

## Seismic Risk and Readiness

The League of Women Voters of Oregon (LWVOR) position regarding seismic risk states, in part:

The League of Women Voters of Oregon believes that all levels of government share the responsibility of coordinating, implementing and funding an effective program to mitigate Oregon's earthquake and tsunami hazards. Priority must be given to mitigation that protects human life and safeguards critical life support systems.<sup>1</sup>

Since the 2011 quake in Japan, we've had an elevated awareness of a possible quake on the West Coast like the magnitude 9 that Japan experienced. Now, in spite of the multiple planned responses to disaster at every level of government and community service, here is the most sobering truth: in the event of a sudden major catastrophe--where services, buildings, bridges, roads, dams, power lines, and water sources collapse--we will each be on our own for some indefinite time. There may be no outside help for days, or weeks, or longer. For people on the coast, the crisis could be dramatically worse.

For all disasters, multiple emergency responses from government and community services exist. Some are still in the planning stages, but many responses are ready to go in the event that disaster were to occur tonight. For the specific threats to our area, we can evaluate our risk level, understand the mitigating responses that are planned or are already in place, and prepare ourselves.<sup>2,3</sup>

### ***I. GEOLOGY OF EARTHQUAKES***

The earth's crust is a network of tectonic plates whose motion shapes the planet's surface. The Pacific Northwest, along with the rest of North America, lies on top of the North American Tectonic Plate (NAP), which is slowly moving in a southwest direction. At its edge, off the coast of northern California up to Alaska, lies the Juan de Fuca Plate (JdFP), which is slowly moving northeast and plunging under the North American Plate. This 600-mile-long area, known as the Cascadia Subduction Zone (CSZ), is causing increased pressure throughout the region.<sup>4</sup> As the subducted plate sinks below the over-riding North American Plate, layers of rock are scraped off, adding to the land mass of the over-riding plate and adding to the coastline.

Research suggests that the last earthquake caused by the CSZ occurred in 1700. These earthquakes are predicted to occur about every 350-500 years. The edges of subduction zones are the sites of some of the most powerful earthquakes, reaching magnitudes of 8, 9 or larger. There is also evidence of tsunamis with these subduction quakes that could measure up to 100 feet high as well as a land drop of several feet.

There are, however, dozens of other fault lines throughout Oregon like the Portland Hills fault, the Corvallis fault and the John Day fault, which can also cause large earthquakes. These earthquakes occur along breaks in the earth's crust and commonly are at relatively shallow depths (6-12 miles) below the surface.<sup>5</sup>

Approximately 15-20 earthquakes a year are felt in the Northwest. Many more occur, especially along the Cascadia Zone, but are of low enough magnitude not to be noticed except by seismic equipment and are known as "slow slip" tremors. This slippage tends to occur regularly every 13-16 months and is far beneath the earth's surface where the rock is more molten and malleable.

A Cascadia quake, the “big one,” could be as great as magnitude 9 and last as long as 3-6 minutes. The hazards facing Oregon include ground shaking that damages or destroys buildings and infrastructure, landslides, floods, fires and tsunamis. Risks vary depending on the type of event that occurs.<sup>6</sup>

Assuming the worst-case scenario of a magnitude 9 Cascadia earthquake, several things will happen quickly. In general, coastal areas can expect severe shaking that will cause poorly constructed buildings to collapse. A tsunami of from 20 to 100 feet could strike depending on the contour of the local land and would reach the coast in about 15-20 minutes. Heavy furniture could be overturned. Damage will be most extreme in buildings constructed before the 1970s. Brick walls and chimneys will start crumbling. Most bridges, tunnels and many roads will be damaged and impassable. The ground will subside by several feet. The power grid could go down as far inland as the I-5 corridor and be out for several months. Water and sewer lines would be damaged and could take between one to three years to repair. Medical facilities may be too damaged to function fully, and medical staff may not be able to reach them.<sup>7</sup> These facilities could take between one to three years to repair. Natural gas could be off for one to three months, and water distribution centers may not be up and running for weeks to months. Police and fire services may be unable to function fully for months, and even high priority highways may be out for 18 months to years.

Further inland the shaking will be less severe, but older buildings may still have minor to major damage depending on when they were constructed and of what materials. Buildings constructed after 2000 will have less damage, but homes built before the 90s will have greater damage with increasing age. Tsunami water may come miles inland along rivers and low-lying areas. There is also potential for failure of multiple dams. Hundreds of thousands of people live downstream of Cougar and other dams, and such failures could cause flooding in metro Eugene and Springfield. Those floodwaters could reach 20 to 40 feet in lower-lying parts of Eugene, Springfield and surrounding communities, including Cottage Grove and Creswell, before spreading out into the floodplain of the south Willamette Valley.<sup>8</sup>

## **II. INDIVIDUAL PREPAREDNESS**

The chaos of a catastrophic event could seriously challenge our ability to think clearly and function well. Remember the effects of the ice storm of 2016 and the snow of 2019 that left many without power and isolated for days. To give ourselves the best chance to do what we will need to do, we must prepare psychologically as well as physically. Part of that preparation is to face the possible realities a disaster could present, and then do what we can to be ready for it.<sup>9</sup>

### **BEFORE ANY DISASTER**

- Create a survival kit. Eugene Water and Electric Board’s (EWEB) “Pledge to Prepare” project<sup>10</sup> prioritizes necessary supplies and suggests a month-by-month plan to gather them, making the task easier to manage and to afford. Other sources have created checklists, and most of them include the following items as well as many more:

- Water, a two-week supply for each person
- Water purification system
- Food
- Flashlights and batteries
- Fire extinguisher
- Battery operated radio
- Whistle
- Medications

More information is provided by the website of the American Red Cross.<sup>11</sup>

- Create a family emergency communications plan that has an out-of-state contact.
  - Plan where to go if you and family members become separated.
  - Consider the needs of your pets and other animals.
  - Participate in a “Map Your Neighborhood” project<sup>12</sup> to learn who your neighbors are and how you can help one another to establish a neighborhood meeting point where you can share information and establish communication with others.
  - Get Community Emergency Response Team (CERT) training<sup>13</sup> so that you can be the “Help Before Help Arrives.”
  - Practice Drop, Cover, Hold On.
- Create a digital “to-go-bag” on your smart phone.<sup>14</sup>
  - Add contact information for services such as locksmith, towing, pharmacy, and Red Cross.
  - Store your medical and emergency information on your phone. Sign up for emergency alerts such as FEMA, Earthquake: American Red Cross, myAlerts, and the Community Emergency Notification System (CENS.)<sup>15</sup>
  - A solar charger for smart phone batteries might allow the phone to function longer.
- Keep cash on hand as banks may be damaged and credit service may be unavailable.<sup>16</sup> Keep copies of important documents ready in case of a need to evacuate.
- If power is out, sanitation systems may fail when sewage could no longer be pumped to a treatment plant. An alternative system might be the twin-bucket toilet: one bucket for liquid and another for solid waste with cat litter to spread over the residue.<sup>17</sup>
- Secure physical objects such as bookcases, refrigerators, televisions, and hanging items. Store heavy and breakable items on lower shelves.
- Consider home improvements such as securing the house to its foundation or strengthening a fragile chimney. Water heaters need to be strapped down. Standard homeowner policies don’t cover earthquakes.
- Establish emergency plans for facilities such as nursing homes, group homes and schools to ensure that both management and individuals know what to do.

#### **DURING AN EARTHQUAKE**

- If you are indoors, drop to hands and knees, cover head and neck with arms, crawl under a sturdy table or desk or to an interior wall or corner. Hold on to sturdy furniture until shaking stops. Do not get in a doorway. Do not run outside.
- If you are in bed, face down and cover head and neck with a pillow.
- If you are outdoors, stay outdoors and away from buildings.
- If you are in a vehicle, pull over and stop. Set the parking brake.
- If you are in a tsunami zone, immediately after the shaking stops go to higher ground inland.

#### **AFTER AN EARTHQUAKE**

- Expect aftershocks after the main quake.
- Hazards might be building damage, leaking gas or water lines, downed power lines, and broken glass.
- Put on shoes to avoid injury.
- Check that you and your family are not injured.
- Turn off the gas if you smell or hear gas.
- If you are trapped, cover your mouth, nose, and eyes from dust. Bang on pipes, use a whistle, or send a text so that someone might find you.

- Text messages may be more reliable than phone calls, and texts use less power.
- Listen to battery charged radio, TV, social media, and cell phone text alerts for damage reports and instructions.
- Report to your pre-designated neighborhood location to assist others and to share information.
- Register with the Red Cross “Safe and Well” website to let people know you are ok. <sup>18</sup>
- Be careful in cleaning up debris. Wear protective clothing, shoes, and gloves. Don’t risk injury by moving heavy debris alone.

### **III. POST-DISASTER COMMUNITY RESPONSES**

The state has created a detailed plan for response following a major quake, the Cascadia Subduction Zone Catastrophic Earthquake and Tsunami Operations Plan.<sup>19</sup> The plan clarifies that local governments are responsible for the management and coordination of the emergency response and recovery activities within their jurisdictions. Our local government agencies including fire, police, emergency services and other city and county services are following the plan, coordinating with one another and with non-government agencies so that their efforts support one another and so that communication among them is facilitated.

#### **IMMEDIATE RESPONSE**

In the first hours after a catastrophe people would be on their own. They must assess their own situation, making personal safety the first priority. The next priority would be to locate family and follow a checklist to shut off gas, check on neighbors, and report to a pre-determined location where neighbors can begin to help one another. Then locate people trapped in collapsed structures and establish communication with others to understand the scope of the problems and relay information.

#### **FIRST 72 HOURS: DETERMINE SCOPE OF DISASTER**

There will almost certainly be no state or federal response for 72 hours. Thus, the response in the first three days post-earthquake is the responsibility of individual people with aid from the county, cities, non-profit groups, volunteers, and first responders as they become available. The initial responsibilities identified in the state plan in the first 72 hours include the following: search for and rescue any trapped people and evaluate the status of communication systems. Then assess bridges, medical facilities, sewage, electrical substations, security and law enforcement, and lines of supply and transport. Local agencies must be able to relay status information if the state is to issue an Emergency Declaration and request help from FEMA.

#### **VOLUNTEERS**

We have approximately one first responder for every 3000 people in our area. Those firefighters and paramedics will be augmented by volunteers including those who have received Community Emergency Response Training (CERT). Currently there are 1500 people with CERT training in Lane County but only 250 are credentialed to substantially assist first responders. Every agency involved with planning for a disaster is coordinating with the Community Organization Active in Disaster (COAD), an organization that includes United Way, Arc, White Bird, St. Vincent de Paul (SVdP), churches, search and rescue, the Red Cross and many others.

#### **COMMUNICATION**

Communication systems like TV, radio, internet, land lines and cell towers may not be functioning. Moveable cell towers are planned, so citizens may have cell service if they have personal solar chargers or generators. Because the system could quickly be overwhelmed, priority for use would go to first responders and organizations that coordinate the work of disaster response. People should set

up phone tree agreements with out-of-state contacts so that only one message need be sent to contact a group. Emergency messages from community agencies may be posted at locations where people gather, such as community centers, grocery stores, fire stations and churches.

Amateur radio (HAM) volunteers are indispensable to establish the scope of a disaster and coordinate actions among survivors. To help transmit information across the county, HAM stations are now set up in the sheriff's office, in fire stations, community centers, libraries, hospitals, and other locations.

Neighborhood associations can apply for grants to purchase general mobile radio service (GMRS) or family radio services (FRS)<sup>20</sup> radios which allow an alternative way of receiving and transmitting information within their neighborhood. Satellite phones and radios, which do not require special training and have a wide range of service, are often used by first responders.

### **WATER**

Using new or existing wells, or portable water treatment systems, EWEB is creating a system of emergency well-fed water stations, with the first at Bethel Farm behind Prairie Mountain School and a second at Howard Elementary School. Other stations are planned near the Sheldon Fire Station, at the Eugene Science Center across from Autzen Stadium, and at the Lane County Fairgrounds. There is also a plan to truck water to various schools. However, water sources will be limited and may require purification. A personal stash of water and some purification system is strongly encouraged. The Eugene and Springfield water systems can be linked in an emergency to allow the two utilities to help each other.

### **POWER**

Public utilities such as EWEB, Springfield Utility Board (SUB), Lane Electric Cooperative and Emerald Public Utility have the responsibility for restoring power as soon as possible. EWEB is using strategies learned from the recent ice and snowstorms to create an on-line map of outages. Its smart meter data has improved its ability to know when and where outages occur, when they are repaired, and how to communicate with customers about the size and status of a power failure. EWEB has installed seismic sensors at its McKenzie River hydroelectric facility and is coordinating with the University of Oregon to establish the ShakeAlert Early Warning System that could give warning of a coming quake. Even one or two seconds could allow time to open floodgates, shut down generators, or open automatic doors of a firehouse so that the engines could get out.

Individuals have some choices beyond utility companies for emergency power sources, such as gas generators, solar panels, and battery storage. Small power grids consisting of solar panels with batteries or diesel generators are in use or planned in many areas, for example the hospital in Florence. An EWEB Greenpower Grant program has provided solar power systems for local nonprofit agencies,<sup>21</sup> and EWEB has a program to provide financing for backup generators.<sup>22</sup>

The Department of Energy controls the fuel allocation in an emergency, with first responders and crucial generators high on its list. The primary fuel stockpile in western Oregon is located in Portland on fill land susceptible to earthquake damage. Lane County is exploring a variety of mechanisms for obtaining fuel including air drops.

### **NATURAL GAS**

Northwest Natural Gas is well-prepared, partly because federal regulations are strong and are closely followed. The pipe system is no longer cast iron; only poly-prop flexible pipe is used today. The company has installed thousands of shut-off valves, so it can isolate an area for shut-off when

necessary, and excess flow valves that can shut off automatically. Its operations control center is alert 24/7. Like other entities involved in public safety, it shares personnel and expertise across state lines.<sup>23</sup>

### **DAMS**

According to the Lane County emergency manager, the dams upstream of Eugene-Springfield share many characteristics with the dams in Japan that did not fail in the Japanese earthquake. The one dam that failed in Japan during the 2011 earthquake had not been constructed and maintained appropriately. Dams on the Willamette and McKenzie Rivers are regularly inspected and maintained by the Army Corps of Engineers. The seasonal drainage of the dams may reduce the risk of flood damage.

### **RESOURCES IN SMALL CITIES AND RURAL AREAS**

The relative isolation of rural areas might become a disadvantage. Power restoration may be delayed, making an alternative source of heat critical. Rural residents' long-term emergency supply kit should be carefully planned since outside help will take longer to arrive. Residents need to know who will need help and who might have help for others, and since neighbors are fewer and farther apart, it's important that they make those deliberate connections before a disaster occurs.

Small cities have a variety of emergency programs in place. Veneta is working on the acquisition of a generator to provide power at an emergency shelter, as well as planning water delivery. Coburg has plans for trailer-based stations for water, generators, and other emergency supplies. Florence coordinates emergency preparedness with Western Lane Emergency Operations Group (WLEOG), a collaboration of fire, ambulance, police, hospital, tribal police, other agencies, and a network of volunteers. They share resources and offer mutual aid under the same incident command and FEMA guidelines.

### **HOSPITALS**

According to the emergency management coordinator for McKenzie-Willamette, hospitals are required to maintain 96-hour sustainability. McKenzie-Willamette has emergency wells that can be tapped and generators prepared to operate for a week. The newer part of the building has been built to withstand a magnitude 9 quake. It has a mass casualty response plan in place. If people need medical help in the first days of a disaster, they should consider going to an urgent care center. Any hospital will likely be overwhelmed with desperate people coming from our entire area. PeaceHealth Riverbend Hospital has drilled a well equipped with a generator having an uninterrupted power source, a battery-powered device. Flood damage is anticipated to affect at most the first floor of the hospital; the hospital will use mobile shelters and space at the Riverbend Annex on International Way for ambulatory patients. Because of tsunami danger, Florence faces particularly difficult emergency hospital and transportation issues and conducts regular exercises to test emergency planning with the Coast Guard, National Guard, and other agencies including the U.S. Navy. Currently these agencies are evaluating beaches along the coast from which small boats might reach hospital and supply vessels anchored well off rocky shores.

### **THE MOST VULNERABLE**

The Eugene emergency manager says that the city plans to set up stations where water, food, and medical help will be accessible for all. However, city services could be overwhelmed by increased demand and by unavailable staff or volunteers. Coburg planners know, for example, that they must

prepare for possible damage to the I-5 McKenzie River bridge that could force many people needing help to divert into their small town, requiring city resources.

Disaster preparation can be expensive for those with low income or those poorly sheltered, unsheltered or dependent on public services. Preparations like structural improvements to homes may not be possible. Space to store long-term supplies may not exist. A housing crisis could be multiplied by people made instantly homeless by structural damage or by being trapped away from home. In the midst of a disaster, there will be people who are unprepared and who will require community help and resources.

#### **IV. ANOTHER SEISMIC RISK: VOLCANIC ERUPTIONS FORMATION**

Oregon's geological origin was volcanic island rocks far out in the ocean at a time when the Pacific Northwest coast ended near the present Oregon-Idaho border. Riding on the floor of the Pacific Ocean as it subducted beneath North America, the rocks were too big or too thick to easily slide beneath the edge of the North American continent. Instead, they remained in the subduction zone and welded themselves to the edge of the growing plate, creating the coastal plain. The Cascade Range, which cuts across much of the eastern two thirds of the state, is the result of continuing eruptions of hundreds of volcanoes. Millions of years of eruptions deposited huge piles of lava flows and ash over large areas of the state. Seventeen million years ago a plume of very hot rock rose from deep within the earth beneath eastern Oregon, setting off a huge pulse of volcanic activity. The first eruptions were a series of gigantic lava floods that erupted from great fissures near the Oregon-Idaho-Washington border. These lava flows were among the largest to have occurred anywhere on earth. Some of these rapidly moving sheets of lava traveled as far as 400 miles from their vents to their far ends at Newport, Oregon. Individual flows covered up to one tenth of the state, and many were over 100 feet thick.<sup>24</sup>

**Volcano** applies to any vent or opening in a planet's crust through which lava, rock fragments, gases, or even just heat may escape from beneath the surface. There are three main volcano types. **Cinder cones**, the most common type of volcano, are relatively small volcanoes. Their eruption is characterized by short-lived, explosive outbursts of nut-size to fist-size lava (cinders) that rise a few hundred meters high. **Shield volcanoes** are broad and have low slopes much like an overturned shield. Their eruptions are characterized by gusher-like lava fountains that generate red-hot lava rivers. **Stratovolcanoes** are the deadliest. Their lower slopes are gentle, but they rise steeply near the summit and produce ash columns that extend as high as 31 miles into the atmosphere. High winds can spread ash thousands of miles from the volcanic vent to around the world. Additionally, these volcano eruptions have pyroclastic flows, which are high-speed avalanches of hot ash, rock fragments, and toxic gases. These flows can be as hot as 1,500 degrees and move at speeds of 100 to 150 mph. Mount St. Helens, Mount Rainier and Mount Mazama (Crater Lake) are examples of stratovolcanoes.<sup>25</sup>

#### **HAZARDS**

Large explosive eruptions can kill people and destroy property hundreds of miles away and even affect global climate. Eruption columns containing solid and molten rock fragments can grow into an eruption cloud reaching heights of 12 miles into the atmosphere. Heavy volcanic ash-fall can collapse buildings and damage crops, electronics and machinery. Volcanic gases, specifically sulphur dioxide, can mix with water to create acid rain, which causes corrosion. Carbon dioxide can be trapped in low areas in deadly concentrations. Fluorine can be absorbed into volcanic ash particles and in high

concentrations can poison livestock and contaminate domestic water supplies. Also, danger comes from fast-moving lava flows, landslides, and mudflows that can reach densely populated areas.<sup>26</sup>

### **PLANNING**

Scientists use a threat score to determine a volcano's danger. It includes a hazard assessment, the type of volcano, how explosive it can be, how recently it has been active, how frequently it erupts, and if there has been seismic activity, how many people live nearby, if evacuations have happened in the past, and if eruptions disrupt air traffic. Eleven of the 18 very high threat volcanoes are in Oregon, Washington and California. Four volcanoes in Oregon that are rated a very high threat include: Crater Lake, Newberry, Three Sisters and Mount Hood. Portland is one of the few cities in the world where young volcanoes exist near an urban area.

These threat scores have been used by the U.S. Geological Survey (USGS) to develop risk mitigation strategies prioritizing those areas with the highest scores. In March 2019, Congress passed a bill (S.47) authorizing the USGS to establish a National Volcano Early Warning System (NVEWS). With NVEWS scientists will be able to make sure all dangerous U.S. volcanoes are monitored at levels consistent with the threat that they pose to communities, infrastructure, and aviation.

The plan includes nationwide volcano monitoring networks that will provide warnings and forecasts before dangerous volcanic events occur. The network consists of broadband seismometers, infrasound arrays, real-time continuous GPS receivers, streaming and near-real-time webcams, real-time volcanic gas sensors, satellite imagery, and other remote-sensing techniques. Monitoring stations with multiple instruments are planned for the nation's high and very high-threat volcanoes. Standardized digital telemetry systems will tie the networks together and make data communication consistent across all observatories.

The NVEWS plan seeks to increase partnerships with local governments and emergency responders; it provides grants to universities and others for cooperative research to advance volcano science, monitoring technologies, and mitigation strategies. It funds staff and computers to improve 24/7 monitoring and to distribute data to scientists, responding agencies, and the public.<sup>27</sup>

### **RESPONSES SPECIFIC TO VOLCANIC ERUPTIONS**

**During a volcanic eruption:** Listen to the National Oceanic and Atmospheric Administration (NOAA) weather radio or TV for updated information, be prepared to evacuate, avoid areas downwind and river valleys downstream from the volcano, close all windows and doors, and bring any pets or livestock into closed shelters. If you are outdoors, seek shelter immediately and avoid low-lying areas and streams. If caught in a rock fall, roll into a ball to protect your head.

**After a volcanic eruption:** Continue listening to NOAA weather radio or TV for the latest information, remain inside your home until officials declare it is safe to leave. Use phones only for emergencies. Once you can leave wear long-sleeve shirts, pants and, if necessary, goggles and a mask to ensure eyes, nose, mouth and skin are covered. Check for damage to walls, roof, foundation, electrical system and waterlines, notify your insurance company of damages.<sup>28</sup>

### **V. CONCLUSION**

Many local entities are better prepared today than they were 10 years ago. All seem to be coordinating with related entities across the cities, counties, and the state and are following the Cascadia Subduction Zone Catastrophic Earthquake and Tsunami Operations Plan. Some estimate that it would take Oregon 50 years more to become resilient to major disaster. For today consider



preparations we can make to anticipate our personal needs and what we can do to help mitigate the effects of possible disaster to our community.

### Discussion Questions

1. What stood out when you read the material?
2. Is your neighborhood involved in Map Your Neighborhood or other disaster planning?
3. How can local governments better disseminate information on preparedness to residents?
4. How can the League provide information in this document more broadly?
5. At what point is the economic cost of disaster preparedness too high?
6. Should the state League position on seismic activity be altered to include the risk of volcanic eruptions?

### Interviews

Kevin Holman, Eugene Emergency Manager; Ken Vogeney, City of Springfield Emergency Manager; Catherine Zunno, Eugene Emergency Preparedness Analyst; Alan Beebe, Mackenzie Willamette Hospital; Patence Winningham-Melcher, Lane County Emergency Manager; Joe Harwood, EWEB Public Information Officer; Jenna Boyd, Management Analyst, Veneta; Megan Messmer, City Project Manager, Florence; Anna Heath, Coburg City Administration; Joe Carney, NW Natural Gas Engineer; Rod Price, EWEB Chief Operations Manager

### Resources

<sup>1</sup> For the full statement of the League of Women Voters of Oregon position on seismic risk go to <http://lwvor.org/full-lwvor-position-index/#Seismic-Risks>

<sup>2</sup> <https://www.oregon.gov/DOGAMI/Pages/earthquakes/EQs.aspx>, [https://en.wikipedia.org/wiki/Cascadia\\_subduction\\_zone](https://en.wikipedia.org/wiki/Cascadia_subduction_zone)

<sup>3</sup> A great place to start if you want information specific to your local area is to use the website <https://www.opb.org> › aftershock-story which allows you to enter your zip code for immediate effects, estimates of earthquake damage and length of time for recovery and repair to be completed. It also gives you information about what you can do to mitigate damage and estimates the amount of supplies you will need to store to live on before you can expect outside help.

<sup>4</sup> <https://www.oregongeology.org/pubs/ims/ims-028/faults.htm>

<sup>5</sup> <https://ktvl.com/news/local/there-are-dozens-of-earthquake-faults-across-oregon-including-one-through-portland>

<sup>6</sup> <https://gis.dogami.oregon.gov/maps/hazvu/>

<sup>7</sup> <https://www.oregongeology.org/earthquakes/earthquakehome.htm>

<sup>8</sup> <https://www.registerguard.com/rg/news/local/35607541-75/drilling-into-the-danger-of-dams.html.csp>

<sup>9</sup> <https://www.redcross.org/get-help/disaster-relief-and-recovery-services/recovering-emotionally.html>, accessed 10/27/19

<sup>10</sup> <http://www.eweb.org/outages-and-safety/preparing-for-emergencies/pledge-to-prepare-campaign>, accessed 11/16/19

<sup>11</sup> <https://www.redcross.org/get-help/how-to-prepare-for-emergencies.html>

<sup>12</sup> <https://www.eugene-or.gov/1177/Neighborhoods>, accessed 11/15/19

<sup>13</sup> <https://www.eugene-or.gov/382/Community-Emergency-Response-Team-CERT>, accessed 11/16/19

<sup>14</sup> Creating a digital go-bag; See <https://www.redcross.org/about-us/news-and-events/news/SanDisk-supports-the-Red-Cross-and-Promotes-Preparedness.html> and <https://www.cnet.com/news/mobile-phones-as-lifelines-tips-for-staying-connected-during-a-disaster/>

- <sup>15</sup> [https://lanecounty.org/government/county\\_departments/lane\\_county\\_emergency\\_management/sign\\_up\\_for\\_emergency\\_notifications](https://lanecounty.org/government/county_departments/lane_county_emergency_management/sign_up_for_emergency_notifications)
- <sup>16</sup> Refer to Financial Preparedness at [ready.gov](http://ready.gov)
- <sup>17</sup> <https://www.portlandoregon.gov/pbem/article/394125>, accessed 10/27/19
- <sup>18</sup> <https://www.redcross.org/get-help/disaster-relief-and-recovery-services/contact-and-locate-loved-ones.html>
- <sup>19</sup> See <https://digital.osl.state.or.us/islandora/object/osl:68546> to obtain a digital copy of the Cascadia Subduction Zone Catastrophic Earthquake and Tsunami Operations Plan, accessed 10/17/19
- <sup>20</sup> <https://midlandusa.com/gmrs-or-frs-radio-how-to-choose/>
- <sup>21</sup> <http://www.eweb.org/about-us/news/2018-greenpower-grant-winners>
- <sup>22</sup> <http://www.eweb.org/residential-customers/rebates-loans-and-conservation/backup-generator-program>
- <sup>23</sup> <https://www.nwnatural.com/residential/safety/earthquakepreparedness>, accessed 11/1/19
- <sup>24</sup> Oregon: A Geologic History, "Foundation Phase", Oregon Department of Geology and Mineral Industries, 2009
- <sup>25</sup> Fisher, Richard et al. Volcanoes Crucibles of Change. Princeton University Press, 1998
- <sup>26</sup> U.S. Geological Survey, "Volcano Hazards Program", 2007
- <sup>27</sup> U.S. Geological Survey, "Science In the Decade 2007-2017": Circular 1309
- <sup>28</sup> Habitat for Humanity, "Habitat Ready Disaster Preparedness for Homeowners," 2017

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