OR-3.

Region 7's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents.

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

According to the Oregon Department of Transportation's (ODOT's) 2014 Seismic Plus Report (**Appendix 9.1.12**), the projected impacts of a CSZ event are considered negligible in this part of the state. However, damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy. Because the projected impacts of a CSZ event are considered negligible in this part of the state Region 7 was not part of the ODOT's 2012 Seismic Lifelines Report. However, ODOT did provide the following descriptions of general impacts a CSZ would have on Region 7's seismic lifelines and the region's overall vulnerability. That information is available in **Seismic Lifelines**.

Figure 2-269. Region 7 Transportation and Population Centers



Source: Oregon Department of Transportation, 2014

Bridges

ODOT lists 491 bridges in the counties that comprise Region 7.

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

Table 2-615 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, 2020). In this region, 6% of bridges are distressed and/or deficient.

Table 2-615. Bridge Inventory for Region 7

	State Owned			County Owned			City Owned			Other Owned			Area Total		
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D
Oregon	42	2,760	2%	258	3,442	7%	30	643	5%	16	121	13%	346	6,966	5%
Region 7	2	215	1%	25	239	10%	3	35	9%	0	2	0%	30	491	6%
Baker	2	81	2%	11	78	14%	0	8	0%	0	0	N/A	13	167	8%
Grant	0	46	0%	5	39	13%	1	9	11%	0	1	0%	6	95	6%
Union	0	71	0%	4	62	6%	1	8	13%	0	1	0%	5	142	4%
Wallowa	0	17	0%	5	60	8%	1	10	10%	0	0	N/A	6	87	7%

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 (2020)

Railroads

Railroads that run through Region 7 support cargo and trade flows. The region's major (Class I) freight rail providers are the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF) railroads. The Class I rail line follows the I-84 corridor and another non-class I rail line provides access to the city of Enterprise (Wallowa County). There are no active rail lines in Grant County. There is one rail yard in the region (in La Grande, Union County) operated by UP (Cambridge Systematics, 2014).

There is no passenger rail available in Region 7.

Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and transport products from other states to and through Oregon (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 7. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can

also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

There are no commercial airports in the region. There are several general aviation public airports including the Baker City and La Grande airports.

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

Table 2-616. Public and Private Airports in Region 7

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Helipad	Private Helipad	Total
Region 7	7	23	0	5	35
Baker	1	5	0	5	11
Grant	2	9	0	0	11
Union	1	3	0	0	4
Wallowa	3	6	0	0	9

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

Energy

Electricity

The region is served by several investor-owned, public, cooperative and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the primary investor-owned utility company serving Wallowa County. Idaho Power Company serves portions of Baker County. The region's electric cooperatives include: Oregon Trail Electric Cooperative (Baker, Grant, and Union), Central Electric Cooperative (Grant), Columbia Power Cooperative (Grant), and the Umatilla Electric Cooperative (Union). The Oregon Trail Electric Cooperative serves the major population centers in the region.

Table 2-617 lists electric power-generating facilities in Region 7. The region has a total of five power-generating facilities: three are hydroelectric power facilities, one is a wind power facility, and one is categorized as "other" (biomass). In total, the power-generating facilities have the ability to produce up to 1,277 megawatts (MW) of electricity.

Table 2-617. Power Plants in Region 7

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 7	3	0	1	0	1	5
Baker	2	0	0	0	0	2
Grant	0	0	0	0	1	1
Union	0	0	1	0	0	1
Wallowa	1	0	0	0	0	1
Energy Production (MW)	1,166	0	101	0	10	1,277

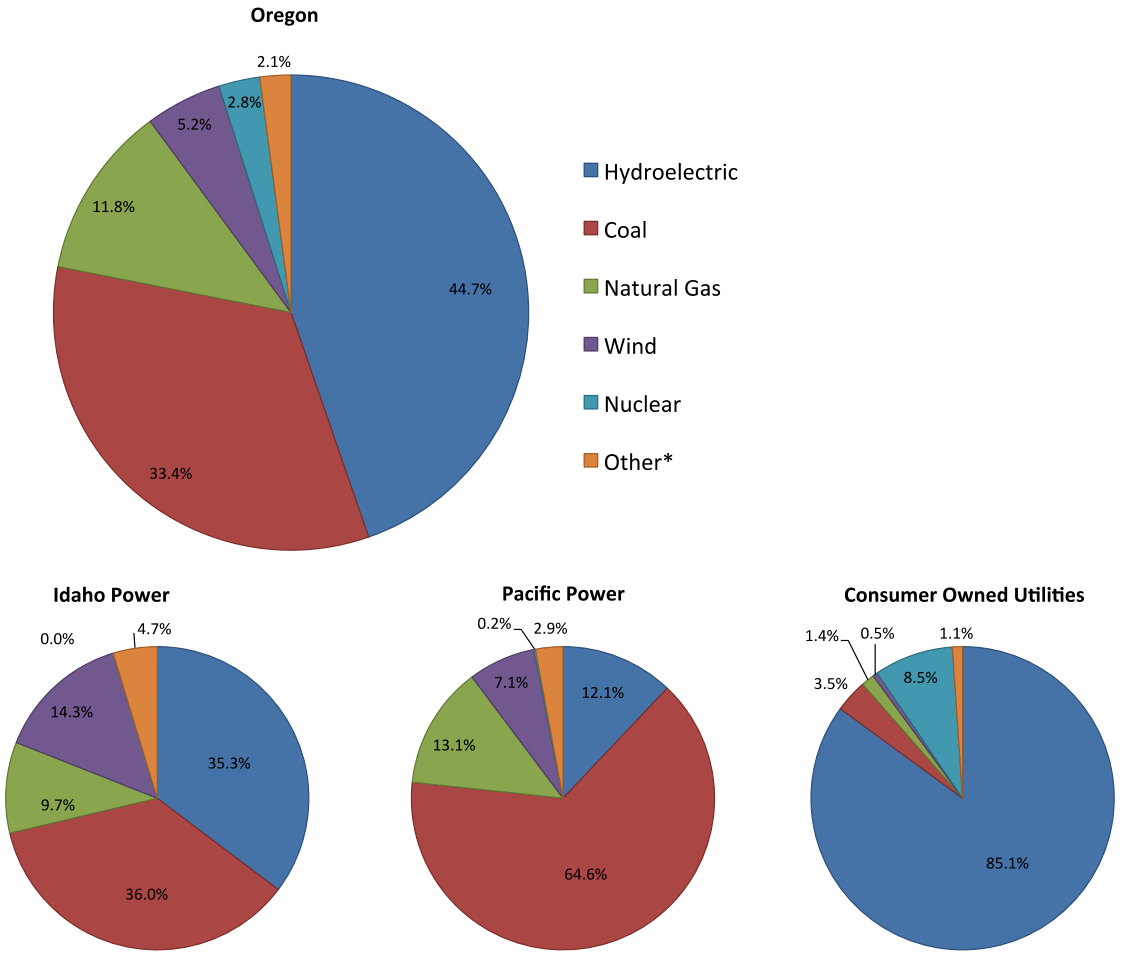
*"Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

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

Oregon has a diverse energy portfolio (Figure 2-270) (Oregon Department of Energy, n.d.b). Consumer Owned Utilities provide for approximately 30% of the state's electricity consumption (largely through Bonneville Power Administration's electric generation facilities) while Pacific Power provides about 28% of the state's electricity need.

Pacific Power generates supply from a variety of sources including sites in Oregon and other western states. Transmission lines from the Rocky Mountain Region provide additional energy sources. Natural hazard events can create additional stresses to energy infrastructure that may lead to system damage or disruption in service. The redundancies and diversity in Pacific Power's energy generation portfolio and pipeline systems adds to the region's resilience in the face of power system damage or service disruption.

Figure 2-270. Oregon Energy Portfolio



Note: 3.9% of Oregon's electricity needs are met through Electric Service Suppliers that are not required to provide descriptions of their power sources to the State of Oregon.

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

Source: Oregon Department of Energy, 2014.

Hydropower

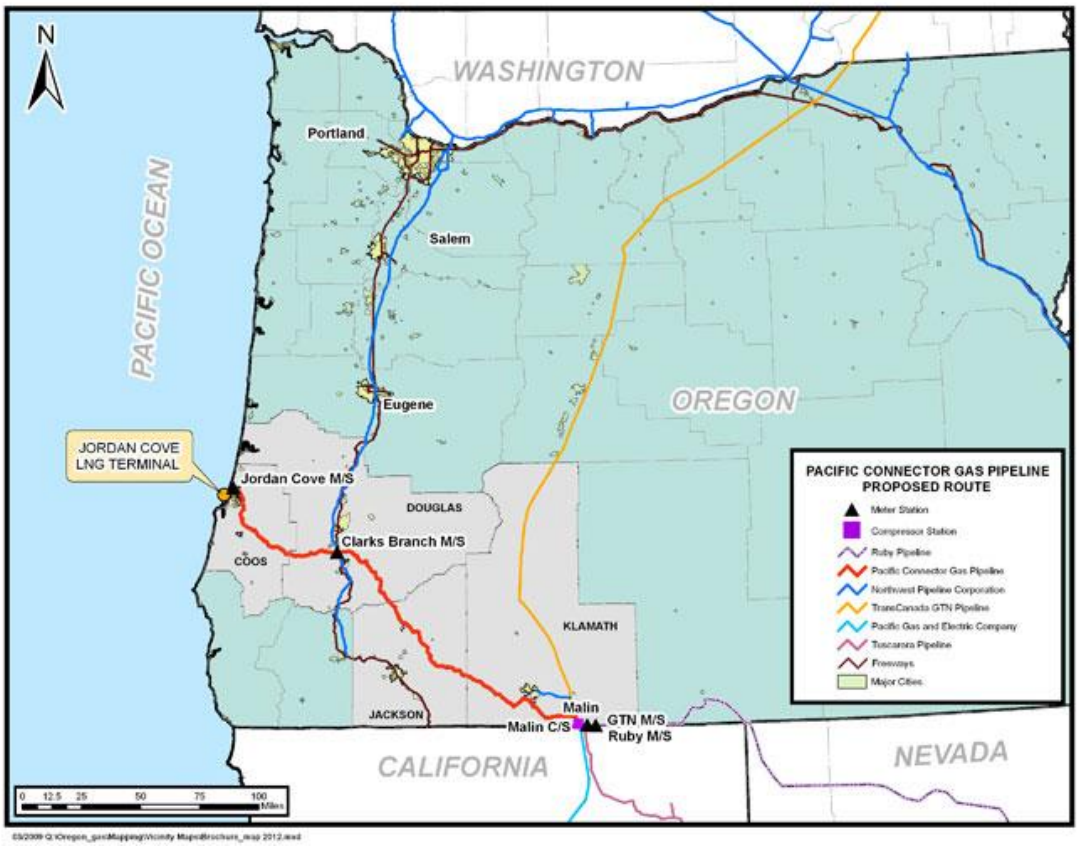
Major dams in the region are located on the Snake River (Brownlee, Oxbow, and Hells Canyon).

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 2-271** shows the Northwest Pipeline, which runs through Union and Baker Counties (in blue) (*Northwest Pipeline* Retrieved from http://www.northwest.williams.com/NWP_Portal/extLoc.action?Loc=FilesNorthwestother&File=pipelineInfo.html). LNG pipelines, like other buried pipe infrastructure, are vulnerable to

earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.

Figure 2-271. Liquefied Natural Gas Pipelines in Region 7



Source: Williams Corporation

Utility Lifelines

Northeast Oregon is an important throughway for oil and gas pipelines and electrical transmission lines, connecting Oregon to Idaho and Washington. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

Region 7 primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The electric, oil, and gas lifelines that run through the County are both municipally and privately owned (Loy et al., 1976).

The network of electrical transmission lines running through Region 7 is operated primarily by Pacific Power and regional electrical cooperatives (and supplied by the Idaho Power Company and Bonneville Power Administration) and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. The Williams Company owns the main natural gas transmission pipeline in northeastern Oregon.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 7 is part of the Eastern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013). There is a memorandum of understanding between these counties that facilitates the launching of emergency messages. Counties in these areas can launch emergency messages by contacting the Oregon Emergency Response System (OERS), which in turn creates emergency messages to communities statewide.

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

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The Oregon State Emergency Alert System Plan does not identify a local primary station for emergency messages. However, messages are provided via the three state primary networks: Oregon Public Broadcasting (Portland), KOBI-TV (Medford), and KWAX-FM (Eugene).

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 7. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is readily available throughout most parts the region with a smaller number of providers and service types available in the more remote parts of the region (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

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

Radio

Radio is readily available to those who live within Region 7 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Due to the remote nature and sparse population Region 7 lacks a station that would serve the Eastern Oregon Operational Area. ,Radio transmitters for the Eastern Oregon Operational Area are:

Local Primary Stations:

- KCMB-FM, 104.7 MHZ (Baker City, Baker, Morrow, Umatilla, and Union Counties);
- KJDY-FM, 94.5 MHZ (John Day, Grant County); and
- WVR-FM, 92.1 MHZ (Enterprise, Wallowa County).

State Primary Stations:

- KOBK-FM, 104.7 MHZ, Baker City (OPB Radio Network, also monitors KBOI-AM 690, Boise, PEP station)
- KOJD-FM, 89.7 MHZ, John Day (OPB Radio Network);
- KTVR-FM, 90.3 MHZ, La Grande (OPB Radio Network); and
- KETP-FM, 88.7 MHZ, Enterprise (OPB Radio Network).

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). ARES Districts 3 (Union, Wallowa) and 6 (Baker, Grant) provide service to Region 7. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). Union County is the only county in the region with an active ham emergency station. Calls for Region 7 include (American Relay Radio League Oregon Chapter, n.d., www.arrloregon.org):

- Baker County: Vacant;
- Grant County: Vacant;
- Union County: KE7QYU; and
- Wallowa County: Vacant.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 7 municipal drinking water supply is obtained from both surface and ground sources. In Wallowa and Grant Counties, the majority of municipal drinking water is from wells drawing from the aquifer with cities having water rights for surface water sources as backup sources in late summer. In Grant County, cities draw drinking water equally from a combination of surface and ground sources. Baker City draws its water from mountain springs and is unique in the state because it uses only ultraviolet water treatment without any filtration. Other cities in Baker County depend primarily on groundwater wells for municipal drinking water. Rural residents also obtain water primarily from both surface sources and groundwater wells.

Region 7 is impacted by several threats to water quality and quantity. Low levels of snowpack can lead to severe surface water shortages in a region that is already subject to annual shortages. Low water levels in surface sources can cause stagnation, low flows, and increased mineralization downstream, which negatively impacts water quality. Effluent runoff from feedlots is a lower priority concern for the region's water quality; however, other agricultural products such as pesticides and herbicides leeching into ground and surface water sources is a concern for water quality. High water temperatures are a concern in the region because of impacts to wildlife as well as increases in bacteria levels associated with high surface water temperatures. Riparian improvement projects are being implemented in Grant County to combat the issue of high surface water temperatures. Other concerns for water quality include industrial contamination, diesel spills, chromium, arsenic, iron and sulfur levels.

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

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

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water

temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

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

In Region 7, most municipal building codes and stormwater management plans (city and county) emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speed, and at lower temperatures. In Region 7, only Baker City refers to LID techniques in its municipal code, requiring new surface parking areas are required to use LID strategies for stormwater runoff. Requiring decentralized LID stormwater management strategies in the other Region 7 counties could help reduce the burden of new development on storm sewer systems and increase the region's resilience to many types of hazard events.

Infrastructure Trends and Issues

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

Damage or service interruption to roads, bridges, rail systems, and ports can have devastating effects the region's economy. Hazards such as flooding and winter weather can close the highways that connect communities in Region 7 to the rest of the state. Fourteen percent of all bridges in Northeast Oregon are distressed or deficient. Railroads that run through Region 7 support cargo and trade flows, and are vulnerable to icy conditions.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are five power-generating facilities located in this region: three hydroelectric, one wind, and one biomass facility. The area is the location of three large dams and hydroelectric projects on the Snake River. LNG is transported through the region via the Northwest Pipeline that runs through Union and Baker Counties.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services may not cover rural areas of the region that are distant from I-84. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lacking system redundancies. Because most drinking water is sourced

from surface water or wells, the region is at risk of high levels of pollutants entering waterways via stormwater runoff or combined sewer overflows (CSO) during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. Baker City is the only community Region 7 that requires low impact development (LID) stormwater management practices in its building code, and it is only required for new surface parking.

Built Environment

Development Patterns

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

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

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people, or an "urban cluster" of at least 2,500 people (but less than 50,000). Grant and Wallowa Counties do not meet either definition. Therefore even though both counties contain incorporated cities, the counties are considered 100% rural.

Statewide, Oregon counties added residents from 2000 to 2010, but several northeast counties lost population over the decade. Baker, Grant, and Wallowa Counties all decreased in population over the 10-year period, a combined population decrease of over 1,300 people. Union County increased by 5% and was the only county to experience growth in both urban and rural areas; however, its rate of urban growth was less than half of the state as a whole. At the city level, La Grande grew the most (+755). The region's population is clustered around the I-84 corridor and the cities of Baker City, La Grande, John Day, and Enterprise.

Table 2-618. Urban and Rural Populations in Region 7, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	−0.1%
Region 7	23,883	24,427	2.3%	32,549	31,908	−2.0%
Baker	9,605	9,518	−0.9%	7,136	6,616	−7.3%
Grant	0	0	—	7,935	7,445	−6.2%
Union	14,278	14,909	4.4%	10,252	10,839	5.7%
Wallowa	0	0	—	7,226	7,008	−3.0%

Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table P2

U.S. Census Bureau (n.d.). 2000 Decennial Census, Table P002

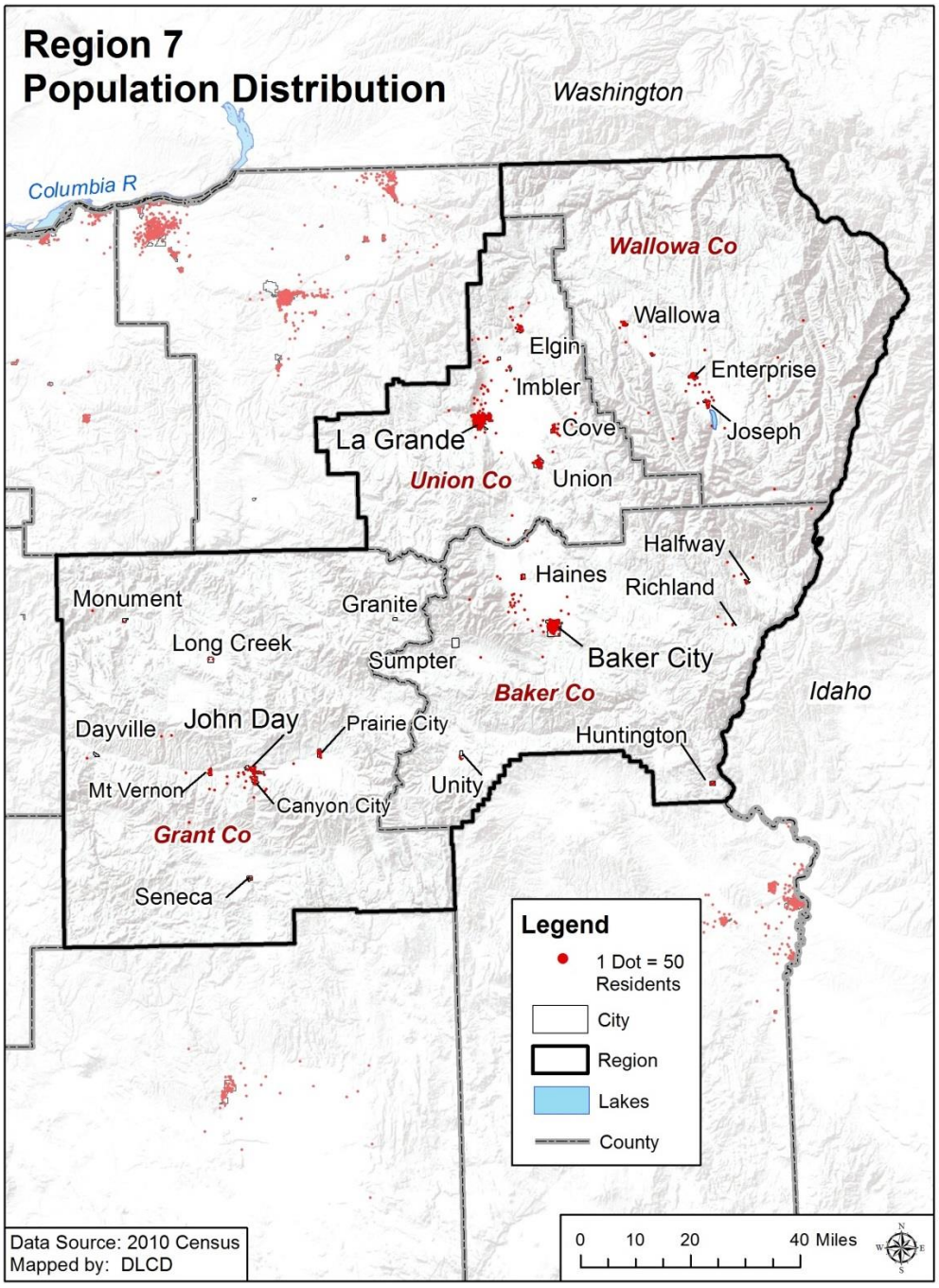
Table 2-619. Urban and Rural Housing Units in Region 7, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 7	10,552	11,039	4.6%	16,357	17,728	8.4%
Baker	4,342	4,498	3.6%	4,060	4,328	6.6%
Grant	0	0	—	4,004	4,344	8.5%
Union	6,210	6,541	5.3%	4,393	4,948	12.6%
Wallowa	0	0	—	3,900	4,108	5.3%

Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table H2

U.S. Census Bureau (n.d.). 2000 Decennial Census, Table H002

Figure 2-272. Region 7 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns

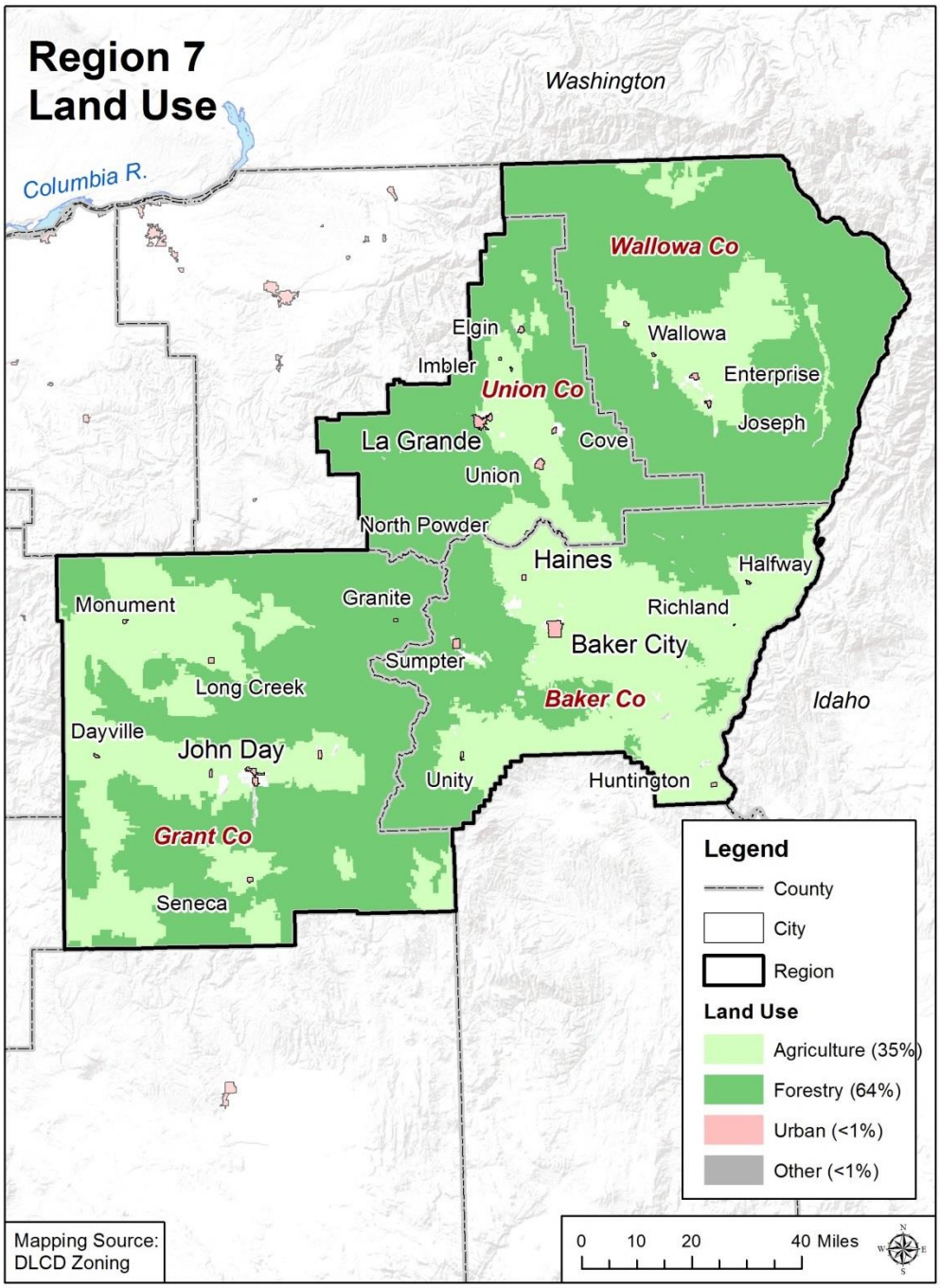
Private land generally has developed more slowly in Eastern Oregon than in Western Oregon between 1974 and 2009. State and local programs have been successful in limiting rural residential and urban development and maintaining large parcel sizes. Demand for large-scale development in this part of the state has historically been very low. Land ownership is almost completely split between federal (60%) and private (39+%) with less than 1% shared by state and local government.

To the extent it has occurred, development has generally been located along existing transportation corridors. Nearly half of the people in Region 7 reside in the cities of Baker City, John Day, La Grande, and Enterprise, and most unincorporated development in this region is located along the I-84 corridor.

As with other regions in the state this area has seen an upswing in building permits since the spring of 2012, although modest (U.S. Census Bureau, 2010). Any regional rate of growth is expected to be small. The Office of Economic Analysis projects that Region 7's population will increase by less than 1% over a 30-year period.

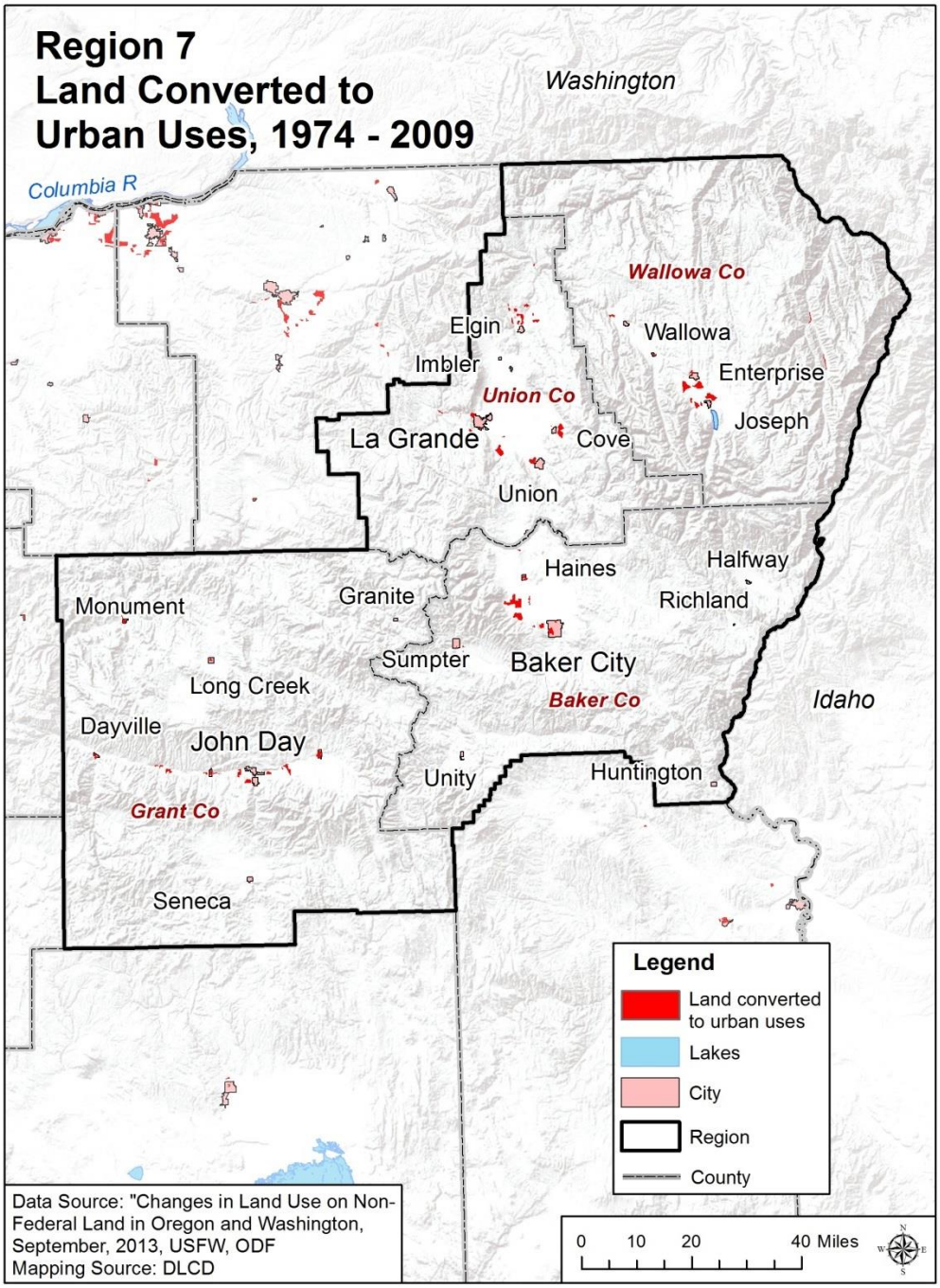
All the cities within the four counties of the region have acknowledged comprehensive land use plans that are periodically reviewed and updated. In 2013, the City of La Grande's Urban Growth Boundary (UGB) was extended, adding over 250 acres of vacant industrial land to the available land inventory.

Figure 2-273. Region 7 Land Use



Source: Department of Land Conservation and Development, 2014

Figure 2-274. Region 7 Land Converted to Urban Uses, 1974–2009



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

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. Almost 71% of the region's housing stock is single-family homes. The region's share of multi-family units is less than half that of the state, and almost two thirds of those units are in Union County. The region has twice the percentage of mobile homes as the state, comprising one quarter of all homes in Grant County. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997).

Table 2-620. Housing Profile for Region 7

	Total Housing Units	Single Family			Multi-Family			Mobile Homes		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	68.1%	☑	0.3%	23.5%	☑	0.3%	8.2%	☑	0.1%
Region 7	29,184	71.7%	☑	1.5%	11.9%	☑	1.2%	16.2%	☑	1.1%
Baker	8,971	74.3%	☑	2.8%	10.1%	☑	2.0%	15.4%	☑	1.9%
Grant	4,371	70.9%	☑	3.6%	7.6%	⊙	2.1%	21.3%	☑	3.3%
Union	11,684	68.6%	☑	2.6%	16.4%	☑	2.5%	14.9%	☑	1.7%
Wallowa	4,158	75.8%	☑	3.4%	7.9%	⊙	2.0%	16.3%	☑	2.4%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau. 2013-2017. American Community Survey 5-Year Estimates

APA Citation: U.S. Census Bureau (2018).Table B25024: Units in Structure, 2013-2017 American Community Survey 5-year estimates. Retrieved from http://factfinder2.census.gov/

Table 2-621. Housing Vacancy in Region 7

	Total Housing Units	Vacant^		
		Estimate	CV**	MOE (+/−)
Oregon	1,733,041	5.6%	☑	0.2%
Region 7	29,184	10.0%	☑	1.1%
Baker	8,971	9.8%	☑	2.0%
Grant	4,371	14.2%	☑	3.1%
Union	11,684	9.2%	☑	1.9%
Wallowa	4,158	8.0%	⊙	2.3%

Notes: ^ Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.
**Green, orange, and red icons indicate the reliability of each Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018), 2013-2017 American Community Survey 5-Year Estimates. http://factfinder2.census.gov/. Table B25004: Vacancy Status

Aside from location and type of housing, the year structures were built (**Table 2-622**) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (State of Oregon Building Codes Division, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as a part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally about one half of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. About 80% of the housing stock was built before 1990 and the codification of seismic building standards.

Table 2-622. Age of Housing Stock in Region 7

	Total Housing Units	Pre 1970			1970 to 1989			1990 or Later		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	34.6%	☑	0.3%	30.5%	☑	0.3%	34.9%	☑	0.3%
Region 7	29,184	46.4%	☑	1.9%	29.4%	☑	1.4%	24.2%	☑	1.5%
Baker	8,971	49.8%	☑	3.4%	24.5%	☑	2.4%	25.6%	☑	2.8%
Grant	4,371	44.4%	☑	4.2%	29.1%	☑	3.7%	26.5%	☑	4.4%
Union	11,684	44.6%	☑	3.2%	33.7%	☑	2.5%	21.7%	☑	2.3%
Wallowa	4,158	46.3%	☑	4.6%	28.1%	☑	3.6%	25.6%	☑	3.5%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau. 2013-2017. American Community Survey 5-Year Estimates. Table B25034

APA Citation: U.S. Census Bureau (2018). Table B25034: Year Structure Built, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

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 2-623** shows the initial and current FIRM effective dates for Region 7 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-623. Community Flood Map History in Region 7

	Initial FIRM	Current FIRM
Baker County	Feb. 28, 1978	June 3, 1988
Baker City	Apr.17, 1984	June 3, 1988
Haines	June 3, 1988	June 3, 1988
Halfway	Sep. 24, 1984	June 3, 1988
Huntington	Sep 24, 1984	June 3, 1988
Sumpter	Sep 24, 1984	June 3, 1988
Grant County	Feb. 15, 1979	May 18, 1982
Canyon City	Sep 18, 1987	Sep 18, 1987
Dayville	Sep 24, 1984	Sep 24, 1984 (M)
John Day	Sep 15, 1977	Feb. 23, 1982
Long Creek	Sep 24, 1984	Sep 24, 1984 (M)
Monument	Sep 24, 1984	Sep 24, 1984 (M)
Mt. Vernon	Sep 18, 1987	Sep 18, 1987
Prairie City	Feb. 17, 1988	Feb. 17, 1988
Seneca	Sep 24, 1984	Sep 24, 1984 (M)
Spray	Aug. 16, 1988	Aug. 16, 1988 (M)
Union County	May 15, 1980	Apr. 3, 1996
Elgin	Nov. 15, 1978	Nov. 15, 1978
Island City	Nov. 15, 1978	Sep 30, 1987
La Grande	Sep 30, 1980	Apr.3, 1996
North Powder	Sep 29, 1978	Sep 29, 1987
Summerville	Jan. 15, 1980	Jan. 15, 1980 (M)
Union City	Dec.15, 1978	Dec. 15, 1978
Wallowa County	June 28, 1977	Feb. 17, 1988
Enterprise	Jan. 23, 1976	Feb. 17, 1988
Joseph	Dec. 5, 1975	Feb. 17, 1988
Lostine	Nov. 8, 1975	Feb. 17, 1988
Wallowa City	April 23, 1976	Feb. 17, 1988

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 7 can be found in **Table 2-624**. The region contains 1.9% of the total value of state-owned/leased critical/essential facilities.

Table 2-624. Value of State-Owned/Leased Critical and Essential Facilities in Region 7

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 7	$139,508,917	1.9%
Baker	$35,831,967	0.5%
Grant	$17,494,768	0.2%
Union	$71,475,427	1.0%
Wallowa	$14,706,756	0.2%

Source: DOGAMI

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 7 is largely a rural county with urban development focused along I-84 and around the population centers of Baker City, Enterprise, John Day, and La Grande. Union County has the only growing urban and rural populations in the region. All counties in the region have higher percentages of mobile homes compared to statewide numbers. Notably, about one quarter of all housing units in Grant County are mobile structures. Almost half the homes were built before 1970 and floodplain management standards, and 80% were built before 1990 and current seismic building standards. None of the region's FIRMs have been modernized or updated. The region's share of state-owned facilities are mostly within Union County.

2.3.7.3 Hazards and Vulnerability

Droughts

Characteristics

Drought is a common occurrence in the northeastern portion of the state. Every county in Region 7 has been impacted by drought on several occasions during the last 20 years. Together, winter snowpack and spring rains provide water for meeting a variety of needs. Extended drought conditions in this region can result in significant losses for the agriculture and tourism industries as well as increased fire danger.

Historic Drought Events

Table 2-625. Historic Droughts in Region 7

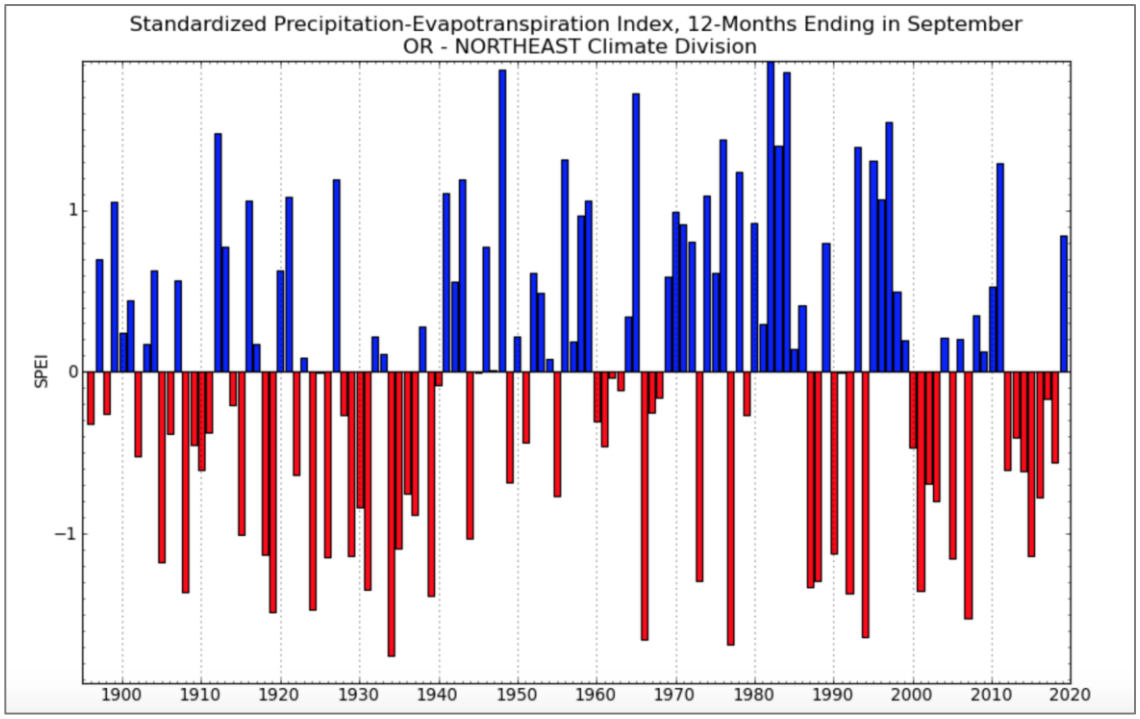
Year	Location	Description
1938-1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country
1977	N & S central Oregon; eastern Oregon	a severe drought for northeast Oregon
1994	Regions 4–8	in 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2002	southern and eastern Oregon	2001 drought declarations remain in effect for all counties, including Region 7's Baker, Union, and Wallowa Counties; Governor adds Grant County in 2002, along with five additional counties, bringing statewide total to 23 counties under a drought emergency.
2003	southern and eastern Oregon	Grant County 2002 declaration remains in effect through June 2003; Governor issues new declarations for Baker, Union, and Wallowa Counties, which are in effect through December 2003
2004	Region 5–8	Baker County receives Governor-declared drought emergency on June 2004, along with three other counties in neighboring regions
2005	Regions 5–7; 13 counties affected	Baker and Wallowa County receive a Governor drought declaration; all Region 5 counties affected, and most of Region 6 affected
2007	Regions 6–8	Grant, Baker, and Union Counties receive a Governor drought declaration; three other counties affected in neighboring regions
2013	Regions 5-8	Baker County receives a drought declaration, as well as four other counties in neighboring regions
2014	Regions 4, 6–8	Grant and Baker County receive drought declarations, including eight other counties in other regions
2015	statewide	36 Oregon Counties across the state receive federal drought declarations, including 25 under Governor's drought declaration
2018	Regions 1, 4-8	Baker and Grant County receive Governor's drought declarations, including 9 other counties in 5 other regions

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

Historic drought information can be obtained from the West Wide Drought Tracker, which provides historical climate data showing wet and dry conditions, using the Standard Precipitation-Evapotranspiration Index (SPEI) that dates back to 1895. **Figure 2-275** shows years where drought or dry conditions affected the north eastern area of Oregon (Climate Division 8).

Based on this index, 1934, 1966, 1977, 1994, and 2007 were severe drought years, while more than a dozen years in this record were moderate drought years.

Figure 2-275. Standard Precipitation-Evapotranspiration Index for Region 7



Drought Severity Scale: -1 to -1.49 = moderate drought; -1.5 to -1.99 = severe drought; -2.0 or less = extreme drought.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Table 2-626. Years with Moderate (<-1), Severe (<1.5), and Extreme (<-2) Drought in Oregon Climate Division 8 according to Standard Precipitation-Evapotranspiration Index

Moderate Drought (SPEI < -1.0)	Severe Drought (SPEI < -1.5)	Extreme Drought (SPEI < -2.0)
1919	1934	
1924	1977	
1939	1966	
1992	1994	
1908	2007	
2001		
1931		
1987		
1973		
1988		
1905		
1926		
2005		
1929		
2015		
1918		
1990		
1935		
1944		
1915		

Note: Within columns, rankings are from more severe to less severe.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Probability

Table 2-627. Probability of Drought in Region 7

	Baker	Grant	Wallowa	Union
Probability	VH	H	M	M

Source: OWRD, DLCD

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

Oregon has yet to undertake a comprehensive risk analysis for drought on a statewide basis, to determine probability or vulnerability for a given community. Considering historical statewide droughts and the number of drought declarations made in recent years, it is reasonable to assume that it is very likely that Region 7 will experience drought in the near future. Baker County has been under an emergency drought declaration on eleven different occasions or in 48% of the years since 1992: 1992, 2001 (remained in effect during 2002), 2003, 2004, 2005, 2007, 2013, 2014, 2015, and 2018. This is only second to Klamath County in Region 6. Grant has received drought declarations in 24% of these years, Union in 21%, and Wallowa in 17%. This accounts for their different probability ratings.

Climate Change

Drought is common in northeast Oregon. Climate models project warmer, drier summers for Oregon, including Region 7. These summer conditions coupled with projected decreases in mid-to-low elevation mountain snowpack due to warmer winter temperatures increases the likelihood that Region 7 would experience increased frequency of one or more types of drought under future climate change. In Region 7, climate change would result in increased frequency of drought due to low spring snowpack (very likely, >90%), low summer runoff (likely, >66%), and low summer precipitation and low summer soil moisture (more likely than not, >50%). In addition, Region 7, like the rest of Oregon is projected to experience an increase in the frequency of summer drought conditions as summarized by the standard precipitation-evaporation index (SPEI) due largely to projected decreases in summer precipitation and increases in potential evapotranspiration (Dalton et al., 2017).

Vulnerability

Table 2-628. Vulnerability to Drought in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	M	M	L	L

Source: OWRD, DLCD

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought. However, Baker and Grant Counties are vulnerable to and have experienced wildfire connected with drought conditions.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

All the counties rated low in social vulnerability except Grant, which rated very low. Vulnerability to wildfire as a result of drought has been taken into account in these ratings. Baker and Grant Counties are the communities most vulnerable to drought in Region 7.

Risk

Table 2-629. Risk of Drought in Region 7

	Baker	Grant	Wallowa	Union
Risk	H	H	M	M

Source: OWRD, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. Based on the probability of drought and vulnerability to it, risk of drought in Region 7 is considered high in Baker and Grant Counties and moderate in Union and Wallowa Counties.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from two sources: (a) shallow crustal events within the North America Plate, and (b) volcanic-earthquakes.

Region 7 contains high mountains and broad valleys. Although there is abundant evidence of faulting, seismic activity is low when compared with other areas of the state. Baker County probably has the most recorded seismic activity in the region. Not surprisingly, it appears to occur in the vicinity of Hells Canyon, an area with a complex geologic history. Several significant earthquakes have occurred in the region: the 1913 Hells Canyon; the 1927 and 1942 Pine Valley–Mountain; the 1965 John Day (M4.4); and the 1965 and 1966 Halfway (M4.3 and 4.2) (**Table 2-630**).

There are also a few identified faults in Union County that have been active in the last 20,000 years. The region has also been shaken historically by crustal earthquakes and prehistorically by subduction zone earthquakes centered outside the area (**Table 2-630**). All considered, there is good reason to believe that the most devastating future earthquakes in Region 7 would probably originate along shallow crustal faults.

Historic Earthquake Events

Table 2-630. Significant Earthquakes Affecting Region 7

Date	Location	Magnitude	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Oct. 1913	Hells Canyon, Oregon	VI	damage unknown
Apr. 1927	Pine Valley-Cuddy Mountain, Oregon	V	damage unknown
June 1942	Pine Valley-Cuddy Mountain, Oregon	V	damage minor
Aug. 1965	John Day, Oregon	4.4	damage unknown
Nov. 1965	Halfway, Oregon	4.3	damage unknown
Dec. 1966	Halfway, Oregon	4.2	damage unknown

Note: No significant earthquakes have affected Region 7 since December 1966.

*BCE: Before Common Era.

Sources: University of Washington. List of Magnitude 4.0 or Larger Earthquakes in Washington and Oregon 1872-2002; Wong and Bott, 1995; Pacific Northwest Seismic Network, https://pnsn.org/

Probability

Table 2-631. Assessment of Earthquake Probability in Region 7

	Baker	Grant	Wallowa	Union
Probability	M	M	L	L

Source: DOGAMI, 2020

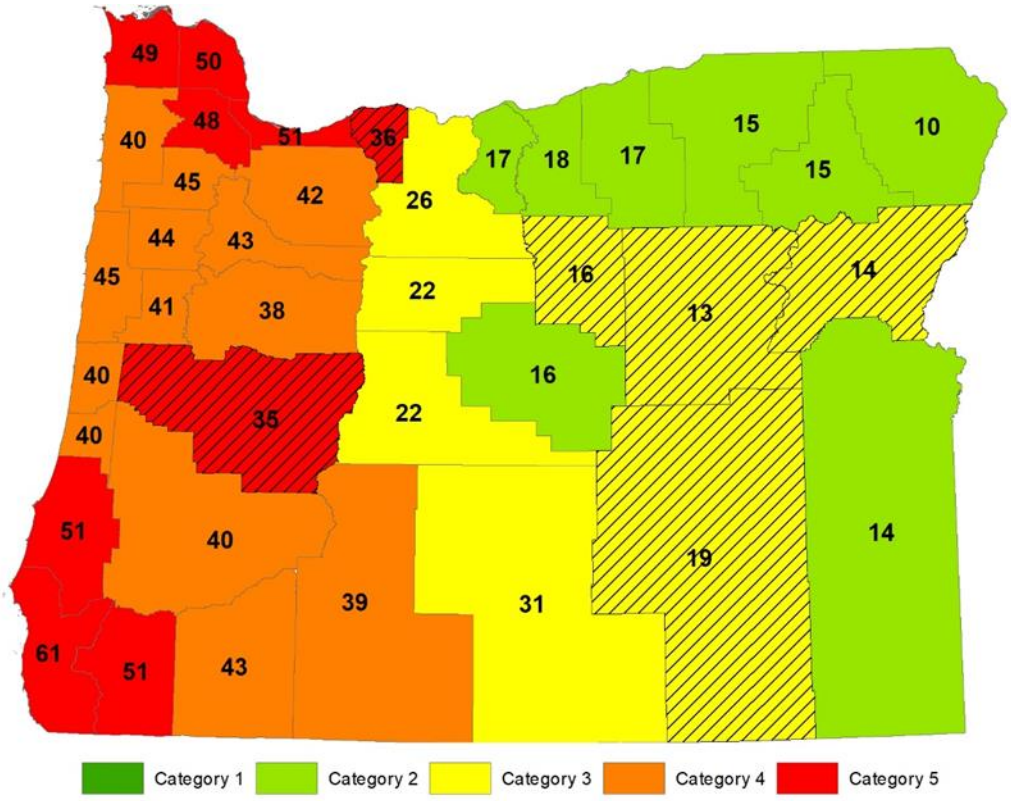
The probability of damaging earthquakes varies widely across the state. In Region 7, the hazard is dominated by local faults and background seismicity.

DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered lidar faults. If a county had newly discovered faults that were within 10-12 miles of a community, the category defined by the average probability of damaging shaking was increased one step.

- Category 1 100-year probability < 10%
- Category 2 100 year probability 10-20%
- Category 3 100 year probability 21-31%
- Category 4 100 year probability 32-45%
- Category 5 100 year probability > 45%

The probability levels for Baker, Grant, Harney, Hood River, and Wheeler Counties, and the non-coastal portion of Lane County were all increased in this way. The results of this ranking are shown in **Figure 2-276**.

Figure 2-276. 2020 Oregon Earthquake Probability Ranking Based on Mean County Value of the Probability of Damaging Shaking and Presence of Newly Discovered Faults



Source: DOGAMI, 2020

Vulnerability

Table 2-632. Assessment of Vulnerability to Earthquakes in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	L	VL	L	M

Source: DOGAMI and DLCD, 2020

Region 7 is considered moderately vulnerable to earthquake hazards due to earthquake-induced landslides, liquefaction, and ground shaking.

In 2007, DOGAMI (Lewis, 2007) completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI surveyed a total of 3,349 buildings, giving each a 'low,' 'moderate,' 'high,' or 'very high' potential of collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore *approximate* rankings (Lewis, 2007). To fully assess a building's potential of collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help prioritize buildings for further study. Results are found in **Table 2-633**, **Table 2-634**, and **Table 2-635**.

Table 2-633 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-633. Buildings with Their Collapse Potential in Region 7

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Baker	4	15	6	8
Grant	12	2	15	17
Union	10	6	14	24
Wallowa	10	2	10	3

Source: Lewis (2007)

Table 2-634. Projected Dollar Losses in Region 7, Based on an M8.5 Subduction Event and a 500-Year Model

	Economic Bae in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from a (M) 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year Event
Baker County	$943,000	less than $1,000	$13,000
Grant County	$415,000	less than $1,000	$3,000
Union County	$1,237,000	less than $1,000	$9,000
Wallowa County	$444,000	less than $1,000	$8,000

Source: Wang and Clark (1999)

Table 2-635. Estimated Losses in Region 7 Associated with a 500-Year Model

	Baker	Grant	Union	Wallowa	Remarks
Injuries	3	0	1	1	
Deaths	0	0	0	0	
Displaced households	10	0	1	1	
Operational the day after the quake[1]:					
Fire stations	N/A	N/A	N/A	N/A	
Police stations	N/A	N/A	N/A	N/A	
Bridges	N/A	N/A	N/A	N/A	
Economic losses to:					
Highways	$5 m	$3 m	$1 m	0	
Airports	$2 m	$2 m	$618,000	$3 m	
Communications	$1,000	$469,900	$$479,000	$116,000	
Debris generated (thousands of tons)	8	1	5	4	

Notes: “m” is million

The Hazus run that produced the data in this table did not account for unreinforced masonry buildings.

[1]The 500-year model includes several earthquakes; the number of facilities operational the day after the earthquake cannot be calculated.

Source: Wang and Clark (1999)

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

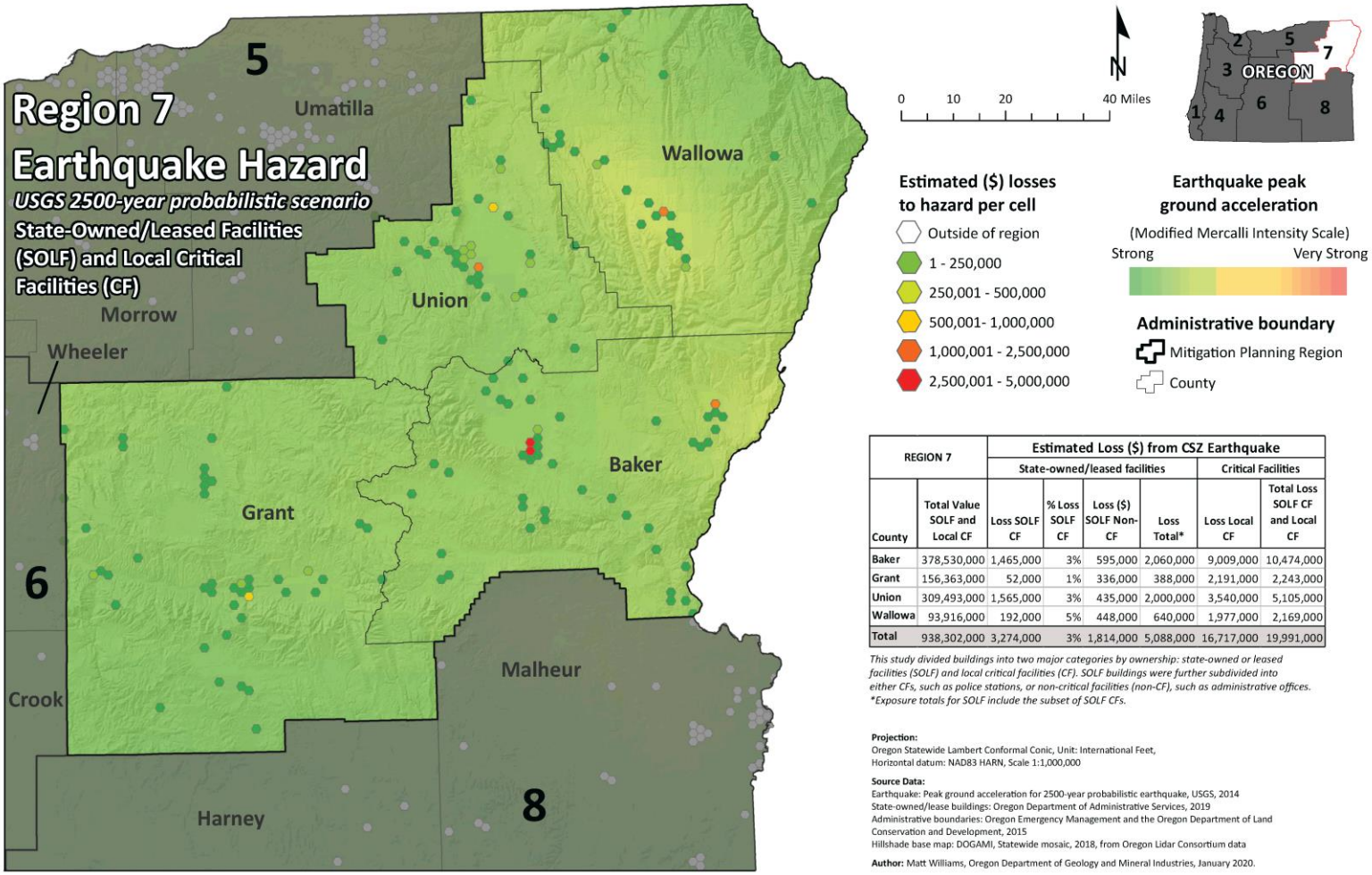
For the 2020 vulnerability assessment, DOGAMI used Hazus-MH to estimate potential loss from a 2500-year probabilistic earthquake scenario in Region 7. The analysis incorporated

information about the earthquake scenario (such as coseismic liquefaction and landslide potential), as well as building characteristics (including the seismic building code and building material). The results of the analyses are provided as a loss estimation (the building damage in dollars) and as a loss ratio (the loss estimation divided by the total value of the building) reported as a percentage at the county level.

DOGAMI used the loss ratio to formulate a separate relative vulnerability score for the state buildings, state critical facilities, and local critical facilities data sets. The percentage of loss for each county was statistically distributed into 5 categories (Very Low, Low, Moderate, High, or Very High).

In Region 7, a 2500-year probabilistic earthquake scenario could generate a potential loss of over $5M in state building and critical facility assets. Baker and Union Counties each contain about 40% percent of the value of those assets. The potential loss in local critical facilities is more than triple that amount, over $16.7M. Baker County again would suffer the greatest loss with 54% of the value of local critical facilities.**Figure 2-277** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a 2500-year probabilistic earthquake scenario.

Figure 2-277. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in an Earthquake Hazard Zone in Region 7.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 7		Estimated Loss ($) from CSZ Earthquake					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Loss SOLF CF	% Loss SOLF CF	Loss ($) SOLF Non-CF	Loss Total*	Loss Local CF	Total Loss SOLF CF and Local CF
Baker	378,530,000	1,465,000	3%	595,000	2,060,000	9,009,000	10,474,000
Grant	156,363,000	52,000	1%	336,000	388,000	2,191,000	2,243,000
Union	309,493,000	1,565,000	3%	435,000	2,000,000	3,540,000	5,105,000
Wallowa	93,916,000	192,000	5%	448,000	640,000	1,977,000	2,169,000
Total	938,302,000	3,274,000	3%	1,814,000	5,088,000	16,717,000	19,991,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Earthquake: Peak ground acceleration for 2500-year probabilistic earthquake, USGS, 2014
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI

Historic Resources

Of the 1,246 historic resources in Region 7, only 6 are in an area of high or very high liquefaction potential, all of them in Grant County. However, 1,074 (86%) of Region 7's historic resources are located in areas of high or very high potential for ground shaking amplification. Of these, roughly a quarter is located in each county.

Archaeological Resources

Six thousand eight hundred ten archaeological resources are located in earthquake hazard areas in Region 7. Of those, eight are located in an area of high earthquake hazards. None are listed on the National Register of Historic Places and only one is eligible for listing. One has been determined not eligible and six have not been evaluated as to their potential for listing. Most archaeological resources in earthquake hazard areas in Region 7 are located in Grant County, followed by Baker and Wallowa.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Wallowa County is the most vulnerable to earthquakes in Region 7, but only moderately vulnerable.

Seismic Lifelines

According to the Oregon Department of Transportation's (ODOT) Oregon Seismic Lifeline Report (OSLR; see **Appendix 9.1.14**), the projected impacts of a CSZ event are considered negligible in this part of the state. Therefore, this region was not part of the OSLR study. However, ODOT did provide the following descriptions of general impacts a CSZ would have on Region 8's seismic lifelines, and the region's overall vulnerability.

REGIONAL IMPACT. Within this region, adverse impacts from the CSZ event and secondary hazards (landslides, liquefaction, etc.) are not anticipated, but damage to I-84 to the west and damage to the Columbia River's freight functions could impact the region's economy.

REGIONAL LOSS ESTIMATES. Losses in this region are expected to be nonexistent to low locally. Economic disruption from major losses in the larger markets of the state will affect the economy in this region.

MOST VULNERABLE JURISDICTIONS. Vulnerability of this whole region to a CSZ event is low. Loss of life, property, and business are not expected to be issues in this area. However, impacts to import and export infrastructure and basic supply lines could have short- to mid-term economic impacts. With an intact surface transportation system to the east, adaptation is expected to be relatively easy.

Risk

Table 2-636. Assessment of Earthquake Risk in Region 7

	Baker	Grant	Wallowa	Union
Risk	M	VL	L	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the earthquake probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Wallowa County is at greatest risk from earthquakes in Region 7, but that risk is moderate.

Extreme Heat

Characteristics

Extreme temperatures are moderately common in Region 7. Wallowa County has an average of about 23 days per year above 90°F.

Historic Extreme Heat Events

Table 2-637. Historic Extreme Heat Events in Region 7

Date	Location	Notes
July 10–14, 2002	Region 5–7	A record breaking heat wave shattered many daily record high temperatures across the state, with a few locations breaking all-time records.
July 20-24, 2006	Region 1–3, 5, 7	An unusually strong ridge of high pressure brought several days of record breaking hot and humid weather to NW Oregon. Many cities in Oregon saw record-breaking daily high temperatures for multiple days in a row. Many daily maximums were between 10 and 20 degrees above normal. A few sites reported record high minimum temperatures during this very humid event; a couple broke all-time record high minimums as well. 4500 homes lost power during this event. In north central and eastern Oregon, daily maximum temperatures between 100 and 113 degrees were observed at lower elevations, with temperatures 90 to 100 degrees at elevations up to 4000 feet. Several people were treated for heat related illness.
June 28–30, 2008	Region 2, 3, 5, 7	An upper level ridge and thermal trough across the Pacific Northwest produced temperatures above 100 degrees for two consecutive days breaking records in many locations. Two people died of heat-related illness.
August 15–17, 2008	Region 5–7	Excessive Heat Event: An upper level ridge and dry air brought excessive heat into eastern Oregon. Many locations experienced multiple days of at least 100 degree temperatures.
July 25–26, 2010	Region 5, 7	Excessive Heat Event: Temperatures topped 100 degrees for two successive days in Hermiston, Pendleton, 5 miles northeast of Pendleton, Ione, Echo, Arlington, and Umatilla.

Source: https://www.ncdc.noaa.gov/stormevents

Probability

The relative probability of extreme heat was determined by dividing the counties by quintiles based on historic and projected future frequency of days with heat index above 90°F (as shown in **Figure 2-62**). Counties in the bottom quintile had the lowest frequency of days with heat index above 90°F relative to the rest of the state and were given a score of 1 meaning "very low." Region 7 relative probability rankings are shown in **Table 2-638**.

Table 2-638. Probability of Extreme Heat in Region 7

	Baker	Grant	Union	Wallowa
Probability	H	L	L	L

Source: Oregon Climate Change Research Institute, https://climatetoolbox.org/

Climate Change

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*). Region 7 experiences some extreme high temperatures and is projected to experience greater frequency of extreme temperatures under future climate change. **Table 2-639** lists the number of days exceeding the heat index of 90°F in the historical baseline and future mid-21st century period under RCP 8.5 for counties in Region 7.

Table 2-639. Annual Number of Days Exceeding Heat Index ≥ 90°F for Region 7 Counties

County	Historic Baseline	2050s Future
Baker	5	27
Grant	3	21
Union	3	20
Wallowa	4	21

Note: Numbers represent the multi-model mean from 18 CMIP5 climate models

Source: Oregon Climate Change Research Institute using data from the Northwest Climate Toolbox, https://climatetoolbox.org/.

Vulnerability

Vulnerability of Oregon counties to extreme heat is discussed in Section 2.2.1.3, Extreme Heat. Vulnerability is defined as the combination of sensitivity to extreme heat and level of adaptive capacity in response to extreme heat.

For this assessment, sensitivity to extreme heat events was defined using the Center for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index, https://svi.cdc.gov/data-and-tools-download.html.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

Adaptive capacity to extreme heat is defined here as percent of homes with air conditioning, however the authors note that this measure has its flaws. First, it assumes that people who have access to cooling systems are able to afford to use them. Second, the data only includes single-family homes, which omits populations living in multi-family housing or who are house-less.

Although extreme heat is moderately rare in Region 7 ("low" probability), many people may not be accustomed or prepared in terms of air conditioning when an extreme heat event occurs ("moderate" adaptive capacity). In Cooling Zones 1 and 2, which include Region 7 counties, just over half of single-family homes have air-conditioning (https://neea.org/img/uploads/Residential-Building-Stock-Assessment-II-Single-Family-Homes-Report-2016-2017.pdf).

The relative vulnerability of Oregon counties to extreme heat was determined by adding the rankings for sensitivity (social vulnerability) and adaptive capacity (air conditioning). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total vulnerability scores of 1–2 earned a ranking of 1 (very low); scores of 3–4 earned a ranking of 2 (low); scores of 5–6 earned a ranking of 3 (moderate); scores of 7–8 earned a ranking of 4 (high); and scores of 9–10 earned a ranking of 5 (very high). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-640 displays the total vulnerability rankings as well as ranking for sensitivity and adaptive capacity for each county in NHMP Region 7. Table 2-641 provides the summary descriptors of Region 7's vulnerability.

Combining sensitivity and adaptive capacity, Region 7's relative vulnerability to extreme heat is "Moderate." Grant County's is "Low." None of the counties in Region 7 are most vulnerable to extreme heat.

Table 2-640. Relative Vulnerability Rankings for Region 7 Counties

County	Sensitivity	Adaptive Capacity	Vulnerability
Region 7	**2**	**3**	**3**
Baker	2	3	3
Grant	1	3	2
Union	2	3	3
Wallowa	2	3	3

Source: Oregon Climate Change Research Institute

Table 2-641. Vulnerability to Extreme Heat in Region 7

	Baker	Grant	Union	Wallowa
Vulnerability	M	L	M	M

Source: Oregon Climate Change Research Institute

Risk

With respect to extreme heat, risk is defined as the combination of exposure to extreme heat events (probability), sensitivity to extreme heat, and level of adaptive capacity in response to extreme heat.

The total relative risk of Oregon counties to extreme heat was determined by adding the rankings for probability and vulnerability (sensitivity and adaptive capacity). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total risk scores of 1-2 earned a ranking of 1 ("very low"); scores of 3-4 earned a ranking of 2 ("low"); scores of 5-6 earned a ranking of 3 ("moderate"); scores of 7-8 earned a ranking of 4 ("high"); and scores of 9-10 earned a ranking of 5 ("very high"). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-642 displays the relative risk ranking as well as rankings for probability and vulnerability for each county in NHMP Region 7. Table 2-643 provides the summary descriptors of Region 7's risk to extreme heat.

Combining probability and vulnerability, Region 7's relative risk to extreme heat is "Moderate." Baker County's is "High."

Table 2-642. Risk Rankings for Region 7 Counties

County	Probability	Vulnerability	Risk
Region 7	**3**	**3**	**3**
Baker	4	3	4
Grant	2	2	2
Union	2	3	3
Wallowa	2	3	3

Source: Oregon Climate Change Research Institute

Table 2-643. Risk of Extreme Heat in Region 7

	Baker	Grant	Union	Wallowa
Risk	H	L	M	M

Source: Oregon Climate Change Research Institute

Floods

Characteristics

The Blue Mountain area of northeastern Oregon is quite distinct from the rest of the state in landform and climate. Nevertheless, its principal flood problems are similar to those found elsewhere in Oregon. The most damaging floods have occurred during the winter months, when warm rains from tropical latitudes melt mountain snow packs. Such conditions were especially noteworthy in February 1957, February 1963, December 1964, January 1965 and April 2019. Somewhat lesser flooding has been associated with ice jams, normal spring runoff, and summer thunderstorms. Heavily vegetated stream banks, low stream gradients (e.g., Grande Ronde Valley), and breeched dikes have contributed to past flooding at considerable economic cost. Region 7 counties also have experienced flooding associated with low bridge clearances, over-topped irrigation ditches, and natural stream constrictions such as Rhinehart Gorge between Elgin and Imbler in Union County.

Oregon's most severe flooding occurs between November and February and most floods are associated with a period of intense warm rain on a heavy mountain snow pack. These periods of flooding coincide with La Niña conditions during the winter months when very moist subtropical air follows a heavy, wet snowfall. Climate records indicate that La Niña conditions occur on average about every 3 to 6 years with the period from 1975-1994 having exhibited a long El Niño period.

The National Weather Service predicts that an ENSO-neutral condition is favored through Northern Hemisphere spring 2020 (~60% chance), continuing through summer 2020 (~50% chance). A historical overview of flooding in Oregon's Region 7 is shown in **Table 2-644**. Table 2 461 lists flood sources for each of the counties in the region.

All of the Region 7 counties have Flood Insurance Rate Maps (FIRMs); however, old maps do not reflect present flood conditions. The most recent FIRMs are as follows:

- Baker, June 3, 1988;
- Grant, May 18, 1982;
- Union, April 3, 1996; and
- Wallowa, February 17, 1988.

Updated lidar is anticipated for Grant County during 2020.

Historic Flood Events

Table 2-644. Significant Historic Floods Affecting Region 7

Date	Location	Description	Type of Flood
1894*	NE Oregon	widespread flooding	not recorded
1910*	NE Oregon	widespread flooding	not recorded
1917*	NE Oregon	widespread flooding	not recorded
1932*	NE Oregon	widespread flooding	not recorded
1935*	NE Oregon	widespread flooding	not recorded
May 1948	Columbia Basin / NE Oregon	unusually large mountain snow melt produced widespread flooding	snow melt

Date	Location	Description	Type of Flood
Dec. 1955 – Jan. 1956	Snake and Columbia basins	warm rain melted snow; runoff on frozen ground	rain on snow
Dec. 1964	entire state	widespread, very destructive flooding; warm rain, melted snow; runoff on frozen ground	rain on snow
Jan. 1974	much of state	warm rain / melted snow / runoff on frozen ground	rain on snow
Feb. 1986	entire state	warm rain / melted snow / runoff on frozen ground	rain on snow
June 1986	Wallowa County	severe thunderstorm / rain and hail / flash flooding	thunderstorm
May 1991	Union and Baker Counties	warm rain / melted snow; considerable damage to cropland and highways; a number of bridges destroyed	rain on snow
May 1998	eastern and central Oregon	persistent rains; widespread damage	rain on snow
July 2004	Union	$5,000 in property damage	
May 2008	Union and Wallowa Counties	flooding along Catherine Creek and Grande Ronde River damaged roads in Union County, causing $30,000 in damages; in Wallowa County the Imnaha River crested above flood stage	rain on snow
May 2011	Grant and Union Counties	heavy rainfall on above-average snowpack caused flooding to low lying areas of Grant and Union Counties; over $2.6 in property damage	rain on snow
March 2014	Union and Grant Counties	Heavy rain fell across much of the northern Blue Mountains and Wallowa County throughout the first week of March. March 9th received very heavy rain with snow levels around 6000ft. This allowed for a significant increase in runoff, which lead to a quick rise in rivers for the period	rain on snow
March 2017	Wallowa County	An extended period of snow melt, combined with a period of heavy rain, caused an extended period of flooding along portions of the Grande Ronde River.	rain on snow
May 2017	Wallowa County	Two hikers were injured in the flash flood. In Wallowa County the Imnaha River at Imnaha had minor flooding early on May 6th, due to snow melt.	flash flood
Sept. 2017	Baker County	Thunderstorms producing heavy rain over the 2016 Rail Fire burned area on the Wallowa-Whitman National Forest resulted in flash flooding and debris flows.	flood after fire
May 2018	Grant and Wallowa Counties	Heavy rain from slow moving thunderstorms caused rock slides and water on roadways within an area that includes Mount Vernon, John Day and Canyon City	flash flood
June 2018	Baker County	Thunderstorms with heavy rainfall developed over Southwest Baker County, Oregon on June 20th, leading to flash flooding and debris flow on the Rail and Cornet-Windy Ridge fires burn scar areas.	flood after fire

Date	Location	Description	Type of Flood
April 2019	Union, Grant, and Wallowa Counties	Snow water equivalents near 200% of normal in the Blue Mountains coupled with warm temperatures and near record rainfall totals for April produced significant river flooding across eastern Oregon. Disaster declared in Grant county (DR-4452)	rain on snow

Source: Taylor and Hatton (1999); FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88; 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; NOAA Storm Event Database, available from https://www.ncdc.noaa.gov/stormevents/ consulted January 2020

Table 2-645. Principal Flood Sources by County in Region 7

Baker County	Grant County	Union County	Wallowa County
Powder River	North Fork John Day River	Grande Ronde River	Wallowa River
Old Settler's Slough	South Fork John Day River	Catherine Creek	Minam River
Pine Creek	Middle Fork John Day River	North Powder River	Lostine River
Eagle Creek	Canyon Creek	Little Creek	Grande Ronde River
Summit Creek	Cottonwood Creek	Gekeler Slough	Wenaha River
Rock Creek	Prairie Creek	Taylor Creek	Imnaha River
Mill Creek		Fresno Creek	Hurricane Creek
Marble Creek		Clark Creek	Prairie Creek
Stices Gulch		Indian Creek	
Snake River		Wolf Creek	
Burnt River			

Sources: FEMA, Baker County Flood Insurance Study (FIS), 06/03/88; FEMA, Grant County Flood Insurance Study (FIS) 05/18/82; FEMA, Union County Flood Insurance Study (FIS), 04/03/96; FEMA, Wallowa County Flood Insurance Study (FIS), 02/17/88.

Probability, Vulnerability, and Risk

Different methods are used to assess probability and vulnerability at local and state levels. These methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. 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. A description of the "OEM Hazard Analysis Methodology" used by local governments is provided in Section 2.1, **Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.17**.

The purpose of the probability and vulnerability scores is to identify high-priority areas to which local and state governments can target mitigation actions.

Probability

Local Assessment

Participants in each county's Natural Hazard Mitigation Plan update process used the OEM hazard analysis methodology to analyze the probability that Region 7 will experience flooding. The resulting estimates of probability are shown in **Table 2-646**.

Table 2-646. Local Assessment of Flood Probability in Region 7

	Baker	Grant	Union	Wallowa
Probability	H	H	H	H

Note: Assessment of flood probability for Grant and Baker Counties date from meetings held in 2019 during the NHMP update process. Assessments for Wallowa and Union county date from the 2014 Northeast Oregon Multi-Jurisdictional NHMP

Source: Oregon Office of Emergency Management, 2019 County Hazard Analysis Scores or *2014 County Hazard Analysis

State Assessment

Using the methodology described in Section **2.2.5.2**, Floods > Probability, the state assessed the probability of flooding in the counties that comprise Region 7.

Table 2-647. State Assessment of Flood Probability in Region 7

	Baker	Grant	Union	Wallowa
Probability	M	H	L	H

Source: DOGAMI

Climate Change

It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence). The likelihood of increase in extreme precipitation events is greater east of Cascades than west. Extreme river flow, while affected by extreme precipitation, is also driven by antecedent conditions (soil moisture, water table height), snowmelt, river network morphology, and spatial variability in precipitation and snowmelt. Most projections of extreme river flows show increases in flow magnitude at most locations across Oregon. Overall, it is more likely than not (>50%) that increases in extreme river flows will lead to an increase in the incidence and magnitude of damaging floods (low confidence), although this depends on local conditions (site-dependent river channel and floodplain hydraulics). Increases in extreme river flows leading to damaging floods will be less likely where storm water management (urban) and/or reservoir operations (river) have capacity to offset increases in flood peak.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by participants in the NHMP update process, the region's vulnerability to flooding is shown in **Table 2-648**.

Table 2-648. Local Assessment of Vulnerability to Flood in Region 7

	Baker	Grant	Union	Wallowa
Vulnerability	M	H	H	M

Note: Assessment of flood probability for Grant and Baker Counties date from meetings held in 2019 during the NHMP update process. Assessments for Wallowa and Union county date from the 2014 Northeast Oregon Multi-Jurisdictional NHMP.

Source: Oregon Office of Emergency Management, 2019 County Hazard Analysis Scores; 2014 County Hazard Analyses

State Assessment

Table 2-649. State Assessment of Vulnerability to Flood in Region 7

	Baker	Grant	Union	Wallowa
Vulnerability	VL	M	VL	L

Source: DOGAMI, DLCD

An exposure analysis performed by DOGAMI was conducted in Grant and Baker Counties by overlaying building locations on the 100-year flood extent. A large number (223 buildings) of Baker County's buildings were found to be within designated flood zones, 219 of which are located in Baker City. Similarly a large number (703 buildings) of Grant County's buildings were found to be within designated flood zones. By comparing the number of non-damaged buildings from Hazus-MH with exposed buildings in the flood zone, DOGAMI estimated the number of buildings that could be elevated above the level of flooding.

In Baker County of the 223 buildings that are exposed to flooding, DOGAMI estimate that 98 are above the height of the 100-year flood. In Grant County, DOGAMI estimated that 215 of the 703 buildings were elevated above the height of the 100-year.

This evaluation can also shed some light on the number of residents that might have mobility or access issues due to surrounding water.

The DOGAMI Risk Assessment and exposure analysis found that several of Grant County's critical facilities are at risk to flood hazard. None of Baker County's critical facilities are exposed to flooding hazards. The DOGAMI report for Grant County estimated that 18% of that county's 39 critical facilities area at risk to be non-functioning due to a 100-year flood. These include the following: Grant Union High School, Grant County Road Department, Oregon Dept. of Transportation, John Day Radio Station KJDY, Oregon Dept. of Forestry, Oregon Trail Electric Co-op, and the USFS Malheur District Office.

While similarly detailed information has not yet been developed for Union and Wallowa Counties, the state has determined that there are 22 state-owned or –leased facilities with a total value over $1.1 million and four local critical facilities with a total value of almost $5 million located in high flood hazard areas in Union County. They include a private school (K-7), and the City of La Grande's water treatment facility. In Wallowa County there are six state-owned or –leased facilities with a total value of over $1.4 million, mostly associated with state parks, and one local critical facility, an elementary school, with a value of almost $400,000 located in high flood hazard areas.

Repetitive Losses

FEMA has identified two Repetitive Loss properties in Region 7 (FEMA NFIP Community Information System, https://isource.fema.gov/cis/, accessed 02/12/2020).

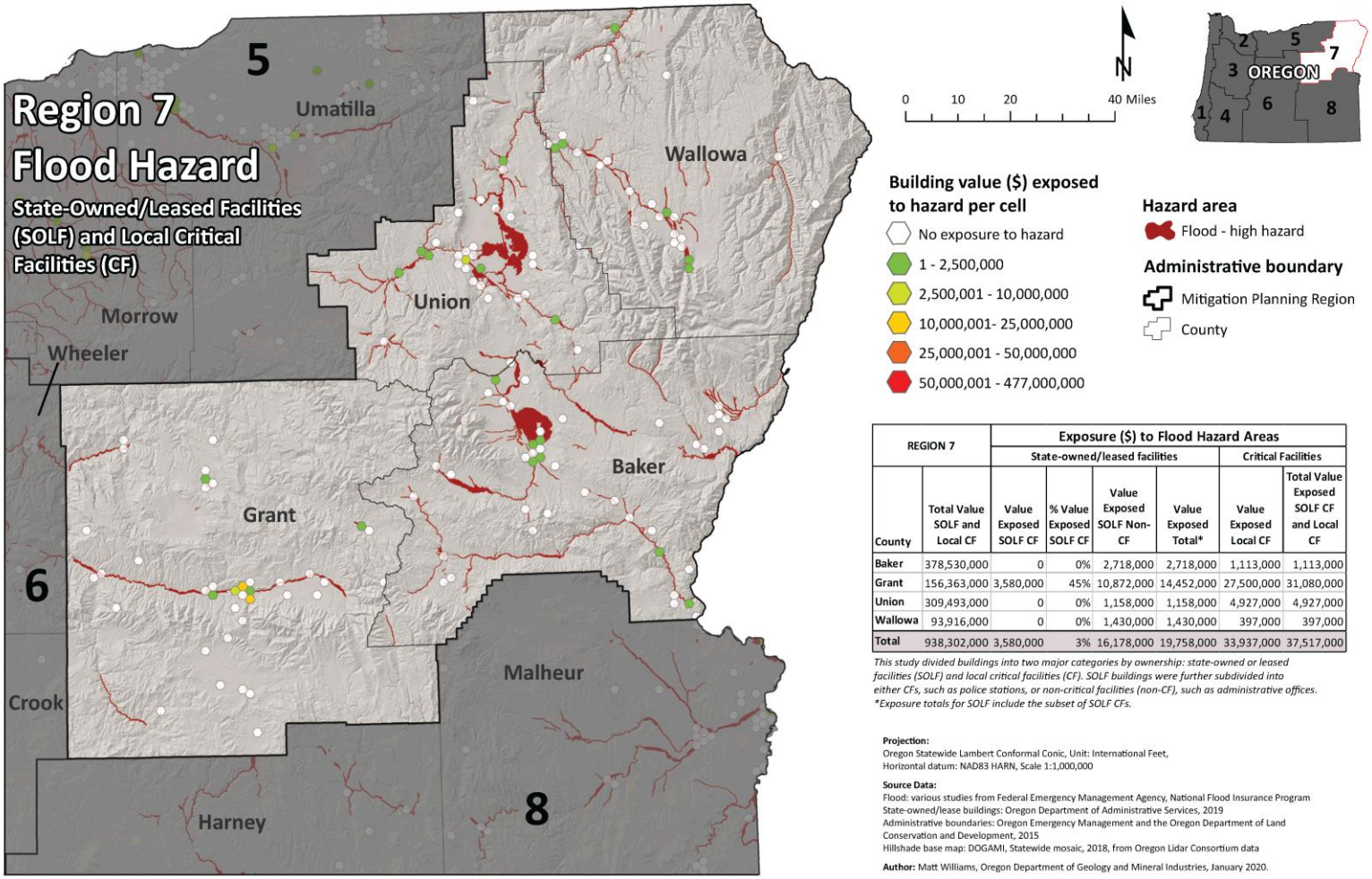
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS) Program, which results in reduced flood insurance costs. No Region 7 communities participate in the CRS Program.

State-Owned/Leased Facilities and Critical/Essential Facilities

For the 2020 Risk Assessment, DOGAMI used a combination of FEMA effective and preliminary flood zone data (FEMA National Flood Hazard Layer, 2019) and FEMA Q3 data (an unpublished digital dataset of paper flood insurance rate maps). All FEMA data that DOGAMI used was current as of 2019. The flood hazard was not divided in to High, Moderate, or Low categories due to the wide variety of flood data, its variable absolute and relative accuracy, and its variable geographic coverage and completeness. Rather, when a building was located within a floodway, 100-year floodplain, or 500-year floodplain, a "High" flood hazard was designated. When there was insufficient information to determine whether a flood hazard exists for a given site, the flood hazard was designated "Other." Sites with "Other" designations could conceivably face relatively high flood hazards or no flood hazard at all.

In Region 7, there is a potential loss from flooding of almost $20M in state building and critical facility assets, 73% of it in Grant County alone. There is a potential loss due to flood of almost twice that much, about $34M, in local critical facilities. Eighty-one percent of that value is in Grant County. **Figure 2-278** illustrates the potential loss to state buildings and critical facilities and local critical facilities from flooding.

Figure 2-278. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in Region 7.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 7		Exposure ($) to Flood Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Baker	378,530,000	0	0%	2,718,000	2,718,000	1,113,000	1,113,000
Grant	156,363,000	3,580,000	45%	10,872,000	14,452,000	27,500,000	31,080,000
Union	309,493,000	0	0%	1,158,000	1,158,000	4,927,000	4,927,000
Wallowa	93,916,000	0	0%	1,430,000	1,430,000	397,000	397,000
Total	938,302,000	3,580,000	3%	16,178,000	19,758,000	33,937,000	37,517,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Flood: various studies from Federal Emergency Management Agency, National Flood Insurance Program
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI, 2020

Historic Resources

Of the 1,246 historic resources in Region 7, fifty-six (4%) are located in an area of high flood hazard. Of those, 35 (63%) are located in Grant County. The next greatest share, 27%, is in Union County.

Archaeological Resources

Of the 188 archaeological resources located in high flood hazard areas in Region 7, eighty-seven percent (163) are located in Baker and Union Counties together, close to half in each county. Only two are listed on the National Register of Historic Places, one in Grant County and one in Union County. Twenty-two are eligible for listing; about half of those are in Union County. Eleven have been determined not eligible for listing and 153 have not been evaluated as to their eligibility.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Grant County, with moderate vulnerability, is the most vulnerable to flooding in Region 7. All the counties have very low or low social vulnerability; Grant County's moderate rating is driven by the large value of state buildings, state critical facilities, and local critical facilities. Grant County also has a large amount of historic resources vulnerable to flooding.

Most Vulnerable Communities

Grant County is the most vulnerable to flood hazards in Region 7.

Risk

Table 2-650. Risk of Flood Hazards in in Region 7

	Baker	Grant	Union	Wallowa
Risk	VL	H	VL	M

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, in Region 7 only Grant County is at high risk from flood events.

Dam Safety

The Oregon Water Resources Department (OWRD) is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were re-written by HB 2085 which passed through the legislature and was signed by Governor Brown in 2019. This law becomes operative on July 1, 2020, with rules and guidance have been drafted and are currently in the public review and comment period.

OWRD coordinates on but does not directly regulate the safety of dams owned by the United States or most dams used to generate hydropower. OWRD is the Oregon Emergency Response System contact in the event of a major emergency involving a state-regulated dam, or any dam in the State if the regulating agency is unknown. The Program also coordinates with the National Weather Service and the Oregon Office of Emergency Management on severe flood potential that could affect dams and other infrastructure.

Analysis and Characterization

Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons. Many dams that fall below this threshold have water right permits for storage from OWRD.

Under normal loading conditions dams are generally at very low risk of failure. Specific events are associated with most dam failures. Events that might cause dams to fail include:

- An extreme flood that exceeds spillway capacity and causes an earthen dam to fail;
- Extended high water levels in a dam that has no protection against internal erosion;
- Movement of the dam in an earthquake; and
- A large rapidly moving landslide impacting the dam or reservoir.

Most of the largest dams, especially those owned or regulated by the Federal Government are designed to safely withstand these events and have been analyzed to show that they will. However, there are a number of dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events. The large majority of state regulated dams do not have a current risk assessment or analysis, and safe performance in these events is uncertain.

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to waters below the dam and the owners property to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure, and resulted in over 2000 lives lost. Oregon's first dam safety laws were developed in response to the St. Francis dam failure in California in 1928. That failure was attributed to unsafe design practice, and because of this about 500 persons perished. In modern times (2006) a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed 7 people. This dam had no recent dam safety inspections because the hazard rating was incorrect.

Where a dam's failure is expected to result in loss of life downstream of the dam, an Emergency Action Plan (EAP) must be developed. The EAP contains a map showing the area that would potentially be inundated by floodwaters from the failed dam. These dams are often monitored

so that conditions that pose a potential for dam failure are identified to allow for emergency evacuations.

Table 2-651. Historic Significant Dam Failures in Region 7

Year	Location	Description
1896	Goodrich dam west of Baker City in Baker Co.	Flood wave killed entire family of 7
1917	Killamacue dam west of Haines in Baker Co.	Property damaged
1937	Spaulding Vaughn dam in Baker Co.	Property damaged
1956	Goodrich dam west of Baker City in Baker Co.	Property damaged in the second failure of a dam at this site

Source: Oregon Water Resources Department Dam Safety Program records

Dam Hazard Ratings

Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The state has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.
- "Low Hazard" is assigned to all other state-regulated dams.
- "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

Hazard ratings may change for a number of reasons. For example, a dam's original rating may not have been based on current inundation analysis methodologies, or new development may have changed potential downstream impacts.

There are 12 High Hazard dams and 11 Significant Hazard dams in Region 7.

Table 2-652. Summary: High Hazard and Significant Hazard Dams in Region 7

	Hazard Rating		
	State		Federal
	High	Significant	High
Region 7	5	11	7
Baker	0	8	5
Grant	0	0	1
Union	4	3	0
Wallowa	1	0	1

Source: Oregon Water Resources Department, 2019

Table 2-653. High Hazard and Significant Hazard Dams in Region 7

County	Name	Rating	Regulator
Baker	Brownlee Dam	High	Federal
Baker	Mason Dam	High	Federal
Baker	Oxbow Hydro Dam	High	Federal
Baker	Thief Valley Reservoir	High	Federal
Baker	Unity Reservoir	High	Federal
Baker	Balm Creek Reservoir	Significant	State
Baker	Camp Creek Reservoir (Baker)	Significant	State
Baker	Clear Creek Reservoir-West Fork	Significant	State
Baker	Goodrich Reservoir	Significant	State
Baker	Killamacue Reservoir	Significant	State
Baker	Love Reservoir (Baker)	Significant	State
Baker	Salmon Creek Reservoir	Significant	State
Baker	Whited Reservoir (Baker)	Significant	State
Grant	Olive Lake	High	Federal
Union	Jubilee Lake	High	State
Union	Morgan Lake	High	State
Union	Pilcher Creek	High	State
Union	Wolf Creek	High	State
Union	Elgin Mill Trmt. Lagoon #2	Significant	State
Union	Jimmy Creek Reservoir	Significant	State
Union	Little Park Dam	Significant	State
Wallowa	Hells Canyon Dam	High	Federal
Wallowa	Wallowa Lake	High	State

Source: Oregon Water Resources Department, 2019

Probability

Engineering risk assessment and analysis of a dam is the best indicator of the probability of failure. Without that, the condition of a dam as determined by OWRD engineering staff is a helpful indicator OWRD has for of the failure potential of a dam.

Dam safety regulators determine the condition of high hazard rated dams, both state- and federally-regulated. A dam's condition is considered public information for state-regulated dams, but the conditions of federally-regulated dams are generally not subject to disclosure. State-regulated significant hazard dams do not yet have condition ratings.

Oregon uses FEMA's condition classifications. These classifications are subject to change and revisions are being considered at the national level. Currently, FEMA's condition classifications are:

- "Satisfactory" means no existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.

- "Fair" means no existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
- "Poor" means a dam safety deficiency is recognized for loading conditions that may realistically occur. Remedial action is necessary. A poor rating may also be used when uncertainties exist as to critical analysis parameters that identify a potential dam safety deficiency. Further investigations and studies are necessary.
- "Unsatisfactory" means a dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
- "Not Rated" means the dam has not been inspected, is not under State jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Only two of the five state-regulated high hazard dams are in satisfactory condition; three are in poor condition.

Table 2-654. Summary: Condition of High Hazard State-Regulated Dams in Region 7

	Condition of State-Regulated High Hazard Dams				
	Satisfactory	Fair	Poor	Unsatisfactory	Not Rated
Region 7	2	0	3	0	0
Baker	0	0	0	0	0
Grant	0	0	0	0	0
Union	2	0	2	0	0
Wallowa	0	0	1	0	0

Source: Oregon Water Resources Department, 2019

Table 2-655. Condition of High Hazard State-Regulated Dams in Region 7

County	Dam Name	Condition
Union	Jubilee Lake	Poor
Union	Morgan Lake	Poor
Union	Pilcher Creek	Satisfactory
Union	Wolf Creek	Satisfactory
Wallowa	Wallowa Lake	Poor

Source: Oregon Water Resources Department, 2019

State-Regulated High Hazard Dams not Meeting Safety Standards

There are three state-regulated high hazard dams in Region 7 that are currently assessed to be below accepted safety standards (in Poor or Unsatisfactory Condition). These dams and the population at risk, based on a screen using the screening tool DSS-WISE, are shown in **Table 2-656**. As the dam safety program conducts analysis over time, the number of dams in less than satisfactory condition may change. Currently dams that are in poor or unsatisfactory condition are in need of rehabilitation or other action to bring them into a fully safe condition. As of December 2019, these are the dams in Region 7 that are not yet demonstrably unsafe, but that do pose unacceptable risk. When Oregon's new dam safety laws take effect July 1, 2020, the condition of some of these dams may be reclassified as unsafe or potentially unsafe.

It is important to note that many state regulated dams have not received a deep level of risk analysis and review, so the number of dams not meeting minimum standards may increase as additional analyses are performed.

Table 2-656. State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 7

Dam	NID#	Condition Rating	Daytime PAR (number of people)	Nighttime PAR (number of people)	County
Jubilee Lake		POOR	Small	Small	Union
Morgan Lake Dam	OR00653	POOR	11,128	6,362	Union
Wallowa Lake (Top of Dam)	OR00465	POOR	1,131	1,334	Wallowa

Note: "PAR" is number of "Persons At Risk" in the dam failure inundation zone based on a conservative estimate using DSS-Wise dam breach estimator. It includes all persons that normally could be in the inundation area. Actual impacts depend on the velocity and depth of water, and will be determined as part of Oregon's HHPD grant tasks.

Source: DSS-Wise output

Climate Change

Most climate change models indicate there may be more extreme precipitation due to the increased energy in the oceanic and atmospheric systems. Of main concerns for dams is the potential for larger floods than experienced in the past. Almost half of the historical dam failures around the world have been due the floods that exceed the flow capacity of the spillway and overtop the dam. Another issue for the Pacific coast is the shorter record of precipitation and flood events in the data records. Even without climate change there is uncertainty in the extreme storms that could occur in an extreme atmospheric river event (about which there is much to learn). If the actual flood is larger than the design flood, spillway capacity may be exceeded and the dam may overtop, or the spillway may erode so that it can rapidly empty the reservoir. These scenarios can present real risks to some dams in Oregon, risks that depending on the location may be greater than earthquake related risks.

Vulnerability

Table 2-656, State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 7, indicates the number of people currently anticipated to be impacted by potential failure of the state-regulated high hazard dams in poor or unsatisfactory condition. OWRD plans to do more analysis to determine the number and value of structures that may be impacted as well.

Most Vulnerable Communities

Given the information presented about state-regulated high hazard dams (county and condition; failure expected to result in loss of life) and significant hazard dams (county; failure expected to result in extensive property or infrastructure damage), Union and Wallowa Counties in Region 7 have high hazard dams in poor or unsatisfactory condition are therefore considered most vulnerable. Of those, by far the greatest number of people in potentially dangerous locations if a dam were to fail are in Union County.

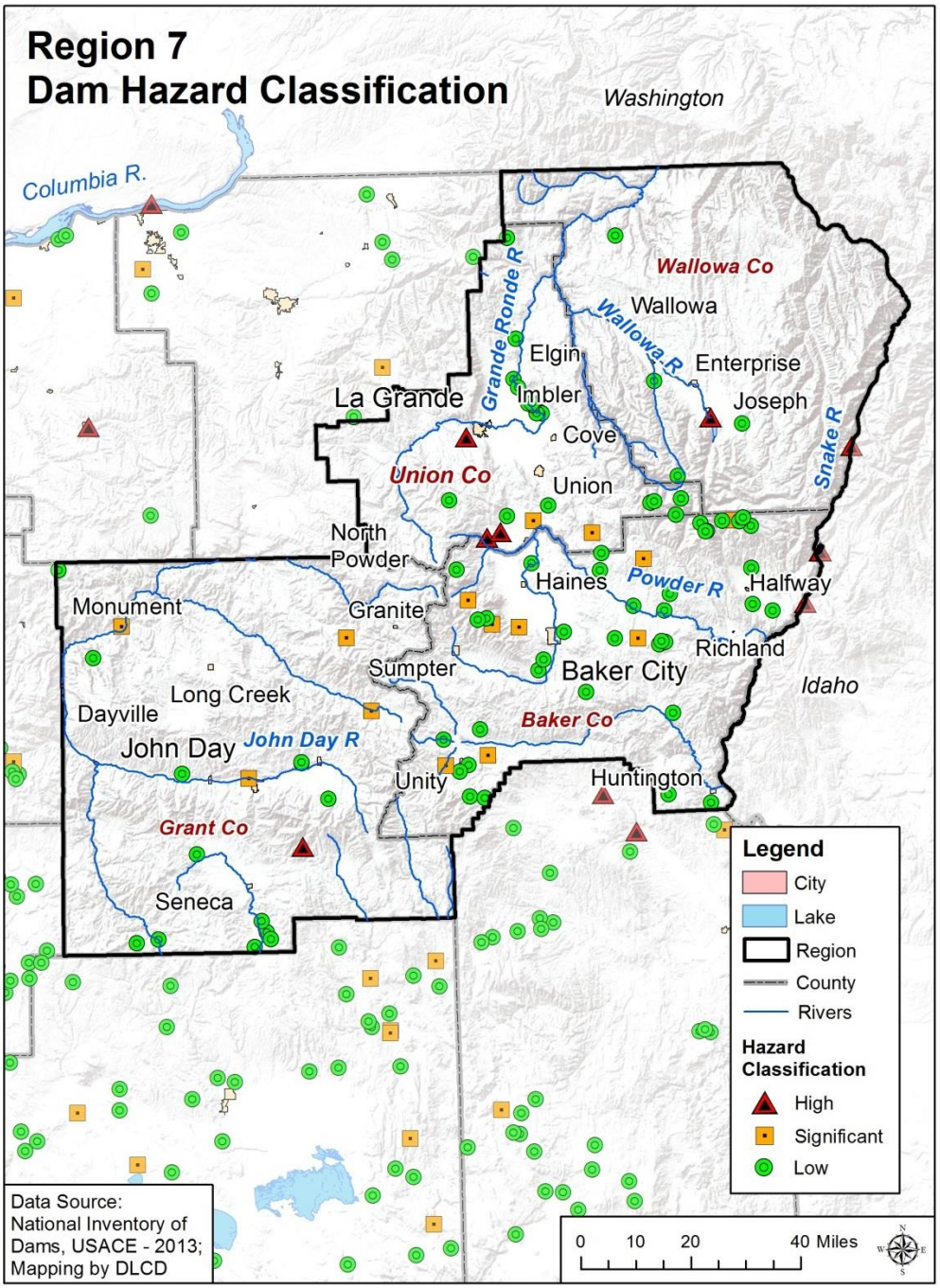
As with high hazard dams, whether counties with significant hazard dams are actually "most vulnerable communities" depends on the conditions of those dams. Since the dams' conditions have not yet been rated, we cannot determine the counties' vulnerability with respect to

significant hazard dams. The county with the most state-regulated significant hazard dams is Baker County (8).

Risk

With FEMA and State funding, OWRD will be completing risk assessments for two of Region 7's state-regulated high hazard dams in poor or unsatisfactory condition over the next several years. For now, the potential for damage to the dam from extreme floods, lack of protection against internal erosion, earthquakes, or landslides and debris indicates greater potential for failure. Coupled with the potential for loss of life and extensive damage to property and public infrastructure, risk is qualitatively determined.

Figure 2-279. Region 7 Dam Hazard Classification



Source: National Inventory of Dams, USACE, 2013

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Blue Mountains and Wallowa Mountains have a moderate to high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

Landslides occur throughout Region 7 but to a much lesser extent than in western Oregon. In general, northeastern Oregon soil profiles are shallow and rainfall is less frequent and intense than in the western portion of the state. Most Region 7 landslides occur within the I-84 corridor, OR-82 (Union County), OR-86 (Baker County), OR-19 (Grant County), and OR-3 (Wallowa County). Notable slides include the 1984 Hole-in-the-Wall slide, which dammed the Powder River in Baker County, and the often-troublesome Whopper Slide near Elgin in Union County. In 1928, two people were killed in a landslide while working on a railroad near Baker City.

Historic Landslide Events

Table 2-657. Significant Landslides in Region 7

Date	Location	Description
1928	Near Baker City, Oregon	Two people lost their lives in a landslide while working on the railroad
Dec. 1964	Baker, Grant, Union, and Wallowa Counties	DR-184
Jan. 1974	Wallowa County	DR-413
1984	Baker County, Oregon	Hole-in-the-Wall slide dammed the Powder River
Feb. 1996	Union and Wallow Counties	DR-1099
Dec. 1996-Jan. 1997	Wallowa County	DR-1160
May 2003	Grant County, Oregon	Property damage: $1,000
Dec. 2003-Jan.2004	Baker, Grant, Union, and Wallowa Counties	DR-1510
Apr. 2019	Grant County	DR-4452

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; FEMA, https://www.fema.gov/disasters

Probability

Table 2-658. Assessment of Landslide Probability in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	VH

Source: DOGAMI, 2020

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

Climate Change

Landslides are often triggered by heavy rainfall events when the soil becomes saturated. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events (*high confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

Vulnerability

Table 2-659. Assessment of Vulnerability to Landslides in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	VL	VL	VL	L

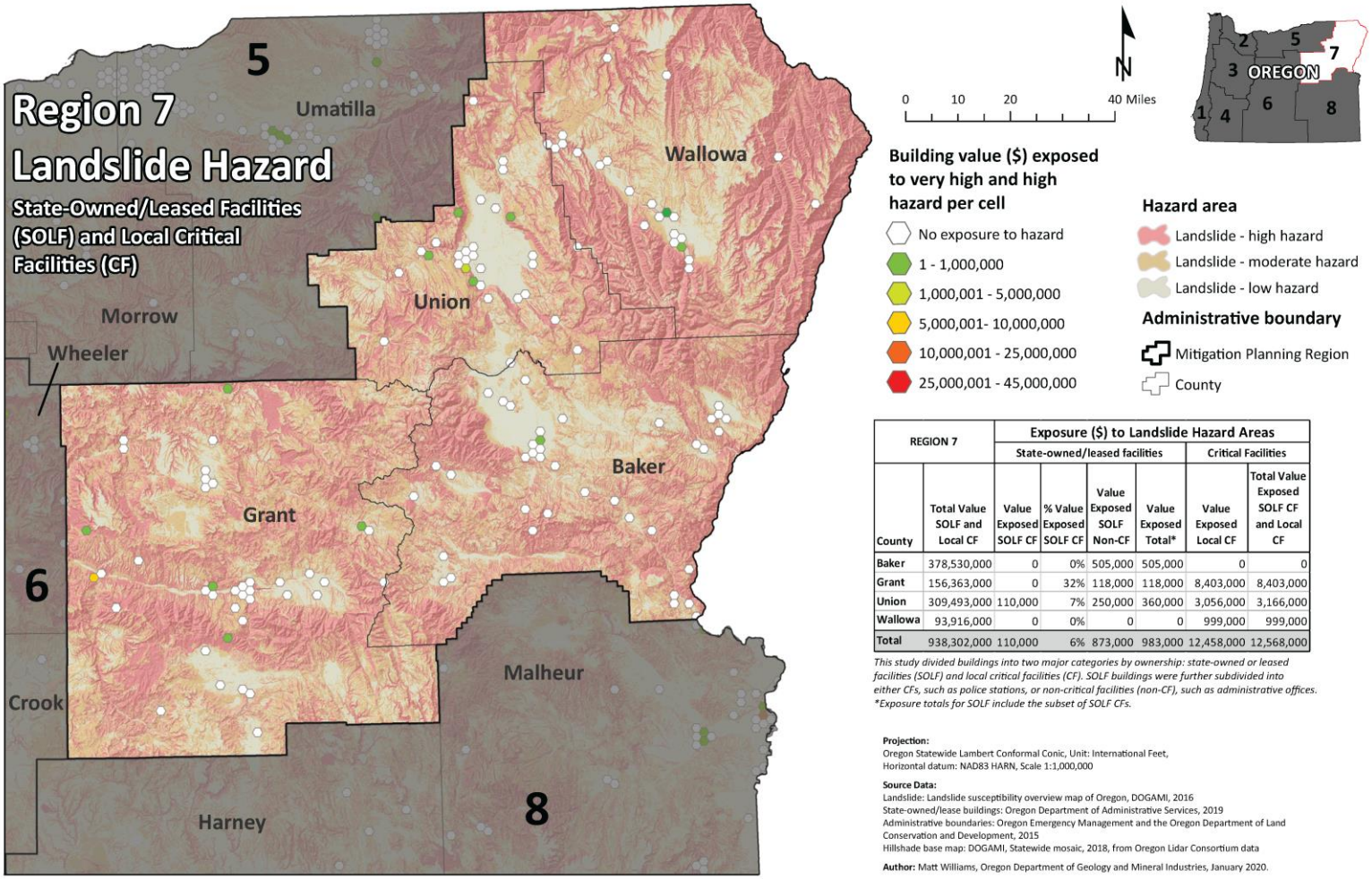
Source: DOGAMI and DLCD, 2020

Although there are fewer historic landslides in this region than most others, the SLIDO-2 landslide inventory indicates a moderate to high hazard. Baker, Union, and Grant Counties all have approximately 500 mapped landslides in SLIDO-2. The communities located in areas of steeper slopes will likely have the highest vulnerability.

State-Owned/Leased Facilities and Critical and Essential Facilities

DOGAMI analyzed the potential dollar loss from landslide hazards to state buildings and critical facilities as well as to local critical facilities in Region 7. Almost $1M in value is exposed to landslide hazards in Region 7, most of it in Baker County followed by Union County. However, the region has local critical facility assets of over $12M at risk of loss to landslides, about two-thirds of it in Grant County and about a quarter of it in Union County. Baker County has none. **Figure 2-280** illustrates the potential loss to state buildings and critical facilities and local critical facilities from landslide hazards.

Figure 2-280. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Landslide Hazard Zone in Region 7.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 7		Exposure ($) to Landslide Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Baker	378,530,000	0	0%	505,000	505,000	0	0
Grant	156,363,000	0	32%	118,000	118,000	8,403,000	8,403,000
Union	309,493,000	110,000	7%	250,000	360,000	3,056,000	3,166,000
Wallowa	93,916,000	0	0%	0	0	999,000	999,000
Total	938,302,000	110,000	6%	873,000	983,000	12,458,000	12,568,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Landslide: Landslide susceptibility overview map of Oregon, DOGAMI, 2016
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI, 2020

Historic Resources

In addition, all of the 1,246 historic resources in Region 7 are exposed to landslide hazards: 35 are in an area of very high or high landslide hazard susceptibility; 196 in moderate; and 1,015 in low. Twenty-nine (83%) of the 35 historic resources exposed to high or very high landslide hazards and 146 of the 196 (74%) exposed to moderate landslide hazards are in Grant County. The number of historic resources in Region 7 overall are distributed fairly evenly among the counties, with Union County having slightly more and Baker County slightly fewer.

Archaeological Resources

Of the 3,849 archaeological resources located in landslide hazard areas in Region 7, seventy-three percent (2,813) are in high landslide hazard areas. Of those, 156 are listed on the National Register of Historic Places and 554 are eligible for listing. Ninety-three have been determined not eligible, and 2,010 have not been evaluated as to their eligibility. Baker, Grant, and Wallowa Counties each have in the neighborhood of 30-35% of the archaeological resources in high landslide hazard areas; only about 5% are located in Union County. Overall, the number of archaeological resources in landslide hazard areas in Region 7 are fairly evenly distributed among Baker, Grant, and Wallowa Counties; only about 6% are located in Union County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Baker, Grant, and Union Counties have very low vulnerability while Wallowa is somewhat more vulnerable with a score of low vulnerability.

Risk

Table 2-660. Assessment of Risk to Landslides in Region 7

	Baker	Grant	Union	Wallowa
Risk	M	L	M	H

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment methodology combined the probability of landslide hazards occurring with the potential cost of damage to exposed state buildings and state and local critical facilities and with an assessment of the social vulnerability of the local population.

According to the 2020 Risk Scores and DOGAMI's expert assessment, Wallowa County is the "most vulnerable community" in Region 7.

Volcanoes

Characteristics

The volcanic Cascade Range is not within Region 7 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is considered nil. However, there is some risk from volcanic ash. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, during the May 1980, Mount St. Helens eruption, the cities of Yakima and Spokane, Washington, 80 and 160 miles away, respectively, were inundated with ash. Ash can reduce visibility to zero and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery.

Ashfall is largely controlled by the prevailing wind direction. The predominant wind direction over the Cascade Range is from west to east. Previous eruptions documented in the geologic record indicate most ashfall drifting to and settling in areas east of the Cascade volcanoes.

Historic Volcanic Events

Table 2-661. Historic Volcanic Events in Region 7

Date	Location	Description
May 1980	northeast Oregon	trace amounts of ashfall from Mount St. Helens

Source: Reports of local geologists present in northeast Oregon in May of 1980.

Probability

Table 2-662. Assessment of Volcanic Hazards Probability in Region 7

	Baker	Grant	Union	Wallowa
Probability	L	L	L	L

Source: DOGAMI, 2020

Mount St. Helens remains a probable source of airborne ash. It has repeatedly produced voluminous amounts of this material and has erupted much more frequently in recent geologic time than any other Cascade volcano. It blanketed Yakima and Spokane, Washington during the 1980 eruption and again in 2004.

The eruptive history of the Cascade volcanoes can be traced to late Pleistocene times (approximately 700,000 years ago) and will no doubt continue. But the central question remains: When? The most recent series of events at Newberry Volcano, which occurred about 1,300 years ago, consisted of lava flows and ashfall. Newberry Volcano's recent history also includes pyroclastic flows and numerous lava flows. Volcanoes in the Three Sisters region, such as Middle and South Sister, and at Crater Lake have also erupted explosively in the past. These eruptions have produced pyroclastic flows, lava flows, lahars, debris avalanches, and ash. Any future eruptions at these volcanoes would most likely resemble those that have occurred in the past.

Geoscientists have provided some estimates of future activity in the vicinity of Newberry Caldera and its adjacent areas. They estimate a 1 in 3,000 chance that some activity will take place in a 30-year period. The estimate for activity at Crater Lake for the same time period is significantly smaller at 0.003 to 0.0003. In the Three Sisters region, the probability of future activity is roughly 1 in 10,000 but any restlessness would greatly increase this estimate.

The location, size, and shape of the area affected by ash are determined by the vigor and duration of the eruption and the wind direction. Because wind direction and velocity vary with both time and altitude, it is impossible to predict the direction and speed of ash transport more than a few hours in advance (Walder et al., 1999). Mount St. Helens is about 250 air miles from the City of Enterprise (Wallowa County), consequently placing that community at risk. Mount Jefferson, located about 150 miles west of the City of John Day, is a possible but unlikely source. The annual probability of 1 cm or more of ash accumulation within the Region 7 counties, from any Cascade volcano, is about 1 in 5,000 (Sherrod et al., 1997).

Vulnerability

Table 2-663. Assessment of Vulnerability to Volcanic Hazards in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	VL	VL	VL	VL

Source: DOGAMI and DLCD, 2020

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

DOGAMI analyzed the potential dollar loss from volcanic hazards to state-owned and –leased buildings and critical facilities as well as to local critical facilities in Region 7. No state buildings, state or local critical facilities are located in volcanic hazard areas.

Historic Resources

None of the 1,246 historic buildings in Region 7 are exposed to volcanic hazards. See Appendix X for details.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

Most of the region's people and infrastructure are located in the major cities along I-84, US-26, and US-395. The communities most vulnerable to volcano-related hazards in the region are La Grande, Baker City, and John Day. The social vulnerability scores are low for Baker, Union, and Wallowa Counties; very low for Grant County.

Risk

Table 2-664. Assessment of Risk to Volcanic Hazards in Region 7

	Baker	Grant	Wallowa	Union
Risk	VL	VL	VL	VL

Source: DOGAMI and DLCD, 2020

According to the 2020 risk scores, none of the communities identified by DOGAMI as being most vulnerable to volcano hazards are located in Region 7. All communities in Region 7 have very low (VL) risk ratings.

The region's vulnerability to the effects of volcanic eruptions is low. Areas in Region 7 could be affected by ashfall from Cascade volcanic eruptions. Most of the region's people and infrastructure are located in the major cities along I-84, US-26, and US-395. The communities most vulnerable to volcano-related hazards in the region are La Grande, Baker City, and John Day.

Wildfires

Characteristics

Region 7 has a significant history of human-caused fires in addition to a prevalence of summer thunderstorms. These thunderstorms in the mountainous and timbered regions of eastern Oregon suggests the potential for lightning-caused fires. Most areas do not have structural fire protection available and some areas do not even have wildland fire protection.

While the rates of urban and rural residential development have declined statewide, they have increased in Eastern Oregon's non-federal forests, potentially impacting fire protection capability. There are now 3 times as many dwellings on non-federal wildland forest in Eastern Oregon as in 1975. Dwelling density is increasing at a faster rate in Eastern Oregon's fire-prone forests than in western Oregon's. Development ranges from homes with city services to seasonal-use recreational cabins. Many isolated clusters of private timberland have been bought and developed into home sites and recreational communities.

Historic Wildfire Events

Table 2-665. Significant Wildfires in Region 7

Year	Name of Fire	Location	Acres Burned	Remarks
1986	Clear	Baker, Grant, Union	6,000	lightning caused (?)
1988	Turner	Baker, Union, Grant	8,000	
1989	Dooley Mountain	Baker		
1989	Stices Gulch	Baker		
1996	Sloan's Ridge	Baker, Grant	10,000	
1996	Wildcat	Grant	10,303	
1999	Cummings Creek	Grant		
2000	Carrol Creek	Grant	3,197	
2000	Thorn	Wallowa	4035	
2001	Monument Complex	Grant		
2001	Horse Creek	Wallowa	16,309	
2002	Malheur Complex/Flagtail	Grant	21,641	
2003	Lightning Creek Complex	Wallowa	16,028	1 structure was lost
2007	Battle Creek Complex	Wallowa	79,299	
2007	Cottonwood Creek	Wallowa	8,100	
2013	Grouse Mountain	Grant	12,076	threatened the town of John Day
2014	Buzzard Complex	Wallowa	>400,000	significantly impacted rangeland and cattle farms
2014	South Fork Complex	Grant	62,476	started with lightning strikes
2015	Canyon Creek Complex	Grant	110,422	started by lightning; destroyed more private property – 43 homes and almost 100 other structures - than any Oregon wildfire for 80 years before it
2015	Grizzly Bear Complex	Wallowa	82,659	started by lightning; destroyed two homes and dozens of other structures

Sources: Wallowa-Whitman National Forest (Baker City), 2002; Oregon Department of Forestry, 2020

Probability

Table 2-666. Assessment of Wildfire Probability in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

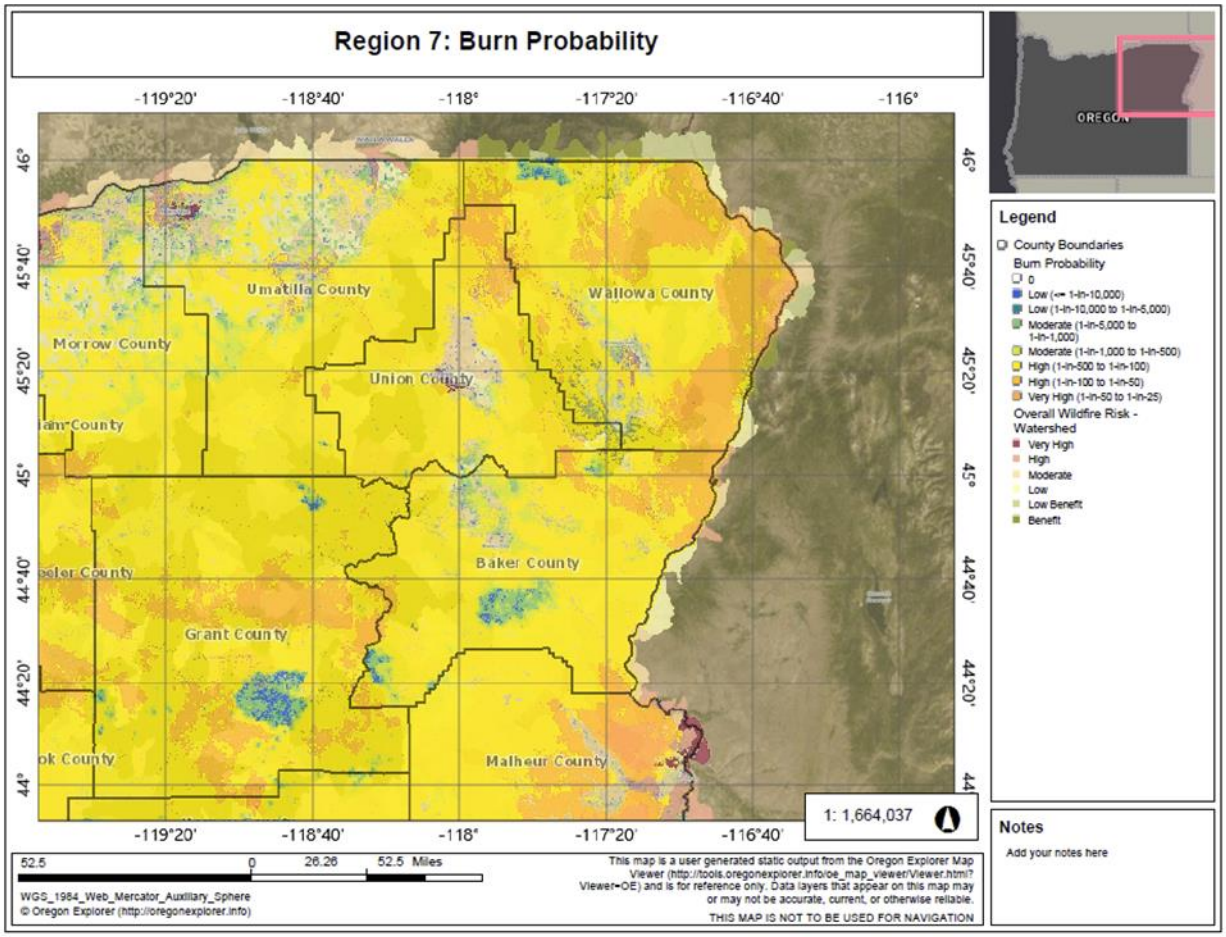
Source: Oregon Wildfire Risk Explorer: Burn Probability layer; PNW Quantitative Wildfire Risk Assessment, 2020

In the PNW Quantitative Wildfire Risk Assessment, Burn Probability was used to look at the likelihood of a large wildfire (>250 acres occurring). In conjunction with that data, examining the number of fire starts reported by ODF for all acreage sizes, gives a full picture of probability of wildfire.

These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these statewide assessments and methodologies is that the scale of the data is not necessarily reflective of the probability at the local and parcel levels, so the fire start data is utilized to help reflect that local level assessment to a certain extent.

Figure 2-281 shows the likelihood of a wildfire >250 acres burning a given location, based on wildfire simulation modeling. This is an annual burn probability, adjusted to be consistent with the historical annual area burned. Be aware that conditions vary widely with local topography, fuels, and weather, especially local winds. In all areas, under warm, dry, windy, and drought conditions, expect higher likelihood of fire starts, higher fire intensities, more ember activity, a wildfire more difficult to control, and more severe fire effects and impacts.

Figure 2-281. Burn Probability



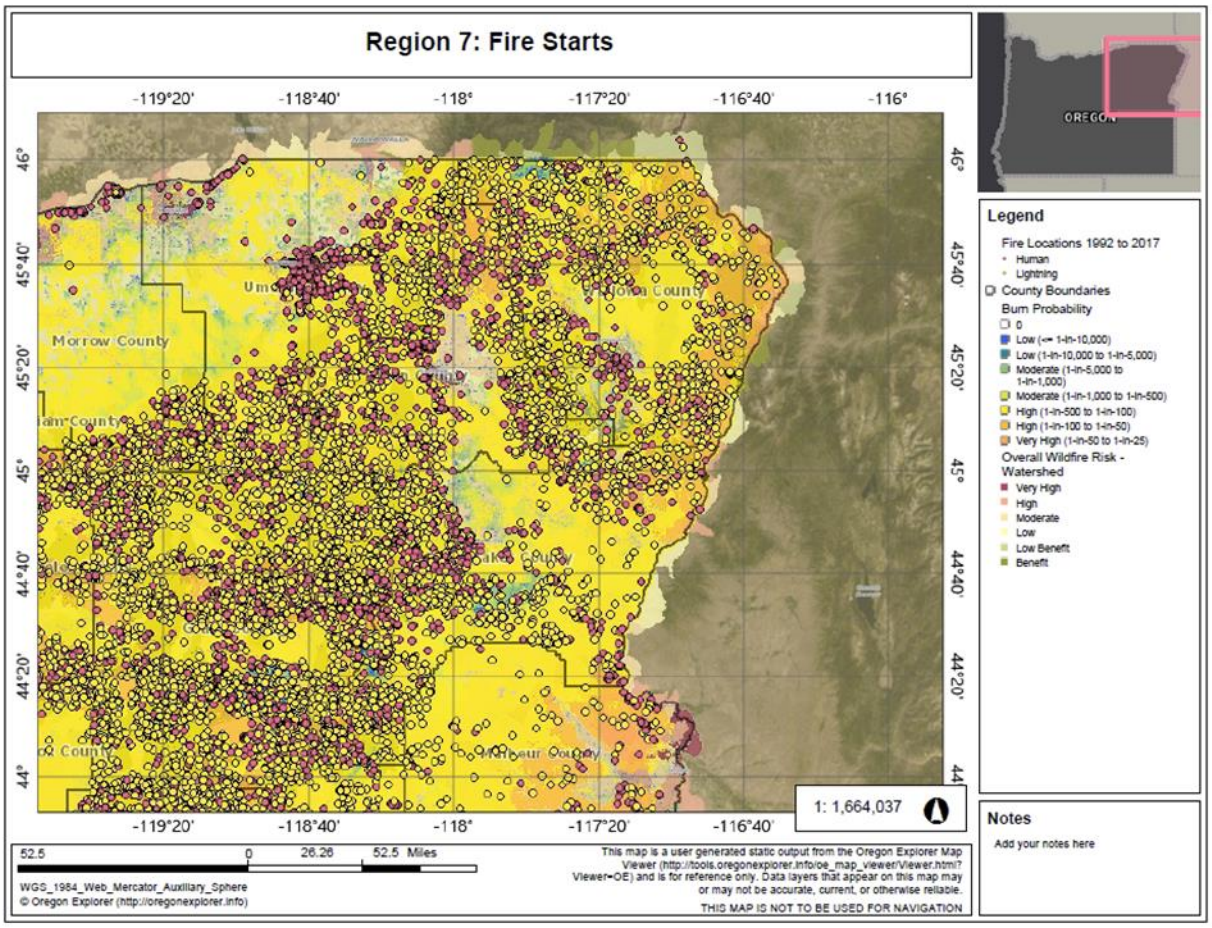
Source: Oregon Wildfire Risk Explorer, March 2020

A combination of climate, fuels, and terrain make this region prone to wildfire. The poor ecological health of the forested ecosystem, particularly in the greater Blue Mountains area, is well documented in federal and scientific reports. Past timber management practices, fire exclusion, and the subsequent buildup of forest fuels have significantly changed the vegetation composition in this region over time. The simplification of stand structure (unnaturally dense) and shift in species composition over time, combined with low precipitation and competition for limited water and nutrients, increases the probability of insect, disease epidemics, and large-scale fire.

A significant number of lightning storms pass through during the summer and fall months, starting many fires that can easily strain wildland firefighting resources. With fuels and low relative humidity, the probability for large fires can significantly increase during lightning events. The number of days per season that these conditions exist is also important to consider.

Over three quarters of all fire starts are attributed to lightning, with a higher percentage of lightning starts on public lands than on private lands. ODF reports a slightly higher percentage of human-caused fires where human activity is more prevalent.

Figure 2-282. Human- and Lightning-Caused Wildfires in Region 7, 1992-2017



Source: Oregon Wildfire Risk Explorer, March 2020

Climate Change

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States. Human-cause climate change is partially responsible for these trends, which are expected to continue increasing under continued climate warming (Dalton et al., 2017).

In ignition-limited forest systems, found on the east side of the state, a long history of fire suppression has resulted in high fuel loads and, forests that have closer canopies and experience greater water competition. These forests experience long, dry fire seasons and are frequently at high fire danger and have a very high potential to burn if exposed to an ignition source. Winter warming will lead to more fine fuels due to greater growth during the cold season; hotter and drier conditions combined with a suppression management regime will lead to large quantity of fuel and closer canopies. Large and severe fires ("unsuppressable megafires") are a result of this large fire debt and climate change combined. It is likely (>66%) that Region 7 will experience increasing wildfire frequency and intensity under future climate change.

One proxy for future change in wildfire risk is a fire danger index called 100-hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. A majority of climate models project that FM100 would decline across Oregon under future climate scenarios. This drying of vegetation would lead to greater wildfire risk, especially when coupled with projected decreases in summer soil moisture. The number of "very high" fire danger days—in which fuel moisture is below the 10th percentile—is projected to increase across the state and in Region 7 counties (Table 2-667).

Table 2-667. Projected Increase in Annual Very High Fire Danger Days in Region 7 Counties by 2050 under RCP 8.5

County	# Additional Days	Percent Change
Baker	15	42%
Grant	14	39%
Union	16	43%
Wallowa	16	44%

Note: Very High fire danger days are defined as days in which the fuel moisture is below the 10th percentile. By definition, the historical baseline has a 36.5 Very High fire danger days. These numbers represent the multi-model mean change.

Source: Oregon Climate Change Research Institute (OCCRI)

Vulnerability

Table 2-668. Assessment of Vulnerability to Wildfire in Region 7 – Communities at Risk

	Baker	Grant	Wallowa	Union
Vulnerability	VH	VH	VH	M

Source: ODF Communities at Risk Report, 2020

Table 2-669. Assessment of Vulnerability to Wildfire in Region 7 – 2020 Vulnerability Assessment

	Baker	Grant	Wallowa	Union
Vulnerability	L	M	L	M

Source: DOGAMI and DLCD, 2020

According to ODF's assessment of Communities at Risk, Baker, Grant, and Union Counties have the highest percentages of wildland acres subject to Fire Risk, Fire Effects, and Fire Threat, making them especially vulnerable.

In addition, each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface areas), thereby increasing vulnerability. These communities have been designated "Wildland-Urban Interface Communities" and are listed in Table 2-670.

A large wildfire could eliminate valuable timber or rangeland for grazing, which might affect local businesses and industry. Recreational areas that draw tourists would also be impacted. Wildlife habitat and diversity, as well as threatened and endangered species of fish, wildlife, and plant life could be annihilated or severely harmed in the long-term depending on the intensity of

the wildfire. Water quality could be impacted if a moderate to high intensity wildfire burned through watersheds, affecting the health of fish and wildlife as well as domestic water supplies for residents.

Many communities in this area are located a long distance from fire stations, which will result in longer response times. There are areas with a single access road that could impair ingress and egress during emergencies. Many homes do not have defensible space and would be difficult to protect from and oncoming fire. Response efforts are further hindered by the lack of water resources in the most vulnerable locations.

Region 7 is characterized as having heavy fuel loading on forestlands with a high potential for crown fires, which are very difficult to extinguish. The slopes are steep and carry fire quickly to upland flashy fuels and crowns. Ignition potential is also high, as many people visit the area.

Table 2-670. Wildland-Urban Interface Communities by County in Region 7

Baker	Grant	Union	Wallowa
Anthony Lakes	Austin	Catherine Creek	Alder
Auburn Gulch	Bates	Cove	Blue Spring
Baker City	Bear Valley	Elgin	Bartlett
Baker Valley	Beech Creek	Glass Hill	Eden
Bourne	Canyon City	Hilgard	Enterprise
Powder River	Dayville	Morgan Lake	Flora
Rattlesnake Estates	Granite	Palmer Junction	Freezeout Creek
Brownlee	John Day	Perry	Grouse
Bulger	Long Creek	Camp Elkanah	Hurricane Grange
Carson Pine Valley	Monument	Imbler	Imnaha
Copperfield	Mt Vernon	Island City	Joseph
Cornucopia	Prairie City	Kamela	Lostine
Durkee	Seneca	La Grande	Minam
Eagle Valley	Tamarack Camp Ground	Medical Springs	Prarie Creek
Elkhorn Mountains		Mt. Emily	Promise
Greenhorn		North Powder	Troy
Haines		Perry Hilgard	Little Sheep Creek
Halfway		Rysdam Duncan Canyon	Sheep Creek
Huntington		S. Fork Catherine Creek	South Fork Lostine River Subdivision
Keating		South Fork Catherine Creek	Troy
McCully Forks		Spout Springs	Upper Lostine
New Bridge		Starkey	Wallowa
Oxbow		Stubblefield Mountain	Wallowa Lake
Pleasant Valley		Summerville	Zumwalt
Richland		Union	
Rye Valley			
Sparta			
Stices Gulch			
Street Creek			
Sumpter			
Surprise Spring			
Unity			
Whitney			

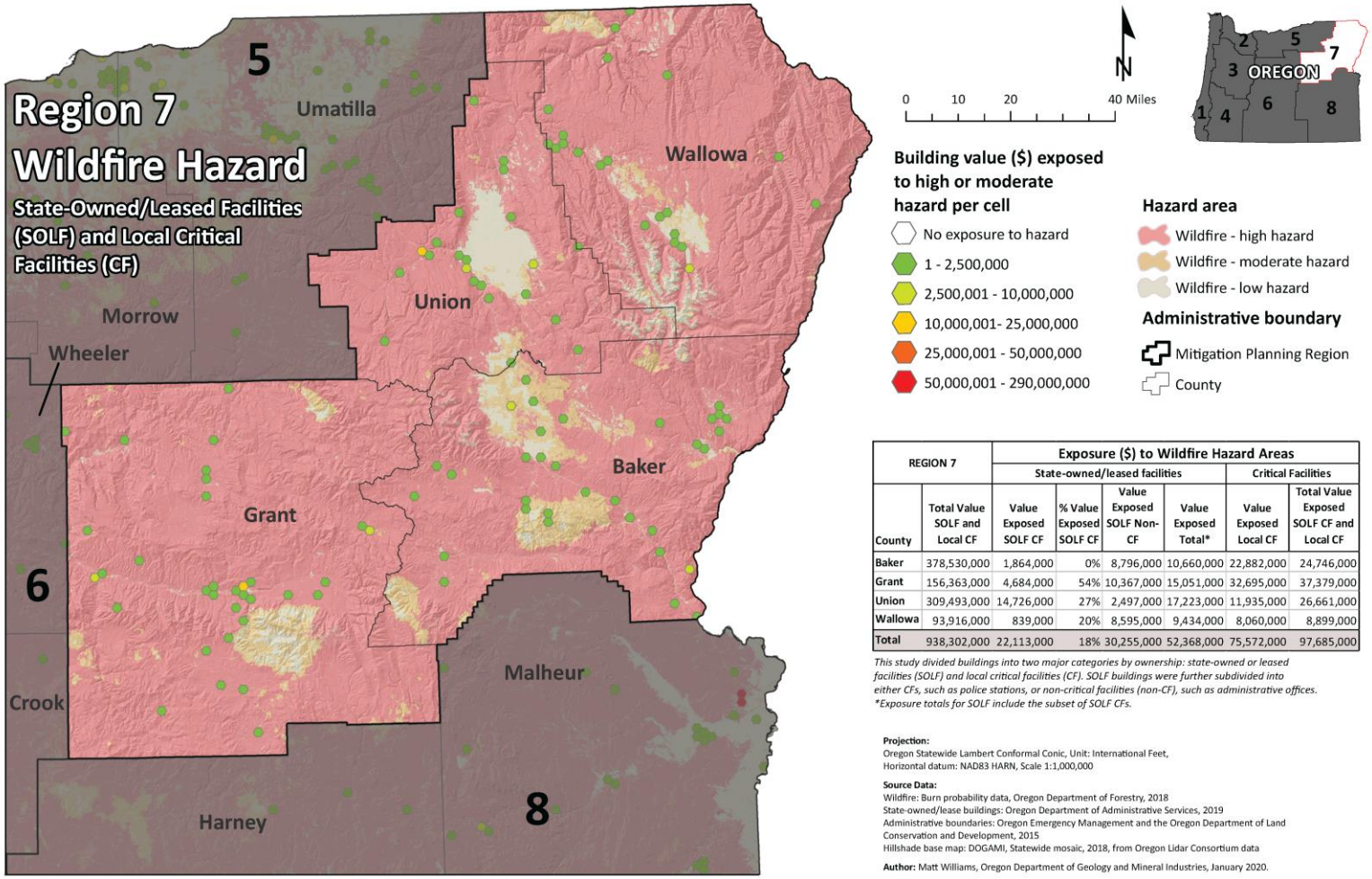
Source: Oregon Department of Forestry 2020 Communities at Risk Report

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI followed ODF guidance and evaluated building exposure to wildfire using the Burn Probability dataset which was classified by ODF in "High," "Moderate," and "Low" categories. Urban areas, lake surfaces, and areas bare of vegetation do not have fire risk classifications in the data and are represented here as "Low."

In Region 7, there is a potential loss to wildfire of about $52M in state building and critical facility assets, around a third of it in each of Union and Grant Counties, and around 20% of it in each of Baker and Wallowa Counties. There is a greater potential loss in local critical facilities: about $75.6M. Grant County contains the most (43%) followed by Baker County with 30%, Union County with 16% and Wallow County with 11%.

Figure 2-283. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in Region 7.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 7		Exposure ($) to Wildfire Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Baker	378,530,000	1,864,000	0%	8,796,000	10,660,000	22,882,000	24,746,000
Grant	156,363,000	4,684,000	54%	10,367,000	15,051,000	32,695,000	37,379,000
Union	309,493,000	14,726,000	27%	2,497,000	17,223,000	11,935,000	26,661,000
Wallowa	93,916,000	839,000	20%	8,595,000	9,434,000	8,060,000	8,899,000
Total	938,302,000	22,113,000	18%	30,255,000	52,368,000	75,572,000	97,685,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,000,000

Source Data:
Wildfire: Burn probability data, Oregon Department of Forestry, 2018
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI , 2020

Historic Resources

Of the 1,246 historic resources in Region 7, one hundred eighteen (9%) are located in an area of high wildfire hazard. Of those, 69% are located in Grant. Of the 38 (3%) located in a moderate wildfire hazard area, 61% are located in Wallowa County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, the counties in Region 7 have low or moderate vulnerability to wildfire. In contrast, the Communities at Risk assessment found all counties except Wallowa to be very highly vulnerable. This can be attributed to the different criteria used for the assessment and the counties' generally low social vulnerability depressing their 2020 overall vulnerability scores.

Risk

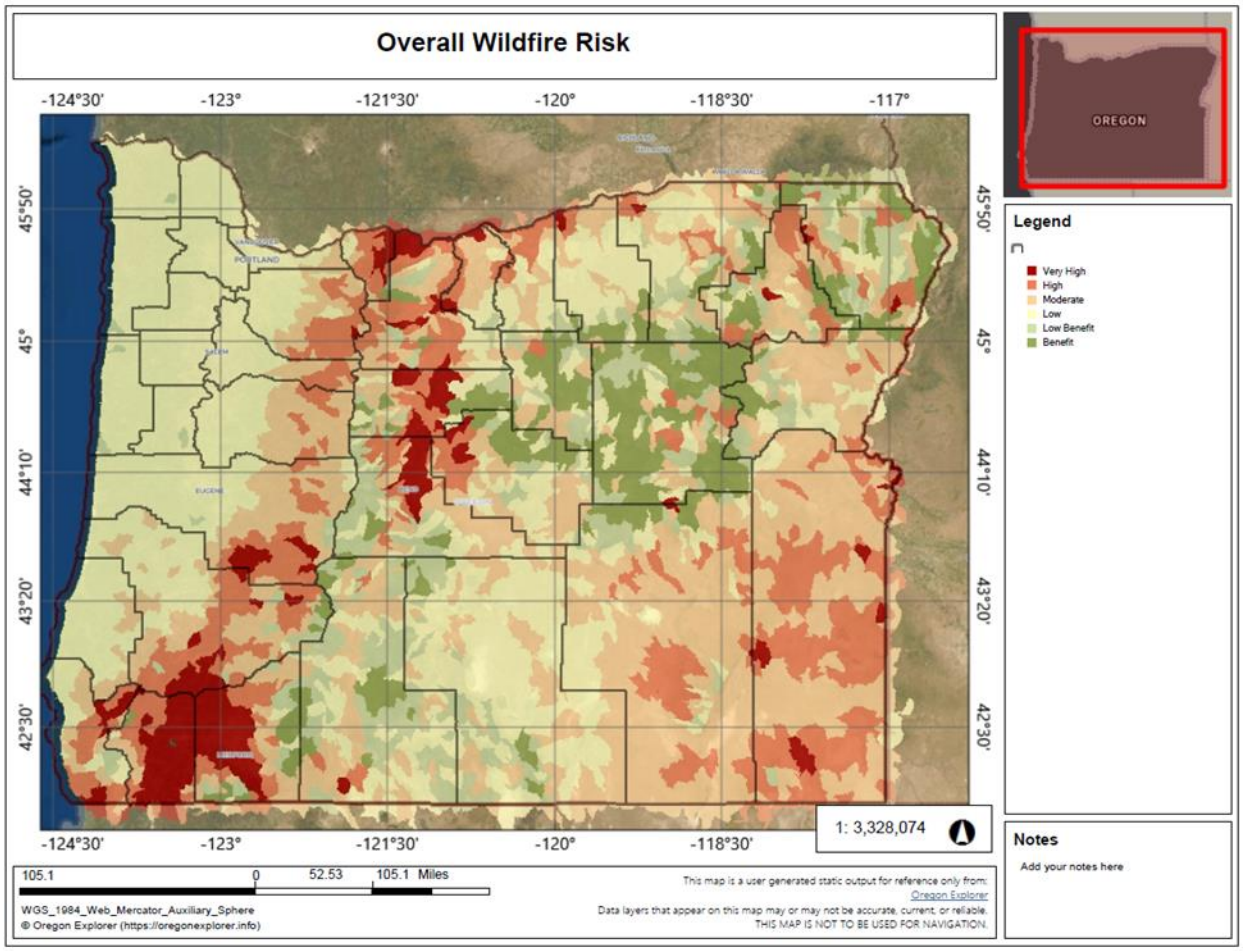
Table 2-671. Risk of Wildfire Hazards in Region 7

	Baker	Grant	Wallowa	Union
Risk	H	VH	H	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the wildfire probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Grant County is at very high risk from wildfire, Baker and Union Counties at high risk, and Wallowa County at moderate risk. This is generally consistent with ODF's assessment, mapped in **Figure 2-284**.

Figure 2-284. Overall Wildfire Risk



Source: Oregon Explorer, 2020

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. The most persistent high winds occur along the Oregon Coast and the Columbia River Gorge, so much so that these areas have special building code standards. This is not the case in the Blue Mountains, although high winds in the valleys are not uncommon. For example, the residents of Union County's Grande Ronde Valley caution newcomers about living in the vicinity of Ladd Canyon, known for its high winds.

Historic Windstorm Events

Table 2-672. Historic Windstorms in Region 7

Date	Affected Area	Characteristics
Apr. 1931	northeast Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 7-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Jan. 1986	northeast Oregon	wind gusts 80–90 mph; heavy drifting snow in Ladd Canyon (Union County)
Dec. 1990	Wallowa County	severe wind storm
Mar. 1991	northeast Oregon	severe wind storm
Dec. 1991	northeast Oregon	severe wind storm
Dec. 1992	northeastern mtns., Oregon	severe wind storm
May 2003	Union County	$1,000 in property damage
June 2003	Wallowa County	$1,000 in property damage
July 2003	Union County	$30,000 in property damage
Oct. 2003	Wallowa County	$1,000 in property damage
Oct. 2003	Union County	$2,000 in property damage
Jan. 2004	Grant and Wallowa Counties	$500 in property damage
Feb. 2004	Union	$1,000 in property damage
Mar. 2004	Union County	$200 in property damage
July 2004	Union County	$300,000 in property damage
Nov. 2004	Union County	$1,000 in property damage
Jan. 2005	Union County	$10,000 in property damage
Nov. 2005	Union County	$100 in damages from a strong wind storm
Nov. 2006	Union and Wallowa Counties	$35,000 in damages from a wind storm with wind speeds measured at 80 mph; Morrow and Umatilla Counties also affected, causing a total storm damage of $70,000
Nov. 2007	Wallowa County	$500,000 in damages from a windstorm near Wallowa Lake State Park
July 2011	Union County	$2,000 in property damage
Apr. 2019	Curry, Douglas, Linn, Wheeler, Grant, and Umatilla	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides
Feb. 2020	Regions 5 and 7: Umatilla, Union, Wallowa Counties	FEMA-4519-DR: Severe storms, tornadoes, straight-line winds and flooding

Sources: United States, Version 5.1 [Online Database], Columbia, SC: University of South Carolina, http://hvri.geog.sc.edu/SHELDUS/.

Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, *Severe Windstorm in Western Oregon*, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007), The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database], Columbia, SC: University of South Carolina, http://hvri.geog.sc.edu/SHELDUS/; https://www.fema.gov/disaster/

Probability

Table 2-673. Assessment of Windstorm Probability in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

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

The 100-year storm in Region 7 is defined as one-minute average winds of 90 mph. A 50 year storm is one-minute average winds of 80 mph. The 25-year event consists of average winds of 70 mph.

Climate Change

There is insufficient research on changes in the likelihood of windstorms in the Pacific Northwest as a result of climate change. While climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, there is as yet no consensus on whether or not extratropical storms and associated extreme winds will intensify or become more frequent along the Pacific Northwest coast under a warmer climate.

Vulnerability

Table 2-674. Assessment of Vulnerability to Windstorms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

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

Many buildings, utilities, and transportation systems within Region 7 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

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

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community

Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

Based on the information in **Table 2-672**, Union and Wallowa Counties are the most vulnerable to damages from windstorms. While none of the counties in Region 7 have even moderate social vulnerability, the high percentages of seniors in Wallowa, Baker, and Grant Counties; of residents with a disability in Wallowa County; and of people living in institutionalized group quarters in Union County increase these counties vulnerability to windstorms. Union and Wallowa Counties are considered the most vulnerable to windstorms in Region 7, followed by Baker County, then Grant County.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

With similar probability of windstorms but greater vulnerabilities, Union and Wallowa Counties are considered to carry the greater risk from windstorms in Region 7.

Winter Storms

Characteristics

Severe winter weather in Region 7 can be characterized by extreme cold, snow, ice, and sleet. There are annual winter storm events in Region 7 with an average of 24 inches of snow; most communities are prepared for them. In the elevated areas of the Wallowa Mountains severe winter storms are more frequent and the snowfall is much heavier. Moderate to heavy snowfall is prepared for and expected on an annual basis in this region. Heavier snowfall is expected and planned for in the areas of the Wallowa Mountains of the region as the elevation gets higher.

Historic Winter Storm Events

Table 2-675. Severe Winter Storms in Region 7

Date	Location	Remarks
Dec. 1861	entire state	storm produced 1–3 feet of snow throughout Oregon
Dec. 1892	northern counties, Oregon	15–30 inches of snow fell throughout the northern counties
Jan. 1916	entire state	two storms; heavy snowfall, especially in mountainous areas
Jan. and Feb. 1937	entire state	deep snow drifts
Jan. 1950	entire state	record snowfalls; property damage throughout state.
Mar. 1960	entire state	many automobile accidents; two fatalities
Jan. 1969	entire state	heavy snow throughout state
Jan. 1980	entire State	series of string storms across state; many injuries and power outages
Feb. 1985	entire state	2 feet of snow in northeast mountains; downed power lines; fatalities reported
Feb. 1986	northeast mountains, Oregon	heavy snow; school closures; traffic accidents; broken power lines
Dec. 1988	northeast mountains, Oregon	three blizzards in a 4-week period; 15-foot drifts; wind over 60 mph
Feb. 1990	entire state	heavy snow throughout state
Jan. 1994	northeast mountains, Oregon	heavy snow throughout region
Jan. 1998	northeast Oregon	heavy snow throughout region
Winter 1998-99	entire state	one of the snowiest winters in Oregon history (snowfall at Crater Lake: 586 inches)
Dec.28, 2003–Jan. 9, 2004	statewide storm	DR-1510. Grant, Union, and Wallowa Counties declared in Region 7. The most significant winter storm in several years brought snowfall to most of Oregon. Two feet of snow in the Blue Mountains in eastern Oregon. Roadside snow levels exceeded six feet along the Tollgate Highway, OR-204. The eastbound lanes of I-84 closed at Ladd Canyon east of La Grande. Additional segments of I-84 eastbound at Pendleton closed as stranded motorists filled truck stops, motels and restaurants in the La Grande area. Freezing rain also in eastern Oregon. Minus 30 degrees reported in Meacham. 60 mph wind gusts in Union County created whiteout conditions, prompting the closure of I-84 between La Grande and Baker City. 2 fatalities.
Jan. 2004	Union County	one fatality
Jan. 2–Feb. 9, 2008	Union, Grant, and Baker, Counties	heavy snow and freezing rain across eastern Oregon; 5–13 inches of snow

Date	Location	Remarks
Dec. 6-23, 2015	Statewide storm events	DR-4258. Clatsop, Columbia, Multnomah, Clackamas, Washington, Tillamook, Yamhill, Polk, Lincoln, Linn, Lane, Douglas, Coos, and Curry Counties declared. Several pacific storm systems moved across the region over the Dec 12-13 weekend. Another series of storms moved across Oregon on Dec 16-17 and Dec 21-23. Each storm system brought several inches of snow to the mountain areas. Snowfall 9.0" 6 miles east southeast of Granite. A narrow but long-lived band of precipitation moved across Wallowa County the morning of December 19th. Several reports of moderate snow occurred over the Joseph and Enterprise areas. Snowfall amounts in inches ranged from 5 to 6 inches, with northern Wallowa County receiving reports of up to 9 inches just outside of Flora. On December 21st heavy snow fell over portions of central Washington and Oregon due to a cold front. Snowfall amounts are as followed: 14" recorded at the Milk Shakes Snotel in Wallowa County.
Feb. 8-9, 2017	Grant County (Central Oregon, Ochoco-John Day Highlands)	A strong Pacific storm system brought snow, sleet and freezing rain to many areas of the Interior Northwest February 7th through 9th.
Feb. 22-26, 2019	Grant, Baker, and Union Counties (Central Oregon, Blue Mountains, Grand Ronde Valley, John Day Basin)	Persistent troughing off the coast of the Pacific Northwest focused a stream of mid-level moisture over the Inland Northwest resulting in a long duration snow event as the plume drifted north and south several times between the 22nd and 27th of February. Snowfall rates were greatly enhanced over central Oregon with the proximity of a nearly stationary surface boundary where snowfall rates were in excess of 1 inch per hour. 26 inches in Meacham, 21 inches in Elgin, 16 inches in Mitchell, 14 inches in Lostine and La Grande, 12 inches in Pendleton and Joseph and 10 inches in John Day.

Source: Taylor and Hatton (1999); Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina; https://www.fema.gov/disaster; https://www.ncdc.noaa.gov/stormevents

Probability

Table 2-676. Probability Assessment of Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Probability	H	H	H	H

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

Winter storms occur annually in Region 7. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions. However, the warming climate will result in less frequent extreme cold events and high-snowfall years.

Vulnerability

Table 2-677. Assessment of Vulnerability to Winter Storms in Region 7

	Baker	Grant	Wallowa	Union
Vulnerability	H	H	M	H

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

Region 7 counties are known for cold, snowy winters. This region is a gateway for neighboring states Washington and Idaho and for the commodity flow to those states. In general, the region is prepared for winter storm events, and those visiting the region during the winter usually come prepared. However, there are occasions when preparation cannot meet the challenge. Drifting, blowing snow has often brought highway traffic to a standstill. Also, windy, icy conditions have often closed mountain passes and canyons to certain classes of truck traffic. In these situations, travelers must seek accommodations, sometimes in communities where lodging is very limited. For local residents, heating, food, and the care of livestock and farm animals are everyday concerns. Access to farms and ranches can be extremely difficult and present a serious challenge to local emergency managers.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Baker, Wallowa, and Union Counties all have low levels of social vulnerability. Wallowa County is in the 90th percentile for the percentage of persons over the age of 64 and for its share of residents with a disability. Baker County also has a higher percentage of residents over the age of 64. Vulnerability in Union County is driven by a higher poverty rate, the share of multi-unit structures, the percentage of people living in institutionalized group quarters, and the percentage of occupied housing units with more people than rooms. Grant County has very low social vulnerability but is in the 90th percentile for its share of residents over age 65 and older.

While social vulnerability is generally low in Region 7 and the population is prepared for moderate to heavy snowfall, all the counties have specific vulnerabilities that indicate their populations are more sensitive to the adverse impacts of winter storms. All Region 7 counties are similarly vulnerable to winter storms.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

All the counties in Region 7 are at risk from the adverse effects of winter storms.