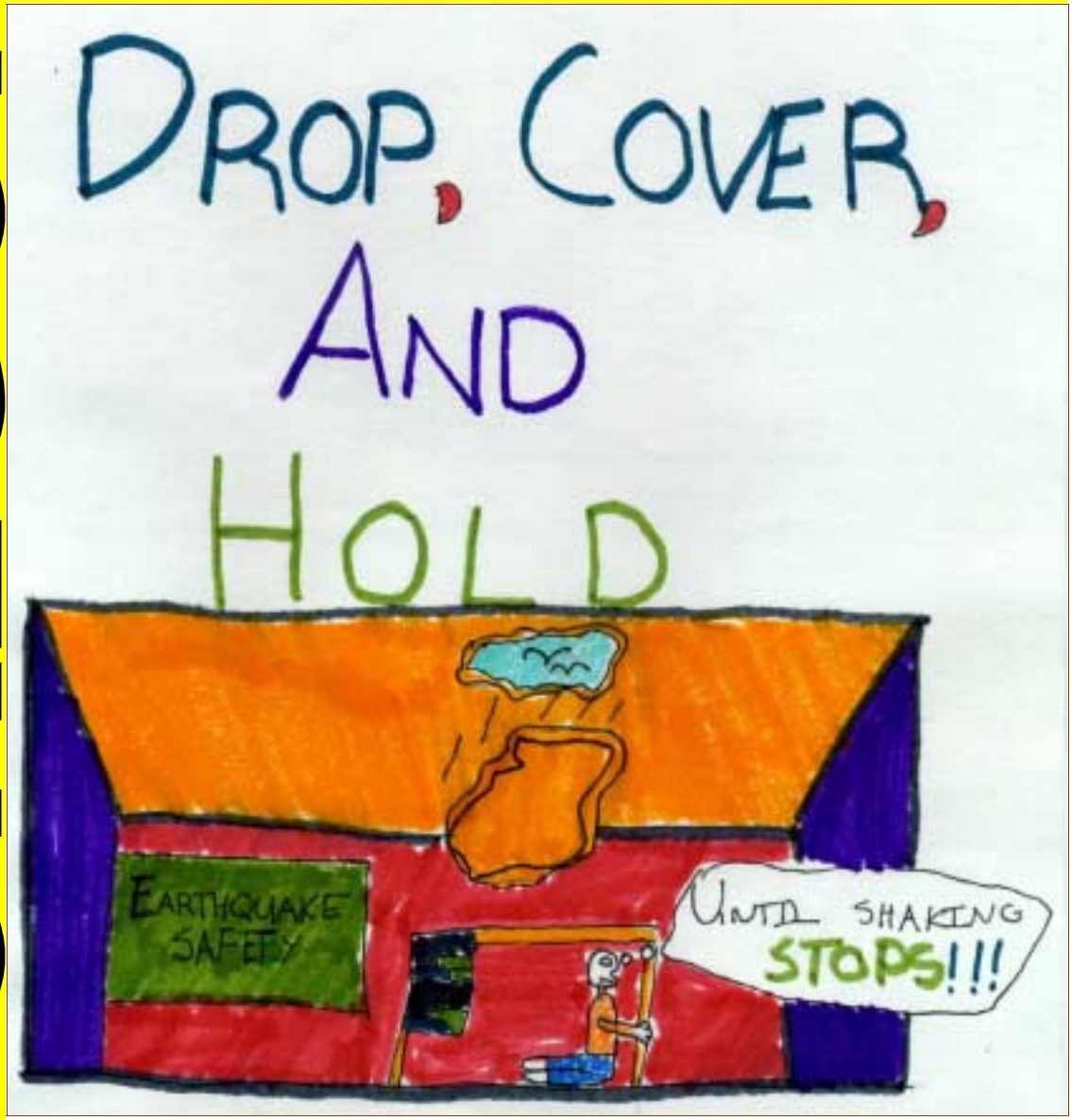
OREGON AT RISK



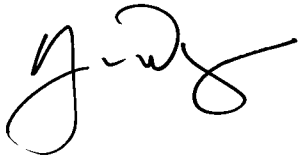
Oregon Seismic Safety Policy Advisory Commission

FOREWORD

I would like to thank each member of the Oregon Seismic Safety Policy Advisory Commission and Mark Reeves (formerly with Department of Geology and Mineral Industries) for their dedication to improving public safety involving earthquakes. Each member and, in particular, Mr. Reeves have devoted numerous hours of thought and effort, which led to the creation of this document.

In addition, thanks to the following for contributing to this document: Peter Green and Suzy Miller of the Governor's office, Myra Lee, Director of Oregon Emergency Management and chair of Oregon Emergency Response System and the Governor's Interagency Hazard Mitigation Task Force, the Oregon Emergency Management Association, State Building Codes Division, Benton County staff, and Tillamook County staff for review comments; Neva Beck and other Department of Geology and Mineral Industries staff for desktop publishing and support; the City of Portland for reproductions; Hewlett Packard for facilitating a focus session; the California Seismic Safety Commission for graphics; and, many others for their input and support.

Last, I owe immense gratitude to John Beaulieu, State Geologist and Director of the Department of Geology and Mineral Industries, for his guidance on my involvement with the Commission.



Yumei Wang, Chair

Current Oregon Seismic Safety Policy Advisory Commission Members

Yumei Wang (2)	Chair; Department of Geology and Mineral Industries
Chris Thompson (1)	Vice Chair; Degenkolb Engineers
Peter Courtney (1)	Senator, Oregon State Senate
Randy Leonard (1)	Representative, Oregon State House
Ann Beier (2)	Department of Land Conservation & Development
Richard Bowman (2)	City of Klamath Falls
Mark Darienzo (2)	Oregon Emergency Management
Jim Doane (1)	Portland Water Bureau
William Elliott (2)	Portland Water Bureau
Rose Gentry (2)	Oregon Department of Transportation
Jim Green (2)	Oregon School Board Association
Anita Hughes (2)	American Red Cross
Don Johnson (1)	US Bank, Commercial Real Estate Division
Tim Josi (1)	Tillamook County Commissioner
Ravi Mahajan (2)	Building Codes Division
Diane Merten (2)	Public Interest Representative
Steven Rose (2)	Bristol Equities
John W. Stephens (1)	Esler, Stephens, & Buckley
Robin O. White (1)	Portland METRO – Building Owners & Managers

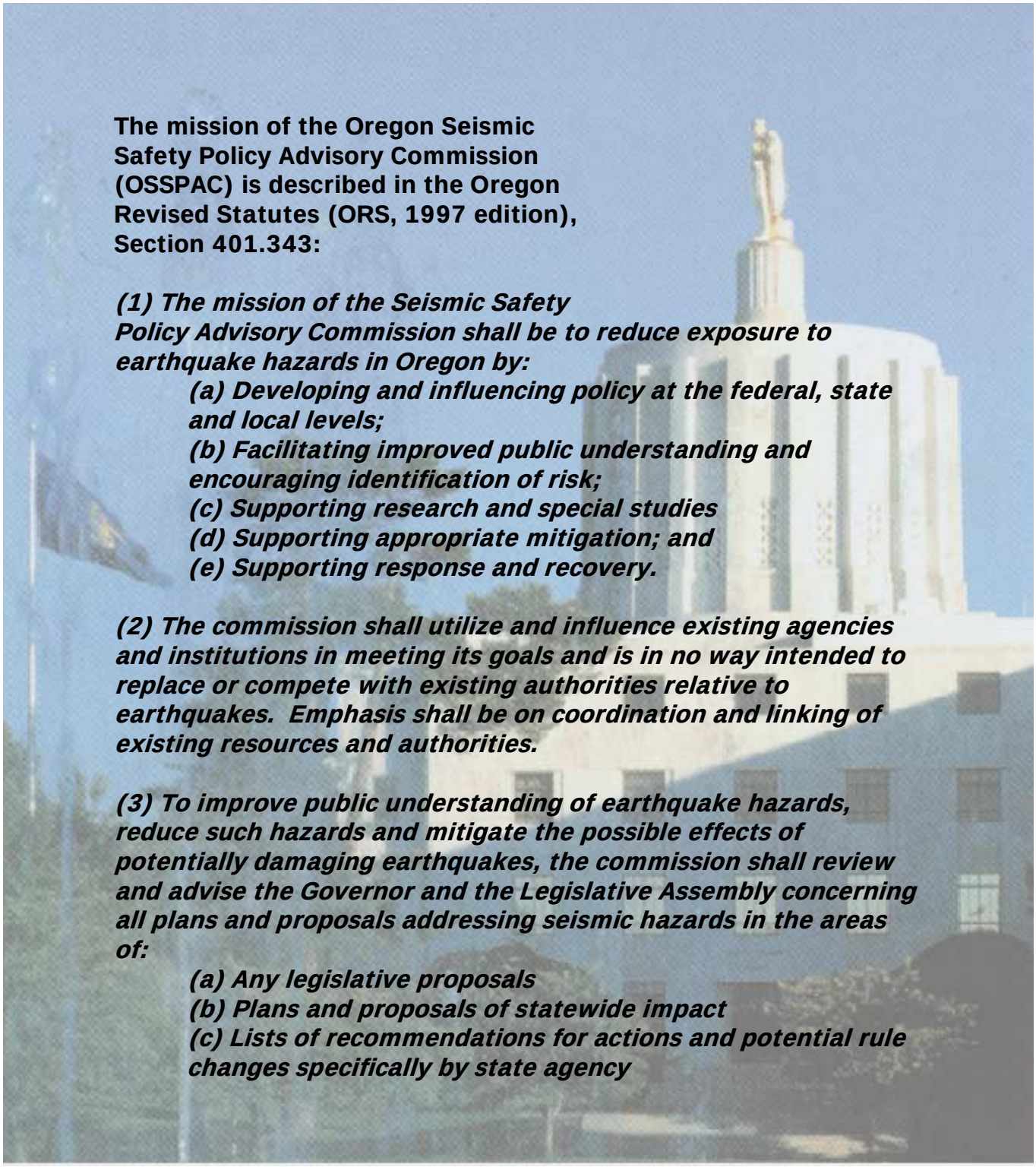
Standing Committees: (1) Legislation, (2) Education

Cover art: Matt Genica, 5th grade
Wilson Elementary, Corvallis, Oregon

Oregon at Risk

Oregon Seismic Safety Policy Advisory Commission

2000



The mission of the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) is described in the Oregon Revised Statutes (ORS, 1997 edition), Section 401.343:

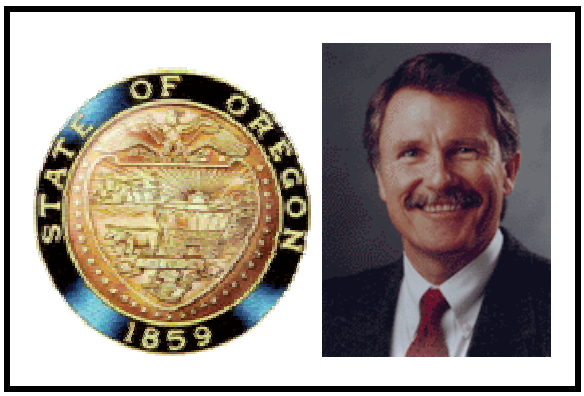
(1) The mission of the Seismic Safety Policy Advisory Commission shall be to reduce exposure to earthquake hazards in Oregon by:

- ***(a) Developing and influencing policy at the federal, state and local levels;***
- ***(b) Facilitating improved public understanding and encouraging identification of risk;***
- ***(c) Supporting research and special studies***
- ***(d) Supporting appropriate mitigation; and***
- ***(e) Supporting response and recovery.***

(2) The commission shall utilize and influence existing agencies and institutions in meeting its goals and is in no way intended to replace or compete with existing authorities relative to earthquakes. Emphasis shall be on coordination and linking of existing resources and authorities.

(3) To improve public understanding of earthquake hazards, reduce such hazards and mitigate the possible effects of potentially damaging earthquakes, the commission shall review and advise the Governor and the Legislative Assembly concerning all plans and proposals addressing seismic hazards in the areas of:

- ***(a) Any legislative proposals***
- ***(b) Plans and proposals of statewide impact***
- ***(c) Lists of recommendations for actions and potential rule changes specifically by state agency***



Governor John A. Kitzhaber, M.D.

Dear Concerned Citizen:

Today in Oregon there is an unacceptable level of risk created by the potential for large magnitude earthquakes combined with a growing population. It is important for you to know that the State of Oregon is committed to an aggressive earthquake loss reduction policy.

No one can prevent earthquakes nor can scientists accurately predict when they might occur. However, by becoming familiar with the **Oregon at Risk** document and applying this information to our daily lives, we can significantly reduce the loss of life and property, as well as work to speed up recovery.

The **Oregon at Risk** document focuses on improving the way that we learn about, build for, and live with earthquakes through the proper use of mitigation. This action will ensure that the lives and properties of the Oregonians will be made safer from potentially devastating earthquakes.

Sincerely,

254 State Capitol, Salem 97310; 503-378-3111
http://www.governor.state.or.us

INTRODUCTION

The Oregon Seismic Safety Policy Advisory Commission (OSSPAC), otherwise known as the Earthquake Commission, has the unique task of promoting earthquake awareness and preparedness through education, research, and legislation. The mission of OSSPAC is to positively influence decisions and policies regarding pre-disaster mitigation of earthquake an tsunami hazards, increase public understanding of hazard, risk, exposure, and vulnerability through education seminars, etc., and be responsive to the new studies and/or issues raised around earthquakes and tsunamis. In order to fulfill the goals of the commission, OSSPAC members have developed five primary objectives. These are to increase or improve:

Objective 1. Earthquake awareness and education,
Objective 2. Earthquake risk information,
Objective 3. The earthquake safety of buildings and lifelines,
Objective 4. Geoscience and technical information, and
Objective 5. Emergency pre-disaster planning, response and recovery efforts.

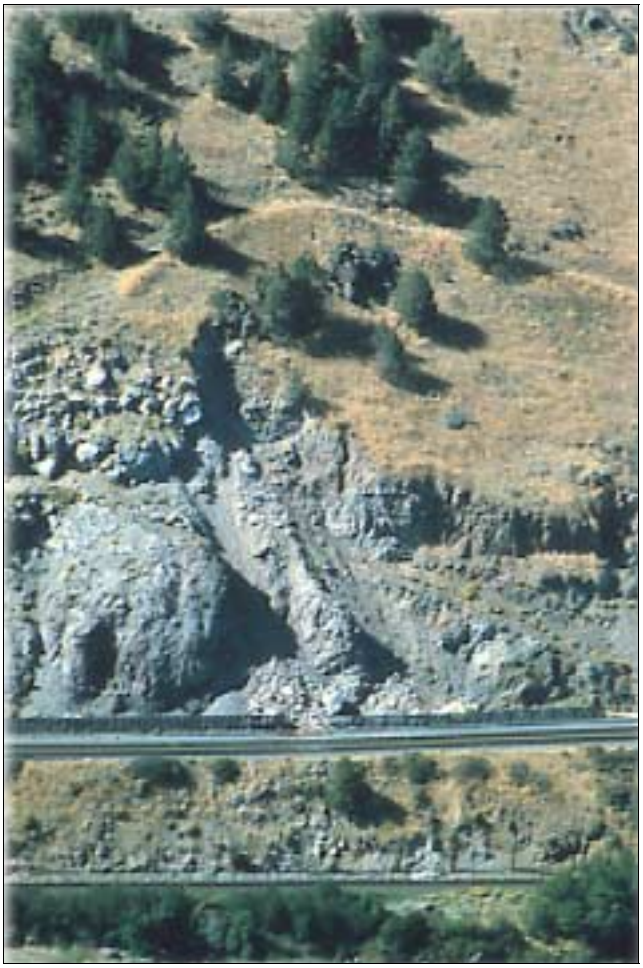
OSSPAC is a well-rounded group of 18 individuals who represent a variety of interests concerned with the formulation of public policy regarding earthquakes. It is made up of six representatives of government, six representatives of the public interest, and six representatives of industries and stakeholders. The variety of interests help direct the goals of the Commission for the benefit of all Oregon citizens.

HISTORY OF COMMISSION

As a result of the Loma Prieta Earthquake in the Bay Area of California in 1989, Oregon residents wanted the State government to address Oregon's earthquake hazards and preparedness of the State. The Interagency Seismic Task Force was formed and recommended that a new state commission be formed in response to this need. Consequently, OSSPAC was formed as a result of Senate Bill 96 in 1991. Since this time, OSSPAC has continued to increase Oregon's awareness to earthquake hazards by supporting earthquake education, research, and legislation. Every two years, OSSPAC provides a summary report to the Governor of the Commission's activities. OSSPAC has also formed relationships with the Western States Seismic Policy Council (WSSPC) and the California Seismic Safety Commission, which provides a persuasive advantage to affect federal policy for the West Coast. A list of the current Commission members is included at the end of this publication.

OREGON AT RISK BACKGROUND

The **Oregon at Risk** document concept was originally developed by members of OSSPAC in response to the need to reduce the consequences of earthquake damage. **Oregon at Risk** is designed to be an understandable, educational information tool for policymakers, educators, and the general public. The goal of this living document is to review the major earthquake sources, define the structures and facilities that are most at risk in the event of an earthquake, identify the stakeholders who need to be prepared for an earthquake, and make recommendations to citizens and government agencies on how to reduce the risk.

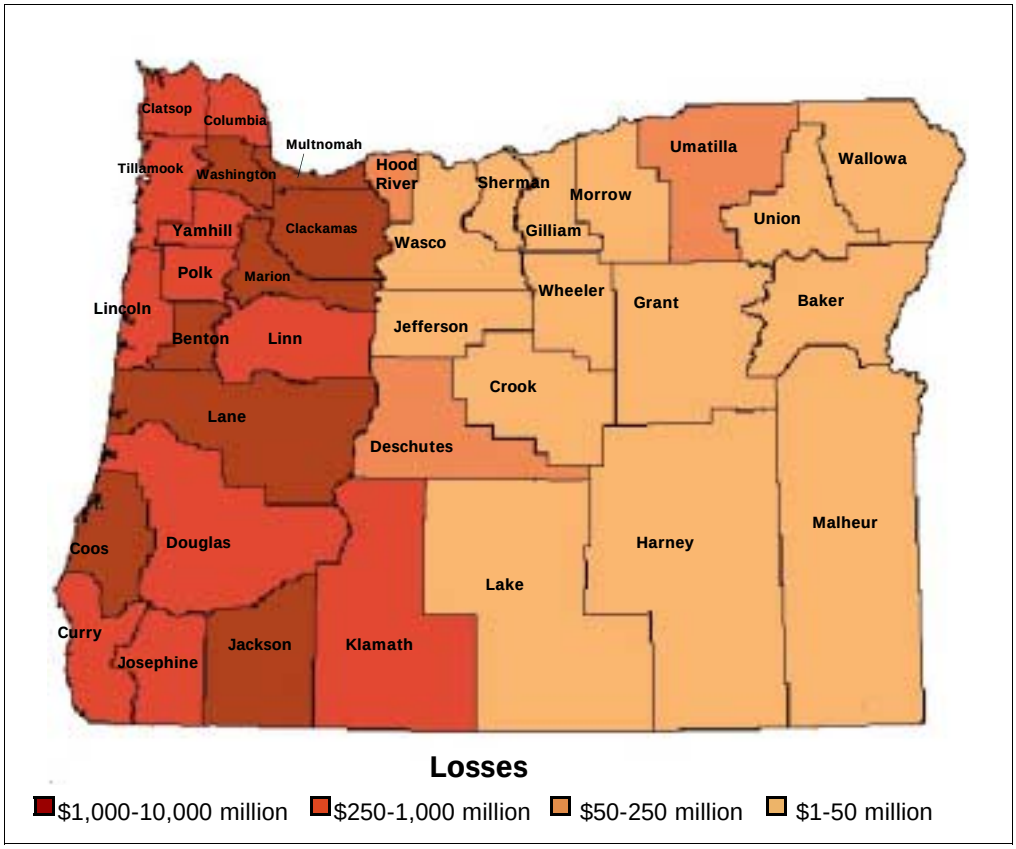


This landslide was triggered by a 1993 Klamath Falls earthquake and caused one of the two deaths from that event. (photo courtesy Oregon Department of Geology and Mineral Industries)

THE STATE OF RISK

A recent study published by the Oregon Department of Geology and Mineral Industries (DOGAMI) estimates damage to every county in the state resulting from earthquakes. The study analyzes two different sources of risk: the Cascadia Subduction Zone earthquake (Magnitude 8.5) and the 500-year earthquake. The 500-year model is an attempt to quantify the risk across the State stemming from more localized earthquake source faults and represents a 1 in 500 chance every year of an earthquake event. The results of the survey are staggering and are summarized in the following map and table:

Statewide, only 65% of essential facilities like fire stations, are expected to be operational after a magnitude 8.5 earthquake. (photo courtesy Tualatin Valley Fire and Rescue)

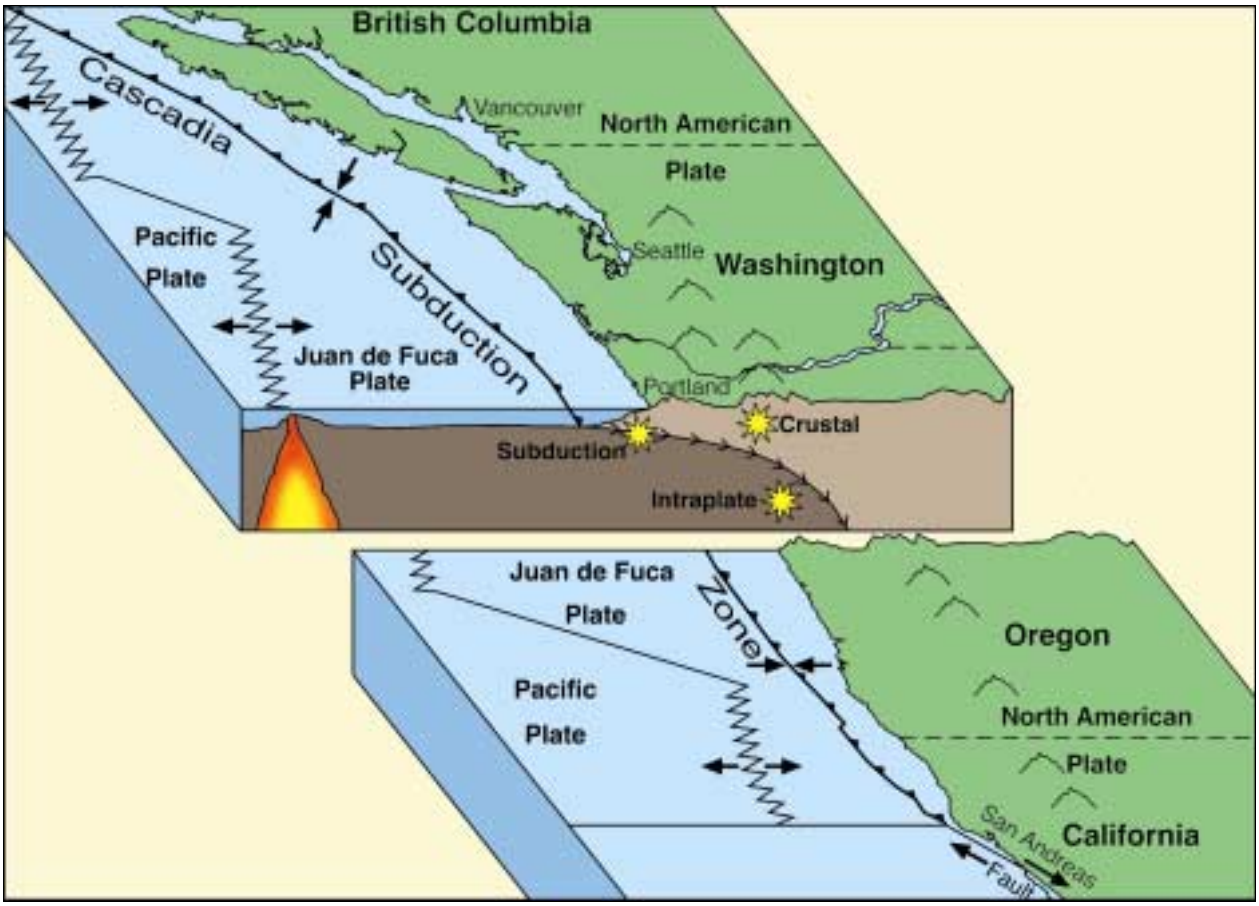


Map of Oregon Counties with prediction of losses resulting from 500 year model (Oregon Department of Geology and Mineral Industries)

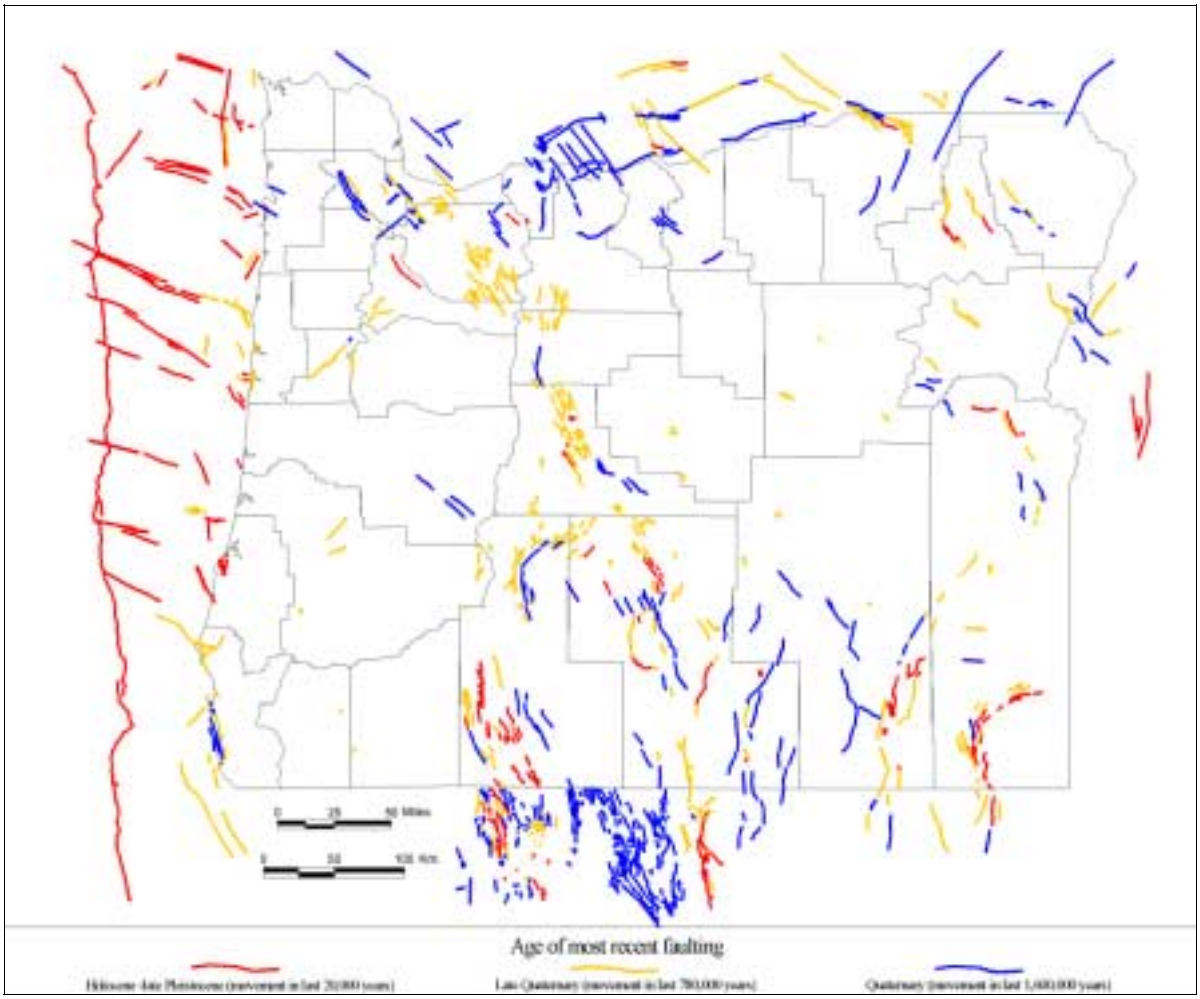
	M8.5 Cascadia Event	*500-year earthquake*
Injuries	12,700	29,180
Deaths	Over 5,000	Over 5,000
Displaced Households	17,300	47,400
Economic losses for Buildings	$12 billion	$32 billion
Economic losses for Highways	$370 million	$1.3 billion
Economic losses for Air-ports	$120 million	$320 million
Economic losses for Communication systems	$100 million	$210 million
Operational the day after the quake:		
Essential facilities	65%	NA
Schools	66%	NA

These figures have a high degree of uncertainty and should be used only for general planning purposes. The 500-year model includes several earthquakes; therefore the number of facilities operational the “day after” cannot be calculated.

Although Oregon residents have not witnessed a large earthquake in this region during their lives, large earthquakes have happened in the past. Strong evidence suggests that a large earthquake of magnitude 8.0 or greater shook the region as recently as January 1700. Research suggests that there have been at least 7 large (magnitude 8.0 to 9.0) Cascadia earthquakes in the last 3500 years. These earthquakes are the result of the Cascadia Subduction Zone located off the Oregon Coast. A subduction zone is defined as the location where two tectonic plates collide, with one plate sliding under another. Tectonic plates are approximately 60-mile thick slabs of earth that move and interact with each other, producing not only earthquakes, but volcanic eruptions as well. In the case of the Cascadia Subduction Zone, the denser Juan de Fuca Plate is being subducted under the more buoyant North American Plate. However, plates do not slide smoothly past each other. They tend to lock up, build pressure, and at some point release the pressure dramatically in the form of an earthquake. Subduction zone earthquakes also produce tsunamis, powerful waves produced by the uplift of the sea floor. Tsunamis arrive in minutes and are often more destructive to coastal communities than the earthquake.



Pacific Northwest earthquake setting. Map and cross section showing the Cascadia Subduction Zone (courtesy of Oregon Department of Geology and Mineral Industries)



Map showing young faults in Oregon and offshore to the Cascadia Subduction Zone (published originally in 1995 by Geomatrix Consultants, Inc. for the Oregon Department of Transportation)

Oregon also has many crustal faults. These faults are more of a local problem, especially to those who are geographically close to these faults. These faults are capable of producing magnitude 7.0 earthquakes and are typically closer to people. Therefore, a smaller magnitude earthquake could result in as much damage to people and developed property as an earthquake from the Cascadia Subduction Zone.

EXISTING BUILDINGS AND LIFELINES

When an earthquake occurs, it causes the ground to shake, in turn causing buildings and existing structures to move. The damage can be very severe if the structures are not designed to withstand this type of movement. Older buildings are especially at risk of structural damage and can even collapse entirely. Unreinforced masonry buildings are likely to have the most damage compared with other types of structures. Everyone lives, works, and plays in buildings on a daily basis. If the building you occupy was built prior to 1993, it is important to know what type of building it is so that your personal risk from ground shaking may be determined. Structures designed and constructed in Western Oregon after 1993 are subject to the revised building codes and therefore higher standards with respect to resistance to ground shaking. These standards were increased based on newly available technical and scientific data about Oregon's seismic risk.

Molalla High School was condemned after the 1993 Scotts Mills earthquake (M5.6). A new high school was built on another site. (photo courtesy Oregon Department of Geology and Mineral Industries)

Lifelines are critical. Lifelines are the conduits that bring services to people in buildings. These include water, communications, electricity, natural gas, and sanitary sewers. These lifelines add greatly to the community's standard of living. During ground shaking, the pipes connecting services to a building can shake at different rates than the building itself, which cause failure of the pipes at this location. In some cases, major fires can result when gas conduits fail. Another common problem is that earthquake-induced failure in one location along the lifeline can make the whole system inoperable, as with some water and electrical distribution systems. This causes expensive repairs and interrupts the service to customers, which can result in high economic loss and public health problems.

Roads are also considered lifelines. Typical roads are not as vulnerable to failure as buildings and conduits. However, bridges, overpasses, and tunnels can be quite vulnerable to failure from earthquakes. Ground shaking could cause an older bridge's deck to separate from its columns and foundation. Extensive seismic detailing did not become part of mainstream bridge design in Oregon until after the Loma Prieta earthquake of 1989. A bridge that is severely damaged in an earthquake can take several months to repair. Damage to a critical freight route could cause economic loss to Oregon businesses that would be many times the cost of the repair. In addition, the failure of these structures can severely limit emergency response operations, such as fire fighting and medical care.

OSSPAC Objectives

For each of the five objectives (listed on pages 7-13), OSSPAC is promoting specific **strategies**, the desired effect of the strategy or **output**, and the potential **outcome**. OSSPAC is coordinating with organizations such as: The Governor's Interagency Hazard Mitigation Task Force, the Oregon Emergency Response System, Oregon Emergency Managers Association, Project Impact Disaster Resistant Communities, and others.

Objective 1: Earthquake awareness and education

Strategy	*Output*	*Outcome*
(1.1) Inform citizens about earthquake and tsunami hazards and risks	Information and training to meet individual or collective needs	All citizens are able to prepare for and respond to an earthquake
(1.2) Promote school building safety through improvements, siting and construction	Allows for continued education after earthquake event	Better performance of schools for education and shelters
(1.3) Promote earthquake safety drills to students and adults	Minimizes the effects of an earthquake event	Better preparedness to minimize disasters and improve school and business continuity
(1.4) Incorporate earthquake and tsunami education in school curricula	A multi-level curriculum for earthquake education in all public schools	All students are provided with earthquake science and safety training as a part of their regular education
(1.5) Disclose geologic hazards in real estate transactions	Homebuyers are made aware of geologic hazards at a property prior to purchase	Homebuyers are more informed in their decisions

Objective 2: Earthquake risk information

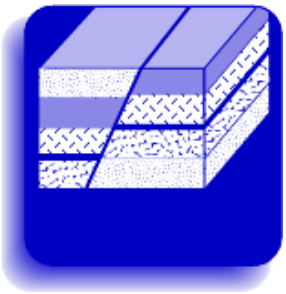
Strategy	*Output*	*Outcome*
(2.1) Determine the top ten highest risk buildings owned by the state	List of state owned buildings in most need of seismic upgrades	Effective prioritization of state's mitigation funds
(2.2) Update estimates of direct losses possible from earthquakes and tsunamis	Comprehensive studies to estimate the potential loss of life, number of injuries, and damage to structures and lifelines from earthquakes and tsunamis of various magnitudes and locations	Earthquakes and tsunamis are placed in a proper policy perspective based on credible projections of losses and societal impacts; emergency planning is improved; and long-term hazard-reduction activities are prioritized
(2.3) Evaluate the indirect losses associated with earthquakes and tsunamis	A study assessing the long term effects of economic losses including wage and job loss, rebuilding cost, impacts on insurance and financial institutions, and costs of business interruption and failure	Identification of economic impacts, resulting in increased preparedness, more rapid recovery, and wise resource allocation
(2.4) Conduct lifeline vulnerability studies	All lifeline sites in high seismic zones as defined in Building Codes are identified and a plan is developed for each one	During earthquake emergency, damaged lifelines in one area will not cripple each other

Broadway Bridge spans the Willamette River in Portland. Bridges are critical lifelines. (photo courtesy of Multnomah County)

Objective 3: Earthquake safety of buildings and lifelines

Strategy	*Output*	*Outcome*
(3.1) Educate and improve plan review procedures on new construction in accordance with current seismic codes	Training for designers, engineers, and plans examiners	Help ensure that new buildings are being designed and reviewed safely by competent professionals to withstand seismic forces
(3.2) Better enforce the state code amendment that requires roof anchors and parapet bracing when reroofing buildings	Copies of the amendment are distributed to building officials, architects, and engineers through the media and professional societies, and education programs are conducted	A gradual decrease in the seismic hazard posed by existing unreinforced masonry buildings
(3.3) Improve the post-earthquake operational status of essential service buildings	All essential services buildings are identified and retrofitted or relocated to meet standards that will allow them to remain operational	The ability to provide unimpeded disaster relief
(3.4) Reduce structural hazards of government- owned buildings	Government-owned buildings structurally modified to better withstand earthquakes	A safer environment to conduct government business and to operate after an earthquake
(3.5) Mitigate nonstructural hazards in government-owned and leased buildings	Assess hazards in government-owned and leased buildings and upgrade as necessary	A safer and operational working environment for government agencies following an earthquake
(3.6) Improve safety of older public school buildings	Identify and reduce structural and non-structural seismic hazards in all pre-1993 public school facilities	Safer facilities for students and teachers, as well as usable buildings in an emergency
(3.7) Improve safety and operational ability of older hospital buildings	Assess earthquake vulnerability of all hospitals and upgrade the structures to better survive an earthquake	Safe structures will provide a more secure environment for patients and staff, improved ability to survive an earthquake and provide disaster relief

(3.8) Improve safety of older high-occupancy buildings (250 persons or more) to be structurally competent	Assess seismic vulnerability of all older, high-occupancy structures and retrofit or disclose building condition upon resale	Prevent collapse, thus reducing life loss, property loss, potential secondary effects, and reconstruction costs
(3.9) Improve the seismic safety of older homes	Create and distribute hazard maps, upgrade information packets, procedural manuals, standards, and requirements to all agents, building contractors, and lending institutions. Establish funding sources and incentives to encourage retrofitting	Improved safety and lower repair costs in the event of an earthquake
(3.10) Improve safety of mobile homes	Seismically brace all new mobile homes in high seismic zones; retrofit inadequately braced existing mobile homes at time or resale. Create and implement incentive packages to encourage retrofit	Increased safety for occupants, reduced amounts of utility rupture, and associated hazards and repair costs
(3.11) Prevent loss of historic buildings	Vulnerability assessments and mitigation completed on buildings on the National Historic Register	The preservation of historic buildings and their associated heritage in the event of an earthquake
(3.12) Improve lifeline survivability in the event of an earthquake	Assess and mitigate earthquake hazards on all lifelines	Functional or easily/rapidly repairable lifelines after an earthquake
(3.13) Improve earthquake performance of water and waste-water systems	Establish appropriate and practical uniform safety and emergency response plans for all water and waste-water systems	Improved safety, performance, and reliability of water and waste-water systems
(3.14) Improve seismic safety of bridges	Continue phase 1 (superstructure) seismic retrofits of prioritized bridges	Safer transportation system to protect the traveling public, support emergency response actions and aid economic recovery



Objective 4: Geoscience and technical information

Strategy	*Output*	*Outcome*
(4.1) Reduce earthquake losses by mapping and identifying geologic hazards	Hazard maps for all earthquake-prone urban areas	Development and management of properties are safer, more reasonable, and more cost effective
(4.2) Perform geologic-hazard investigations for critical public facilities prior to instruction	Geologic-hazard investigations are performed for all new critical public facilities for proper design or relocation of proposed structures	Critical facilities will not be sited in hazardous areas, and facilities that are needed for emergency response will remain intact
(4.3) Make land use compatible with known hazards, through local government ordinances	Local governments are encouraged or required to adopt geologic-hazard ordinances as needed	Land use is safer and consistent with identified geologic hazards
(4.4) Determine appropriate seismic criteria and procedures for evaluating performance of existing dams	Guidelines for seismic safety assessments of existing dams	Uniform, state-of-the-art assessments of seismic safety of dams to identify and mitigate hazards
(4.5) Compare known landslide hazard areas with current lifeline routes	Transportation lifeline routes are developed with landslide hazards in mind	Lifeline routes less vulnerable to closure by an earthquake-caused landslide
(4.6) Incrementally develop a strong-motion detection program	Deploy accelerographs throughout the State to record strong ground shaking	Strong shaking is better quantified so it can be incorporated into safe, cost-effective design of buildgs. Information rapidly available for crisis management
(4.7) Improve the existing tsunami inundation zone maps	Continue to produce detailed tsunami inundation zone maps for the coast	Provide more realistic scenarios for evacuation planning purposes
(4.8) Monitor faults using Global Positioning System (GPS) measurements	Regular monitoring of a network of GPS benchmarks	Strain buildup and ground deformation for accurate estimation of the likelihood of large earthquakes
(4.9) Map and characterize existing faults	Determine hazards associated with faults for planning	Safer building environment be designing for or avoiding known hazards

Objective 5: Emergency pre-disaster planning, response, and recovery

Strategy	*Output*	*Outcome*
(5.1) Prepare individuals and families to be self-reliant for at least 72 hours	Provide information on 72-hour kits	Increased personal preparedness
(5.2) Establish viable Red Cross shelter agreements	Locate shelters and secure agreements	Provide post-disaster shelters
(5.3) Establish Community Emergency Response Teams (CERTs) statewide	Trained volunteer community emergency response teams exist statewide	Reduce life, property, and environmental loss by providing more immediate trained response in a disaster
(5.4) Develop effective exercise and training programs for hospitals	All hospitals' staff are trained for earthquake emergency response, including implementing a standardized triage system	Hospitals are prepared for earthquake response
(5.5) Promote the use of earthquake loss estimation programs by local jurisdictions	Train local jurisdictions in the earthquake loss estimation programs	The programs will assist communities with earthquake mitigation planning
(5.6) Coordinate state, local and private sector earthquake response training and exercises	A statewide program of regularly scheduled earthquake emergency response training and exercises	State, local, and private responders are prepared to work as a coordinated team to respond to an earthquake
(5.7) Establish a state emergency disaster fund	Financial assistance to local communities if federal funds are unavailable or limited	Reduce the devastating impact of disasters on communities
(5.8) Improve coordination between technical and emergency response staff during an earthquake	Develop a Post Earthquake Technical Clearinghouse plan	Increase effectiveness of response and recovery operations

(5.9) Promote the integration of emergency management programs state-wide	Support the state's comprehensive emergency management plan	Provide for coordinated response and recovery efforts in the state, when needed
(5.10) Improve Pacific Ocean tsunami warning capabilities of coastal communities	Promote coordinated warning systems along the coast	Effective nearby and distant tsunami warning
(5.11) Improve tsunami evacuation from tsunami inundation zones	Promote tsunami evacuation planning efforts	Effective evacuation of residents and tourists from tsunami inundation zones
(5.12) Enhance communication capabilities for emergency responders	Develop a communication system that will allow for the use of new technologies and provide the capability of expansion during peak disaster use	Emergency response capability will be enhanced because the new communication system will allow for multi-agency use and coordinated response
(5.13) Develop and implement coordinated, effective tsunami evacuation plans for coastal communities	State, local, and private responders have procedures, training, and equipment to implement evacuation	Coastal communities are prepared to promptly and effectively implement an evacuation to protect the public from a tsunami
(5.14) Post identifying information on bridges and buildings	Each public bridge and building is marked on both ends with bridge name, bridge number, route number and milepost. Public buildings are also easily identified by name and location.	Public and first responders can promptly report correct locations of damaged bridges and buildings
(5.15) Train more survey inspectors (ATC 20)	More inspectors with technical ability to quickly quantify structural risk available	More structural surveys of risk completed

For more information, contact:

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Salem OR 97301
(503) 378-2911
http://www.osp.state.or.us/oem

American Red Cross
Oregon Trail Chapter
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Portland OR 97227
(503) 284-0011
http://www.redcross.org

Federal Emergency Management Agency
Federal Regional Center
130 228th Street SW
Bothell WA 98021-9796
(425) 487-4604
http://www.fema.gov/Reg-X/index.htm

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