Chapter 11
Earthquake

(Hazard Analysis Score = 203)

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Why are Earthquakes a threat to Beaverton?

Social and geological records show that Oregon has a history of seismic events. Recent research suggests that the Cascadia Subduction Zone is capable of producing magnitude 9 earthquakes.

Geologists scrutinizing soil layers in a 12-foot-deep trench have uncovered more evidence that the Portland Hills Fault is able to generate earthquakes. The fault runs in a northwest-southeast direction from about the northern edge of Forest Park, along the foot of Portland's West Hills and under downtown Portland. It crosses beneath the Willamette River between the Marquam and Ross Island bridges, runs under Milwaukie and ends about a mile south of the Clackamas River near Oregon City and Gladstone. Sediment layers in the trench were deformed by an earthquake roughly 10,000 years ago, recent enough for the fault to be labeled "active," the scientists said. They also have found clues that two quakes may have occurred on the hidden fault. Deformation of soil deposits both at the school site and the trench suggest that the ancient earthquake may have measured about a magnitude 6.5. That would be a moderate quake that could cause substantial damage.[1]

The existence of other active faults in the Portland Metro Area and other areas of the state are suspected but not confirmed in many cases. Where known to exist, it is believed that they are capable of generating magnitude 7 earthquakes.

Earthquakes pose a serious threat to many Oregon communities. The state ranks third in the nation for future earthquake damage estimates in the future. Projected losses in the Cascadia region alone could exceed $12 billion, destroy 30,000 buildings, and take 8,000 lives in the event of a magnitude 8.5 Cascadia Subduction Zone earthquake.[2] Local governments, planners, emergency managers, and engineers must consider this threat as they seek to balance development and risk. Identifying locations susceptible to seismic activity generated by local faults or the Cascadia Subduction Zone, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in Beaverton.[3]

Historical Earthquake Events

Several moderate earthquakes have affected Beaverton in the past century. Little damage has occurred in Beaverton as a result, but the earthquakes have rattled nerves, and served to remind residents that their community is at risk of experiencing damaging earthquakes. Multiple small quakes have been occurring in the Portland metro area over the past couple of years. Though most have been too small to be felt in Beaverton it demonstrates the seismic instability of the region. Recent events of note included a magnitude 3.0 earthquake on July 25, 2003 that occurred 9.19 miles NW of Portland and a magnitude 3.3 earthquake that occurred 3.54 miles SSE of Mt. Hood on July 7, 2003.[4]

April 24, 2003, 3.9 Magnitude Earthquake

A 3.9 magnitude earthquake occurred in the Portland area on April 24, 2003. This quake was the largest quake to be generated by a fault under the Portland area in over 40 years. The quake was followed by seven aftershocks and smaller-deeper tremors were detected for several weeks after.[5] The quake was centered 15.8 km northwest of Portland and 42.0 km north of Canby.

February 28, 2001, Nisqually Earthquake- Magnitude 6.8

The most recent earthquake to be felt in Beaverton was the Nisqually earthquake, on February 28, 2001. This earthquake was centered northeast of Olympia, Washington, and measured 6.8 on the Richter scale. In the Puget Sound area, this quake caused 400 injuries, one quake-related death, and about $2 billion dollars in damage.[6] In Beaverton, many employees of various businesses went out into parking lots and streets in reaction to the quake, but no damage was caused by it. According to Karen Eubanks of Tualatin Valley Fire and Rescue, Washington County's 911 system was "jammed for several minutes with callers wanting to know more about the quake."[7] While Oregon experienced little damage from this earthquake, it reminded residents what can happen during major earthquakes.

Ironically, the Portland Metropolitan area was planning an earthquake drill in April of 2001 as part of Earthquake Awareness Month, called "Metroshake."[8] This drill involved all cities in the Portland Metropolitan area, as well as Portland Emergency Management, Multnomah County, the State Office of Emergency Management, and the Tualatin Valley Water District, among others. The drill simulated a 6.0 Magnitude quake centered under Lake Oswego, and was run for the purpose of identifying problems in the emergency procedures and plans among cities and agencies.[9] According to chief controller of the Metroshake exercise Scott Porter, "It's really ironic. The 6.8 magnitude quake (in Seattle) happened at 5 minutes to 11:00 A.M., and our scenario was set for 11:00. It's really kind of scary."[10]

March 25, 1993, Scotts Mills Earthquake- Magnitude 5.7

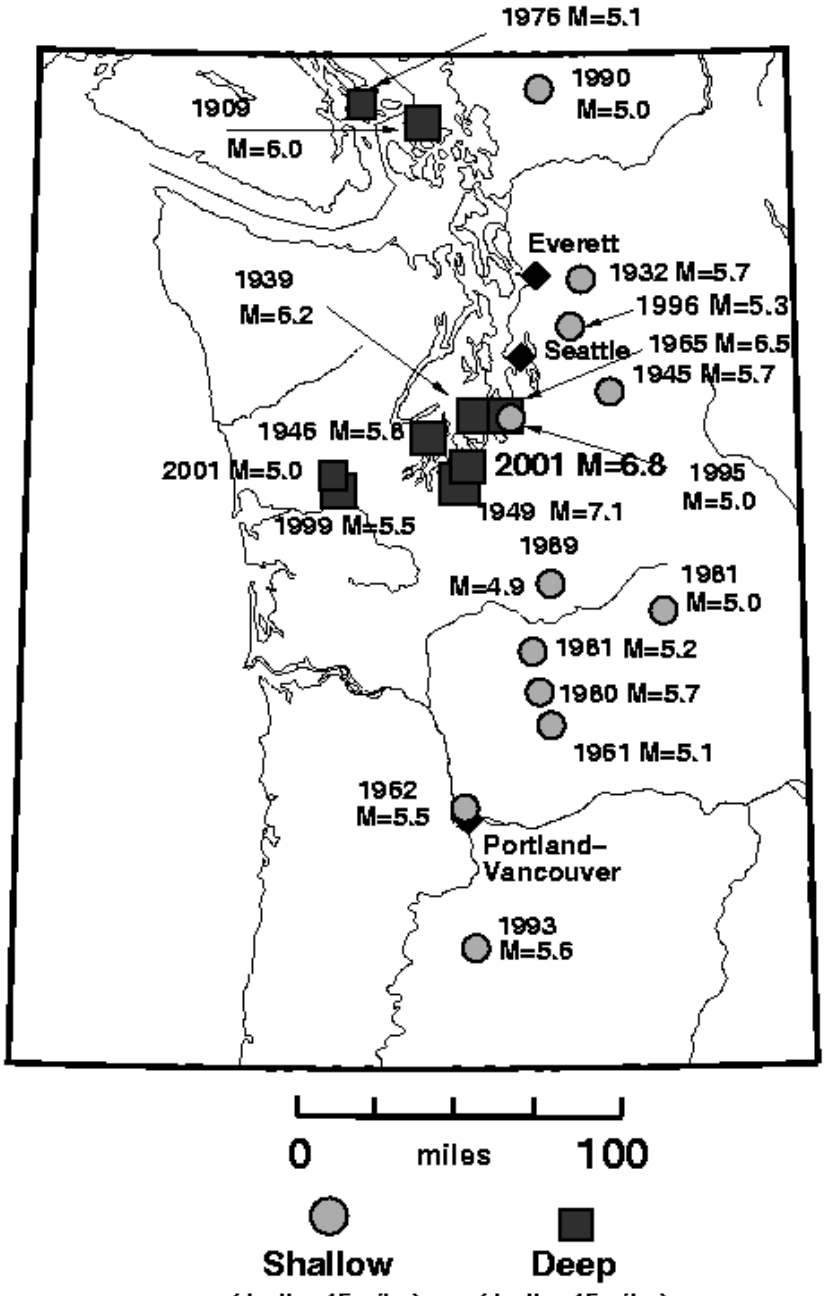
In 1993, the Scotts Mills earthquake (also known as the "Spring Break Quake") shook Beaverton. It was a magnitude 5.7 on the Richter scale, and caused extensive damage primarily in the communities of Molalla, Woodburn, Newberg, McMinnville, and Salem. In Beaverton, some cracks that were already in school walls got larger. The quake trapped one man in an elevator because the electric motor shorted during the shaking.[11] In addition, the *Valley Times* reported that only 4% of Oregonians were insured at the time of this earthquake.[12] By comparison, the household survey indicated that 57% of respondents had earthquake insurance in 2003.

November 5, 1962, Vancouver, Washington- Magnitude 5.2

Three and a half weeks after the devastating Columbus Day Storm, an earthquake that measured approximately 5.2 on the Richter scale shook the Portland area. It was the largest quake to be generated by a fault

under Portland and Vancouver.[13] According to the *Valley Times,* there were no reports of significant damage from the quake in Beaverton. Grocery stores did report rolling of canned goods, but little damage occurred.[14] This earthquake disappeared quickly from headlines, most likely because residents were still recovering from the Columbus Day Storm at the time of the earthquake.[15]

Figure 11-1. Selected Pacific Northwest Earthquakes since 1872



Source: Pacific Northwest Seismograph Network.
www.geophys.washington.edu/SEIS/PNSN/INFO_GENERAL/hist.html

April 13, 1949, Olympia, Washington- Magnitude 7.1

On April 13, 1949, Beaverton residents felt an earthquake that was centered near Olympia, Washington. In Washington, this quake caused 8 deaths. In Beaverton, the only damages incurred were a few cracked chimneys and fallen plaster.[16] Beaverton High School closed its doors at noon, shortly after the earthquake. According to the school's superintendent, this was not because of the danger, but because the quake left them little concern for their studies.[17]

Causes and Characteristics of Earthquake in Beaverton

Most large earthquakes in the Pacific Northwest are shallow crustal, deep intraplate, or subduction zone earthquakes. These earthquakes can have great impact on Oregon communities. The city of Portland, which lies just east of Beaverton, has at least three crustal faults beneath it. There are several crustal faults near Beaverton that could generate an earthquake of magnitude 6.5 or larger.

Crustal Fault Earth quakes

Crustal fault earthquakes are the most common of earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.[18] While most crustal fault earthquakes are smaller than magnitude 4.0 and generally create little or no damage, they can produce earthquakes of magnitudes 7.0 and higher and cause extensive damage. The 30-mile long Portland Hills Fault, which runs in a northwest to southeast direction through Portland, was confirmed to be an active fault by DOGAMI in May 2001.[19] This indicates that Portland and its neighbors could face future damages from a magnitude 6.5 or larger earthquake.[20]

Deep Interplate Earthquakes

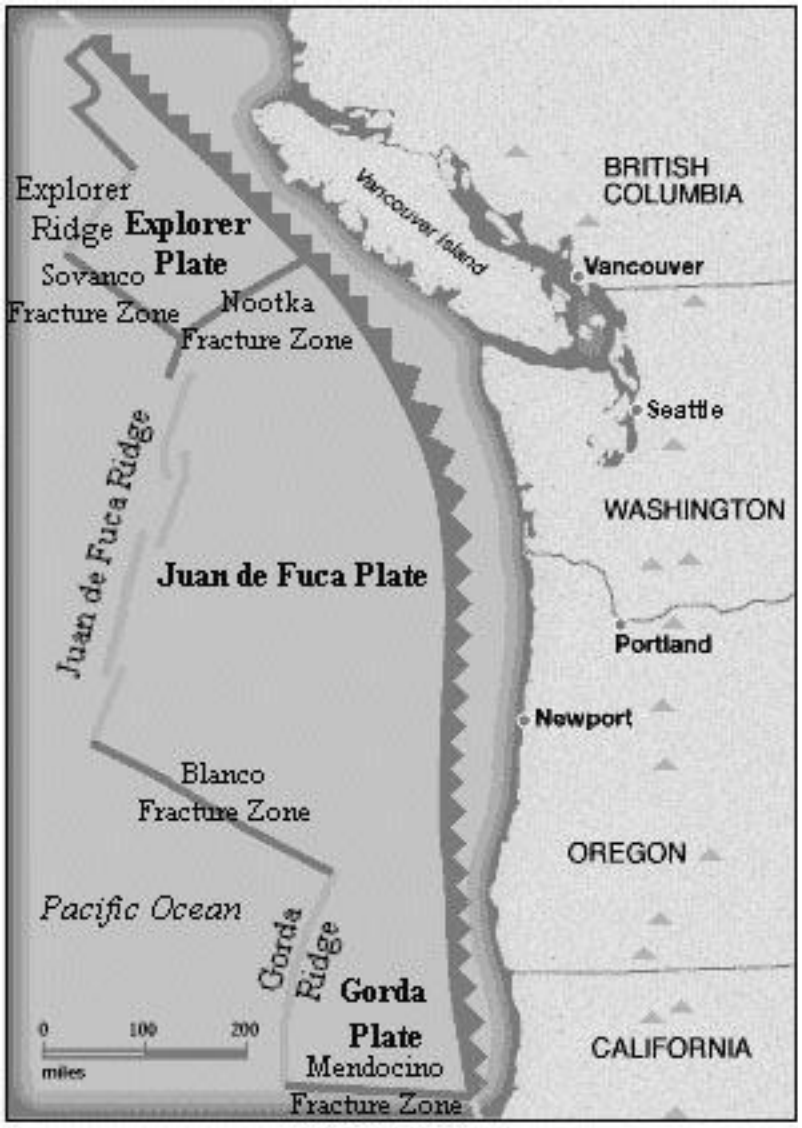
Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach magnitude 7.5.[21] The February 28, 2001 earthquake in Washington State was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah. A 1965 magnitude 6.5-intraplate earthquake centered south of Seattle-Tacoma International Airport caused seven deaths.[22]

Subduction Zone Earthquakes

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1-2 inches per year. This boundary is called the Cascadia Subduction Zone (see Figure 11.2). It extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress. Subduction zones similar to the Cascadia Subduction Zone have produced earthquakes with magnitudes of 8.0 or larger. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5) and the 1964 southern Alaska (magnitude 9.2) earthquakes. Geologic evidence shows that the Cascadia Subduction Zone has generated great

earthquakes, most recently about 300 years ago. It is generally accepted to have been magnitude 9.0 or greater. The average recurrence interval of these great Cascadia earthquakes is approximately 500 years, with gaps between events as small as 200 years and as large as 1000 years. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon including Beaverton. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.[23]

Figure 11-2. Cascadia Subduction Zone



Source: Department of Land Conservation and Development. www.lcd.state.or.us/coast/hazards/juandefucaplates.htm

Earthquake Related Hazards

Ground Shaking

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-Related Landslides

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy roads, buildings, utilities, and other critical facilities necessary to respond to and recover from an earthquake. Many communities in Oregon, including Beaverton, are likely to encounter such risks, especially in areas with steep slopes. As the City annexes sloped lands to the northeast and southwest, earthquake-related landslides will begin to pose a bigger threat to homes and infrastructure.

Liquefaction

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.[24] Areas of susceptibility to liquefaction include areas with ground water tables and sandy soils.[25]

Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. Amplification depends on the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.[26] Amplification can also occur in areas with deep sediment filled basins. The Tualatin Valley is a good example. The thick sediments and the bowl shape of the basin combine to amplify ground shaking.[27]

Community Earthquake Issues

Earthquake damage occurs because structures cannot withstand severe shaking. Buildings, airports, schools, and lifelines, including: water and gas lines, transportation systems, electricity, and communication networks suffer damage in earthquakes and can cause death or injury to humans.

The welfare of homes, businesses, and public infrastructure is very important. Addressing the integrity of buildings, critical facilities, and infrastructure, and understanding the potential costs to government,

businesses, and individuals as a result of an earthquake, are challenges that Beaverton faces.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people, putting lives at risk and creating great costs to clean up the damages. Changes in the seismic zone rating for the Willamette Valley, in 1990 and 1993, lead to corresponding increases in the construction standards for buildings being built in Beaverton and the rest of the Willamette Valley. In 1993, the seismic zone for the Willamette Valley was upgraded from 2B to 3, requiring stricter construction standards. In most Oregon communities, including Beaverton, many buildings were built before 1993 when building codes were not as strict. Upgrading existing buildings to resist earthquake forces is more expensive than meeting code requirements for new construction. Current building codes only require seismic upgrades when there is significant structural alternation to the building or where there is a change in use that puts building occupants and the community at a greater risk. Therefore, the number of buildings at risk remains high. The lack of funding for such activity is a major issue. Some of the buildings in the old downtown area of Beaverton are more susceptible to earthquake damage because they are made of unreinforced brick and concrete. Although coordination among county and city building code officials is in progress, much work remains to be done to identify and plan for the risks to older structures.

Infrastructure and Communication

Residents in Beaverton commute frequently by automobile and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community – it disconnects people from work, school, food, and leisure, and separates businesses from their employees, customers, and suppliers.

Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link – with even minor damages making some areas inaccessible. Because bridges vary in size, materials, siting, and design, any given earthquake will affect them differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made. Much of the interstate highway system was built in the mid to late 1960's.

Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems,

electricity, and communication networks. Ground shaking and amplification can cause pipes to break, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. All lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

Businesses

Seismic activity can cause great loss to businesses – both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to small shop owners who may have difficulty recovering from their losses. According to the business survey conducted as part of this plan, most businesses could remain closed for only two days before suffering serious economic hardship.

Individual Preparedness

A 1999 DOGAMI survey shows that about 39% of respondents think an earthquake will occur in Oregon within the next 10 years. Only 28% of Oregon residents say they are prepared for an earthquake, and 22% have earthquake insurance. In addition, only 24% correctly identified what to do during an earthquake.[28] According to the household survey conducted in conjunction with the development of this plan, earthquake was one of the respondents' top concerns. Also, as reported earlier, around 56.6% of respondents have insurance for earthquakes.

Because the potential for earthquake occurrences and earthquake-related property damage is relatively high, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property as well as being insured for earthquake, are just a few steps individuals can take to prepare for an earthquake.

Death and Injury

Death and injury can occur both inside and outside of buildings due to falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life. Deaths can be prevented with proper building design and individual preparedness.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer structural or lifeline damage, quick response to suppress fires is less likely. Therefore, it is necessary for fire stations and critical facilities to be well protected from natural disasters.

Debris

Following damage to structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

Earthquake Hazard Assessment

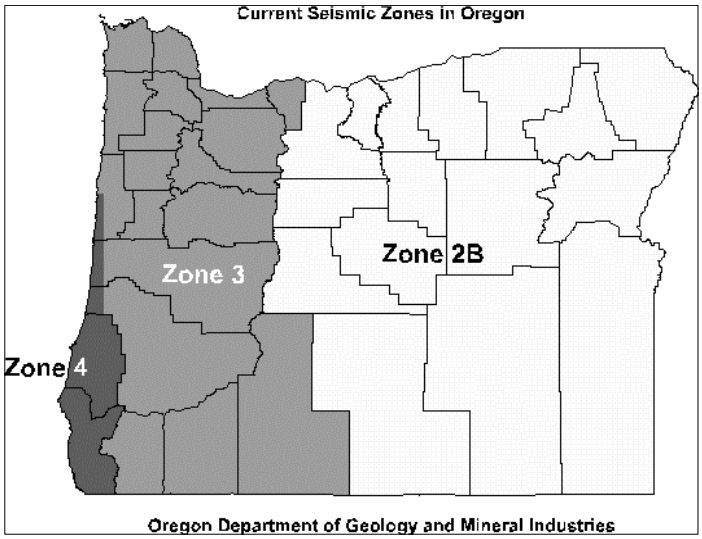
Hazard Identification

The Department of Geology and Mineral Industries (DOGAMI), in partnership with other state and federal agencies, has undertaken a rigorous program in Oregon to identify seismic hazards and risks, 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.[29]

The Oregon Building Codes Division revised and upgraded its construction standards for new buildings to make them resistant to seismic events. The change in State Building Codes reflects updated seismic zones (see Figure 11.3). An increase in zone number reflects increased risk of seismic activity. Many buildings in Beaverton were built prior to the imposition of the new seismic zone code requirements, established in 1993.

(New 12/2010) Establishing a probability for earthquakes is difficult and could vary between the types of earthquakes that could impact the City. Based on history, there is a high probability that an earthquake will occur in the region that could be felt in Beaverton. The probability of a damaging earthquake however is harder to determine. The 2008 United States National Seismic Hazard Map shows that the City lies in an area where there is a 2% chance in a 50 year period that it will experience significant horizontal shaking. The level of shaking is expressed as a percentage "g" which is the rate of acceleration of a falling object due to gravity. The region that includes Beaverton will experience horizontal shaking of at a level of 32 to 48% of "g."[30]

Figure 11-3. Seismic Zones in Oregon



Vulnerability Assessment

The effects of earthquakes span a large area, and an earthquake occurring in the city would probably be felt throughout the county. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges, many high tech and hazardous material facilities, extensive sewer, water, and natural gas pipelines, a petroleum pipeline, and other critical facilities and private property located in the city. The areas that are particularly vulnerable to potential earthquakes in the city have been identified as those areas near the crustal fault lines.

The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

Risk Analysis

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experience in a geographic area over a period of time. Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the city due to an earthquake event in a specific location. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available. DOGAMI is leading state initiative in producing relative earthquake maps and conducting risk analyses of various regions in the state.

Table 11-1 presents preliminary damage figures for Washington County for both an 8.5 Cascadia subduction zone event and a 500-year event. This data is not currently available on the city-level. It should be noted that the figures have a high degree of uncertainty and should be used only for general planning purposes.[31]

Table 11-1. Estimated Earthquake Damage Summary for Washington County

Washington County	8.5 Cascadia Subduction Zone event	500-year model
Injuries	555	2,910
Deaths	10	62
Displaced Households	2,062	7,666
Short term shelter needs	1,284	4,660
Economic losses for buildings	$931 million	$3.8 million
Operational the day after the quake:		
Fire Stations	66%	NA
Police Stations	64%	NA
Schools	64%	NA
Bridges	79%	NA
Economic losses to:		
Highways	$15 million	$61 million
Airports	$5 million	$23 million
Communication Systems:		
Economic losses	$752,000	$4 million
Operating the day of the quake	60%	NA
Debris generated (Thousands of tons	763	2,817

Source: Wang, Y., and J.L. Clark, "Earthquake damage in Oregon: Preliminary estimates of future earthquake losses", Special Paper 29, DOGAMI, 1999, p 57.

Existing Mitigation Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazards mitigation plans and planning literature, guidance from the Beaverton Natural Hazards Mitigation Steering Committee, and interviews with both Beaverton and Washington County stakeholders. The goals for the City of Beaverton Natural Hazards Mitigation Action Plan are broad based to include all of the identified hazards addressed in the plan. Goals for this mitigation plan address four categories:

1. Protect Human Life, Commerce, Property and Natural Systems
2. Improve Hazard Communication and Coordination through Partnerships
3. Enhance Emergency Services
4. Ensure Implementation of Mitigation Activities

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, or federal agencies or organizations.

City Programs

Building Codes

The City's Building Division is responsible for enforcing the State of Oregon Building Codes, which incorporate seismic considerations. These "Codes" are the laws that regulate how a building is to be constructed, ranging from how strong the walls must be, to how much insulation must be in them.

Local Seismic Upgrades

The City of Beaverton is currently undergoing seismic upgrades to the City's water system including the water facilities and reservoirs. [32] [33] The City also completed structural upgrades to City Hall with a Hazard Mitigation Grant from DHS/FEMA and non-structural seismic upgrades to its Operations Department facilities using general funds.

Exercises (Revised 03/2011)

City personnel participated in earthquake Exercises in 2003, 2008 and 2009. These exercises simulated the occurrence of a large subduction zone earthquake off the coast of Oregon. The purpose of the exercises was to test the City's procedures in response to a large earthquake, and to identify short and long term efforts needed to respond to a large-scale disaster.[34]

State Programs

State Building Codes[35]

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.[36]

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.[37]

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. The 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.

Senate Bill 13: Seismic Event Preparation

Senate Bill 13, signed by Governor John Kitzhaber on June 14, 2001, requires each state and local agency and persons employing 250 or more full-time employees to develop seismic preparation procedures and inform their employees about the procedures. Further, the bill requires agencies to conduct drills in accordance with Office of Emergency Management guidelines. These drills must include "familiarization with routes and methods of exiting the building and methods of duck, cover and hold during an earthquake."

Senate Bill 14: Seismic Surveys For School Buildings

The Governor signed Senate Bill 14 on July 19, 2001. It requires the State Board of Higher Education to provide for seismic safety surveys of buildings that have a capacity of 250 or more persons and are routinely used for student activities by public institutions or departments under

the control of the board. A seismic safety survey is not required for any building that has previously undergone a seismic safety survey or that has been constructed to the state building code standards in effect for the seismic zone classification. Subject to available funding, if a building is found to pose an undue risk to life and safety during a seismic event, a plan shall be developed for seismic rehabilitation or other seismic risk reducing activities. All seismic rehabilitation or other actions to reduce seismic risk must be completed before January 1, 2032, subject to available funding.

Senate Bill 15: Seismic Surveys For Hospital Buildings

Governor John Kitzhaber signed Senate Bill 15 on July 19, 2001. It requires the Health Division to provide for seismic safety surveys of hospital buildings that contain an acute inpatient care facility. Seismic surveys shall also be conducted on fire stations, police stations, sheriffs' offices, and similar facilities subject to available funding. The surveys should be completed by January 1, 2007. A seismic survey is not required for any building that has undergone a survey or that has been constructed to the state building code standards in effect for the seismic zone classification at the site. Subject to available funding, if a building is evaluated and found to pose an undue risk to life and safety during a seismic event, the acute inpatient care facility, fire department, fire district or law enforcement agency using the building shall develop a plan for seismic rehabilitation of the building or for other actions to reduce the risk. All seismic rehabilitations or other actions to reduce the risk must be completed before January 1, 2022, subject to available funding.

Oregon Seismic Rehabilitation Grant Program (New 03/2011)

In 2009, Oregon established a new seismic rehabilitation grant program, which provides state bond funds to help strengthen public school buildings prone to major structural damage. This program was created as a means to eliminate collapse-prone, high occupancy, school and public safety buildings to avoid mass casualties in future major earthquakes, as well as increase community preparedness. The Oregon seismic rehabilitation grant program is a competitive grant program and is administered by the Oregon Emergency Management.

Under the leadership of Senate President Peter Courtney, in 2009 the 75th Oregon Legislature provided $15 million bond funds for public schools, $15 million bond funds for emergency facilities, and three staffers for the new seismic rehabilitation grant program. In addition, the Legislature provided $31 million for seismic mitigation for university buildings and $3 million for seismic upgrades for community college buildings.

Earthquake Awareness Month

April is Earthquake Awareness Month. During the month, the State Office of Emergency Management encourages individuals to strap down

computers, heavy furniture, and bookshelves. In addition, Oregon Natural Hazards Workgroup distributed a flyer with educational information about how to prepare for an earthquake.

Earthquake Education

Earthquake education in schools is ongoing in Oregon. Schools conduct periodic earthquake drills and educate students how to respond when an earthquake event occurs. For example, St. Cecelia, a local private school, performs earthquake drills along with fire drills.[38]

Federal Programs

National Earthquake Hazards Reduction Program (NEHRP)

NEHRP's mission includes improved understanding, characterization and prediction of hazards and vulnerabilities; improved model building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The Act designates FEMA as the lead agency of the program, and assigns several planning, coordinating and reporting responsibilities.

National Earthquake Loss Reduction Program (NEP)

NEP was formed as a result of the report "Strategy for National Earthquake Loss Reduction" prepared by the Office of Science and Technology Policy (OSTP) in April 1996. The NEP "aims to focus scarce research and development dollars on the most effective means for saving lives and property and limiting the social disruptions from earthquakes, coordinate federal earthquake mitigation research and development and emergency planning in a number of agencies beyond those in NEHRP to avoid duplication and ensure focus on priority goals, and cooperate with the private sector and with state and local jurisdictions to apply effective mitigation strategies and measures." The NEP does not replace NEHRP, but encompasses a wider range of earthquake hazard reduction activities than those supported by the NEHRP agencies, and provides a framework within which these activities can be more effectively coordinated.

The National Earthquake Technical Assistance Program (NETAP)

The NETAP is a technical assistance program created to provide ad hoc short-term architectural and engineering support to state/local communities as they are related to earthquake mitigation. The program was designed to enhance the state/local communities' ability to become more resistant to seismic hazards. This assistance cannot be used for actions that are covered under the State's/Territories Performance Partnership Agreement (PPA). This program assists in carrying out the statutory authorities of the National Earthquake Hazards Reduction Act of 1977, as amended.

Technical assistance under the NETAP is available for use by the state/local communities within the 45 eligible and or participating

seismic states and U.S. territories. This assistance is provided at no cost to the requesting local community/state government.

Examples of NETAP projects are seismic retrofit/evaluation training, evaluation of seismic hazards critical/essential facilities, post earthquake evaluations of buildings and development of retrofit guidance for homeowners.

National Seismic Hazard Mapping Project

National maps of the earthquake shaking hazard in the United States have been produced since 1948. Scientists revise these maps as new earthquake studies improve their understanding of this hazard. After thorough review, professional organizations of engineers in turn update the seismic-risk maps and seismic design provisions contained in building codes. More than 20,000 cities, counties, and local government agencies use building codes, such as the Uniform Building Code, to help establish the construction requirements necessary to preserve public health and safety in earthquakes. The 1996 U.S. Geological Survey shaking-hazard maps for the United States are based on current information about the rate at which earthquakes occur in different areas and on how far strong shaking extends from quake sources.

Earthquake Mitigation Action Items (Revised 03/2011)

The earthquake mitigation action items provide direction on specific activities that the City, organizations and residents can undertake to reduce risk and prevent loss from earthquake events. There are four short-term action items and five long-term earthquake action items described below. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

ST-EQ#1: Identify funding sources for implementing earthquake mitigation in Beaverton

Possible Actions

- Coordinate with Washington County to leverage funds for earthquake loss reduction program similar to the City of Seattle's Project Impact model; and
- Evaluate grant and foundations that support earthquake mitigation activities.

Coordinating Organization: City of Beaverton
Internal Partners: Community Development Department, Emergency Management
External Partners: Federal Emergency Management Agency (FEMA), Oregon Emergency Management

(OEM), Partners for Loss Prevention, Washington County

Timeline: Future Plan Cycle

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems; Improve Partnerships for Communication and Coordination; Ensure Implementation of Mitigation Activities

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ST-EQ#2: Reduce non-structural hazards in homes, schools, businesses, and government offices.

Possible Actions

- Provide training to government and school facility managers and teachers on securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits;
- Encourage facility managers, business owners, and teachers to refer to FEMA's practical guidebook: Reducing the Risks of Nonstructural Earthquake Damage;
- Conduct periodic safety inspections of nonstructural seismic hazards;
- Encourage homeowners to use Is Your Home Protected from Earthquake Disaster? A Homeowner's Guide to Earthquake Retrofit (IBHS) for economic and efficient mitigation techniques; and
- Organize retrofitting classes for homeowners, building professionals, and contractors.

Coordinating Organization: City of Beaverton

Internal Partners: Emergency Management**,** Economic and Capital Development Department

External Partners: Washington County, Federal Emergency Management Agency, Oregon Emergency Management, School District

Timeline: On-going

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems; Ensure Implementation of Mitigation Activities

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ST-EQ#3: Pursue structural mitigation of critical facilities, infrastructure, public buildings, and schools for the earthquake threat.

Possible Actions

- Coordinate with Washington County to identify and retrofit critical facilities, to stricter seismic standards; and
- Encourage the state legislature to adopt retrofitting incentives.

Coordinating Organization: City of Beaverton

Internal Partners: Community Development Department, Public Works, Emergency Management

External Partners: School Districts, Special Districts, Hospitals, Washington County, Oregon Department of Transportation (ODOT)
Timeline: On-going
Plan Goals Addressed: Enhance Emergency Services

ST- EQ#4: Improve technical data and analysis of earthquake hazards.

Possible Actions

- Develop and update an inventory of at- risk structures in Beaverton;
- Update Beaverton earthquake HAZUS data to improve accuracy of the vulnerability assessment for Beaverton;
- Encourage local government officials to use Metro's earthquake hazards reports and earthquake maps to develop additional maps land use documents; and
- Conduct risk analysis incorporating HAZUS data and earthquake maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities and regulating land use.

Coordinating Organization: City of Beaverton
Internal Partners: Community Development Department, ISD/GIS
External Partners: Portland State University, Washington County, Metro, Oregon State University
Timeline: On-going
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

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LT-EQ#1: Establish a program aimed at helping private property owners and businesses perform structural retrofitting.

Possible Actions

- Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.); and
- Lobby state legislature to allow for adopting incentives that authorizes property tax incentives or deferrals to offset the costs of voluntary rehabilitation for existing buildings.

Coordinating Organization: City of Beaverton
Internal Partners: Economic and Capital Development Department, Community Development Department, Neighborhood Program – Mayor's Office, Emergency Management
External Partners: Washington County Assessment and Taxation, State Finance, Federal Emergency Management Agency (FEMA), Beaverton Area Chamber of Commerce, Westside Economic Alliance
Timeline: On-going

Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems; Improve Partnerships Communication and Coordination, Ensure Implementation of Mitigation Activities

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LT-EQ#2: Encourage purchase of earthquake hazard insurance by forming partnerships with the insurance and real estate industries.

Possible Actions

- Make contacts with insurance industry representatives to keep up to date about their requirements, rates, and plans;
- Provide earthquake insurance information to customers; and
- Work with Real Estate Industry representatives to educate them about what types of structures are resistant to earthquakes.

Coordinating Organization: City of Beaverton
Internal Partners: Economic and Capital Development Department, Community Development Department, Neighborhood Program – Mayor's Office, Emergency Management
External Partners: Washington County, Insurance Information Service of Oregon and Idaho (IISOI)
Timeline: On-going
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

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LT-EQ#3: Develop public/private partnerships to pursue efficient methods to retrofit structures.

Possible Actions

- Develop incentives (tax incentives or public recognition) for private contractors and architects to work on retrofitting public buildings and other infrastructure. This may help to minimize the funding shortage issue that has caused a number of high risk sites to remain without retrofitting; and
- Educate building contractors and architects on seismic design principles.

Coordinating Organization: City of Beaverton
Internal Partners: Economic and Capital Development Department, Community Development Department, Neighborhood Program – Mayor's Office, Emergency Management
External Partners: Home Builders Association, American Planning Association, American Institute of Architects, Westside Economic Alliance, Chamber of Commerce, Downtown Business Association, and renters groups
Timeline: On-going
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

LT-EQ#4: Improve local capabilities to perform earthquake building safety evaluations.

Possible Actions

- Offer training in procedures for earthquake building safety evaluations to CERT volunteers through Beaverton's new Community Emergency Response Team Program; and
- Offer periodic training in ATC-20 and ATC-21 procedures for earthquake building safety evaluations and encourage local building officials and other public and private officials (facilities, maintenance, engineering, architecture) to attend.

Coordinating Organization: City of Beaverton
Internal Partners: Emergency Management, Finance/ISD/GIS
Partner Organizations: Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM)
Timeline: On-going
Plan Goals Addressed: Protect Human Life, Commerce, Property and Natural Systems

LT-EQ#5: Assure that all Beaverton residents, regardless of income, disability, or ethnic group, receive information about earthquakes and have the opportunity to mitigate earthquake hazards in their home.

Possible Actions

- Enforce seismic building codes; and
- Develop educational materials in appropriate languages including: Spanish, Vietnamese, Laotian, and Korean.

Coordinating Organization: City of Beaverton
Internal Partners: Community Development, Neighborhood Program – Mayor's Office, Emergency Management
External Partners: Committee for Citizen Involvement (CCI), School Districts
Timeline: On-going
Plan Goal Addressed: Improve Partnerships for Communication and Coordination, Protect Human Life, Commerce, Property and Natural Systems.

Earthquake Resource Directory

(Revised 03/2011) – See Appendix G: Consolidated Resource Directory.

Earthquake Endnotes

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