PLANNING FOR NATURAL HAZARDS:

Seismic TRG

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Oregon Department of Land Conservation & Development

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Section 1:
Introduction to the Seismic Technical Resource Guide

Seismic hazards pose a significant threat in Oregon. The purpose of this guide is to help planners, local decision-makers, and community leaders reduce risk to life and property from seismic hazards. The guide is designed to help your local government address seismic hazard issues through effective comprehensive plan inventories, policies and implementing measures.

1.1 The Threat of Seismic Hazards to Oregon Communities

Seismic events have occurred since the formation of the earth and posed little threat to life and property until earthquakes began affecting developed areas.[1] Seismic events were once thought to pose little danger to Oregon communities. However, recent earthquakes and scientific evidence suggest that the risk is much higher than previously thought. Earthquakes combined with considerable publicity have increased seismic awareness in the state. Seismic hazards pose a real and serious threat to many communities in Oregon, requiring local governments, planners, and engineers to consider their community's safety. Currently, no reliable scientific means exist to predict earthquakes. Therefore, identifying seismic-prone locations, adopting strong policies and implementing measures and utilizing other mitigation techniques are essential to reducing risk from seismic hazards in your community.

Tip Box

Organization of Natural Hazards Technical Resource Guide:

The Natural Hazard Technical Resource Guide consists of eight chapters. The three preliminary *Planning for Natural Hazards* chapters include hazard-related information on reviewing your comprehensive plan, the elements of a comprehensive plan, and legal issues. Reviewing your comprehensive plan gives your community an opportunity to assess the adequacy of its existing natural hazard inventories and policies. The five hazard-specific chapters then provide detailed information on flood, landslide, coastal, wildfire, and seismic hazards. Appendices include information on Goals 2,7,17 and 18, a resource directory and a land use tools matrix for hazard mitigation.

1.2 How to use the Seismic Technical Resource Guide

The Seismic Technical Resource Guide provides information to help communities in Oregon plan for seismic hazards. Each section heading asks a specific question to help direct you through information related to strengthening your comprehensive plan's factual base, policies and implementing measures. This guide also contains numerous references and contacts for obtaining additional information about seismic hazards.

Section 2:
Is Your Community Threatened by Seismic Hazards?

Section 2 presents an overview of the causes and characteristics of earthquakes, and provides information to assist communities in seismic hazard identification.

Section 3:
What are the Laws in Oregon for Seismic Hazards?

Section 3 summarizes current laws that Oregon communities are required to address for seismic hazards.

Section 4:
How can Your Community Reduce Risk from Seismic Hazards?

Section 4 describes evaluation techniques for the development review process and hazard mitigation methods to help communities reduce risk from seismic hazards.

Section 5:
How are Oregon Communities Addressing Seismic Hazards?

Section 5 examines how several communities are implementing programs to reduce risk from seismic hazards. These examples illustrate plan policies, and implementing measures for seismic hazards.

Section 6:
Where can Your Community find Resources to Plan for Seismic Hazards?

Section 6 is a resource directory listing contacts, programs, and documents that planners, local governments and citizens can use to get more information on seismic hazards.

Section 2:
Is Your Community Threatened by Seismic Hazards?

Identifying hazard areas is a key step in developing effective plan policies and implementing measures to reduce loss of life and property damage. This section will assist your community in determining how seismic hazards may affect current and future development. An overview of the causes and characteristics of seismic hazards is included, along with information on identifying seismic hazards in your community.

2.1 What are the Specific Hazards Associated with Earthquakes?

Ground shaking, ground shaking amplification, liquefaction, landslides, tsunamis, and surface faulting are the specific hazards associated with an earthquake. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake. Information on the different types of earthquake hazards and mapping of high hazard areas are available from the Oregon Department of Geology and Mineral Industries (see Section 6 for contact information).

Tip Box

Goal 2

Oregon Statewide Planning Goal 2 requires cities and counties to develop a factual base (including inventories) as part of their comprehensive plans. Statewide Planning Goal 7 requires communities to inventory known hazards. Inventories contain facts about land use, natural resources, public facilities and development trends within the planning area, and provide the basis for comprehensive plan policies. Inventories must be periodically updated to reflect the best current information about resources, trends and local conditions that would affect plan decisions.

Sidebar

Glossary of terms:

This guide uses a number of technical terms in describing seismic hazards. Definitions of some of the terms are as follows:

- *Faults* – breaks in the earth's crust along which movement has taken place. Faults are found deep within the earth or on the surface (San Andreas Fault).
- *Ground shaking* – seismic waves felt on the earth's surface. Primary cause of damage during an earthquake.
- *Ground shaking amplification* – increase in ground shaking (and damages caused by earthquake) due to soil types that cause seismic waves to "amplify" and increase in strength.
- *Liquefaction* – occurs when ground shaking causes granular soils (e.g., sand, gravel and silt) to turn from a solid material into a liquid material. Soils lose strength and can no longer support the weight of buildings.
- *Magnitude*- the measure of the earthquake's size; the amount of energy released by an earthquake.
- *Subduction zone/Cascadia subduction zone* – Subduction describes the motion of one plate being pushed under another plate. In Oregon, there is high potential for a subduction zone earthquake due to the relationship between the Juan de Fuca plate and the North American plate. The area where the two plates are moving is known as the "Cascadia subduction zone."

2.1.1 Ground Shaking

Ground shaking is the motion or seismic waves felt on the earth's surface caused by an earthquake. Ground shaking is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault that is slipping, and distance from the epicenter (where the earthquake originates). Ground shaking can be amplified, that is intensified, or de-amplified by the near-surface soils and can also cause secondary hazards such as liquefaction and landslides. Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock. *Building construction and design play a vital role in the survival of a structure during earthquakes.* Wood structures tend to withstand earthquakes better than structures made of brick or un-reinforced masonry buildings.[2]

Ground shaking hazard maps, such as Department of Geology and Mineral Industries' (DOGAMI) Earthquake Hazard Maps for Oregon depict the ground shaking levels expected at three occurrence frequencies – every 500, every 1,000 and every 2,500 years. The maps indicate the general ground shaking level that a community needs to prepare for based on the three scenarios. *DOGAMI's maps are some of the most important sources of information for your community in evaluating seismic hazards.*[3]

2.1.2 Ground Shaking Amplification

Soils and soft sedimentary rocks near the surface can modify ground shaking caused by an earthquake. This modification may be increased amplification or decreased strength of shaking and may change the frequency of the shaking. How much amplification occurs is determined by the thickness of the geologic materials and their physical properties. Ground motion amplification will exacerbate the risk for buildings and structures built on soft and unconsolidated soils. Information on the potential for ground motion amplifaction is critical for evaluating your community's seismic hazards.

2.1.3 Surface Faulting

Faults are planes or surfaces in earth materials along which failure occurs. Materials on opposite sides of faults move relative to one another in response to the accumulation of stress.[4] Faults can be found deep within the earth or on the earth's surface. Earthquakes occurring from faults slipping deep within the earth usually only create ground shaking. Surface faults, such as the San Andreas in California, create ground shaking and ground displacement. With surface faults, avoidance is the most effective strategy because little can be done to prevent ground displacement. Collecting information about the faults, implementing mitigation and response strategies and understanding the risks your community faces is the best protection.[5]

2.1.4 Earthquake-Induced Landslides

Earthquake-induced landslides are secondary hazards that occur from ground shaking. These landslides can destroy roads, buildings, utilities and critical facilities necessary to recovery efforts after an earthquake. Many Oregon communities are built in environments with high potential for earthquake-induced landslide hazards. The potential for these types of landslides is greatest in areas with steep slopes.

TRG Key

Information regarding landslides and identification of landslide prone areas can be found in Section 2 of the Landslide Technical Resource Guide.

2.1.5 Liquefaction

Liquefaction occurs when ground shaking causes granular soils to turn from a solid state into a liquid state. This causes soils to lose their strength and their ability to support weight. When the ground can no longer support buildings and structures, buildings and their occupants are at risk.[6] When evaluating your community for seismic hazards, it is important to collect information on liquefiable soils for future planning, mitigation and response.

2.1.6 Tsunamis

Tsunamis are secondary hazards that are created from earthquakes under the ocean and cause flooding and damage to coastal communities. A tsunami, often incorrectly referred to as a “tidal wave,” is a series of gravity-induced waves that can travel great distances from the earthquake’s source and impact coastal areas.[8]

Definition Box

Granular soils are more likely to experience liquefaction during an earthquake. They are mainly comprised of gravel, sand, or silt. When combined with shallow groundwater, liquefaction potential increases in the event of an earthquake.[7]

Tsunamis pose a real threat to the Oregon coast in the event of a subduction zone earthquake. A tsunami is a series of waves rather than one large wave. Tsunamis, produced by *distant* subduction zone earthquakes, will arrive in several hours giving residents enough time to evacuate to higher ground. However, the initial tsunami produced by a *local* subduction zone earthquake will arrive within 5 to 30 minutes. The time of arrival depends on location. Southern coastal areas will have less time to evacuate than northern coastal areas. The waves will continue to arrive over an 8 to 10 hour period and it is important to stay away from low-lying areas until the official all clear is given.

After a Cascadia subduction earthquake (see glossary), there will be little time for evacuation. Residents should understand that local tsunami warning systems might not give sufficient notice of the impending danger. The warnings could sound at approximately the same time as the initial tsunami wave is inundating the coastline. Because a tsunami travels so quickly, it is important that coastal residents recognize shaking from a subduction zone earthquake as a “natural warning system” that signals the probable arrival of a major tsunami. Residents should immediately seek higher ground when ground shaking has occurred.[9]

To prevent and minimize damage from a tsunami, local officials should acquire tsunami inundation zone maps from DOGAMI. These maps show low-lying areas that could be affected during a tsunami. Communities are required by the State Building Code to ensure that critical facilities are not located in tsunami inundation zones. Information from the tsunami inundation zone maps can also be used to establish development-free zones if the community desires to regulate land use in these areas.[10]

2.1.7 Volcanoes

Volcanic activity can trigger earthquakes, just as earthquakes can trigger volcanic events. Volcanic-activated earthquakes are triggered as magma moves upward through the earth's crust. The magnitude and impact of a seismic event associated with a volcanic eruption is similar to that of an earthquake resulting from a crustal fault deformation. Additional information on volcanic eruptions and their relationships to seismic events can be found at the United States Geological Survey's Web page- **http://vulcan.wr.usgs.gov/home.html**.

2.2 What are the Types of Earthquakes in Oregon?

Based on historical records and geologic investigations, three types of earthquakes occur in Oregon: (1) shallow crustal fault; (2) deep intraplate; and (3) subduction zone earthquakes.

2.2.1 Earthquakes Occurring on Crustal Faults

When crustal faults slip, they can produce earthquakes of magnitudes up to 6.0 or greater. Although most crustal fault earthquakes are smaller than 4.0 and generally create little or no damage, some of them can cause extensive damage that tends to be localized in the vicinity of the area of slippage. Many areas, such as Portland, have crustal faults that could produce earthquakes with a magnitude greater than 6.0. The crustal earthquakes also pose high risks to Willamette Valley communities.

2.2.2 Deep Intraplate Earthquakes

Deep intraplate earthquakes occur at depths between 30 to 100 kilometers below the earth's surface. These earthquakes occur in the subducting oceanic crust and can be up to 7.5 in magnitude.

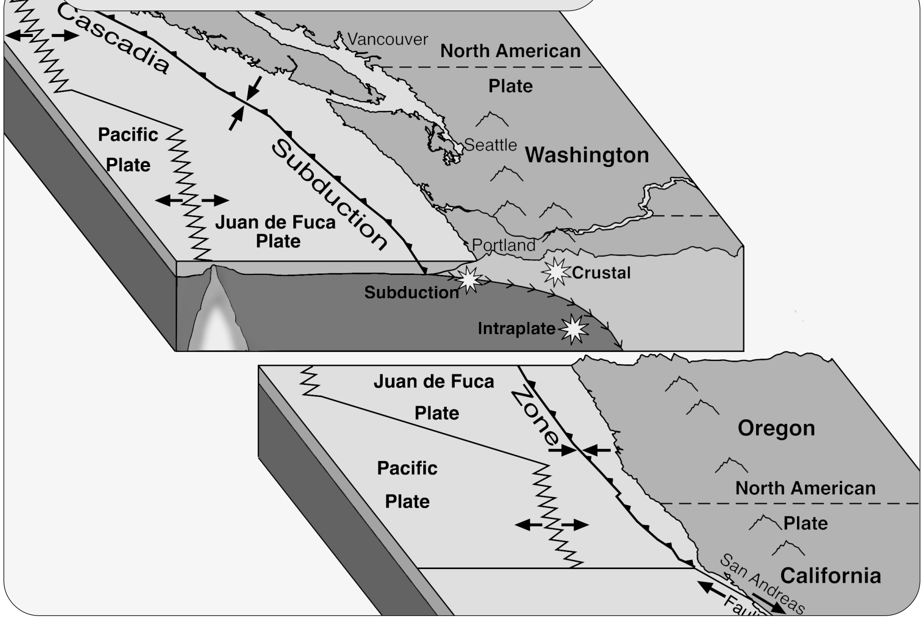
2.2.3 Subduction Zone Earthquakes

Subduction is a term that describes the motion of one plate being pushed under another, less dense plate. *Subduction zone earthquakes pose the most significant threat to Oregon's coastal residents*. Known as great thrust earthquakes, they occur at shallow depths below the ocean floor at the boundary between the two plates in the subduction zone. These earthquakes can be generated off the coast of Oregon along the sloping boundary between the descending Juan de Fuca plate and the North American plate. This area — known as the Cascadia subduction zone — could produce an earthquake of a magnitude 8.0 to 9.0, or greater. Earthquakes of this magnitude occur once every

500 to 600 years, with some gaps between events as little as 200 years and as large as 1000 years. The last major earthquake of this magnitude occurred in late January, 1700. An earthquake of this size would cause enormous damage to the coast and large portions of Western Oregon. In many areas, especially on the coast, liquefaction and landslides could damage buildings and their foundations, destroy bridges and cause massive loss of life. Shaking from a great subduction zone earthquake could last for as long as 5 minutes.

Although the Cascadia subduction zone is located off the Oregon and Washington coast, the amount of energy released in this type of earthquake would be catastrophic to the entire Northwest region, and would likely cause damage in Seattle and Portland. Disaster response would be severely limited with communities throughout Western Oregon and Washington seriously damaged.[11]

Cascadia Subduction Zone



Source: *Shoreland Solutions.* *Chronic Coastal Natural Hazards Model Overlay Zone. Salem, Ore.: Oregon Department of Land Conservation and Development (1998) Technical Guide-3.*

2.3 What is the Effect of Earthquakes in Developed Areas?

During an earthquake, serious damage may be caused by the displacement of faults and ground shaking. Damage created by earthquakes can be reduced through mitigation and preparation. Communities can identify seismic hazards by using maps produced by DOGAMI or by working with other geologists to conduct their own evaluations. Communities should enact local policies and ordinances to minimize damages and prepare communities for seismic events. Knowledge of seismic hazards in specific areas prior to development can potentially prevent property destruction. Buildings that were not built to any seismic standard often can be retrofitted and strengthened to help withstand earthquakes. [12]

Seismic Key

More information on reducing risk from seismic hazards can be found in Section 4 of this guide.

2.4 How can Your Community Identify Seismic-Prone Locations?

DOGAMI has released earthquake hazard maps for many communities in Western and Southern Oregon. These maps combine the effects of ground shaking amplification, liquefaction and earthquake-induced landslides to show the earthquake hazards relative to the local geologic conditions. All maps and CD-ROMs are available for purchase through Nature of the Northwest Information Center (see Section 6 of this guide for contact information). Communities may need additional technical assistance in interpreting the maps.

Creating multiple overlays that identify seismic risk areas on a map can help planners, policy makers, building code officials, and engineers understand which areas should have minimal development. Incorporating soil liquefaction potential, fault locations, tsunami run-up areas in coastal areas, past earthquake occurrences, groundwater level, and predicted ground response onto a single map will allow local decision makers to recognize potential threats before development projects are started.

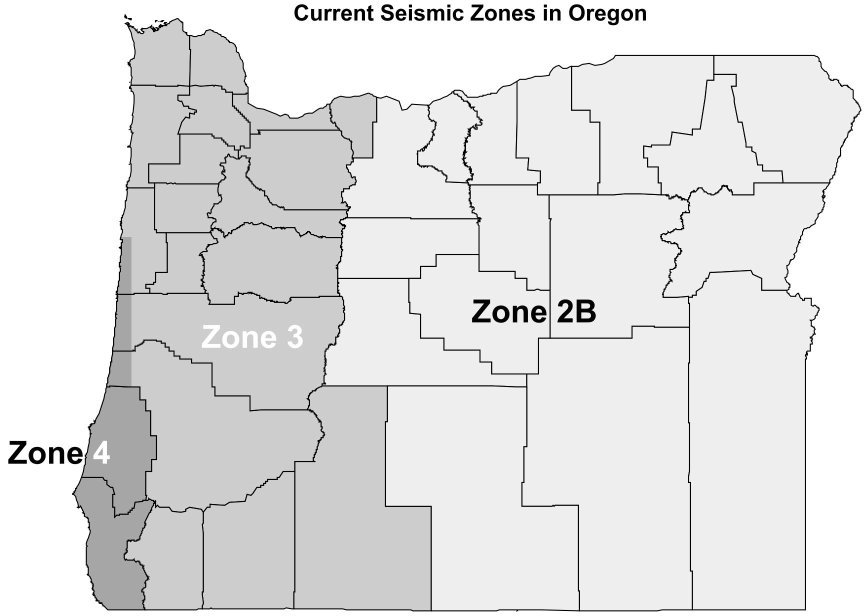
Until recently, earthquakes were thought to pose little risk to the residents of Oregon. This perception has changed dramatically with recent earthquake events and information provided by geological and soil science researchers. In response to this growing awareness, the *Oregon Building Codes Division* revised construction standards for new buildings to make them resistant to seismic events. The State Building Codes reflect three seismic zones. An increase in zone number reflects increased seismic activity.

Seismic Key

For more information on Oregon State Building Codes see Section 3.

Cascadia Subduction Zone

Current Seismic Zones in Oregon



Oregon Department of Geology and Mineral Industries

Source: *Shoreland Solutions.* *Chronic Coastal Natural Hazards Model Overlay Zone. Salem, Ore.: Oregon Department of Land Conservation and Development (1998) Technical Guide-3.*

Sidebar

Earthquake Zones in Oregon

- Zone 2 – Almost all counties east of the crest of the Cascades.
- Zone 3 – Most counties west of the crest of the Cascades (includes the Willamette Valley and the Portland Metro area).
- Zone 4 – All of Curry and Coos Counties and a thin band from Douglas County to just north of Newport in Lincoln County.

Zones are based on predicted ground motion and potential risk from large earthquakes within 50 years. New structures must be built to standards capable of resisting the forces caused by ground shaking applicable to the various seismic zones. For example, a structure in Zone 4 must be 33 percent stronger or more seismically resistant than a structure built in Zone 3. Oregon's coastal areas are subject to significant subduction-type seismic activity. The northern coast is currently Zone 3; however, based on new scientific data, consideration is being given to upgrading it to Zone 4.[14]

Sidebar

Earthquake Maps:

The Oregon Department of Geology and Mineral Industries (DOGAMI), in partnership with other State agencies and Federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards, including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in Oregon through DOGAMI. Refer to Section 6 of this guide for DOGAMI contact information.[13] As of June 2000, the following seismic hazard maps are available from DOGAMI:

Earthquake Maps

- Earthquake scenario and probabilistic ground shaking map for *Portland Hills (Multnomah, Washington and Clackamas Counties) 1999;* (map # IMS-16)
- Relative Earthquake Hazard Map – *Eugene-Springfield metro area – 1999; (map #*IMS 14*)*
- Earthquake Hazard Maps – *Coastal Oregon including Astoria-Warrenton, Brookings, Coquille, Florence-Dunes City, Lincoln City, Newport, Reedsport-Winchester Bay, Seaside-Gearhart-Cannon Beach and Tillamook – 1999;* (map # IMS 10)
- Earthquake Hazard Maps – *Ashland, Cottage Grove, Grants Pass, Sutherlin-Oakland and Roseburg – 1999;* (map # IMS 9)
- Earthquake Hazard Maps – *Canby-Aurora, Lebanon, Sweet Home, Woodburn-Hubbard, Silverton-Mt. Angel and Stayton-Sublimity-Aumsville – 1999;* (map # IMS – 8)
- Earthquake Hazard Maps – *St. Helens- Columbia City-Scappoose, Sandy, Hood River, McMinnville-Dayton-Lafayette, Newberg-Dundee, Sheridan-Willamina, and Monmouth-Independence – 2000;* (map # IMS-7)
- Relative Earthquake Hazard Map of the Portland Metro Region – *Clackamas, Washington and Multnomah Counties – 1997*
- Earthquake Hazards – *Salem (Polk and Marion Counties – 1996;* (map # GMS 105)
- Earthquake Hazards for Oregon – *1996;* (map # GMS 100)

Tsunami Maps

- Tsunami Hazard Map – *Warrenton area – Clatsop County – 1999;* (map # IMS 12)
- Tsunami Hazard Map – *Astoria area – Clatsop County – 1999;* (map # IMS 11)
- Tsunami Hazard Map – *Seaside-Gearhart – Clatsop County – 1997;* (map # IMS 3)
- Tsunami Hazard Map – *Yaquina Bay – Lincoln County – 1997;* (map # IMS 2)

Tsunami Hazard Map – *Siletz Bay – Lincoln County – 1995;* (map # GMS 99)

The Department of Geology and Mineral Industries maps are available from *The Nature of the Northwest Information Center* (503) 872-2750. Publications can also be ordered on line from **http://www.naturenw.org**. Descriptions of the maps are provided on the website. There is a small charge for these maps.

2.5 Summary: Identifying Seismic Hazards in Oregon

- ❑ Earthquakes produce a variety of hazards which can affect Oregon communities.
- ❑ Numerous hazard maps are available for seismic hazard identification in Oregon.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

Chapter 2: Elements of a Comprehensive Plan provides information on three phases of hazard assessment: hazard identification, vulnerability assessment and risk analysis. The factual base of your community's comprehensive plan should reflect a current inventory of all natural hazards and a vulnerability assessment. The inventory should include a history of natural disasters, maps, current conditions and trends. A vulnerability assessment will examine identified hazards and the existing or planned property development, current population, and the types of development at risk. A vulnerability assessment will set the foundation for plan policies.

Your community should ask the following questions in determining whether or not its comprehensive plan has adequately inventoried seismic hazards:

- ❒ Are there seismic hazards in your community?
- ❒ Does your comprehensive plan hazard inventory describe seismic hazards in terms of the geographical extent, the severity and the frequency of occurrence?
- ❒ Has your community conducted a community-wide vulnerability assessment?

Section 3:
What are Laws in Oregon for Seismic Hazards?

Oregon communities have a statutory mandate to develop comprehensive plans and implementing ordinances. As a part of the comprehensive planning process, cities and counties must address areas with "known" natural hazards. This section of the Seismic Guide presents laws that Oregon communities are required to address.

3.1 Oregon Laws Related to Seismic Hazards

3.1.1 Goal 7: Areas Subject to Natural Disasters and Hazards

Goal 7 is the Statewide Planning requirement that directs local governments to address natural hazards in their comprehensive plans. Goal 7 states that, "Developments subject to damage, or that could result in loss of life, shall not be planned or located in known areas of natural disasters and hazards without appropriate safeguards. Plans shall be based on an inventory of known areas of natural disasters and hazards..."

TRG Key

Information on Goal 7 can be found in Appendix A of the Natural Hazards Technical Resource Guide.

3.1.2 State Building Codes

The Oregon State Building Codes Division adopts statewide standards for building construction that are administered by the state, cities and counties throughout Oregon. The codes apply to new construction and to the alteration of, or addition to, existing structures. The One and Two Family Dwelling Code and the Structural Specialty Code (both included in the State Building Code) contain maps identifying the various seismic zones for Oregon, as described in Section 2 of this guide. The Structural Specialty Code is based on the 1997 edition of the Uniform Building Code published by the International Conference of Building Officials and amended by the state of Oregon. The Uniform Building Code contains specific regulations for development within seismic zones.[15]

Within these standards are six levels of design and engineering specifications that are applied to areas according to the expected degree of ground motion and site conditions that a given area could experience during an earthquake (ORS 455.447). The Structural Code requires a site-specific seismic hazard report for projects including essential facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures, such as large schools and prisons.

The seismic hazard report required by the Structural Code for essential facilities and special occupancy structures must take into consideration factors such as the seismic zone, soil characteristics including amplification and liquefaction potential, any known faults, and potential landslides. The findings of the seismic hazard report must be considered in the design of the building. The Dwelling Code simply incorporates prescriptive requirements for foundation reinforcement and framing connections based on the applicable seismic zone for the area. The cost of these requirements is rarely more than a small percentage of the overall cost for a new building.[16]

The requirements for existing buildings vary depending on the type and size of the alteration and whether there is a change in the use of the building to house a more hazardous use. Oregon State Building Codes recognize the difficulty of meeting new construction standards in existing buildings and allow some exception to the general seismic standards. Upgrading existing buildings to resist earthquake forces is more expensive than meeting code requirements for new construction. State code only requires seismic upgrades when there is significant structural alteration to the building or where there is a change in use that puts building occupants and the community at a greater risk. Your local building official is responsible for enforcing these codes.[17] Although there is no statewide building code for substandard structures, local communities have the option of adopting one to mitigate hazards in existing buildings. The state has adopted regulations to abate buildings damaged by an earthquake in Oregon Administrative Rules (OAR) 918-470. Oregon Revised Statutes (ORS) 455.020 and 455.390-400 also allow municipalities to create local programs to require seismic retrofitting of existing buildings within their communities. The building codes do not regulate public utilities and facilities constructed in public right-of-ways, such as bridges that are regulated by the Department of Transportation.

3.1.3 State Legislation

During the last ten years, the legislature has passed a number of laws that address the risk of earthquakes and encourage earthquake preparedness.

1991 Legislation:

The legislature passed Senate Bill 96 in 1991. This law requires site-specific seismic hazard investigations before the construction of essential facilities, hazardous facilities, major structures, and special-occupancy structures (e.g., hospitals, schools, utilities and public works, police and fire stations). These requirements are adopted into the State Building Code. The law also provides for the installation of strong-motion sensors in selected major buildings and mandates that school officials in all public schools lead students and staff in earthquake drills. (See Oregon Revised Statutes 455.447 and 336.071)[18]

1995 Legislation:

Fourteen earthquake-related bills were introduced during the 1995 session. Several passed, including a new requirement for earthquake education and tsunami drills to be conducted in public schools (ORS 336.071), a requirement for essential and special-occupancy structures to be built outside of tsunami inundation zones (ORS 455.446), provisions for the inspection and entrance of buildings damaged by earthquakes (ORS 455.448) and specific provisions for the abatement of buildings damaged by earthquakes. Senate Bill 1057 created a task force to evaluate the risks impacting existing buildings and make recommendations to the 1997 legislature.

1997 Legislation:

The Seismic Rehabilitation Task Force created in 1995 (see above) submitted House Bill 2139. The bill proposed an inventory over a period of six years to determine the type of construction and the degree of safety of each building in the state, excluding one- and two-family homes and other specific buildings. The bill also proposed that the time frame for retrofitting buildings identified as vulnerable to earthquake damage be: (1) within 15 years for unreinforced masonry (URM) buildings with parapets, signs, and other appendages, except for cornices and non-structural cladding, that may constitute a falling hazard during an earthquake; (2) within 30 years for the remainder of the URM buildings; and (3) within 70 years for all other unsafe buildings. This upgrading process was to have been encouraged by tax credits, property tax abatements and public education. House Bill 2139 was not passed, because of the fiscal impact and community priorities. However, it proposed good strategies that local communities may want to consider (see reference to local rehabilitation programs in the State Building Code subsection above).[19]

1999 Legislation:

Although the legislature considered several proposals on seismic safety, no new laws were adopted during the 1999 session.

3.1.4 Oregon Seismic Safety Policy Advisory Commission (OSSPAC) - ORS 401.337 to 401.353

OSSPAC is a state advisory commission created in February 1990 through an executive order from Governor Neil Goldschmidt. It is made up of 18 members with interests in earthquake safety including: Oregon Emergency Management, State Building Codes, and the Departments of Geology and Mineral Industries, Land Conservation and Development, and Transportation; two representatives from the Oregon state legislature; one local government representative; one member from education; three from the general public; and six members from affected industries, such as homebuilders and banking industries. The purpose is to reduce exposure to Oregon's earthquake hazards by: (1) developing and influencing policy at the federal, state and local levels; (2) facilitating improved public understanding and encouraging identification of earthquake risk; and (3) supporting research and special studies, appropriate mitigation and response and recovery.

The group has proposed legislative concepts to the State legislature on improving seismic safety in Oregon. They are currently preparing a document entitled "Oregon at Risk" discussing seismic hazards in the state. For information on OSSPAC, contact Oregon Emergency Management at 503-378-2911.

Tip Box

Preparation of Site Specific Hazard Reports

In 1996, the State of Oregon Boards of Geologists and Engineering Examiners prepared guidelines to assist in preparing site specific hazard reports for essential facilities, major structures and special occupancy structures as provided in Oregon Revised Statute (ORS) 455.447. A complete listing of all report elements is included in Section 2905 of the Oregon Structural Speciality Code.

3.2 Summary: Laws for Seismic Hazards

- ❒ Oregon Statewide Planning Goal 7: Areas Subject to Natural Hazards
- ❒ Oregon State Building Codes
- ❒ State Legislation
- ❒ Oregon Seismic Safety Policy Advisory Commission (OSSPAC)

Planning for Natural Hazards: Reviewing your Comprehensive Plan

Statewide Planning Goal 2 requires that comprehensive plan policies be supported by a sound factual base. Section 3 of the Seismic Technical Resource Guide describes laws that communities are required to address in comprehensive plans.

Your community should ask the following questions after identifying seismic hazards in your area:

- ❒ Does your community's comprehensive plan contain an inventory of seismic hazards, a vulnerability assessment and policies addressing seismic hazards?
- ❒ Has your community's comprehensive plan been updated to reflect the latest information on seismic hazards in your community?
- ❒ Does your comprehensive plan have policies and implementing measures to reduce risk to existing and future development in seismic hazard areas?

Section 4:
How can Your Community Reduce Risk from Seismic Hazards?

Seismic Key

Section 2 of this document provides information that can assist your community in identifying seismic hazards.

Avoiding development in hazard areas is the most effective way to reduce risk. There are, however, many areas in Oregon where some degree of hazard is unavoidable. Communities in vulnerable areas should manage and reduce their risk from seismic hazards if the risk cannot be completely eliminated.

Section 4 describes methods to evaluate site-specific development and other implementing measures to reduce risk from seismic hazards. Implementing measures are the ordinances and programs used to carry out decisions made in the comprehensive plan. They include zoning ordinances, and other land use regulations which directly regulate land use activities.

4.1 How can Your Community Plan for Seismic Hazards?

It is possible to plan, at least to some degree, for seismic hazards. The nature of your community's response will depend on severity of the hazard. Avoiding, or significantly limiting development in seismic areas through zoning and careful planning lessens the need for other types of mitigation measures, and is the safest strategy for reducing risks to development in the most dangerous locations.

To successfully plan for a seismic hazard, your community should consider the following steps:

- ✓ **Identify the hazard**
  Hazard identification is the first phase of hazard assessment and is part of the foundation for developing plan policies and implementing measures for natural hazards.

- ✓ **Avoid the hazard**
  Restrict development in hazard-prone areas. For areas with high density development and potential for severe property damage or loss of life, this option should be taken. This strategy works better for some seismic hazards like surface faulting, tsunamis, and liquefaction, than for other, less localized seismic events.

- ✓ **Evaluate site-specific development**
  Communities are required to follow building codes and should enact policies and measures to review site-specific development in seismic-prone areas.

- ✓ **Implement regulatory strategies through land use planning**
  Minimizing development in hazard areas through low density and regulated development can reduce risk of property damage and loss of life. This section provides information on specific land use planning and zoning measures.

Tip Box

The Three Levels of Hazard Assessment

1. Hazard Identification
2. Vulnerability Assessment
3. Risk Analysis

If your community identifies landslide hazards through a hazard identification process or a vulnerability assessment, you should adopt a process to review individual development permits in those landslide-prone areas. For further description of the three levels of hazard assessment, refer to Chapter 2: Elements of a Comprehensive Plan.

Seismic Key

For more information on identifying seismic hazards, refer to section 2 of this Chapter.

✓ **Implement non-regulatory measures**

Additional mitigation strategies and non-regulatory measures can further reduce risk from seismic hazards. *This section provides information on non-regulatory strategies in the home and business environment.*

4.2 How can Development Requests in Seismic-Prone Areas be Evaluated?

Conducting a site-specific evaluation prior to construction helps engineers design buildings to avoid or mitigate the possible effects of a seismic event. For example, if proposed construction occurs in sandy soils located in an area where seismic activity poses a threat, options include relocating the building, placing supports deep into the ground until they rest on a more stable soil or bedrock, or designing a foundation with a seismic base isolation system. Seeking technical assistance from engineering geologists or geotechnical engineers is highly recommended.

4.3 What Land Use Tools and Building Codes can be Used in Planning for Seismic Hazards?

Examples of land use techniques and other regulatory strategies that can be implemented include:

4.3.1 Identify the Hazard

Mapping areas that may pose seismic threats to the community is a potential regulatory requirement. The maps of seismic-prone areas should be incorporated into the local hazard inventory.

4.3.2 Zoning Ordinances

Zoning ordinances can address seismic hazards by restricting or prohibiting development in seismically active areas. This can be accomplished by creating hazard overlay zones to restrict development. The development of overlay zones is accomplished by mapping hazard areas within the community. Mapping is then coupled with supplemental standards that would contain setback regulations; clearing, excavation, and grading restrictions; and requirements for seismic evaluation of the site.

Other techniques include designating seismic hazard areas for open spaces such as parks or greenways or for low density uses. A tradeoff allowing already existing parks not in seismic hazard areas to be developed could potentially occur. Refusing new construction of “essential facilities” in seismic hazard areas such as tsunami inundation zones and over active fault systems will help ensure emergency services and lifelines remain open during a seismic event. Essential facilities are defined as hospitals and other medical facilities, fire and police stations, emergency-preparedness shelters, standby power generating facilities, and any structures required for emergency response. These services are essential to communities in case of an emergency and will need to be operating in the event of an earthquake disaster. Moving these types of facilities away from seismic hazards also will potentially steer private development and lifelines such as utilities and roadways away from high-risk areas.

4.3.3 Seismic Hazard Area Ordinances

Communities can adopt sensitive area ordinances that require an analysis of projects proposed to be located within designated seismic hazard areas. The resulting reports should address the nature of the hazard, and discuss what steps should be taken to minimize damage from earthquakes and the secondary impacts such as landslides.

4.3.4 Adopting an Ordinance for Mitigating Dangerous Buildings

Adopting an ordinance for retrofitting buildings at risk from seismic hazards allows local communities to focus on individual buildings that may be structurally vulnerable or unsound. A Hazardous Building Abatement ordinance, usually based on the ICBO Code for Abatement of Dangerous Buildings, allows the building official or local enforcement officer to require property owners to abate hazardous conditions. The property owner is required to bring a particular building classified as hazardous or substandard, closer to compliance with the current building code, or face demolition or condemnation of that building. The owner is liable for repairs or demolition costs.

Seismic Key

Refer to Section 5 for more information on Portland and seismic hazards.

4.3.5 Creating a Local Rehabilitation Program for Existing Buildings

Creating a local rehabilitation program for existing buildings by incorporating FEMA regulations in combination with a dangerous building code for retrofitting buildings to withstand earthquakes can be accomplished through ordinances. (Refer to *FEMA Standard 237*: *Seismic Rehabilitation of Buildings – Phase I, Issues Identification and Resolution* and related FEMA publications). Seismic Rehabilitation Programs are authorized by Oregon statute in ORS 455.020 and 455.390-400. In order to implement such a program, an inventory of existing buildings including such information as their occupancy, age, construction type, general condition and configuration is needed. An inventory is necessary to evaluate whether the buildings should be rehabilitated and strengthened. Unreinforced masonry buildings, structures containing hazardous materials and essential facilities such as hospitals, fire and police stations and water treatment plants, are buildings that should be considered for upgrade depending on their condition. Incentive programs and fundraising are options for smaller communities needing to accomplish retrofitting projects. California has used this type of program extensively and the city of Portland has also adopted a local program based on these standards.

4.3.6 Adoption of Local Development Standards

Adoption of local development standards for installation and construction of utility services and roads, or “adequate public facilities”, is critical to local communities. Such facilities are essential to emergency response and must be able to function following a seismic event. Public water mains are “looped” in order to provide fire or domestic service if part of a water line is broken by a slide or ground movement. Sometimes it is possible to design multiple routes for gravity sewer lines or back-up power if sewer lines are on lift (pump) stations. Standards for street and bridge construction and installation of utilities help to ensure these facilities resist damage. The Oregon Department of Transportation and American Public Works Association are developing and publishing a joint set of construction standards.

4.4 What are Additional Methods to Reduce Risk from Seismic Hazards?

Mitigation through the use of non-regulatory, voluntary strategies allows communities to gain cooperation, educate the public and provide solutions to ensure safety in the event of an earthquake.

4.4.1 Public Education and Outreach[20]

Public education and outreach can be inexpensive and provide information that results in safer households, work places and other public areas. Some outreach materials include: informational brochures about community seismic risks and mitigation techniques, public forums, newspaper articles, training classes and television advertisements.

Examples of non-structural improvements to homes and businesses that could be included in public education and outreach materials are:

- Anchor bookcases and filing cabinets to nearby walls.
- Install latches on cabinet doors and drawers to prevent contents from spilling.
- Move heavier items down to lower shelves and put ledge barriers on the end of shelves.
- Attach computers, televisions and appliances to desks or countertops.
- Apply safety film to windows.
- Secure water heaters to a nearby wall to prevent fire damage.
- Install a main gas shut-off device and ensure the location of the shut-off switch is known.
- Attach the home or structure to a foundation to prevent the structure from sliding. If the building has a perimeter foundation then the sill plate must be bolted to the foundation. If there are support wood studs running from the foundation to the first floor then checks should be made by professionals to ensure adequate bracing exists.
- Secure masonry chimneys to the framing of the roof to prevent them from collapsing. Have a professional inspect the chimney after it has been secured.

4.4.2 Incentive Programs

Incentive programs include a variety of benefits to building owners or developers that help to offset the cost of mitigation. The following incentives can be established through ordinance, policy or cooperative agreements:

- *Density bonuses* that shift development away from a hazardous site, but do not penalize the developer by reducing number of units.
- *Tax credits* to reduce a property owner's tax liabilities. Using conservation easements for tax break incentives on land that is deemed seismically hazardous is a viable way to use the tax credit system. This option allows a community to maintain open spaces while restricting development in hazard areas.
- *Property tax incentives or deferrals* can be authorized by ordinance to offset the costs of voluntary rehabilitation of existing buildings.
- *Real estate disclosures* provide homebuyers with incentives to take action pertaining to seismic hazards. Knowledge of a potentially hazardous area ensures that the homebuyer is more aware of existing dangers and encourages the purchase of earthquake insurance, upgrading the existing structure or not moving into the hazardous area at all.
- *Property Acquisition or purchase of development rights* places management responsibilities for hazard areas into the hands of local officials. Once the land is purchased, it may be managed to protect public safety.
- *Increased funding of public infrastructure programs* can help to upgrade lifeline infrastructure.
- *Phasing retrofitting projects* over a set time frame allows upgrades as more money becomes available.

Seismic Key

More detailed examinations of community seismic hazard mitigation measures for Portland and Klamath Falls, Oregon are included in Section 5 of this guide.

4.5 What are Examples of Seismic Mitigation Activities?

4.5.1 Corvallis, Oregon

The City of Corvallis has adopted a local grading and excavation ordinance based on Appendix Chapter 33 of the 1994 Uniform Building Code (UBC). Section 3309.7 states, "The building official may require a geotechnical investigation in accordance with Sections 1804.2 and 1804.5 (of the UBC) when, during the course of an investigation the report shall address the potential for liquefaction when all of the following conditions are discovered:

1. Shallow ground water, 50 feet (15,240mm) or less.
2. Unconsolidated sandy alluvium.
3. Seismic Zones 3 and 4."[21]

Corvallis has adopted this local standard to make it clear that they will require a geotechnical study of soil conditions where liquefaction soils may exist.

Tip Box

The 1998 Oregon Structural Speciality Code contains similar provisions for local adoption in Appendix Chapter 38.

4.5.2 Seattle, Washington

In 1990 the city hired seismic and design analysts to determine the seismic resistance of city-owned buildings. Fire and police stations were given top priority and those deemed unsafe have been retrofitted to meet structural requirements in the event of an earthquake.[22]

4.5.3 East Bay Municipal Utility District (EBMUD), California

The EBMUD provides water to over 1.2 million people in the San Francisco area. One of the most active faults in California bisects the service district. In 1994, the EBMUD started a ten-year, $189 million capital improvement program that would secure facilities and water for fire prevention, and restore water to customers within 10 days of a catastrophic earthquake.[23]

4.5.4 Berkeley, California

In 1992, Berkeley started its Hazard Mitigation Bond Program with the passage of two general obligation bond measures and the establishment of municipal residential upgrade incentive programs. Berkeley upgraded every major public building and installed secondary water supply systems to protect the water system in the event of an earthquake. The city provided incentives to non-profit agencies and property owners by giving a waiver on all permit fees for seismic upgrades, a 1.5% transfer tax rebate on upgrade costs, funding for low-income homes, and mitigation courses for tenants and landlords. Berkeley is currently looking at funding options with local banks involving low-interest loans for homeowners under the federal Community Reinvestment Act.[24]

4.5.5 Monroe, Washington and Tigard, Oregon

Children in elementary schools are involved in programs that teach safe practices in the event of an earthquake. School children in both locations practice earthquake drills and learn what precautions to take in the event of an earthquake. FEMA has a similar program for children called “Quake Ready.” Oregon schools are required to practice earthquake drills along with their regular fire drills.[25]

4.5.6 Summary of Community Programs

These programs, ideas and community examples are just a few that are currently in place nationally. In general, most activities related to reducing seismic hazards have been associated with building codes, public education and fiscal incentives to retrofit existing structures. There will be greater opportunities to use traditional land use planning tools as communities have better information on seismic hazards and better inventories of structures that are at risk. Every community should develop their own strategies consistent with local conditions and community support. Public education and outreach are essential in establishing successful seismic mitigation programs.

4.6 Summary: Reducing Your Community's Risk from Seismic Hazards

- ❒ *Avoid the hazard* if possible, since risk reduction techniques can be very expensive or may not be feasible in areas prone to seismic hazards.
- ❒ *Reduce the level of risk* in hazard-prone areas by minimizing development, reducing density, or implementing mitigation measures if developing in hazard-prone locations is unavoidable.
- ❒ *Evaluate development* in seismic-prone locations. Evaluation can happen through local government regulations and by understanding the geology of the area. Technical assistance from state agencies such as DOGAMI can assist in hazard mapping and assessment.
- ❒ *Consider non-regulatory strategies* such as retrofitting existing houses and businesses, and dedication of land for open space to reduce risk from seismic hazards.
- ❒ *Provide public outreach* and information sessions for residents and potential residents living in seismic-prone terrain regarding the hazards and steps residents can take to protect themselves.
- ❒ *Research mitigation strategies* used by other communities located in seismic-prone areas.

TRG Key

Refer to the Comprehensive Plan Evaluation Guide Chapter 2 for more information on developing inventories and a listing of critical facilities.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

Implementing measures tied to specific actions are essential to carrying out plan policies in a comprehensive plan. Your local government should ask the following questions in assessing the adequacy of your comprehensive plan in addressing the level of seismic hazard:

- ❒ Do your comprehensive plan policies authorize lower density zoning provisions for areas of high vulnerability to natural hazards?
- ❒ Has your community implemented a process for evaluating site-specific development?
- ❒ Does your community have an approach to reduce risk from seismic hazards through a combination of regulatory and non-regulatory measures?
- ❒ Do the implementing measures carry out your comprehensive plan's policies related to seismic hazards in your community?

Sidebar

The report produced by the herein mentioned Portland study is entitled *Earthquake Risk Analysis, Volumes 1 & 2*. This report can be obtained through publishers Goettel & Horner Inc, 2725 Donner Way, Sacramento,CA 95818 (916)451-4160

Section 5:
How are Oregon Communities Addressing Seismic Hazards?

Section 5 describes how two Oregon communities are addressing seismic hazards.

5.1 Innovative Approaches to Seismic Retrofits in Portland, Oregon

Background

In 1993, revisions to the Uniform Building Code and the upgrade of seismic zones in Oregon caused Portland to identify many of its buildings as potentially dangerous. To minimize the impact on building owners and the real estate market, the city did not require these buildings to be immediately retrofitted. The city instead targeted owners who were requesting building permits. The city concentrated on improving unreinforced masonry buildings (URMs), whose seismic design load is considerably weaker than that of other buildings. The city formed a seismic task force comprised of building owners, banks, engineers, and architects. Portland first obtained an inventory of buildings within the Portland Metro area. They partnered with Portland State University (at a cost of $12 per building) to conduct inspections of buildings to identify those at risk from seismic hazards.

Portland also funded a study concerning the level of risk the city faces and the potential cost of rehabilitating the buildings in their community. The report from this study discusses the following topics: (1) a review of Portland's earthquake hazards from known faults or fault zones; (2) an assessment of the life safety risks associated with some classes of buildings when subjected to the range of future earthquakes that can affect Portland; (3) an analysis of the benefits associated with life safety seismic retrofits of vulnerable existing buildings compared to the typical costs of such retrofits; and (4) conclusions regarding the types, locations and uses of buildings that would be good candidates for seismic retrofit. Out of these discussions, Chapter 24.85 from Title 24 of Portland's City Code was formulated.

Title 24 Building Regulations

Chapter 24.85 addresses seismic-specific upgrades to existing buildings, design standards, building additions and alterations, and the phasing of improvements. It applies to building permits seeking to change the occupancy, add square footage, or otherwise alter the building. There must be a seismic evaluation performed if structural work is planned for any building built prior to 1974.

Portland Title 24 Outline – Building Regulations

Chapter 24.85 – Interim Seismic Design Requirements for Existing Buildings
Added by Ordinance No. 168627 passed March 22, 1995.

- General Provisions
- Seismic Definitions

- Design Standards
- Change of Occupancy (list of relative hazards and occupancy classifications)
- Building Additions
- Building Alterations

For information or the actual building regulations contact the City of Portland: City Information and Referral; City Hall; 1221 SW 4th Ave.; Portland, OR 97204. The code is also available online at **http://ordlink.com/codes/portland/index.htm**.

Funding retrofitting projects can be costly and a burden to many property owners. To offset these costs, Portland has developed some creative ideas to fund these upgrading projects. Upgrades can be phased in over a maximum ten-year period from the start of the project to its completion. Phasing allows the property owner to upgrade over a period of time without having to fund the entire project in one large payment. Tax incentives can be awarded to those willing to upgrade a structure to meet seismic regulations.

Communities can use Portland's work in seismic regulations as a model in developing their own building regulations.

Tip Box

To find information on California rehabilitation, contact the Governor's Office of Emergency Services to obtain "*Bay Area Regional Earthquake Preparedness Project, Seismic Retrofit Incentive Programs, A Handbook for Local Governments*" dated fall 1992, document number P92001BAR. The Office can be reached via Association of Bay Area Governments, PO Box 2050, Oakland, CA 94604-2050, (510) 464-7900.

5.2 Reducing Seismic Risk in Klamath Falls, Oregon

Background

Klamath Falls is located in the south-central part of Oregon, just north of the Oregon-California border. The city is situated in an earthquake prone area between the High Cascades volcanic regime and the Basin and Range system of faulting. Klamath Falls has experienced minor earthquakes since the 1950's. On September 20, 1993, earthquakes hit 16 to 20 miles west-northwest of Klamath Falls. At 8:15 pm, a foreshock earthquake (a smaller earthquake preceding larger events) of magnitude 3.9 struck. Two main shocks registered at magnitudes of 5.9 and 6.0. The earthquakes were felt over a 300 by 200 mile radius and caused extensive damage in Klamath Falls resulting in the deaths of two people.

Public facilities sustained damages of over $1.6 million, while 940 residences suffered at least minor damages involving cracked walls, broken windows, collapsed chimneys, and damaged plumbing. Businesses reported damages exceeding $2 million, while other non-residential structures estimated damages around $260,000.

Two miles north of Klamath Falls, The Oregon Institute of Technology (OIT) experienced non-structural damage, including toppled bookcases and filing cabinets, and collapsed storage shelves. Most of the structural damage was limited to buildings with brick walls.[26]

Funding Seismic Risk Reduction

After the earthquakes, FEMA hosted a series of informational workshops on earthquake mitigation and preparation. The Physical Plant Director at the OIT attended the workshops and found ways to obtain grants from FEMA to help repair non-structural damage. He obtained a $10,000 grant from FEMA, which OIT used to anchor bookcases and furniture over five feet tall to the walls. OIT allocated remaining funds to initiate other non-structural improvements on OIT's campus.[27]

OIT no longer builds with brick and continues to anchor new shelves and furniture. Construction is now completed with steel frames and insulated, Styrofoam stucco walls and panels that will not collapse. Stresses from earthquakes are concentrated to the reinforced corners of buildings.

Implementing Measures

As a result of the destructive 1993 earthquake mentioned above, Klamath Falls adopted a dangerous building ordinance. At the time of this guide's production, the city is considering three additions to their ordinance based on what Portland has done. Contact City of Klamath Falls at (541) 883-5316 for more information on the ordinance and these additions.

5.3 Summary: Oregon Communities Addressing Seismic Hazards

Portland is using a Variety of Tools to Address Seismic Hazards Including:

- Analysis of Portland's seismic risks;
- Updating building code provisions to address modifications to existing structures and the requirements for seismic retrofitting;
- Phase-in period for retrofit requirements providing building owners with time to fund the project; and
- Incentives to help offset retrofit costs including tax credits.

In Klamath Falls:

- Oregon Institute of Technology sought funding to help pay for retrofitting. Mitigation measures were put into place including: anchoring bookshelves, changing building practices to reflect the seismic hazard and no longer builds with brick.
- A dangerous building ordinance was adopted after 1993 earthquake damage.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

Your comprehensive plan should be coordinated with and reflect other comprehensive plans, plan policies and implementing measures of other communities within your region. Natural hazards do not respect community boundaries making it important to coordinate with other jurisdictions in your area. In reviewing your comprehensive plan, your community should ask the following questions in developing plan policies and implementing measures for seismic hazards:

- ❒ What policy measures would assist your community in planning for the seismic hazard?
- ❒ Is your comprehensive plan consistent with plans or actions of other jurisdictions and regional plans and policies (such as school, utilities, fire, park, and transportation districts)?
- ❒ Are there communities that face similar seismic threats that have developed ordinances or non-regulatory programs that could be adopted by your community?

SideBar

The Governor's Interagency Hazard Mitigation Team (GIHMT) is an important organization for interagency coordination, formalized by Governor Kitzhaber after the 1996-97 flood and landslide events. One of the most important roles of the GIHMT is to provide a forum for resolving issues regarding hazard mitigation goals, policies and programs. The team's strategies to mitigate loss of life, property and natural resources are reflected in the state's *Natural Hazards Mitigation Plan*. This plan is dubbed the "409 plan" since it is required by section 409 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 93-288). The GIHMT reviews policies and plans and makes recommendations with an emphasis on mitigation and education. Representatives from Oregon Emergency Management staff the GIHMT.

Section 6: Where can Your Community find Resources to Plan for Seismic Hazards?

This section is a resource directory including contacts, documents, and internet resources to assist planners, local governments and citizens in obtaining further information on seismic hazards.

6.1 State Agency Resources

Oregon Department of Geology and Mineral Industries (DOGAMI)

The mission of the Department of Geology and Mineral Industries is to serve a broad public by providing a cost-effective source of geologic information for Oregonians and to use that information in partnership to reduce the future loss of life and property due to potentially devastating earthquakes, tsunami, landslides, floods, and other geologic hazards. The Department has mapped earthquake hazards in most of western Oregon.

Contacts: Deputy State Geologist, Seismic Hazards Team Leader,
Tsunami and Coastal Hazards Team Leader
Address: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
Phone: 503-731-4100
Fax: 503-731-4066
Website: **http://sarvis.dogami.state.or.us/homepage/**

The Nature of the Northwest Information Center

The Nature of the Northwest Information Center is operated jointly by the Oregon Department of Geology and Mineral Industries and the USDA Forest Service. It offers selections of maps and publications from state, federal and private agencies. DOGAMI's earthquake hazard maps can be ordered from this site.

Address: Suite 177, 800 NE Oregon Street # 5, Portland, Oregon 97232
Phone: (503) 872-2750
Fax: (503) 731-4066
Hours: 9 am to 5 pm Monday through Friday
E-mail: Nature.of.NW@state.or.us

Oregon Department of Consumer & Business Services - Building Codes Division

The Building Codes Division (BCD) sets statewide standards for design, construction and alteration of buildings that include resistance to seismic forces. BCD is active on several earthquake committees and funds construction related continuing-education programs. BCD registers persons qualified to inspect buildings as safe or unsafe to occupy following an earthquake and works with OEM to assign inspection teams where they are needed.

Contact: Building Codes Division
Address: 1535 Edgewater St. NW, P.O. Box 14470
Salem, Oregon 97309-0404
Phone: (503) 378-4133
Fax: (503) 378-2322
Website: **http://www.cbs.state.or.us/external/bcd**

Oregon State Police (OSP)-Office of Emergency Management (OEM)

The purpose of OEM is to execute the Governor's responsibilities to maintain an emergency services system as prescribed in Oregon Revised Statutes Chapter 401 by planning, preparing and providing for the prevention, mitigation and management of emergencies or disasters that present a threat to the lives and property of citizens of and visitors to the State of Oregon. OEM coordinates the initial response to an earthquake including on-site inspectors providing damage assessment. OEM also holds a statewide emergency response exercise pertaining to a possible Cascadia subduction zone earthquake, however the last one was in 1994 and the next one is not scheduled until 2002.

Contact: Earthquake and Tsunami Program Coordinator
Address: 595 Cottage St. NE, Salem, Oregon 97301
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: **http://www.osp.state.or.us/oem/**

6.2 Federal and Regional Agency Resources

Federal Emergency Management Agency (FEMA)

FEMA is heavily involved with seismic risks in Oregon and has aided in several projects in Portland and Klamath Falls. The Federal Emergency Management Agency (FEMA) is an independent agency of the federal government, reporting to the President. FEMA's purpose is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA provides disaster relief funds following a natural hazard and works most closely with Oregon Emergency Management (OEM).

Contact: Public Affairs Officer
Address: Federal Emergency Management Agency, Federal Regional Center
130 228th Street, St., Bothell, WA 98021-9796
Phone: 425-487-4610
Fax: 425-487-4690

U.S. Geological Survey (USGS)

The USGS is an active seismic research organization that also provides funding for research. (For an example of such research, see *Recommended Seismic Publications* below).

Contact: USGS, National Earthquake Information Center
Address: Box 25046; DFC, MS 967; Denver, Colorado 80225
Phone: 303-273-8500
Fax: 303-273-8450

Building Seismic Safety Council (BSSC)

The Building Seismic Safety Council (BSSC) established by the National Institute of Building Sciences (NIBS), deals with the complex regulatory, technical, social, and economic issues and develops and promotes building earthquake risk mitigation regulatory provisions for the nation.

Address: 1090 Vermont Avenue, NW, Suite 700, Washington, DC 20005-4905
Phone: (202) 289-7800
Fax: (202) 289-109
Website: **http://www.bssconline.org/**

Western States Seismic Policy Council (WSSPC)

The WSSPC is a regional organization that includes representatives of the earthquake programs of thirteen states (Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming), three U.S. territories (American Samoa, Commonwealth of the Northern Mariana Islands and Guam) one Canadian Province, and one Canadian Territory (Yukon). The primary aims of the organization have been: to improve public understanding of seismic risk; to improve earthquake preparedness; and, to provide a cooperative forum to enhance transfer of mitigation technologies at the local, state, interstate, and national levels.

The mission of the Council is to provide a forum to advance earthquake hazard reduction programs throughout the western region and to develop, recommend, and present seismic policies and programs through information exchange, research, and education.

Contact: WSSPC, Executive Director
Address: 121 Second Street, 4th Floor; San Francisco, CA 94105
Phone: (415) 974-6435
Fax: (415) 974-1747
Email: wsspc@wsspc.org
Website: **http://www.wsspc.org**

National Tsunami Hazard Mitigation Program (NTHMP)

The National Tsunami Hazard Mitigation Program is a state/federal partnership created to reduce the impacts of tsunamis to U.S. coastal states by coordinating the state efforts of Alaska, California, Hawaii, Oregon, and Washington with federal activities of the National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency(FEMA), and the United States Geological Survey (USGS). The three main areas of focus are hazard assessment, warning guidance, and mitigation

Contact: NTHMP, Chair
Address: NOAA/PMEL; 7600 Sand Point Way; Seattle WA 98115
Phone: (206) 526-6800
Fax: (206) 526-6815
Website: h**ttp://www.pmel.noaa.gov/tsunami-hazard**

Cascadia Region Earthquake Workgroup (CREW)

The Cascadia Region Earthquake Workgroup provides information on regional earthquake hazards, facts and mitigation strategies for the home and business office. The Cascadia Region Earthquake Workgroup (CREW) is a coalition of private and public representatives working together to improve the ability of Cascadia Region communities to reduce the effects of earthquake events. Members are from Oregon, Washington, California and British Columbia. Goals are to:

- Promote efforts to reduce the loss of life and property.
- Conduct education efforts to motivate key decision makers to reduce risks associated with earthquakes.
- Foster productive linkages between scientists, critical infrastructure providers, businesses and governmental agencies in order to improve the viability of communities after an earthquake event.

Contact: CREW, Executive Director
Address: 1330A S. 2nd Street, #105; Mount Vernon, WA 98273
Phone: (360) 336-5494
Fax: (360) 336-2837
Website: **http://www.crew.org**

6.3 Recommended Seismic Publications

The following list groups documents into three categories: primary, secondary, and technical. Documents listed as primary are those that every community should have in its resource library. Secondary documents are not as essential as primary documents and may not be readily accessible, yet they still provide useful information to communities. Technical documents are those that focus on a particular specialized aspect of seismic hazard mitigation.

Primary Resources

These documents represent the principal resources communities can use to better plan for a seismic hazard. They are key tools for reducing the risks associated with seismic-prone areas.

<u>Environmental, Groundwater and Engineering Geology: Applications for Oregon – Earthquake Risks and Mitigation in Oregon</u> Yumei Wang, (1998) Oregon Department of Geology and Mineral Industries, Star Publishing.

> This paper deals with earthquake risks in Oregon, what is being done today and what policies and programs are in action to help prevent loss and damage from seismic events. This article also gives a good list of organizations that are doing work in this field within the state. This article is somewhat technical but provides vital information to communities around the state.
>
> *To obtain this document***:** It may be difficult to obtain this document as it is part of a larger book edited by Scott Burns of Portland State University. Try contacting DOGAMI at 503-731-4100 or the Nature of the Northwest Information Center at 503-731-4444.

<u>Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners</u>, Wolfe, Myer R. et. al., (1986) University of Colorado, Institute of Behavioral Science, National Science Foundation.

> This handbook provides techniques that planners and others can utilize to help mitigate for seismic hazards. It provides information on the effects of earthquakes, sources on risk assessment and effects of earthquakes on the built environment. The handbook also gives examples on application and implementation of planning techniques to be used by local communities.
>
> *To obtain this document:* Contact the University of Colorado's Natural Hazards Research and Applications Information Center at (303) 492-6818.

Strategic Design and Applications of Earthquake Hazard and Risk Characterizations, Dr. John Beaulieu, DOGAMI

This document provides the reader with concise information on strategies for local earthquake hazards zoning and for risk determinations and loss estimations within a community. It also informs the reader of strategies to use for zonation mapping, risk assessments and loss estimation in developing local policy.

To obtain this document: Contact DOGAMI at 503-731-4100.FEMA Standards. An existing inventory giving required upgrades and building stock. To obtain these standards: Call 1-800-480-2520

Planning for Natural Hazards: Reviewing your Comprehensive Plan

Coordination and consistency is essential to implementing plan policies that reduce seismic risk within your community. Your community should ask the following questions in reviewing your comprehensive plan to assist you in identifying resources to strengthen plan policies and implementing regulations:

- ❒ Have you made use of technical information and assistance provided by agencies to assist your community in planning for seismic hazards?
- ❒ What documents or technical assistance does your community need to find to further understanding of seismic hazards and begin the process of assessing community risk from seismic hazards?

Sidebar

Project Impact: Building Disaster Resistant Communities

FEMA's Project Impact is a nationwide initiative that operates on a common sense damage reduction approach, basing its work and planning on three simple principles:

1. Preventive actions must be decided at the local level;
2. Private sector participation is vital; and
3. Long-term efforts and investments in prevention measures are essential.

Project Impact began in October of 1997 when FEMA formed partnerships with seven pilot communities across the country. FEMA offered expertise and technical assistance from the national and regional level and used all the available mechanisms to get the latest technology and mitigation practices into the hands of the local communities. FEMA has enlisted the partnership of all fifty states and U.S. Territories, including nearly 200 Project Impact communities, as well as over 1,100 businesses.[28]

Benton, Deschutes, and Tillamook counties, and Multnomah County with the city of Portland are the Oregon communities currently participating in this initiative to build disaster resistant communities. Application for participation in the program in Oregon is through the Oregon State Police: Office of Emergency Management in Salem.[29] For more information about Project Impact visit http://www.fema.gov on the World Wide Web (http://www.fema.gov/impact/impact00.htm), or contact the Oregon State Police: OEM.

Secondary Resources

These documents provide additional information and tools for reducing the risks associated with seismic-prone areas.

Earthquakes, Bolt, Bruce A., University of California, Berkeley, W.H. Freeman and Company, (1995) New York.

Using Earthquake Hazard Maps: A Guide for Local Governments In the Portland Metropolitan Region, Spangle Associates, (1998) Urban Planning and Research, Portola Valley, California, October.

The Great Earthquake Experiment, Mileti, Dennis, (1993) Westview Press.

Putting Down Roots in Earthquake Country, (1995) USGS.

Evaluation of Earthquake Hazard Maps for the Portland Metropolitan Region, Spangle Associates, (1999) June.

Risk Reduction Strategies for Geologic Hazards – A Reference Manual for Oregon, John Beaulieu & Dennis Olmstead (1999) DOGAMI.

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USGS Response to an Urban Earthquake, Northridge '94, Prepared by USGS for FEMA (1996) Open-File Report 96-263.

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Technical Resources

The documents listed here focus on the technical aspects of seismic hazard mitigation. They may require interpretation by a technical specialist.

Shaping the Earth - Tectonics of Continents & Oceans, Moores, Eldridge M., University of California at Davis, W.H. Freeman and Company, (1990) New York.

The Behavior of the Earth, Allegre, Claude, (1988) Harvard University Press.

A Method for Producing Digital Probabilistic Seismic Landslide Hazard Maps: An Example from the Los Angeles, California, Area, Jibson, Randall W., et. al., (1998) U.S. Department of the Interior and USGS, Open File Report 98-113.

The Geology of Earthquakes, Yeats, Sieh, Allen (1997) Oxford University Press.

6.4 Internet Resources

Federal Emergency Management Agency

http://www.fema.gov/pte/prep.htm

The Federal Emergency Management Agency (FEMA) Preparedness, Training, and Exercises Directorate provides "fact sheets" - including preparedness tips - concerning most natural and technological hazards. This website is the primary source for questions and to find out what is being done throughout the country in hazard mitigation. Go to this website before going to any others. The collection includes:

http://www.fema.gov/library/quakef.htm - "Fact Sheet: Earthquakes"

http://www.fema.gov/library/tsunamif.htm - "Fact Sheet: Tsunamis"

EQNet

http://www.eqnet.org

EQNet is a collaborative effort of many of the institutions providing earthquake information in the U.S. It is a free, one-stop source for locating Internet information related to earthquake hazards mitigation.

The U.S. Geological Survey

http://quake.wr.usgs.gov or http://www.socal.wr.usgs.gov

The U.S. Geological Survey's Western Region Earthquake Hazards Information home page is an excellent place to begin any search for seismic information. It includes pages on the latest seismic events, earthquake hazard preparedness, and all other aspects of earthquakes. It also has an entire section devoted to the 1906 San Francisco earthquake and an extensive and notated list of other Web quake sites.

The Western Region's Pasadena Office Southern California Earthquake Information Page, at the second URL above, offers real-time earthquake data of the region, as well as information about past, present, and future quakes. It also provides USGS papers, reports, and other products concerning the 1994 Northridge, California quake, as well as maps, links, and a raft of other useful information about earthquakes.

http://geohazards.cr.usgs.gov

The USGS Central Region Geologic Hazards Page covers earthquakes, landslides, and geomagnetism. The earthquake section (http://geohazards.cr.usgs.gov/eq) offers numerous products related to the USGS national seismic hazard-mapping program. For example, users can look up the seismic hazard in any part of the continental U.S. by zip code, and the section also includes a custom-mapping feature, through which the user can specify latitude and longitude bounds and produce customized hazard maps of the selected area. Additionally, large versions (24"x36") of the national and western U.S. seismic hazard maps can be ordered using forms available from the Web site.

http://www.neic.cr.usgs.gov

The USGS's National Earthquake Information Center Web site comprises pages and pages, maps and maps of seismicity information from around the world. It offers general information about the center and its services, current quake information, general quake information, and access to other earthquake information sources. In addition, users can now search the National Earthquake Information Services (NEIS) historical database to identify historical seismic events (2100 B.C. to the present) for any location, using several user-defined parameters.

The Central United States Earthquake Consortium (CUSEC)

http://www.cusec@cusec.org

The CUSEC is comprised of the following public-private sector partners. Five core organizations: CUSEC State Geologists, Institute for Business and Home Safety (IBHS), the Mid-America Earthquake Center (MAE), FEMA, and USGS. Nine additional partners include the Federal Department of Transportation, Federal Highway Administration (FHWA), Association of Contingency Planners (ACP), Disaster Recovery Business Alliance (DRBA), Extreme Information Infrastructure (XII), Institute of Gas Technology (IGT), American Society of Civil Engineers (ASCE) and USGS Mid-Continent Mapping Center (MCMC).

NISEE

http://www.eerc.berkeley.edu/library/websites.html

The NISEE Web site provides a nice "Yahoo-like" guide to other Internet sources of earthquake information. This page, updated regularly, links to about 200 multidisciplinary earthquake engineering and engineering-related sites by subject, and includes a search engine as well as category listings. The main categories are: Seismology and Geophysics; Geotechnical Engineering; Structural Engineering; and Policy, Planning and Economics; and each of these categories then includes four or more subcategories. Sites providing educational resources (on-line library databases, etc.) are clearly marked with a special icon.

MAE Center

http://mae.ce.uiuc.edu/

The MAE Center is one of three national earthquake engineering research centers established by the National Science Foundation and its partner institutions. The MAE Center consists of a consortium of seven core institutions, and is funded by NSF and each core university as well as through joint collaborative projects with industry and other organizations. Center projects fall under four general types: 1) research, 2) implementation of research results, 3) education and 4) outreach. The center's Web site offers more information about the organization, its goals and intended products, each of its core programs - coordinated research, essential facilities, transportation networks, hazards evaluation, outreach, and education - as well as recent news from the center.

The Southern California Earthquake Center

http://www.scec.org

The Southern California Earthquake Center (SCEC) is a Science and Technology Center of the National Science Foundation that brings scientists together for joint research to reduce vulnerability to earthquake hazards in Southern California. The formal mission of the center is to promote earthquake hazard reduction by estimating when and where future damaging earthquakes will occur, calculating the expected ground motion, and disseminating that information to the public. The SCEC Home Page contains background information about SCEC, links to its many member academic institutions, and pages of information on the Southern California earthquake hazard. Both the SCEC newsletter and SCEC publications list are available from this site, which also, includes an Earthquake Hazard Analysis Map (http://scec.gps.caltech.edu/PhaseII.html) - a map of probable future Southern California earthquakes, as well as abundant seismic data available from the SCEC Seismic Data Center (**http://www.scecdc.scec.org**).

Natural Hazards Center

http://www.colorado.edu/hazards/sites/sites.html

The Natural Hazards Center contains more information on websites pertaining to seismic hazards. This site provides other internet links that will complement the specific websites mentioned above.

Seismic Endnotes:

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[14] Oregon Building Codes Division

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[20] Protect Your Home Against Earthquake Damage, Institute for Business and Home Safety, 175 Federal Street, Suite 500, Boston, MA. 02110-2222, August, 1999.

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[23] (ibid.)

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[25] (ibid.)

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[29] OEM Murray, Joseph. Personal Interview. 9 Feb 2000.