Natural Hazard

Mitigation Plan

CITY OF PORTLAND
Office of Emergency Management
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Portland Office of Emergency Management
Mitigation & Planning
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City of Portland

Natural Hazards Mitigation Plan

Report for:

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City of Portland
Natural Hazards Mitigation Plan

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Executive Summary

The City of Portland (the City) developed this Natural Hazard Mitigation Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

Natural hazard mitigation is defined as a method permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Natural hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.[1]

Why Develop this Mitigation Plan?

This natural hazard mitigation plan is intended to assist the City of Portland in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City. The City received funds to develop the plan from the Hazard Mitigation Grant Program (HMGP) and the Flood Mitigation Assistance Program, both Federal Emergency Management Agency (FEMA) grant programs. The City of Portland provided the additional funds for the plan's development from its General Fund.

How is the Plan Organized?

The Mitigation Plan contains background on the purpose of the plan, the methodology used to develop the plan, a profile of Portland, chapter II on four primary natural hazards that have the potential to impact the City, and several appendices. All of the sections are described in detail in Chapter I, Introduction.

The Plan also includes resources and information to assist city residents, public and private sector organizations, and others to participate in activities that mitigate against the effects of natural hazards. The mitigation plan provides recommendations for activities that will assist the City in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for the hazards of flood, landslides, earthquake, severe weather, and wildfire. An overview of these action items is included in this Executive Summary.

Who Participated in Developing the Plan?

The City of Portland recognized the importance of establishing a collaborative planning process to develop both short-term and long-term risk reduction strategies with strong ties to the existing programs and divisions of governance. Therefore, the City develop a steering committee and five hazard specific subcommittees comprised of individuals and specialists with natural hazard mitigation understanding and responsibilities from city bureaus, state agencies, and community organizations in and around Portland. These committees included representatives from the following organizations:

- City of Portland Office of Emergency Management
- Portland State University
- Oregon Department of Geology and Mineral Industries
- Bureau of Planning
- Bureau of Development Services
- Bureau of Environmental Services
- Bureau of Fire and Rescue
- Bureau of Maintenance
- Bureau of Water Works
- Portland Office of Transportation
- Tri-Met
- Non-profit organizations (such as the Audubon Society of Portland)
- Private industries (such as Ashforth Pacific Inc. and Siltronic Corporation).

What is the City's Vision?

The City of Portland's vision related to emergency preparedness is to strive to create a "Disaster Resilient City." The steering committee further describes this vision:

> By creating a legacy of mitigation activities, City and community leaders' proactive implementation of long term, cost effective mitigation measures has protected its population, its properties, its natural and built environment and its investments. The forethought of Portland's leaders has preserved the City through decades of hazard events.

The plan fosters coordinated partnerships and the development of multi-objective strategies for reducing the risks posed by natural hazards.

What are the City's Goals?

The plan goals describe the overall direction that the City of Portland's agencies, organizations, and citizens can take to work toward mitigating risk from natural hazards. The Portland plan goals were developed with significant input from the City's project steering committee. The overarching mission is to reduce risk, prevent loss of property and commerce, and promote expedient recovery, while safeguarding people and the environment from natural disaster events through a coordinated and collaborative community partnership. This mission is implemented through the following five goals:

Goal #1	Identify risk level and evaluate Portland's vulnerability to natural hazards
Goal #2	Implement activities to protect human life, property and natural systems.
Goal #3	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population
Goal #4	Establish a disaster resilient economy.
Goal #5	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

How are the Action Items Organized?

The action items are organized within the following matrix, which lists all of the multi-hazard and hazard-specific action items included in the mitigation plan. Data collection and research and the public participation process resulted in the development of these action items. The matrix includes the following information for each action item:

- **Coordinating Organization.** The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. The coordinating organizations for all action items listed in this plan are bureaus or departments within the City of Portland.
- **Internal Partners:** Internal partner organizations are departments within the City that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.
- **External Partners:** External partner organizations can assist the City in implementing the action items in various functions and may include local, regional, state, or federal agencies, as

well as local and regional public and private sector organizations.

The internal and external partner organizations listed in the mitigation plan are potential partners recommended by the project steering committee, but who were not necessarily contacted during the development of the plan. Partner organizations should be contacted by the coordinating organization to establish commitment of time and or resources to action items.

- **Timeline**. Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term action items (ST)* are activities which city agencies are capable of implementing with existing resources and authorities within one to two years. *Long-term action items (LT)* may require new or additional resources or authorities, and may take between one and five years to implement.
- **Levels of Immediate Capability** The Hazard Mitigation Steering Committee voted prioritized the plan's five goals determining the most important as "Identifying the risk level and evaluating Portland's vulnerability." Each action item is associated to at least one goal, some more than one. These are listed in Section 4 of the Plan. The risk assessment identified various hazards that may threaten Portland city facilities from low to severe. The rank order of Portland's hazards are Earthquake, Landslide, Wildfire, Flood and Severe Weather. The 3rd step of prioritizing the action items and determining the ability for the City to immediately implement the action item was to review each action against availability of resources and funding. High – can immediately implement, Low – need a great deal of outside funding and resources with Medium landing somewhere in between.
- **Ideas for Implementation**. Each action item includes ideas for implementation and potential resources, which may include grant programs or human resources. The matrix includes the page number within the mitigation plan where this information can be found.
- **Plan Goals Addressed.** The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals following implementation.

How will the Plan be Implemented?

The plan maintenance section of this document details the formal process that will ensure that the City of Portland's Natural Hazards Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a plan revision every five years. This section describes how the City will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how the City of Portland intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the Comprehensive Plan, Capital Improvement Plans, and Building Codes outlined in the Development Code and Engineering Design Manual.

Plan Adoption

The Portland City Council will be responsible for adopting the City of Portland Natural Hazards Mitigation Plan and providing the support necessary to ensure plan implementation. After the plan is adopted via resolution by the City Council, the Director of POEM will be responsible for submitting it to the State Hazard Mitigation Officer at Oregon Emergency Management. Oregon Emergency Management will then submit the plan to the Federal Emergency Management Agency (FEMA–Region X) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Portland will gain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds.

The effectiveness of the City of Portland's non-regulatory Natural Hazard Mitigation Plan will be contingent on the implementation of the plan and incorporation of the outlined action items into existing City plans, policies, and programs. The Natural Hazard Mitigation Plan includes a range of action items that, if implemented, would reduce loss from hazard events in the City of Portland. Together, the action items in Portland's Natural Hazard Mitigation Plan provide the framework for activities that city bureaus can choose to implement over the next five years. The Hazard Mitigation Steering Committee has prioritized the plan's goals and identified actions, which will be implemented, as resources permit, through existing plans, policies, and programs.

Coordinating Body

The Disaster Policy Council (DPC) will be the coordinating body for the mitigation plan. The DPC has been established by ordinance (178616, effective July 21, 2004); it includes representatives from applicable city bureaus, including, but not limited to, the current Hazard Mitigation Steering Committee members. One of the DPCs roles will be to review the mitigation plan annually and to oversee the update process. The DPC consists of the Mayor, a City Commissioner, the City Attorney, the Chief of Portland Police Bureau, the Chief of Bureau of Fire & Rescue, the Director of Portland Office of Emergency Management, and the Directors of many other Portland bureaus.

Convener

The City's Office of Emergency Management (POEM) and the Bureau of Planning will be jointly responsible for overseeing the plan's implementation and maintenance. The Emergency Management Director will work with the Disaster Policy Council Chair to facilitate Natural Hazard Mitigation Plan meetings. Plan implementation and evaluation will be a shared responsibility among all of the assigned Disaster Policy Council members. Upon advisement of the Disaster Policy Council and the Directors of the Bureau of Planning and POEM, the Portland Office of Emergency Management will be the main instigator of review, coordination, and promotion.

Implementation through Existing Programs

The City of Portland addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvement plans, City codes and an array of non-regulatory projects and programs. The natural hazard mitigation plan provides a series of recommendations – many of which are closely related to the goals and objectives of existing planning programs. To the extent possible the City of Portland will incorporate the recommended mitigation action items into existing programs and procedures.

Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's (FEMA) methods of identifying the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Formal Review Process

The City of Portland has developed a method to ensure that a regular review and update of the Hazard Mitigation Plan occurs. All Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan and POEM is responsible for contacting the Committee members and organizing the annual plan review meeting.

Continued Public Involvement

The City of Portland is dedicated to involving the public directly in the continual reshaping and updating of the Hazard Mitigation Plan. The Disaster Policy Council members are responsible for the annual review and update of the plan.

POEM will continue to identify opportunities for the public's engagement in implementation and update of the plan. Public participation will continue to be invited through a series of presentations to community organizations, such as neighborhood associations, the Oregon Continuity Planners Association, and watershed councils. Copies of the plan are also posted on the Portland Office of Emergency Management website, and will be available there during update cycles. This website also contains an email address and phone number to which people can direct their comments and concerns. The web address is www.portlandonline.com/oem.

Executive Summary Endnotes

[1] Massachusetts Department of Environmental Management. 1999. "Hazard Mitigation: Managing Risks, Lowering Costs. http://www.state.ma.us/dem/programs/mitigate/whatis.htm Accessed 8/2/02

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority -----------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
City of Portland Natural Hazard Mitigation Plan Action Items - Organized by Hazard									
Multi-Hazard Mitigation Action Items									
Short-Term Multi-Hazard #1	Continue to involve the public in updating the Natural Hazard Mitigation Plan.	Portland Office of Emergency Management, Bureau of Planning, Office of Neighborhoods	ST				✓		✓
Short-Term Multi-Hazard #2	Form a committee to identify and coordinate critical transportation (street and highway) networks.	Portland Department of Transportation, Bureau of Maintenance / *Bureaus of Planning, Fire & Rescue, Police, Parks and Recreation, Urban Forestry*	ST		✓		✓		✓
Short-Term Multi-Hazard #3	Revise Portland's Comprehensive Plan to address natural hazards including, but not limited to, floods, landslides, earthquakes, wildland fires, and winter storms.	Bureau of Planning / *Portland Office of Emergency Management*	ST		✓	✓			✓
Short-Term Multi-Hazard #4	Incorporate assessment of terrorist threats into Portland's Hazard Mitigation Plan. Additionally, consider natural hazards if future opportunities to address terrorist threats to Portland arise.	Portland Office of Emergency Management / *Bureaus of Fire & Rescue, Police, and Transportation*	ST		✓			✓	✓
Short-Term Multi-Hazard #5	Acquire Light Detection and Ranging (LIDAR) images of the Portland Metro area and the Bull Run Watershed.	Portland Office of Emergency Management / *Corporate GIS, Bureau Environmental Services, Fire and Rescue, Bureau of Water, Portland Office of Transportation*	ST		✓				✓
Short-Term Multi-Hazard #6	Use findings from Portland's Risk Assessment (HAZUS-MH) to enhance the existing debris removal plan.	Bureau of Sustainable Development / *Portland Office of Emergency Management, Portland Office of Transportation, Maintenance, Bureau of Environmental Services*	ST		✓	✓			
Short-Term Multi-Hazard #7	Create a mitigation mapping committee.	Portland Office of Emergency Management, Corporate GIS / *Bureau of Environmental Services, Portland Department of Transportation, Bureau of Development Services, Fire Bureau, Water Bureau, Bureau of Planning*	ST		✓				✓
Short-Term Multi-Hazard #8	Partner with utilities as they ensure continuity of service to the City of Portland.	Portland Office of Emergency Management / *Disaster Policy Council, Mitigation Sub-Committee leaders; Cable and Franchise*	ST					✓	
Short-Term Multi-Hazard #9	Develop a city employee emergency response plan to assure that city employees know what is expected of them so that services are continued.	Portland Office of Emergency Management / *Disaster Policy Council; Human Resources, OMF, Bureau of General Services, Fire and Rescue, Police, Emergency Communications*	ST				✓		
Long-Term Multi-Hazard #1	Revise Portland's Comprehensive Plan to address natural hazards including, but not limited to, floods, landslides, earthquakes, wildland fires, and winter storms.	Bureau of Planning / *Portland Office of Emergency Management*	LT		✓	✓			✓

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority -----------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Long -Term Multi-Hazard #2	Develop a public outreach program to raise awareness of hazard risk.	Portland Office of Emergency Management / *Bureau of Planning, Disaster Policy Council, NETs, Bureau of Sustainable Development, Bureau of Development Services, Bureau of Environmental Services, Bureau of Water, Parks and Recreation, Office of Neighborhood Involvement, Portland Office of Transportation, Bureau of Maintenance*	LT				✓		
Long-Term Multi-Hazard #3	Increase the responsiveness of the emergency permitting procedures for post-hazard event periods through development of a procedural plan and the purchase of a mobile permitting van.	Bureau of Development Services / *Portland Department of Transportation, Bureau of Maintenance, Bureau of Environmental Services, Water Bureau, Risk Management*	LT				✓		✓
Long-Term Multi-Hazard #4	Develop citywide vegetation protection/planting goals, policies, and plans and implementing tools. Coordinate with vegetation management strategy development for wildfire, flood, and landslide hazard mitigation.	Bureau of Planning, Bureau of Environmental Services / *Bureaus of Development Services, Parks and Recreation; Fire & Rescue*	LT			✓			✓
Long-Term Multi-Hazard #5	Coordinate emergency standard operating procedures and plans between disaster responder organizations in the Portland metro region and TriMet, to coordinate and expedite decision-making during emergencies.	POEM, PDOT, Maintenance, Bureau of Fire & Rescue, BOEC,	LT		✓	✓		✓	
Long-Term Multi-Hazard #6	Promote the development of TriMet communications and dispatch capability to immediately implement changes to transit routes and service due to disruption of streets, roads, bridges and lt. rail transit tracks.	Bureau of Transportation, BOEC	LT			✓			
City of Portland - Risk Assessment Score Rating: High									
Short-Term Flood #1	A covenant is recorded with the deed of new development in the floodplain to ensure that space below the BFE is not converted to habitable space. This should be codified to improve compliance.	Bureau of Development Services	ST			✓			
Short-Term Flood #2	Continue to co-fund improvements to river and stream gauges in the Portland metropolitan area with the United States Geological Survey.	Bureau of Environmental Services	ST			✓			
Short-Term Flood #3	Convene an interagency committee to determine which datum will be used when the City is responding to a flood event. This decision will not preclude agencies from using their own datum during non-flood times.	Harbor Master, Fire Bureau / *Bureau of Development Services, Portland Office of Emergency Management*	ST						✓
Short-Term Flood #4	Secure the agreements necessary to design and implement the redevelopment of Freeway Land Company site (within the Lents Urban Renewal Area) to better manage floods.	Bureau of Environmental Services / *Portland Development Commission; Bureau of Planning, Portland Office of Transportation, Portland Parks and Recreation*	ST			✓			
Short-Term Flood #5	Acquire outside funding to hire a consultant to lead the application process for a Class 5 rating the next time the City submits for the Community Rating System certification.	Bureau of Environmental Services, Community Rating System Coordinator / *Bureau of Development Services; Bureau of Planning; Parks; Portland Office of Emergency Management; Bureau of Maintenance*	ST						✓

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					Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Flood #6	Support MCDD in the continued calibration and updating of hydraulic models for conveyance and internal flood impacts to the four managed floodplains managed by Multnomah County Drainage District # 1.	Portland Office of Emergency Management, Bureau of Environmental Services / *Bureau of Planning*	ST		✓				
Short-Term Flood #7	Develop a multiple-agency plan for evacuation of the managed Columbia River floodplain in Multnomah County in the event of a potential levee failure.	Mitigation Program Coordinator, Portland Office of Emergency Management / *Portland Office of Transportation*	ST						✓
Short-Term Flood #8	Secure funding to implement the passive flood management projects that are recommended in the Johnson Creek Restoration Plan. Coordinate with Portland Development Commission's urban renewal efforts in Lents and with other partners in other parts of the watershed.	Bureau of Environmental Services, Johnson Creek Watershed Manager / *Portland Development Commission, Parks and Recreation*	ST						✓
Short-Term Flood #9	Identify funding for the design and construction of the Springwater Wetlands Complex, a 30-acre floodplain wetland restoration project in the Lents area of Johnson Creek.	Johnson Creek Watershed Manager, Bureau of Environmental Services / *Parks and Recreation, Portland Development Commission*	ST			✓			
Short-Term Flood #10	Improve definitions and refine standards for stormwater retention in the Stormwater Management Manual (SWMM).	Development Services Division, Bureau of Environmental Services / *Bureau of Development Services, Bureau of Planning*	ST						✓
Short-Term Flood #11	Support development of a multiple-agency plan for Marine Drive closure coordination.	Portland Office of Emergency Management Mitigation Program Coordinator / *Bureau of Water, Portland Office of Transportation*	ST			✓			
Short-Term Flood #12	Provide staff to participate in Flood Fight Trainings lead by the Multnomah County Drainage District.	Portland Office of Emergency Management, Mitigation Program Coordinator / *Bureau of Maintenance, Police, Water Bureau*	ST				✓		✓
Short-Term Flood #13	Install a river gauge in the vicinity of the bridge over Johnson Creek at 108th. The gauge should be able to send data to a remote monitoring site.	Bureau of Maintenance, Environmental Systems Division Manager / *Bureau of Environmental Services; Portland Office of Transportation*	ST			✓			
Short-Term Flood #14	Install one-way valves on the outlet pipes of the storm inlets on SE Foster Road between 101st and 112th.	Environmental Systems Division Manager, Bureau of Maintenance / *Bureau of Environmental Services*	ST			✓			
Long-Term Flood #1	Increase funding for the Johnson Creek Willing Seller Program; establish willing seller programs in other watersheds where flood hazard and priority restoration areas coexist.	Watershed Managers, Bureau of Environmental Services / *Department of Parks and Recreation, Bureau of Planning, Water Bureau*	LT						✓
Long-Term Flood #2	Review and amend City Code to require that all facilities that store or handle hazardous materials (including large tanks), and which are located in the 500-year floodplain or landslide hazard areas, develop a hazardous materials inventory statement. This statement will be made available for Fire Bureau review. Require that these storage tanks are either adequately protected or relocated outside of the 500 year floodplain.	Chief Fire Marshal / *Harbor Master, Fire Bureau, Portland Office of Emergency Management, Bureau of Development Services*	LT			✓			
Long-Term Flood #3	Develop a plan for addressing flooding in the Holgate Lake area.	Bureau of Environmental Services / *Bureau of Development Services, Parks and Recreation, Bureau of Planning*	LT						✓
Long-Term Flood #4	Improve hydraulic bottleneck that prevents discharge of chlorinated effluent to the Willamette River during high river levels.	Operating Manager Tryon Creek Wastewater Treatment Plant, Bureau of Environmental Services	LT			✓			

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Long-Term Flood #5	As Waterfront Park remodeling is designed, ensure that Portland's downtown property and critical facilities remain protected from floodwaters.	Parks and Recreation / *Harbor Master/ Fire Bureau, Bureau of Planning, Bureau of Development Services*	LT			✓			
Long-Term Flood #6	Support Multnomah County Drainage District (MCDD) as they develop a multiple-agency plan for initiation of traffic closure on the Columbia River as advised by MCDD and the Army Corps of Engineers.	Mitigation Program Coordinator, Portland Office of Emergency Management / *Portland Office of Transportation*	LT						✓
Long-Term Flood #7	Partner with Army Corps of Engineers to conduct modeling of the Willamette River upstream of Portland to identify areas that, if acquired or restored, would contribute to mitigation of peak flows in Portland or result in significant reduction of flood damages.	Bureau of Environmental Services Systems Analysis Group	LT		✓				
Long-Term Flood #8	Develop citywide, watershed or sub-watershed specific goals, policies, and provisions for amount of impervious surface that should be reduced. Develop implementation tools to meet these goals.	Bureau of Planning, Bureau of Environmental Services / *Bureau of Development Services, Portland Office of Transportation*	LT			✓			
Long-Term Flood #9	Upgrade trestles that carry the main conduits of the water delivery system.	Water Bureau	LT			✓		✓	
Long-Term Flood #10	Create redundancy in the water delivery system at the three Sandy River crossings by burying conduits under the river.	Water Bureau, Operations and Support Manager	LT			✓			
Long-Term Flood #11	Provide funding for and participate in the development of a flood inundation model for the managed floodplains and downtown seawall.	Portland Office of Emergency Management Mitigation Program Coordinator / *COP, Bureau of Environmental Services, Water Bureau*	LT						✓

Earthquake Mitigation Action Items

City of Portland - Risk Assessment Ranking High

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Earthquake #1	Using television and print media, educate the public about the importance of signs containing bridge identification information during an earthquake.	Portland Office of Transportation	ST				✓		
Short-Term Earthquake #2	Assess existing earthquake related mitigation plans and vulnerability studies to identify areas of conflict, duplication, or gaps.	Portland Office of Emergency Management / *Fire Bureau, Office of Transportation, Bureau of Environmental Services, Water Bureau, Bureau of Development Services, Bureau of Planning*	ST						✓
Short-Term Earthquake #3	Update the vulnerability analysis of Columbia Boulevard Wastewater Treatment Plant (CBWTP), Tyron Creek Wastewater Treatment Plant (TCWTP), and wastewater pump stations.	Bureau of Environmental Services	ST		✓				
Short-Term Earthquake #4	Prioritize the return of power to treatment plants (Tryon Creek and Columbia Boulevard) and pump stations.	Bureau of Environmental Services / *Portland Office of Emergency Management*	ST			✓			
Short-Term Earthquake #5	Lobby to implement legislation of General Obligation Bonds to fund rehabilitation of critical structures.	Governmental Relations / *Bureau of Development Services, Portland Development Commission, Portland Office of Emergency Management, Office of Transportation, Parks and Recreation*	ST						✓

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority ------------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Earthquake #6	Address earthquake-generated landslide issues.	Portland Office of Emergency Management	ST			✓			
Short-Term Earthquake #7	Work with local jurisdictions to assess the capacity of landfills to accommodate earthquake debris; develop coordinated plans for disposal of debris in the aftermath of an earthquake.	Portland Office of Emergency Management / *Bureau of Maintenance, Office of Sustainable Development*	ST					✓	
Short-Term Earthquake #8	Study the feasibility of mandatory or voluntary installation of seismic shutoff valves on natural gas meters at commercial and residential buildings.	Bureau of Fire / *Bureau of Development Services, Bureau of Fire, Portland Office of Emergency Management*	ST			✓			
Short-Term Earthquake #9	Develop emergency evacuation plans for residential areas that are near significant hazardous materials storage facilities and heavy industrial areas.	Fire Bureau / *Portland Office of Emergency Management*	ST		✓	✓			
Short-Term Earthquake #10	Revise seismic design requirements for existing buildings.	Bureau of Development Services	ST		✓	✓	✓	✓	✓
Long-Term Earthquake #1	Evaluate funding alternatives that might accelerate seismic retrofitting of the City of Portland's bridges.	Portland Office of Transportation	LT			✓		✓	
Long-Term Earthquake #2	Conduct a vulnerability analysis of Portland's sewer system to identify elements with the potential for failure.	Bureau of Environmental Services / *Corporate Geographic Information Systems, Portland Department of Transportation, Fire Department, Police Department, Portland Office of Emergency Management, Bureau of Water*	LT		✓				
Long-Term Earthquake #3	Develop a plan to strengthen sewer infrastructure in areas where street overlays and sewers have potential to collapse in a seismic event.	Portland Office of Transportation / *Corporate GIS; Bureau of Maintenance, Bureau of Environmental Services, Bureau of Water, Portland Office of Emergency Management*	LT			✓			
Long-Term Earthquake #4	Develop a sewer failure response plan.	Environmental Services / *Corporate GIS, Maintenance, Environmental Services, Bureau of Water*	LT						✓
Long-Term Earthquake #5	Develop an educational program that targets homeowners, providing them with inexpensive methods that they can use to strengthen their homes against earthquake damage.	Portland Office of Emergency Management / *Bureau of Development Services, Bureau of Water, Fire Department*	LT			✓	✓		
Long-Term Earthquake #6	Assess the vulnerability of the water distribution system to seismic events; work toward hardening the system.	Bureau of Water	LT			✓			
Long-Term Earthquake #7	Partner with DOGAMI and USGS to obtain funding for completion of fault mapping and improved technology for the transfer of data and information.	Portland Office of Emergency Management	LT		✓				
Long-Term Earthquake #8	Study development regulations and policies to ascertain if regulations can be made to limit development of high risk facilities in known areas of earthquake hazards.	Portland Office of Emergency Management / *Bureau of Development Services, Bureau of Planning, Portland Department of Transportation, Bureau of Fire*	LT						✓
Long-Term Earthquake #9	Assess the stability of levees in the Columbia Corridor area, and develop appropriate emergency response plans to address potential levee failure and associated hazards.	Portland Office of Emergency Management / *Bureau of Water, Fire Bureau, Bureau of Environmental Services, Bureau of Maintenance*	LT			✓			✓

Landslide Mitigation Action Items

City of Portland - Risk Assessment Rating Medium

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority -----------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Landslide #1	Continue to maintain and improve internal City communications to facilitate coordination of landslide mitigation activities.	Bureau of Development Services / *Bureau Of Environmental Services, Portland Department Of Transportation, Bureau Of Maintenance, Bureau of Water, Parks and Recreation, Risk Management*	ST						✓
Short-Term Landslide #2	Improve property owner awareness of the importance of proper maintenance of private drainage systems.	Bureau of Environmental Services / *Bureau of Maintenance*	ST				✓		
Short-Term Landslide #3	Mitigate Portland's water supply infrastructure from landslide hazards.	Bureau of Water	ST			✓			
Short-Term Landslide #4	Initiate more operations and maintenance pilot projects along roads that inform the development of standards for managing stormwater in ditches in landslide prone areas.	Bureau of Environmental Services / *Bureau of Maintenance*	ST				✓		
Short-Term Landslide #5	Continue development of standards for small pump stations as an alternative to gravity sewers in inaccessible or high risk areas.	Bureau of Environmental Services / *Bureau of Development Services*	ST			✓			
Long-Term Landslide #1	Develop a comprehensive landslide map for the City of Portland to identify hazard areas and improve communication with the public.	Bureau of Development Services / *Planning Bureau, Water Bureau, Bureau of Environmental Services, Portland Department of Transportation, Bureau of Maintenance, Parks Department*	ST		✓		✓		
Long-Term Landslide #2	Acquire land or apply conservation easement for long term and permanent mitigation of risk.	Bureau of General Services / *Bureau of Planning, Parks and Recreation, Bureau of Development Services, Bureau of Environmental Services, Risk Management*	ST			✓			
Long-Term Landslide #3	Complete a study of the West Hills drainage system that addresses the cumulative effects of development in the area.	Bureau of Environmental Services, Planning and Modeling and Engineering Services / *Bureau of Planning, Bureau of Development Services (Site Development)*	ST		✓				
Long-Term Landslide #4	Review the effectiveness of regulations related to development in identified landslide hazard areas.	Bureau of Development Services (Land Use Services and Site Development), Bureau of Planning, *Bureau of Environmental Services*	LT			✓			
Long-Term Landslide #5	Update the Bureau of Environmental Services Sewer and Drainage Facilities Design Manual.	Bureau of Environmental Services	LT			✓			
Long-Term Landslide #6	Employ alternate construction methods such as trenchless construction on City projects to reduce the impact that development can have in landslide prone areas.	Bureau of Environmental Services	LT			✓			

Wildfire Mitigation Action Items

City of Portland - Risk Assessment Rating Medium

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Identify risk level	Implement activities	Promote public awareness	Establish a disaster resilient economy	Build and support the capacity
Short-Term Wildfire #1	Consolidate unassigned and/or unmanaged vegetated areas owned by the City of Portland under a single land management umbrella.	Parks, Bureau of Environmental Services / *Water, Portland Office of Transportation, Bureau of General Services*	ST						✓
Short-Term Wildfire #2	Procure funding for management of vegetated natural areas with high wildfire danger, including public and private properties.	Fire, Portland Parks and Recreation, Bureau of Environmental Services / *Bureau of Planning, Portland Office of Transportation, Bureau of General Services*	ST						✓

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority ------------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Wildfire #3	Review and index existing maps with pertinent wildfire information. Identify parameters and methods for new maps as needed to meet wildfire mitigation goals.	Fire, Bureau of Development Services,Corporate GIS / *BIT, Planning, Parks, Bureau of Environmental Services, Bureau of Water*	ST		✓				
Short-Term Wildfire #4	Provide wildfire management training for City staff.	Portland Fire and Rescue / *Parks and Recreation, Bureau of Environmental Services, Bureau of Water, Bureau of Maintenance*	ST						✓
Short-Term Wildfire #5	Amend the *Portland Plant List* and other related City plant lists and landscaping guides to include/identify fire resistant native plants, and planting strategies that could be encouraged or required in local landscaping.	Bureau of Planning / *DS, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation*	ST						✓
Short-Term Wildfire #6	Integrate, as appropriate, fire prevention goals and provisions into City policies, plans, and codes. Identify and address ambiguities or conflicts among city requirements.	Bureau of Planning / *Bureau of Development Services, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation*	ST						✓
Short-Term Wildfire #7	Identify conditions of approval and mitigation strategies that could be applied to new development or redevelopment in high fire risk areas.	Bureau of Development Services / *Bureau of Planning, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, and Portland Office of Transportation*	ST			✓			
Short-Term Wildfire #8	Integrate wild land fire risk educational opportunities into existing City stewardship programs. Provide education for both internal and external partners.	Bureau of Environmental Services / *Fire and Rescue, Bureau of Water, Bureau of Planning, Bureau of Development Services, Parks and Recreation, Portland Office of Transportation, Portland Office of Emergency Management, Office of Neighborhood Involvement*	ST				✓		
Short-Term Wildfire #9	Improve the system for identifying new construction in areas subject to wildfires and communicating this information to the affected land owners.	Bureau of Development Services / *Fire and Rescue; Bureau of Water, Portland Office of Transportation, Office of Neighborhood Involvement, Bureau of Planning*	ST				✓		✓
Short-Term Wildfire #10	Conduct systematic reviews of Portland's large, publicly owned, wildland tracts regarding fire safety and ecological health to inform land management decisions.	Portland Parks and Recreation / *Bureau of Environmental Services, Fire and Rescue, Bureau of Water, Bureau of Planning, Portland Office of Transportation, Office of Neighborhood Involvement*	ST		✓				
Short-Term Wildfire #11	Adopt the national "Fire Danger Rating System" and install the signs at key points in the City.	Fire and Rescue / *Office of Neighborhood Involvement*	ST				✓		
Short-Term Wildfire #12	Implement a neighborhood wildland interface disaster planning program.	Portland Office of Emergency Management, Neighborhood Emergency Team, Office of Neighborhood Involvement / *Fire and Rescue, Police*	ST				✓		
Short-Term Wildfire #13	Review and potentially refine City contract specifications for machinery operations during "Red Flag" weather conditions.	Fire and Rescue / *Bureau of Environmental Services, Portland Parks and Recreation, Water, Bureau of Maintenance*	ST			✓			
Short-Term Wildfire #14	Convene a standing wildland interface fire technical group.	Fire and Rescue / *Portland Parks and Recreation, Bureau of Environmental Services, Portland Office of Emergency Management, Bureau of Water, Portland Office of Transportation, Bureau of Development Services, Bureau of Planning*	ST						✓

Natural Hazard	Action Item	Coordinating Organization / *Internal Partners*	Timeline	Ideas for Implementation	Plan Goals Addressed Highest Priority ------------------> Identify risk level and evaluate Portland's vulnerability to natural hazards	Implement activities to protect human life, property and natural systems.	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination	Establish a disaster resilient economy.	Build and support the capacity and commitment to continuously become less vulnerable to hazards.
Short-Term Wildfire #15	Index City wildfire mitigation plans and activities.	Fire and Rescue / *Portland Parks and Recreation, Bureau of Environmental Services, Portland Office of Emergency Management, Portland Office of Transportation, Metro, Bureau of Development Services, Bureau of Planning*	ST						✓
Short-Term Wildfire #16	Identify water grid engineering requirements for firefighting in wildfire areas.	Bureau of Fire, Bureau of Water	ST			✓			
Long-Term Wildfire #1	Improve public education and understanding about wildfire occurrence, risk, and prevention.	Portland Fire and Rescue / *Parks, Bureau of Environmental Service, Portland Office of Transportation, Bureau of Planning*	LT				✓		
Long-Term Wildfire #2	Review the feasibility of adopting portions of nationally recognized wildfire interface codes to strengthen building standards in wildfire risk areas.	Portland Fire & Rescue, Bureau of Development Services	LT			✓			
Long-Term Wildfire #3	Design and conduct a study to determine the effectiveness of maintenance agreements that are established when new land divisions are approved to manage vegetation in open space tracts.	Bureau of Development Services, Fire and Rescue / *Bureau of Planning, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation, and the Office of Neighborhood Involvement*	LT		✓				
Long-Term Wildfire #4	Complete an assessment to characterize high priority wildfire risk areas and recommend specific mitigation strategies.	Fire and Rescue / *Parks and Recreation, Bureau of Environmental Services, Bureau of Planning, Bureau of Development Services, Bureau of Water, Portland Office of Transportation*	LT		✓				
Long-Term Wildfire #5	Explore avenues for funding interface home construction upgrades to low income homeowners.	Fire and Rescue / *Bureau of Development Services, Office of Neighborhood Involvement*	LT						✓

Section 1
Introduction

The City of Portland (the City) developed this Natural Hazard Mitigation Action Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

A natural disaster occurs when a natural hazard impacts people or property and creates adverse conditions within a community. Natural hazards include: floods, earthquakes, volcanic eruption, extreme weather, and wildfire. Each has the potential to harm people or property.[i] This plan focuses on the natural hazards that could affect the City of Portland, Oregon. Portland's topography, the presence of streams and its proximity to the Cascade Range and the Columbia Gorge play a large role in determining which natural hazards affect the City. Portland is subject to and has been affected by flooding, landslides, earthquakes, wildfires, windstorms, extreme winter storms, and volcanic eruption in the past. The historic impacts of these hazards have resulted in economic loss and damaged infrastructure in and around the City.

Why Develop a Mitigation Plan?

The dramatic increase of the costs associated with natural disasters over the past decades has fostered interest in identifying and implementing effective means of reducing vulnerability. This natural hazard mitigation plan is intended to assist the City of Portland in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City. The City received funds to develop the plan from the Hazard Mitigation Grant Program (HMGP) and the Flood Mitigation Assistance grants, both Federal Emergency Management Agency (FEMA) grant programs. The City of Portland provided the additional funds for the plan's development from its General Fund.

In 2000, the Federal Emergency Management Agency issued the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under this Act, states, communities, and tribal governments must complete FEMA-approved natural hazard mitigation plans to be eligible for certain federal assistance.[ii] This plan will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Portland will gain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds.

The plan is non-regulatory in nature, meaning that it does not set forth any new policy. It does, however, provide: (1) a foundation for coordination and collaboration among agencies and the public in the City of Portland; (2) identification and prioritization of future mitigation activities; and (3) assistance in meeting federal planning requirements and qualifying for assistance programs. The mitigation plan works in conjunction with other City plans and programs including the Comprehensive Land Use Plan, Comprehensive Emergency Management Plan, and the Capital Improvement Plan as well as the State of Oregon Natural Hazard Mitigation Plan.

The plan provides a set of actions to prepare for and reduce the risks posed by natural hazards through education and outreach programs, the development of partnerships, and implementation of preventative activities such land use or watershed management programs. The actions described in the plan are intended to be implemented through existing plans and programs within the City.

The plan will set the stage for a concerted and managed effort to identify ways to reduce loss, to meet the Disaster Mitigation Act of 2000 requirements, and prioritize action items for benefit/cost analysis.

Why Natural Hazard Mitigation?

What is natural hazard mitigation? Natural hazard mitigation is defined as permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.[iii]

Engaging in mitigation activities provides jurisdictions with a number of benefits including reduced loss of life, property, essential services, critical facilities, economic hardship, reduced short-term and long-term recovery and reconstruction costs, increased cooperation and communication within the community through the planning process and increased potential for state and federal funding for recovery and reconstruction projects.

Who Will the Plan Affect?

Ultimately, the benefactors of mitigation efforts are the citizens and businesses of Portland. The plan affects the City of Portland and a portion of its urban service area. It protects those who live, work, and visit Portland. While this plan does not establish mandates for the City, it does provide a viable framework for planning for natural hazards. The resources and background information in the plan are applicable citywide, and the goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

Policy Framework for Natural Hazards in Oregon

Planning for natural hazards is an integral element of Oregon's statewide land use planning program, which began in 1973. All Oregon cities and counties have comprehensive plans and implementing ordinances that are required to comply with the statewide planning goals. The challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide land use planning Goal 7: Areas Subject to Natural Hazards, calls for local plans to include inventories, policies, and ordinances to guide development in hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, resources exist at the state and federal levels. Some of the key agencies in this area include Oregon Emergency Management (OEM), Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI), and the Department of Land Conservation and Development (DLCD).

The Disaster Mitigation Act of 2000 (DMA 2000) is the latest federal legislation addressing mitigation planning. The legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur. As such, the Act established a Pre-Disaster Mitigation Program and new requirements for the national post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and local levels. It identifies new requirements that allow HMGP funds to be used for planning activities, and increases the amount of HMGP funds available to states that have developed a comprehensive, enhanced mitigation plan prior to a disaster. States and local communities must have approved mitigation plans in place in order to qualify to receive post-disaster HMGP funds. Mitigation plans must demonstrate that their proposed mitigation measures are based on a sound planning process that accounts for the risk to the individual and their capabilities.

Oregon Emergency Management (OEM) is working with FEMA and local governments statewide to coordinate activities with *the Partnership* and the Oregon Pre-Disaster Mitigation program in a manner which will:

- assist in achieving the broad goals of both programs
- assist communities in addressing the requirements of the new Federal Rule.

To accomplish these goals, *the Partnership* and the Oregon Pre-Disaster Mitigation program promote a collaborative partnership approach to mitigation planning and activities that encourage inter-governmental coordination, foster public-private partnerships, and build local capacity to develop risk reduction strategies and activities.

Plan Methodology

The City of Portland Natural Hazard Mitigation Plan was developed using a planning process created by the Community Service Center's Oregon Natural Hazard Workgroup at the University of Oregon.[iv] The planning process was designed to: (1) result in a plan that is DMA 2000 compliant; (2) coordinate this plan with the State's Natural Hazard Mitigation Plan and Partners for Disaster Resistance & Resilience: Oregon Showcase State Initiative; and (3) build a network within the City government and organizations that can play an active role in plan implementation. Following is a summary of major activities included in the planning process.

Steering committee:

At the request of Mayor Vera Katz, the project steering committee convened approximately every four to six weeks (a total of five meetings) to guide the development of this plan. The committee played a vital role in developing the mission and goals for the mitigation plan. The committee consisted of representatives of public and private agencies and organizations in the City of Portland, including:

- Miguel Ascarrunz, Director and Elise Marshall, Assistant Director, City of Portland Office of Emergency Management
- City of Portland Commissioner Dan Saltzman
- Dr. Ron Tammen, Steering Committee Chair, Portland State University, Hatfield School of Government
- Dr. Vicki McConnell, State Geologist, Department of Geology and Mineral Industries
- Bonny McKnight, Citywide Landuse Group and Neighborhood Coalitions
- Meryl Redisch, Executive Director, Audubon Society of Portland
- Don Eggleston, Principal, SERA Architects
- Myron Burr, Environmental Manager, Siltronic Corporation
- Dan Caufield, Planning and Operations Manager, Tri-Met
- Wade Lange, Sr. Property Manager, Ashforth Pacific Inc.
- Gil Kelley, Director, Bureau of Planning
- Ray Kerridge, Director, Bureau of Development Services
- Dean Marriott, Director, Bureau of Environmental Services
- Ed Wilson, Chief, Bureau of Fire and Rescue

- Jeanne Nyquist, Director, Bureau of Maintenance
- Mort Anoushirivani, Director, Bureau of Water Works
- Brant Williams, Director, Portland Office of Transportation

Hazard Specific Subcommittees:

The City of Portland recognized the importance of establishing a collaborative planning process to develop both short-term and long-term risk reduction strategies with strong ties to the City existing programs and divisions of governance. Therefore, the City developed five hazard specific subcommittees composed of individuals and specialists with natural hazard mitigation understanding and responsibilities from city bureaus, state agencies, and community organizations in and around Portland. The subcommittees were able to provide insight on community issues, policies and programs related to natural hazards and developed a list of current mitigation activities that are being implemented by the various organizations, in addition to identifying potential future actions items.

The committee consisted of representatives of public and private agencies and organizations in the City of Portland, including:

Severe Weather

- Dave Harrington, Chair, Portland Office of Transportation and Maintenance
- Ken Carlson, Eric Thomas, and Phil Burkart, Bureau of Development Services
- Bryan McNerney, City Forester, Parks and Urgan Forestry
- John McGregor, Bureau of Environmental Services
- Lt. Allen Oswalt, Bureau of Fire and Rescue
- Michael Armstrong, Office of Sustainable Development
- Mike Stuhr and Mary Leung, Bureau of Water
- Steve Todd, National Weather Service
- Dan Caufield, Tri-Met

Earthquake

- Jed Sampson, Chair, Bureau of Development Services
- Deborah Stein, Bureau of Planning
- Mary Ellen Collentine, Bureau of Water
- Gary Ott, Bureau of Environmental Services
- Bruce Walker and Judy Crockett, Office of Sustainable Development
- Mike Speck, Bureau of Fire and Rescue
- Calvin Lee and Bill Long, Portland Office of Transportation

- Kenny Asher, Portland Development Commission
- Don Eggleston, SERA Architects
- Dan Caufield, Tri-Met
- Dr. Vicki McConnel, Department of Geology and Mineral Industries
- Gail Dreckman, Bonneville Power Administration

Flood

- Daniela Cargill, Chair, Bureau of Environmental Services
- Chris Wanner, Bureau of Water
- Bill Freeman, Bureau of Development Services
- Fred Wearn, Portland Development Commission
- Christ Payne, Harbor Master, Portland Fire and Rescue
- Chris Scarzello, Bureau of Planning
- Fred Burckhardt, Portland Office of Transportation
- Dave Hendricks, Multnomah County Drainage District

Wildfire

- Richard Haney, Chair, Portland Fire and Rescue
- Roberta Jortner, Bureau of Planning
- George Helm, Rebecca Esau, Bureau of Development Services
- Dennis Kessler and Chris Wanner, Bureau of Water
- Andi Curtis, Bureau of Environmental Services
- Mark Wilson and Charley Davis, Parks and Recreation
- Kevin Williams, Portland Office of Transportation
- Mitch Luckett, Audubon Society of Portland
- Karen Trombley, Tryon Creek State Park
- Louisa Evers, Bureau of Land Management

Landslide

- Liane Welch, Chair, Portland Office of Transportation
- Tom Caulfield, Portland Office of Transportation
- Tricia Sears and Bill Freeman, Bureau of Development Services
- Deborah Lev, Parks and Recreation
- Mark Braun and Barbara George, Bureau of Environmental Services
- B.C. Bob Ferrington, Bureau of Fire and Rescue
- Sallie Edmunds, Bureau of Planning

- Tim Collins, Bureau of Water
- Mitch Luckett, Audubon Society of Portland
- Bonny McKnight, Neighborhood Landuse
- Dr. Scott Burns, Portland State University, Department of Geology

State and federal guidelines and requirements for mitigation plan:

The City's research team reviewed natural hazard mitigation plans from other jurisdictions, current FEMA planning requirements, the FEMA Pre-Disaster Mitigation Program requirements, and the National Flood Insurance Program's Community Rating System. Statewide reference materials consisted of community and county mitigation plans, including:

- Metro's Regional Hazard Mitigation Policy and Planning Guide
- Oregon Natural Hazards Workgroup, Plan Framework (ONHW)
- City of Beaverton Natural Hazard Mitigation Plan
- Washington County Natural Hazard Mitigation Plan
- Clackamas County Natural Hazard Mitigation Plan
- *Planning for Natural Hazards: Oregon Technical Resource Guide* (DLCD)
- *Natural Hazard Mitigation Plans: An Evaluation Process (OEM)*
- State of Oregon Natural Hazards Mitigation Plan (OEM)
- Post-Disaster Hazard Mitigation Planning Guidance for State and Local Governments (OEM)
- Partners for Disaster Resistance & Resilience: Oregon Showcase State Initiative's Community Planning Resources

The City of Portland plan builds upon above listed resources and is based upon the University of Oregon's Oregon Natural Hazards Workgroup, plan framework and collaborative planning process.

Hazard specific research:

Prior to convening the sub-committees, a research team from Tetratech developed the HAZUS-MH program and completed the hazard profile and assessment. The team worked with data collection professionals from a variety of Portland agencies to compile the metadata that became the basis for risk assessment in the plan. The hazard reviewed the data and research on five hazards: flood, landslide, earthquake, severe weather, and wildfire. Research materials came from state agencies including Oregon Emergency Management, Department of Geology and Mineral Industries, Department of Land Conservation and Development, Bureau of Community Development, Metro Regional Government Data Research Department, Portland State University Department of Metropolitan Studies, the U.S. Census, and Oregon

Department of Forestry. Historical records from local agencies served as the main source of information on the past impacts of hazards in the community. The subcommittees identified current mitigation activities, resources and programs, and potential action items from research material, input from the steering committee.

Plan Organization

How do I use the plan?

Each section of the mitigation plan provides specific information and resources to assist people in understanding the City and the hazard-specific issues facing citizens, businesses, and the environment. Combined, the sections work together to create a mitigation plan that guides the mission to reduce risk and prevent loss from future natural hazard events. This plan structure enables people to use the section(s) of interest to them.

Chapter I: Mitigation Action Plan

Executive Summary: Five-Year Action Plan

The *Five-Year Action Plan* provides an overview of the mitigation plan mission, goals, and action items. The plan action items are included in this section, and address multi-hazard issues, as well as hazard-specific activities that can be implemented to reduce risk and prevent loss from future natural hazard events.

Section 1: Introduction

The Introduction briefly describes historical events that have impacted the area, mitigation planning, and the methodology used to develop the plan. It also includes information about the steering committee's role, how stakeholders provided input.

Section 2: Community Profile

The Community Profile briefly describes the City in terms of demographic, economic, and development trends as well as geography and environment, housing, and transportation.

Section 3: Risk Assessment Summary

This Risk Assessment provides information about Portland's natural hazard risk assessment. It is general in scope, providing background on the process of producing risk assessments as well as an overview of Portland's risk information. Complete risk assessment information for each of the hazards identified in this plan can be found in Appendix C.

Section 4: Mitigation Plan Vision, Mission, Goals, and Action Items Overview

This Plan Vision provides information on the process used to develop the goals and action items in the plan. It also describes the framework that focuses the plan on developing successful mitigation strategies.

Section 5: Multi-Hazard Action Items

This section provides information on goals and action items that address all the natural hazards in the mitigation plan.

Section 6: Plan Implementation, Maintenance and Public Participation

This section provides information on the implementation, monitoring, and evaluation and updating of the plan and finally, the role of the public.

Chapter II: Hazard Specific Information

Four chronic hazards and one catastrophic hazard are addressed in this plan. Chronic hazards occur with some regularity and may be predicted through historic evidence and scientific methods. The chronic hazards addressed in the plan include:

- *Section 7: Flood*
- *Section 8: Landslide*
- *Section 10: Extreme Weather*
- *Section 11: Wildfire*

Catastrophic hazards do not occur with the frequency of chronic hazards, but can have devastating impacts of life, property, and the environment. The one catastrophic hazard presented in the plan is:

- *Section 9: Earthquake*

Each of the hazard specific sections includes information about historical impacts, risk assessments, specific community issues, and action items, and local resources associated with the hazard.

Chapter III: Resources

The plan appendices are designed to provide users of the City of Portland Natural Hazard Mitigation Plan with additional information to assist them in understanding the contents of the mitigation plan, and potential resources to assist them with implementation.

Appendix A: Economic Analysis of Natural Hazard Mitigation Projects

This Appendix describes the Federal Emergency Management Agency's (FEMA) requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix B: Documentation of Planning Process

This Appendix provides background information about the meetings, presentations, and other outreach that have supported the planning process.

Appendix C: City of Portland HAZUS-MH Risk Assessment Report

This Appendix provides a list of acronyms for city, county, regional, state and federal agencies and organization that may be referred to within the City of Portland Natural Hazard Mitigation Plan.

Appendix D: Capability Assessment Matrix

This Capability Assessment is designed to assess the operations, readiness, and capabilities of those organizations associated with the plan's action items to assess which items in the prioritized list can be implemented using existing resources and which items require outside funding. It can be used to help the DPC answer the question, "Does the coordinating agency have the capability needed to implement the action item?"

Section Endnotes

[i] Federal Emergency Management Agency. 2002. *How-To Guide #2: Understanding Your Community's Risks; Identifying Hazards; and Determining Risks.*

[ii] DMA 2000, State and Local Plan Criteria: Mitigation Planning Workshop for Local Governments, <http://www. fema.gov/fima/planning_toc4.shtm>

[iii] Massachusetts Department of Environmental Management. 1999. "Hazard Mitigation: Managing Risks, Lowering Costs. http://www.state.ma.us/dem/programs/mitigate/whatis.htm Accessed 8/2/02

[iv] More information on the Oregon Natural Hazards Workgroup can be found at http://darkwing.uoregon.edu/~onhw Accessed 8/25/04

Section 2
Community Profile

Why Plan for Natural Hazards in Portland?

In 2000, the U.S. Congress passed the Disaster Mitigation Act of 2000. Under this Act, states, communities, and tribal governments must complete Federal Emergency Management Agency (FEMA)-approved natural hazard mitigation plans to be eligible for certain federal assistance programs such as the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation competitive grant program. In February 2002, FEMA published the Interim Final Rule 44 CFR Part 201, which defines the requirements for natural hazard mitigation plans.[1]

While the City of Portland's climate is generally mild and it has relatively gentle topographic relief, natural hazards do pose a threat to the city's economy and its citizen's property and health. Natural disasters have caused major problems in Portland in recent history. Heavy winter rainstorms and windstorms, along with occasional severe winter storms, pose a threat to the City. Portland's location near a major subduction zone places it in danger of experiencing a major earthquake. Planning for the occurrence of these hazards will help strengthen vital components of the city's infrastructure and minimize the risk and incidence of personal injuries, fatalities, and property damage.

History of Natural Hazards in Portland

The City of Portland is directly affected by a number of natural hazards including: extreme weather events such as windstorms and severe winter storm; floods: landslides; earthquakes; and wildfires. This section presents a brief history of natural events that have significantly impacted Portland.

Severe Weather

Severe storms, including windstorms, heavy snowfall, ice storms, and heat storms occur with some frequency in the City of Portland. On October 12, 1962, the largest windstorm in recorded history hit Oregon. The infamous "Columbus Day Storm," the most powerful non-tropical storm to hit the lower-48 states, affected all of western Oregon. In terms of both human life and property, the Columbus Day Storm was by far the most costly to Oregon residents and the entire Northwest in recorded history. The storm claimed 23 lives and caused $235 million (1962 dollars) in property damage throughout the Northwest.

For more information about severe weather and its potential impacts, please see Section 10: Severe Weather.

Earthquakes

Portland is located inland to the Cascadia Subduction Zone and within a region expected to withstand severe damage from a 9.0+ subduction earthquake. Both the number of older unreinforced masonry buildings and liquefiable soils are recognized as conditions that amplify the hazard. The Portland Hills Fault Zone and the East Bank Fault Zone are potential hazardous areas for local, crustal earthquakes to occur.

Several moderate earthquakes have affected Portland in the past century. Little damage has occurred in Portland as a result, but the earthquakes have rattled nerves, and served to remind residents that their community is at risk of experiencing damaging earthquakes. The most recent earthquake to affect Portland was a 3.9 magnitude earthquake that occurred April 24, 2003, and was centered 15.8 km northwest of Portland and 42.0 km north of Canby. This quake was the largest quake to be generated by a fault under the Portland area in over 40 years, and was felt throughout the Portland area. The quake was followed by seven aftershocks and smaller-deeper tremors were detected for several weeks after.[2]

For more information about earthquakes and their potential impacts, please see Section 9: Earthquakes.

Floods

Flooding has greatly impacted Portland in the past, and has the potential to do so in the future. One of the more severe flood years on record occurred in 1996, when many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels. On Friday, February 9, 1996, the Willamette river crested 10 feet 6 inches above flood stage, just inches away from testing the plywood wall build above Portland's downtown seawall. The Columbia River crested at 11 feet 2 inches above flood stage, causing concern about the levees that protect Portland International Airport and areas north of Columbia Boulevard. Johnson Creek crested at 6 feet 5 inches above flood stage. Each year, there is about a one in 25 chance of a similar storm. A more serious storm could bring floodwaters over the downtown seawall and into the central business district.[3]

For more information about floods and their potential impacts, please see Section 7: Floods.

Landslides

Landslides are common in Portland because the area has steep slopes, abundant precipitation, and in some areas, weak soils. As many as 800 landslides accompanied the storms of the winter of 1996. Portland's two most famous landslides have occurred in the West Hills and were reactivated by construction activity. The Washington Park Landslide was reactivated in 1895 when the city cut off the ancient landslide toe when it put in two new reservoirs. This landslide has since slowed to four centimeters per year. The Children's Museum, World Forestry Center and the Oregon Zoo also are built on a large landslide that was reactivated in 1957 by the widening of Highway 26 which also cut off the toe; this landslide is now stabilized.

For more information about landslides and their potential impacts, please see Section 8: Landslides.

Wildfires

Portland's considerable urban forest land increases its susceptibility to wildfires within the city limit. The most recent sizeable wildland fire was the Mocks Crest (or Willamette Bluffs) fire that occurred in August of 2001. A two-mile section of grass and brush was ignited along the railroad tracks paralleling the Willamette River. The fire quickly traveled up the bluff to Willamette Drive threatening structures at the University of Portland along with dozens of homes. This fire grew to a 5th alarm mobilizing all off-duty members of Portland Fire and Rescue along with mutual aid from five surrounding fire departments. Fire crews rotated through the scene for 2 _ days.

For more information about wildfires and their potential impacts, please see Section 11: Wildfire.

Geography and Environment

The City of Portland, Oregon, in Multnomah County, lies at the confluence of two major rivers, the Columbia River and the Willamette River. The Columbia River Gorge, lies to the east, providing a break in the Cascade Mountain range. Several large volcanoes surround the city, including Mount St. Helens, Mount Hood, and Mount Adams. The city lies about 70 miles east of the Pacific Coast.

Rivers and Streams

The City of Portland is located in the Willamette River Basin, which is approximately 11,460 square miles. The Willamette River Basin is the largest watershed in the state, with 13 major tributaries joining between its headwaters at Waldo Lake (south east of Eugene) and the confluence with the Columbia River at Kelley Point. Though the City of Portland only occupies 1% of the Willamette River's drainage basin, its 17 square miles are the most urbanized and heavily used of all in the basin. Approximately 60 miles of ditches, the Columbia Slough and a series of smaller sloughs throughout and surrounding the City protect Portland from flood damages.

Climate

The National Climatic Data Center has established climate zones in the US for areas that have similar temperature and precipitation characteristics. Oregon's latitude, topography, and proximity to the

Pacific Ocean give the state diversified climates. Portland is in Zone 2. The climate in Zone 2 generally consists of wet winters and dry summers. In 2001, 89% of the precipitation occurred between October and May; 11% of the annual rainfall occurred between June and September, and 4% occurred in July and August.[4] There is an average of only five days per year of measurable snow with snowfall accumulations rarely measuring more than two inches.[5] Table 2-1 describes the monthly average precipitation and temperature in Portland.

Table 2-1. Monthly Average Precipitation (inches) and Temperature (degrees Fahrenheit), Portland, Oregon

Month	Average High	Average low	Warmest on record	Coldest on record	Average dew point	Average precipitation
January	45	34	65	-2	33	5.4
February	50	36	71	-3	36	4.1
March	56	39	83	19	38	3.7
April	61	42	93	29	41	2.5
May	68	48	100	29	46	2
June	73	53	102	39	50	1.6
July	80	57	107	43	53	0.5
August	79	57	107	44	54	0.9
September	74	52	105	34	51	1.6
October	64	46	92	26	47	3.1
November	52	40	73	13	40	5.5
December	46	36	65	6	36	6.5

Source: Oregon Climate Service, 2001.

Most of the winds that come from the west are subdued by the time they reach the Portland area because of the influence of the Coast Range. The most destructive winds are those which blow from the south, parallel to the major mountain ranges.[6] Some winds blow from the east, but most often do not carry the same destructive force as those from the Pacific Ocean. Severe storms affecting Portland with snow and ice typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from October through March.[7]

While snow is relatively rare in western Oregon, the Columbia Gorge provides a low-level passage through the mountains. Cold air, which lies east of the Cascades, often moves westward through the Gorge, and funnels cold air into the Portland Area. If a wet Pacific storm happens to reach the area at the same time, larger than average snow events may result.[8] This situation may also result in ice storms.[9] Like snow storms, ice storms are characterized by cold temperatures and moisture, but subtle changes can result in varying types of ice formation, including freezing rain, sleet, and hail.[10]

Minerals and Soils

Several common natural hazards are related to soil stability and water retention. These hazards include landslides, erosion, flooding, and liquefaction resulting from an earthquake. Mineral and soil compositions are important factors for determining whether Portland is prone to hazards such as landslides.

Soils on the west side of the Willamette River vary from clay loam with low permeability and relatively high erosion potential to gravelly loams, which are relatively well drained and moderately permeable. The flat areas along the west bank of the Willamette River are urban and highly disturbed, and many consist of unstable fill.

On the east side of the Willamette River, soils are highly variable; similar to the west side, however, they are generally urban and highly disturbed. Much of the area along the Columbia River has been filled with dredged sand, which drains very well. In undisturbed areas along the Columbia River, percolation rates are very slow. Areas south of Columbia Boulevard have soils that drain well. In the southeast areas of the City, soils vary from moderate to low permeability. In areas with well-draining soil, it is possible to manage stormwater through infiltration.

Significant Geological Factors

Most of the Pacific Northwest lies within the Cascadia Subduction Zone (Figure 2-1), where the Juan de Fuca and North American plates meet. The convergence of these tectonic plates puts most areas of western Oregon and Washington at risk for a catastrophic earthquake with a magnitude of 8.0 or higher. Portland lies in this area of risk. Another earthquake risk is the Portland Hills fault, which may be capable of generating moderately large earthquakes. As a result of the subduction zone, there are active volcanoes nearby, including Mt. St. Helens in southwest Washington, and Mt. Hood. Major eruptions of these volcanoes may cause significant ash fall in the Portland area.

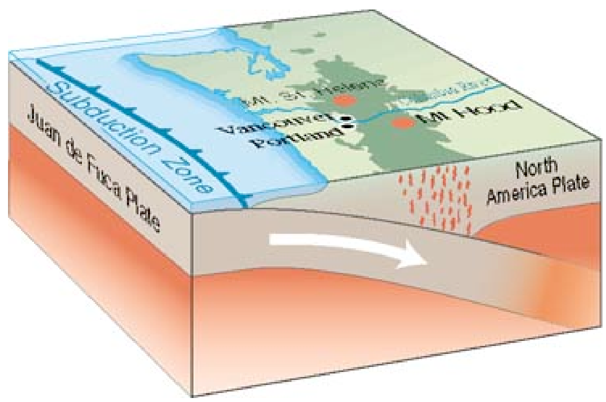

Figure 2-1 Cascadia Region Subduction Zone

Population and Demographics

Population growth in Portland has exceeded forecast expectations.[11] Between 1990 and 2000, the Portland grew nearly 21%, from 437,319 to 529,121. Table 2-2 provides population data for the Portland Metro region, including projections for 2010.

Table 2-2. Population Trends, Portland Metro area, 1950-2010

Year	Population	Percent Change
1950	619,522	
1960	728,088	18%
1970	880,675	21%
1980	1,050,367	19%
1990	1,174,291	12%
2000	1,444,219	23%
2010	*1,877,700*	*30%*

Source: Metro Regional Databook, November 2004 and 2015 Metro Regional Forecast, January 1996.

While natural hazards do not discriminate, the impacts in terms of loss and the ability to recover vary greatly among those affected.[12] According to Peggy Stahl of the FEMA Preparedness, Training and Exercise Directorate, 80% of the disaster burden falls on the public. Women, children, minorities and the poor bear a disproportionate amount of this burden.[13] Because these groups are especially at risk during disasters, it is important to identify those populations within Portland. Potential language, economic, physical, and social barriers could inhibit disaster preparedness and limit the efficacy of relief efforts during a disaster.

In Portland, 31% of households are female-headed households. There are approximately 125,561 Portland residents below the age of 20; this represents 24% of the City's total population. In 2000, 7% of Portland's population was Hispanic or Latino,[1] 6% were Asian and 7% was Black or African American. About 8% percent of Portland's families are living below the poverty level; of those, 5% are female-headed households, most with related children under the age of 18.[14]

Communication is crucially important before, during, and after a disaster event. The population must be made aware of the risk, understand how to prepare, and be able to navigate the process of recover. For this reason, language should be a major consideration for hazard planners. Table 2-3 shows the number of people who either do not speak English well or do not speak it at all.

Table 2-3. Non-English speaking population, Portland, 2000

	Number who speak another language		Number who speak English not well or not at all	
Age	Number	% of total population	Number	% of total population
5-17	17,053	3.4%	2,863	0.6%
18-64	60,688	12.2%	18,492	3.7%
65+	6,387	1.3%	2,739	0.6%
TOTAL	84,128	16.9%	24,094	4.8%

Source: U.S. Census, 2000.

[1] Includes those who identify as Hispanic or Latino plus other race(s).

Land and Development

In Portland, the largest portion of the land (about 52%) is dedicated to residential uses. About 20% is dedicated to industrial uses. This information is important for hazard planners to consider because the type of development in each land use designation reacts differently to hazard events. In industrial lands, for example, hazardous materials spills might be an issue, whereas in residential areas, planners may need to consider evacuation routes for residents or target homes for mitigation. Table 2-4 describes the land use designations in the City of Portland.

Table 2-4. Zoning, Portland, 2004

Zoning	Percent of total land
Residential	52%
Commercial	8%
Industrial	20%
Employment	3%
Open Space	18%

Source: City of Portland Bureau of Planning (Deborah Stein 10/27/04).
Note: The data is current as of October 27, 2004.

The zoning designations, however, don't necessarily represent the actual amount of development that falls into each category. In Portland, about 50% of the total developed square footage is on land that has been zoned for single family residential use and 11% is on land zoned for multi-family residential use. About 38% of Portland's developed square footage in on land zoned for commercial use. While industrial zoning represents 20% of the total land, it represents just 1% of the developed square footage.[15]

Development Regulations

Portland has adopted a number of regulations regarding development in areas subject to natural hazards. Following is a brief description of the applicable regulations.[2]

There exists a potential conflict between preserving environmental sensitive lands and "buildable" lands in the Urban Growth Boundary (UGB) inventories in the Portland Metro area. Removing environmentally sensitive lands from development infringes on the ability of the jurisdiction to maintain the required 20 years of housing capacity. The Metro Council's Resolution Number 99-2820 "encourages

[2] In November 2004, Oregon voters passed Ballot Measure 37, which requires that if a land use regulation reduces the value of land, a government entity must either pay the property owners for the reduced value or forego enforcement of the regulation. Though Measure 37 specifically excludes regulations that protect public health and safety, his measure could impact the city's ability to regulate land development to prevent loss from hazards.

all local jurisdictions in the Metro region to actively protect environmentally sensitive areas, even if they include lands that Metro is required by state law to classify as "buildable" for its UGB inventory."[16] A previous resolution related to the resolution above, 97-2562B, provided similar recommendations to local jurisdictions. The resolution indicates that:

> the protection of environmentally sensitive lands from development could result in a decline in net buildable acres in a local jurisdiction. Upon demonstration by a local jurisdiction that such protection results in an inability to meet jobs, housing and other targets established in the Urban Growth Management Functional Plan, which includes a recommendation which identifies land that would provide for the unaccommodated capacity located inside or outside the urban growth boundary and near or adjacent to the city of county, the Metro Council will grant an exception consistent with Title 8 of the Functional Plan. The exception will be granted to the extent the local jurisdiction establishes that decline in net buildable acres is the result of lands being protected from development by locally adopted and implemented regulations.[17]

The City's Comprehensive Plan currently outlines goals, policies, and actions regarding natural hazards in Portland. Policies designed to meet the State's comprehensive planning requirement, Goal 7 of the "Areas Subject to Natural Disaster and Hazards" include the provision of safe housing, regulating development in areas subject to flooding, and providing a network of emergency response routes for first responders.

Housing and Community Development

Gaining an understanding of the City's current housing stock as well as trends in community development are important in planning for natural hazards because development in Portland has increased steadily with population growth. Older housing stock can be more susceptible to damage in hazard events, especially if it was built prior to the implementation of newer code designed to reduce loss. The largest portion of Portland's housing stock (34%) was built before 1939, and could therefore be more severely impacted by earthquakes and severe weather events. Table 2-5 provides further information about housing ages in Portland.

Table 2-5. Age of housing units, Portland, April 2000

Year Built	Number	Percent
1990-March 2000	24,077	10%
1980-1989	13,630	6%
1970-1979	28,759	12%
1960-1969	27,212	11%
1950-1959	35,470	15%
1940-1949	27,352	12%
1939 or earlier	80,769	34%
TOTAL	237,269	100%

Source: US Census Bureau, 2000.

This situation can be exacerbated when vulnerable populations live in older housing stock. In Portland, 71% of homeowners who are living below the poverty line and 73% of homeowners over the age of 75 live in homes built before 1950. When these homes are impacted by disasters, these homeowners are less likely to have the physical and financial resources to respond or recover.

Employment and Industry

Portland residents' median earnings are $23,524[18]. Median earnings are $26,992 for male workers, and $20,619 for females. According to the 2000 Census, Portland had 276,081 employees. Although growth has slowed over the past few years, economists project increased job growth in all major industries in the coming years.[19] This is partly due to the fact that the Portland region has one of the more diversified economies on the West Coast.

Table 2-6 provides a breakdown of jobs and the number employed by industry type.[20] Appendix C: Risk Assessment contains further information about commercial and industrial lands that are at risk from natural hazards.

Table 2-6. Employment by industry, Portland, 2000

Industry	Number employed	Percent
Agriculture, forestry, fishing and hunting, and mining	1,100	0%
Construction	14,965	5%
Manufacturing	34,513	13%
Wholesale trade	12,768	5%
Retail trade	31,708	11%
Transportation and warehousing, and utilities	15,318	6%
Information	8,740	3%
Finance, insurance, real estate, and rental and leasing	19,033	7%
Professional, scientific, management, administrative, and waste management	33,106	12%
Educational, health, and social services	54,321	20%
Arts, entertainment, recreation, accommodation, and food services	25,993	9%
Other services	15,119	5%
Public administration	9,397	3%
Total employed population	**276,081**	**100%**

Source: US Census Bureau, 2000.
Note: The data in Table 2-6 represent how many Portland *residents* are employed in each industry. The Census does not count employees at their place of work.

The largest sector of the region's economy, manufacturing, represents production of durable goods such as electronics, metals, machinery, and lumber and woods products. The Portland metropolitan area remains the center of the region's high-tech industry; over 3,000 firms employ more than 79% of the total Oregon and Southwest Washington workforce in this sector. The largest employer in the metropolitan area, Intel, has a total of about 15,000 employees and falls into this category. Retail sales are also important. While the area ranks 25th nationally in population, it has the 24th largest retail market in the country, with retail sales exceeding $27 billion.[21]

Transportation and Commuting

Transportation in Portland includes state and county highways, arterial streets, collector streets, neighborhood routes, local streets, Tri-Met bus service, Westside Light Rail, and multiple bicycle routes. Portland's transportation network serves both residential and commercial commuters. The Tri-County Metropolitan District of Oregon (Tri-Met) provides public transportation in Portland. Tri-Met's service includes 95 bus routes and 38 miles of light rail line (called Metropolitan Area Express, or MAX). The 33-mile MAX Blue Line connects the cities of Portland, Gresham, Beaverton and Hillsboro. The

Red Line connects the Portland International Airport with downtown Portland, and the Yellow line runs north from downtown to connect North Portland. Together, the MAX lines carry about 80,000 riders each weekday. Additionally, Portland has a streetcar system that carries approximately 4,000 passengers per day in the downtown area and Northwest Portland.

Many of Portland's residents take advantage of public transit for their daily commutes. Commuters and their routes are important considerations for hazard planners; transit routes keep the economy functioning and provide important lifelines for emergency response. Additionally, if a disaster were to occur during rush hour, commuters could be seriously impacted. The largest portion of commuters leave home between 7:30 and 7:59 a.m. in the morning and require between 15 and 19 minutes to arrive at work. The majority of them drive alone; the next largest portion take the bus.[22] Table 2-7 shows the modes of transportation that commuters use in Portland.

Table 2.7. Modes of transportation for commuters, Portland, 2000

Mode of transportation	Number	Percent
Car, truck, or van	204,688	75.5%
Drove alone	172,491	63.7%
Carpooled	32,197	11.9%
Public transportation	33,410	12.3%
Bus	30,492	11.3%
Streetcar	1,195	0.4%
Subway or elevated	1,039	0.4%
Railroad	446	0.2%
Taxi	238	0.1%
Motorcycle	480	0.2%
Bicycle	4,775	1.8%
Walked	14,192	5.2%
Other	1,671	0.6%
Worked at home	11,780	4.3%
Total, all modes but driving alone	*98,505*	*36.3%*
Total	**270,996**	**100.0%**

Source: U.S. Census Bureau, 2000.

Goods travel in and out of Portland through a variety of routes. Waterborne commerce is an important driver in the regional economy. The Port of Portland owns and manages five marine terminals; in 2002, over 4,500,000 short tons of goods were shipped in from foreign ports and 11,000,000 short tons of U.S. goods left the Port of Portland.[23] Passenger and cargo rail lines traverse the city. A major north-south interstate freeway, I-5, cuts through the city. I-205 provides an alternate route around the eastern edge of the city, and I-405 provides access to downtown Portland.

Critical Facilities and Infrastructure

Critical facilities and infrastructure are those that are essential to the health and welfare of the population; these are especially important following a disaster. As defined for the Portland Risk Assessment, this category includes: schools, hospitals, fire stations, police stations, and hazardous materials sites, transportation systems, lifeline utility systems, and high-potential loss facilities.

- **Essential Facilities**. For the City of Portland, the essential facilities are police and fire stations, hospitals, City Hall, 1900 Building, the Bureau of Emergency Communications, the 911 call center, and the Justice Center.
- **Critical Facilities.** Critical facilities are those facilities that critical to the health and welfare of the population and that are especially important following a hazard. Critical facilities include essential facilities (described above), transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous materials sites. As defined by the Portland Risk Assessment, this category includes: schools, hospitals, fire stations, police stations, and hazardous materials sites. Private commercial establishments although critical to the recovery of a community are also a part of this listing.
- **Infrastructure**. Critical infrastructure includes public services that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and transportation facilities (such as airports, heliports, highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry docks, piers and regional dams).
- **Lifelines.** Lifelines include utility systems (potable water, wastewater, oil, natural gas, electric power facilities and communication systems) and transportation systems (airways, bridges, roads, tunnels and waterways). Communications facilities are also important lifelines.
- **High Potential Loss Facilities**. Facilities that would have a high loss associated with them, such as nuclear power plants, dams, and military installations are included in the high potential loss facilities category. In Portland, this would include the Hazardous Materials Sites in the Guilds Lake area and the inner city dams operated by the Portland Water Bureau.

Further information about critical and essential facilities is available in Portland's Continuity of Operations Plan.

Section Endnotes

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[2] Oregonlive.com, (May 14, 2003) http://www.oregonlive.com/search/index.ssf?/base/science/105291437197590.xml?oregonian?scg
[3] Flood and Landslide Mitigation Work Group, Portland Bureau of Buildings. "Flood and Landslide Hazard Mitigation Plan: Based on lessons learned in February, 1996". October, 1996.
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[5] National Weather Service, Portland Bureau, (March 2001). http://www.wrh.noaa.gov/Portland/snowstorm.html
[6] Ibid.
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[8] Taylor, George H. and Hannan, Chris, *The Oregon Weather Book*, (1999) Oregon State University Press.
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[10] Ibid.
[11] Metro, 2015 Regional Forecast and Urban Development Patterns February 1996.
[12] Hazards Workshop *Session Summary #16, Disasters, Diversity, and Equity.* Annual Hazards Workshop, (July 12, 2000) University of Colorado, Boulder.
[13] Ibid.
[14] US Census <http://www.census.gov> 2000
[15] Metro Data Resource Center RLIS Lite August 2004 CD. Taxlot data continuously updated. Square footage recorded by assessor.
[16] Portland Metro Council Resolution 99-2820
[17] Portland Metro Council Resolution 97-2562B
[18] U.S Census http://www.census.gov 2000
[19] Portland Development Commission, "Portland Metropolitan Region Fact Book," 2004.
[20] US Census. <http://www.census.gov> (2000).
[21] Portland Development Commission, "Portland Metropolitan Region Fact Book," 2004
[22] US Census <http://www.census.gov> 2000
[23] Portland Development Commission, "Portland Metropolitan Region Fact Book," 2004

Section 3
Risk Assessment Summary

This Section provides information about Portland's natural hazard risk assessment. It is general in scope, providing background on the process of producing risk assessments as well as an overview of Portland's risk information. Complete risk assessment information for each of the hazards identified in this plan can be found in Appendix C.

What is a Risk Assessment?

A risk assessment is the process for identifying and evaluating the impact of natural hazards on the human-built environment, businesses, social structure and services, and the natural environment. Risk assessments provide information about the areas where the hazards may occur, the value of existing land and property in those areas, and an analysis of the potential risk to life, property, and the environment that may result from natural hazard events. Specifically, Federal Section 322 requires that the following elements are present in a risk assessment:

1) ***Hazard Identification*** identifies the geographic extent of the hazard, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data. Portland identified five major hazards that consistently affect or threaten this geographic area. These hazards – floods, landslides, wildfires, extreme weather, and earthquakes – were identified through a process that utilized input from a project steering committee, subject matter experts and historical records (as well as through the City of Portland Risk Assessment).

2) ***Profiling Hazard Events*** describes the causes and characteristics of each hazard, how they have affected Portland in the past, and what part of Portland's population, infrastructure, and environment has historically been vulnerable to each specific hazard. A profile of each hazard addressed in this plan is provided in Chapter 2, Sections 7 through 11. For a full description of the history of hazard specific events, please see these sections and Appendix C.

3) ***Vulnerability Assessment/Inventorying Assets*** combines the hazard identification with an inventory of existing (or planned) property and population that would be exposed to a hazard. Critical facilities are of particular concern because they provide essential products and services that are necessary to preserve the welfare and quality of life in Portland and fulfill important public safety, emergency response, and/or disaster recovery functions.

4) ***Risk Analysis/Estimating Potential Losses*** involves estimating the damage, injuries, and financial losses likely to be sustained from hazard events in a geographic area over a given period of time. This level of analysis typically involves using mathematical models, such as HAZUS. The two measurable components of risk analysis are magnitude of the impact that may result from the hazard event and the likelihood of the hazard occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets. Where available, the best available data was used to determine the magnitude and likelihood of future natural hazard events. For each hazard where data was available, quantitative estimates for potential losses are included in the hazard assessment.

5) ***Assessing Vulnerability/ Analyzing Development Trends*** provides a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. This plan provides a comprehensive description of the character of City of Portland in Section 2: Community Profile. This general description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, transportation and commuting patterns, and historic and cultural resources. Analyzing these components of Portland can help in identifying potential issues or concerns, and can serve as a guide for incorporating the goals and ideas contained in this mitigation plan into other community development plans.

THREE PHASES OF HAZARD ASSESSMENT:

Hazard Identification → Vulnerability Assessment → Risk Analysis

HAZUS-MS Pilot Project Background

Portland's risk assessment was completed in 2001 as part of a pilot project initiated between the Federal Emergency Management Agency and the City of Portland. The project was designed to demonstrate the applicability of using Hazards U.S. Multi-Hazard (HAZUS-MH) software to address the risk assessment requirements of the Disaster Mitigation Act of 2000 (DMA 2000). The risk assessment project was conducted to evaluate priority hazards of primary concern to the community, and to estimate potential damages and losses. The risk assessment provides a foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of future hazard events.

Two methodologies were used to assess potential exposure and losses associated with priority hazards for this pilot project. For flood and earthquake, specific hazard parameters (ground motion for earthquake and discharge velocity for flood) were compared to a variety of infrastructure inventory parameters (for example, first floor elevations and building types). These were modeled to determine potential impact to humans, buildings, roads, and other assets. For landslide and wildland fire, historic data were not adequate to support the estimation and modeling of future events and losses. Instead, HAZUS-MH inventory data, professional judgment, and hazard area data regarding the geographic scope of each hazard were used to estimate exposure. Over the long term, Portland will collect additional data to assist in estimating potential losses for these hazards.

The value of such a study in the City of Portland is three-fold. First, it provides a basis for mitigation decision making through a federally recognized quantitative methodology. Second, it estimates potential loss from a disaster through GIS mapping and consistent, defensible data that is accepted in applications for expedited disaster recovery reimbursement requests. Third, it provides risk information in the form of maps and statistics that appeal to planners, engineers, and program developers who might not ordinarily consider disaster management in their planning.

Risk Assessment Summary

This section provides an overview of Portland's 2001 risk assessment. The complete, hazard-specific results of the pilot project are detailed in Appendix C.

- Portland is subject to substantial natural hazard risks. Of the 1,037 "major disaster declarations" in the United States between 1972 and 2000, the State of Oregon has claimed 12, ranking it 22nd in the number of disaster declarations for any state or territory. Total aggregated losses from natural disasters in Oregon have reached into the hundreds of millions of dollars during the past decade.
- Seismic activity, heavy precipitation, weather extremes, and geography will continue to result in earthquakes, floods, and landslides. In addition, periods of long dry summers and fuel accumulation (tree, grass, and understory growth) can contribute to the potential for wildfires.
- During the winters of 1996 and 1997, the Portland area experienced floods, landslides, ice storms, and other disasters. Over $220 million was provided to Oregon under several federal relief programs for three flood and landslide disasters that occurred in 1996 and 1997.
- Portland assets equal over $59 billion, including residential and commercial structures and building content, critical facilities and infrastructure (utilities and transportation lifelines).
- Areas along the Willamette River include flood zones, landslide potential, liquefaction potential, soft soil areas and significant

development. The multiple hazard areas along the river, combined with the level of development, appear to indicate that this area may face greater risk of losses than other areas of the study region.

Earthquake Risk Summary

Over the past 100 years, 56 recorded earthquake events have caused a total of 17 deaths and $2 billion in losses. The risk from earthquakes is considered to be severe. The widespread, regional nature of the earthquake hazard means that the entire Portland population is estimated to be at risk. Risk to infrastructure varies depending on the type of construction and proximity to liquefaction zones. The following provides further detail:

- For the 100 year mean return period earthquake event, 150 – 200 major injuries or fatalities could occur and 2,000 households could require shelter. For a 500 year mean return period event, as many as 900 major injuries or fatalities could result and as many as 5,000 households could require shelter.
- Total damage to commercial and residential structures could reach over $1 billion dollars in a 100-year earthquake; in a 500-year earthquake, that number jumps to nearly $4.5 billion.
- In a 500 year earthquake event, about 13% of the total value of critical facility infrastructure (schools, hospitals, fire stations, and police stations) could be lost.
- About 115 hazardous materials sites could experience significant damage.
- In a 500 year event, major damages to transportation lifeline systems is expect. A total of 6.7 miles of key roads, 14.7 miles of railway tracks, and .2 miles of light rail are predicted to experience damage. About 2.3% of the economic value of bridges could be lost in a 500 year event. Damage would also occur during a 100 year event, but significantly less damage is expected.
- Utility lifelines are a major consideration in an earthquake event. Potable water pipelines, sewers, natural gal pipelines, and oil pipelines are all expected to receive damages in a 100 and a 500 year event.

For more information on earthquake related risks, refer to Appendix C.

Flood Risk summary

Flooding results when rain or snowmelt creates water flows that exceed the carrying capacity of river channels or other watercourses and storage facilities. Significant historic flooding has been recorded for the Willamette and Columbia River basins in 1861, 1880, 1881, 1909, 1913, 1927, 1928, 1942, 1946, 1948, 1961, 1964/65, and 1996 (Oregon OEM

2000). Statewide floods in 1996 caused five deaths, forced thousands into shelters, destroyed hundreds of homes, and caused damages in excess of $220 million. City of Portland was forced to erect makeshift barriers to prevent floodwaters from moving into the downtown area.

- The period of occurrence for floods is usually October through April; the probability of an event occurring within this time period is highly likely. Even though there can be a significant warning time (up to 3 hours for tributaries and possibly days for rivers), flooding can force the shut down of facilities for up to 30 days or more.
- In Portland, 29,900 persons live within the impacted area for a 100 year mean return period flood event.
- Commercial building class losses account for 37% of the total estimated loss for the 100 year flood event.
- The total commercial exposure for a 100 year event could be nearly $1.5 billion; the total residential exposure at risk is estimated at $2.5 billion.
- The total expected average annualized loss associated with riverine flooding for residential and commercial occupancy classes is $15.4 million.
- There are 19 hazardous materials sites at risk from a 100 year flood, and 61 at risk from a 500 year flood.
- Eighty electrical power substations are at risk from a 100 year flood.

For more information on flood related risks, refer to Appendix C.

Landslide Risk Summary

Dominant landslide-prone areas were identified based on terrain information (slope and stability factors), geologic characteristics, and degrees of water saturation. The following provides further information about the infrastructure at risk.

- There are 28,100 households at risk from the variety of landslides in the Portland area. These are debris flows in valley bottoms, steep bluffs along rivers and west hills silt soils with most of the households in the west hills silt.
- Less than one-third of these homes have income less than $20,000 per year, and almost one-quarter of the residents in this area are over 65 years of age.
- The value of the total commercial and residential structures exposed to landslides is $7.9 billion.
- Three hospitals, sixteen schools, six fire stations and nine hazardous materials sites are at risk from landslides, in addition to 71 highway and railway bridges.

- A total of 126 electric power substations are in the vicinity of possible landslides; 18.6 miles of sewer are vulnerable.

For more information on landslide related risks, refer to Appendix C.

Wildfire Risk Summary

Wildfire risk was assessed based on a number of factors, including slope, vegetation fuel types, and built environment data. As there were no historical data available, the frequency and severity of the hazard could not be reliably calculated; annualized risk was computed. However, areas of concern were identified. Using this information, risk can be estimated.

- There are two major areas of Portland that are classified in the wildland fire zone. The two dominant areas are Forest Park and Powell Butte.
- Steep slopes and winding roads add to the risk for the property owners as response could be delayed due to the terrain.
- The population exposed to this hazard would be 64,400; of these, 7,500 are over 65 years.
- Total residential and commercial structures at risk amount to nearly $8 billion.
- Infrastructure at risk from wildland fire includes 10 schools, 30 bridges and 138 electrical power substations.

For more information on landslide related risks, refer to Appendix C.

Severe Weather Risk Summary

Severe weather was not evaluated through the HAZUS-MH methodology. Historically, severe weather has had a major impact on Portland. The City of Portland is vulnerable to high winds, black ice and snow. In the 2003-4 winter season, $452,000 was awarded by FEMA to the entire county for the costs incurred by the city and county during the 19 day ice storm and cold snap.

For more information on severe weather related risks, refer to Appendix C.

Section 4
Mitigation Plan Mission, Goals, Action Items

This section provides information on the process used to develop the mission, goals and action items addressed in the mitigation plan. It also describes the framework that focuses the plan on developing successful mitigation strategies. The framework is made up of three parts—*Mission*, G*oals* and *Action Items:*

- *Mission*— The mission statement is a philosophical or value statement that answers the question "Why develop a plan?" In short, the mission states the purpose and defines the primary function of the City of Portland's Natural Hazards Mitigation plan. The mission is an action-oriented statement of the plan's reason to exist. It should be broad enough that it need not change unless the community environment changes.
- *Goals*—Goals are designed to drive actions and they are intended to represent the general end toward which the City's effort is directed. Goals identify how the City intends to work toward mitigating risk from natural hazards. They should not specify how the City is to achieve the level of performance. The goals are guiding principles for the specific recommendations that are outlined in the action items.
- *Action Items*—The action items are detailed recommendations for activities that city departments, citizens and others could engage in to reduce risk (See Section 5 for information on the plan's action items).

Natural Hazard Mitigation Vision and Mission

Vision

The City of Portland's vision is to strive to create a "Disaster Resilient City."

By creating a legacy of mitigation activities, City and community leaders' proactive implementation of long term, cost effective mitigation measures has protected its population, its properties, its natural and built environment and its investments. The forethought of Portland's leaders has preserved the City through decades of hazard events.

Mission Statement

The mission of the City of Portland Natural Hazards Mitigation Plan is:

> *To reduce risk, prevent loss of property and commerce, and promote expedient recovery, while safeguarding people and the environment from natural disaster events through a coordinated and collaborative community partnership.*

Mitigation Plan Goals

The plan goals help to guide the direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals listed here serve as checkpoints as agencies and organization begin implementing mitigation action items.

Meetings with the project steering committee, subcommittees, stakeholder interviews, served as methods to obtain input and identify priorities in developing goals for reducing risk and preventing loss from natural hazards in Portland.

Portland's Natural Hazards Mitigation Plan goals are based on the goals established by State of Oregon's Natural Hazards Mitigation Plan. The City's project steering committee reviewed the state's goals and made recommendations during a meeting on June 10, 2004, for adapting them to the City's needs. The following are the resulting goals for the City of Portland's Natural Hazards Mitigation plan.

Goal #1	Identify risk level and evaluate Portland's vulnerability to natural hazards
Goal #2	Implement activities to protect human life, property and natural systems.
Goal #3	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population
Goal #4	Establish a disaster resilient economy.
Goal #5	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Mitigation Plan Action Items

The mitigation plan identifies short and long-term action items developed through data collection and research. Mitigation plan activities may be considered for funding through state and federal grant programs, including the Federal Emergency Management Agency's Hazard Mitigation Grant Program and Pre-Disaster Mitigation Competitive Grant Program, as funds are made available. Action items address both multi-hazard (MH) and hazard specific issues for the hazards addressed in this plan. To facilitate implementation, each action item includes information on timeline, coordinating and partner organizations, ideas for implementation, and plan goals addressed.

Coordinating Organization:

The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. The coordinating organization for all action items within the Portland plan will be the City of Portland.

Internal Partners:

Internal partner organizations are departments within the City that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External Partners:

External partner organizations can assist the City in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

The internal and external partner organizations listed in the Mitigation Plan are potential partners recommended by the project steering committee, but not necessarily contacted during the development of the plan. The coordinating organization should contact the identified partner organizations to see if they are capable of and interested in participation. This initial contact is also to gain a commitment of time and or resources towards completion of the action items.

Timeline:

Action items include both short and long-term activities. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that city departments may implement with existing resources and authorities within one to two years. *Long-term action items* (LT) may require new or additional resources and/or authorities, and may take between one and five years to implement.

Ideas for Implementation:

Each action item includes ideas for implementation and potential resources. This information offers a transition from theory to practice. The ideas for implementation serve as a starting point for this plan. This component of the action items is dynamic as some ideas may be not feasible and new ideas can be added during the plan maintenance process. (For more information on how this plan will be implemented and evaluated, see Chapter 5).

The action items are suggestions for ways to implement the plan goals only. Some of these items may prove to be unrealistic and others more refined ideas may be identified and added to the plan. Ideas for implementation include things such as collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure. A list of potential resources outlines what organization or agency will be most qualified and capable to perform the implementation strategy. Potential resources often include utility companies, non-profits, schools, and other community organizations.

Plan Goals Addressed

The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals following implementation.

Section 5
Multi-Hazard Action Items

This section describes mitigation measures that are not specific to only one hazard. There are several potential impacts that are common among more than one of the five hazards covered in this plan. Structural damage, for example, can be caused by earthquakes, high-winds, or landslides. At the same time, there are mitigation measures and potential action items that are applicable to more than one hazard. Implementation of multi-hazard mitigation measures will increase a community's hazard resilience regardless of which hazard might strike.

What is the threat to Portland?

While remote, the potential exists that the city could experience the impacts of two different natural hazards at the same time. Additionally, several of the natural hazards that may occur would have the same or similar impacts on property, infrastructure, and lives. Addressing these multi-hazard items together rather than by hazard offers a more practical, coordinated, and cost effective approach than trying to address them within each hazard.

Mitigation Plan Goals and Existing 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 with guidance from the Portland Natural Hazards Mitigation Steering Committee. The mitigation plan establishes five goals:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resilient economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Existing Mitigation Activities

Existing mitigation activities include current and on-going mitigation programs and activities that are designed to reduce loss from hazard events. These programs are implemented by city, county, regional, state, federal agencies, utilities and/or other organizations. In Portland, existing mitigation activities include a capital improvement plan, emergency operations centers, emergency response and recovery plan, transportation and comprehensive plan, and educational programs. Additional existing mitigation measures are described in the hazard specific sections of Chapter Two of this plan.

Multi-Hazard Mitigation Action Items

Multi-hazard action items are those activities that cut across the five hazards in the mitigation plan: flood, severe weather, wildfire, landslide, and earthquake. The multi-hazard actions were created as part of the process of developing the hazard-specific action items found in Chapter Two of this plan. Five subcommittees (one committee for each hazard) comprised of representatives from City bureaus worked to develop both the hazard-specific and the multi-hazard action items.

There are eight short-term and five long-term multi-hazard 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 pursing strategies for implementation.

Multi-Hazard Mitigation Action Items

The multi-hazard mitigation action items provide direction on specific activities that organizations, businesses, and residents in the City of Portland can undertake to reduce risk and prevent loss from multi-hazard events. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that city bureaus may implement with existing resources and authorities. *Long-term action items* (LT) require new or additional resources and/or authorities.

Short Term Actions

ST-MH#1: Continue to involve the public in updating the Natural Hazard Mitigation Plan

Key Issues Addressed

- The general public is an important stakeholder in natural hazard mitigation planning; involving them in the planning process will lead to a more realistic and responsive plan.
- Public participation is also a requirement of the Federal Emergency Management Agency.

Ideas for Implementation

- Design and implement a system for collecting public comment through the Portland Office of Emergency Management website and other public forums.
- Incorporate comments from the website into Portland's Natural Hazard Mitigation Plan action items.
- Continue outreach to the public regarding mitigation activities and plan updates, and incorporate these comments into the yearly review of the plan.

Coordinating Organization:	Portland Office of Emergency Management, Bureau of Planning
Internal Partners:	All bureaus
External Partners:	The public
Level of Immediate Capability:	High
Estimated Timeline:	Ongoing
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards; Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-MH#2: Form a committee to identify and coordinate critical transportation (street and highway) networks.

Key Issues Addressed

- The identification of critical transportation networks before a disaster event can improve the efficiency of response and reduce impacts on public safety and commercial traffic following a disaster. Currently, several different bureaus maintain critical transportation networks; improved coordination would be useful in a major event.
- Hazard events can affect general transportation routes (including public transit routes), especially in a situation in which evacuation is necessary. These changes should be coordinated with emergency transit route planning to avoid conflict; information about changes should be efficiently communicated to the public.

Ideas for Implementation

- Form a committee to identify transportation networks that would be used in any event that involved road closures, such as severe weather, earthquake, or flood. Prioritize debris clearance from that route.
- Research existing committee findings from committees such as the Intelligent Transportation System and the Regional Emergency Transportation Route committee of REMTEC.
- Coordinate emergency standard operating procedures and plans between natural disaster responder organizations in the Portland metro region and TriMet, to coordinate and expedite decision-making during emergencies. For example, coordinate re-opening of disrupted streets, roads, and bridges with the restoration of disrupted transit service.

- Collaborate with TriMet to develop communications and dispatch capability to (1) immediately implement changes to transit routes and service due to disruption of streets roads, bridges, and light rail transit tracks during and following a natural disaster, and (2) immediately provide transit service change update information to the public. Improve TriMet's service information systems including transit station changeable message sign displays, and telephone-based and internet-based systems.
- Relate emergency routes to the emergency transportation work that Regional Emergency Management Technical Committee (REMTEC), Oregon Department of Transportation, and Washington Department of Transportation have completed, as well as to seismic emergency transportation routes in City Public Works Annex.

Coordinating Organization:	Portland Department of Transportation, Bureau of Maintenance
Internal Partners:	Bureaus of Planning, Fire & Rescue, Police, Parks and Recreation, Urban Forestry
External Partners:	Tri-Met, Pacific Corp, PGE, Multnomah County, Metro, REMTEC, BOMA, Pacific Power and Light
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems; Identify risk level and evaluate Portland's vulnerability to natural hazards; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-MH#3: Improve enforcement of state recommendations to prohibit essential facilities in hazard areas.

Key Issues Addressed

- Essential facilities, such as police and fire stations and hospitals, must be available in times of disasters. These buildings must meet higher building design standard in the Oregon Structural Specialty Code.

Ideas for Implementation

- Develop an all-hazard map for essential facility siting review.
- Develop review process to include representatives of essential facilities operations.
- Provide guidelines to builder to include worst case scenario continuity plan and benefit cost analysis of location relative to life and dollar loss due to building inoperability.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Portland Office of Emergency Management; Fire Bureau, Police, Governmental Affairs, Portland Development Commission, Bureau of Governmental Services
External Partners:	State Building Code Division
Level of Immediate Capability:	High
Estimated Timeline:	1 – 3 years
Plan Goals Addressed:	Establish a disaster resilient economy; Implement activities to protect human life, property and natural systems; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-MH#4: Review Portland's Hazard Mitigation Plan to ascertain which actions will also benefit terrorism prevention programs.

Key Issues Addresses

- Natural and anthropogenic (human–caused) hazards can have very similar impacts on the ground. Additionally, funding available to states for assessment of terrorist threats may be leveraged to assess impacts from natural hazards.

Ideas for Implementation,

- Review needs assessment for terrorism grant process and compare to it to the mitigation plan and HAZUS MH report to find areas of overlap.
- As funding becomes available to mitigate either natural or anthropogenic disasters, consider opportunities to leverage that funding to meet multiple goals.

General Comments

- Actions found to benefit both natural and human-caused hazards may be highly ranked in the cost/benefit analysis and prioritized for funding and implementation.

Coordinating Organization:	POEM
Internal Partners:	Bureaus of Fire & Rescue, Police, and Transportation
External Partners:	Multnomah Co. Emergency Management and Public Health
Level of Immediate Capability:	High
Estimated Timeline:	1 year
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards; Identify risk level and evaluate Portland's vulnerability to natural hazards; Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination

ST-MH#5: Acquire Light Detection and Ranging (LIDAR) images of the Portland Metro area and the Bull Run Watershed.

Key Issues Addressed

- LIDAR images are a tool for mapping faults, locating recent fault movement, steep slopes, flood plains and landslides. Land use planning and design can consider findings of the high-resolution maps that can better determine appropriate building practices for highlighted locations.

Ideas for Implementation

- Partner with Department of Geology and Mineral Industries, USGS and other local cities and counties to lower costs of data collection.
- Partner with outside business organizations whose customers could benefit from the information, such as the insurance industry and contractors.
- Currently the initial set up for mapping the Portland metropolitan area is established which creates a savings for subsequent flyovers.
- The cost for LIDAR maps is about $525 per square mile.

General Comments

- Tryon Creek State Park has been LIDAR mapped and as a result the creek bed revealed is greater than previously understood.
- The lower Columbia River is due to be flown this winter.

Coordinating Organization:	Portland Office of Emergency Management

Internal Partners:	Corporate GIS, Bureau Environmental Services, Fire and Rescue, Bureau of Water, Portland Office of Transportation
External Partners:	Multnomah County, Oregon Department of Geology and Mineral Industries, USGS, Institute of Business and Home Safety
Level of Immediate Capability:	High
Estimated Timeline:	1 year
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-MH#6: Use findings from Portland's Risk Assessment (HAZUS-MH) to enhance the existing debris removal plan.

Key Issues Addressed

- Portland's Risk Assessment defines areas of Portland that could be most impacted by disaster and therefore have the largest impacts from debris following a major hazard event. The Risk Assessment could be used to focus the debris removal plan.

Ideas for Implementation

- Review HAZUS MH findings relative to City's capabilities post disaster and proposed mitigative actions.
- Recommend actions to be included into debris removal plan that will lessen the loss of property (decrease debris to be removed) and the health hazards possible from debris.
- Review building age and construction along emergency routes to ascertain which will have the greatest amounts of debris and outflow of people.

General Comments

- A regional disaster debris removal plan is currently being developed through Metro in collaboration with the professional hauling agencies and county agencies.
- Sustainable Development is responsible for coordination of Debris Removal for the City of Portland.
- Transportation system stability is key to debris removal

Coordinating Organization:	Bureau of Sustainable Development
Internal Partners:	Portland Office of Emergency Management, Portland Office of Transportation, Maintenance, Bureau of Environmental Services

External Partners:	Multnomah Country Health Department; Metro
Level of Immediate Capability:	Medium
Estimated Timeline:	1 to 3 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards; Implement activities to protect human life, property and natural systems.

ST-MH#7: Create a mitigation mapping committee.

Key Issues Addressed

- Currently, bureaus are not collaborating in the process of creating and using hazard maps. Increased inter-bureau communication about data sources and availability would save time and money, and increase the impact that maps could have for mitigation purposes.

Ideas for Implementation

- Develop committee.
- Identify maps which exist and which are needed and their purpose.
- Partner with DOGAMI, Metro, local partners and USGS to obtain funding for completion of mapping and technology transfer of information.
- Coordinate LIDAR (Light Imaging and Radar Detection) mapping projects and the dissemination of LIDAR data.
- Create a timeline for update and a criteria-based process for use as justification, key notations, meta data used, accessibility, classes for instruction in development and use.

General Comments

- Mapping allows for a visual explanation that, using the approved data, can validate the need and justify a cause.
- Mapping can be used prior to, during and post disaster to establish a variety of needs, resources and costs.
- HAZUS MH is a case in point, of a program not accepted into the fold of maps are known about that can focus on hazard related issues.

Coordinating Organization:	Portland Office of Emergency Management, Corporate GIS
Internal Partners:	Bureau of Environmental Services,

	Portland Department of Transportation, Bureau of Development Services, Fire Bureau, Water Bureau, Bureau of Planning
External Partners:	Department of Geology and Mineral Industries, Multnomah County Drainage District, METRO
Level of Immediate Capability:	Medium
Estimated Timeline:	2 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-MH#8: Partner with utilities as they ensure continuity of service to the City of Portland.

Key Issues Addressed

- Without electricity, commerce, health and the continuity of services to the population are threatened. Bonneville Power Administration, Portland General Electric and Pacific Power are three utilities that provide electrical power, manage transmission of electrical power and on whom the City of Portland is dependent upon for electrical sustenance.

Ideas for Implementation

- Ask for a report by the Regional Utility Focus Group (REMTEC Sub-Committee) to the Disaster Policy Council.
- Partner with utilities to develop mitigation strategies.
- Investigate the seismic performance of an unequal leg transmission tower compared to an equal leg tower.
- Assure that the potential for liquefaction at river crossings to interrupt power is addressed.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Disaster Policy Council, Mitigation Sub-Committee leaders; Cable and Franchise
External Partners:	Regional Emergency Management Technical Committee (REMTEC) Utility Focus Group, PGE, PacifiCorps, NW Natural Gas

Level of Immediate Capability:	Medium
Estimated Timeline:	2 to 4 years
Plan Goals Addressed:	Establish a disaster resilient economy

ST-MH#9: Develop a city employee emergency response plan to assure that city employees know what is expected of them so that services are continued.

Key Issues Addressed

- In a disaster, employees need to know how to protect themselves as well as their family and their job
- There is no city employee response plan that is readily known at all levels
- Although training has been given periodically, for emergency response teams to the Emergency Operations Center, Floor Warden, Building Evacuation or Family Preparedness, these programs are disjointed and do not fulfill the employee need.

Ideas for Implementation

- Marketing committee membership should be mandatory on employee plan.
- Each bureau should be represented in the planning process.
- Employees should receive recognition for participation in trainings by City Council and awards given for measure of involvement.
- Training of floor wardens and first responder teams should be ongoing.

General Comments

- While some plans are in place, they are not institutionalized, nor are they coordinated across bureaus.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Disaster Policy Council; Human Resources, OMF, Bureau of General Services, Fire and Rescue, Police, Emergency Communications
External Partners:	American Red Cross
Level of Immediate Capability:	Medium
Estimated Timeline:	2-4 years
Plan Goals Addressed:	Promote public awareness, engage public participation and enhance partnerships through education,

outreach and coordination of a diverse and representative group of the City's population.

Long Term Action Items

LT-MH#1: Revise Portland's Comprehensive Plan to address natural hazards including, but not limited to, floods, landslides, earthquakes, wildland fires, and winter storms.

Key Issues Addressed

- Many natural hazard loss reduction measures can be implemented through land use changes and regulations. Portland's Comprehensive Plan should include a section of action items that reflect this.

Ideas for Implementation

- During the next comprehensive plan update process, consider the inclusion of appropriate action items for the Natural Hazard Mitigation Plan.
- Consider action items that might be appropriate to consider for inclusion in Portland's Comprehensive Plan.

General Comments

- The timeframe for Portland's next comprehensive plan update has not been established.
- Currently, the Comprehensive Plan does have actions that relate to natural hazard loss reduction, but they are spread throughout the many chapters of the plan.

Coordinating Organization:	Bureau of Planning
Internal Partners:	Portland Office of Emergency Management
External Partners:	Department of Land Conservation and Development, Neighborhood and Business Associations
Level of Immediate Capability:	Medium
Estimated Timeline:	2-4 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards; Identify risk level and evaluate Portland's vulnerability to natural hazards; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-MH#2: Develop a public outreach program to raise awareness of hazard risk.

Key Issues Addressed

- It is essential for the City to have a broad public outreach and information program so that its residents are aware of the potential hazards and how to avoid or respond to them. Coordinating this outreach effort would leverage resources and allow for a more comprehensive approach.

Ideas for Implementation

- Identify City public outreach professionals who might be involved in this process.
- Develop a mitigation marketing outreach team.
- Develop a mitigation marketing plan to identify areas where coordinated efforts could maximize outreach impact.
- Incorporate with internal City employee/family training and seasonal campaigns of statewide agencies.
- Identify business partners for outreach opportunities.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	All bureaus
External Partners:	Red Cross, State and other local emergency management programs, SBA, regional partners, Portland Public Schools
Level of Immediate Capability:	Medium
Estimated Timeline:	3 to 5 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

LT-MH#3: Increase the responsiveness of the emergency permitting procedures for post-hazard event periods through development of a procedural plan and the purchase of a mobile permitting van.

Key Issues Addressed

- When recovering from a hazard event, property owners need to have the ability to quickly and legally rebuild damaged structures.

Ideas for Implementation

- Though some emergency permitting is currently in place, a procedural plan should be developed.
- Consult with businesses and contractors to maximize applicability, use, and awareness of emergency permitting procedures.
- Improve existing emergency permitting through the purchase of "mobile permitting vans;" these could be deployed after an emergency to provide permits on-site to property owners. When not in use during emergencies, these vans could be used for outreach.

General Comments

- Identified in 1996 Flood Action Plan and Landslide Mitigation Report: Summary of Bureau Assignments, Recommendation #3.
- Landslides in Environmental Overlay Zones memo (dated 12/9/02) identifies procedures for landslides that occur in environmental overlay zones. Referenced contact Staff are from Site Development and Land Use Services in the Bureau of Development Services.
- Level of capability hinges on difficulty with information technology issues and funding for permit process.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Portland Office of Transportation, Bureau of Maintenance, Bureau of Environmental Services, Water Bureau, Risk Management
External Partners:	Neighborhood associations, local businesses
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Establish a disaster resilient economy; Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-MH#4: Develop citywide vegetation protection/planting goals, policies, plans, and implementing tools. Coordinate with vegetation management strategy development for wildfire, flood, and landslide hazard mitigation.

Key Issues Addressed

- Vegetation helps retain stormwater, reduce erosion, slow floodwaters, act as a wind break, and can, when appropriate vegetation is planted and maintained, can reduce the likelihood of wildfires.

Ideas for Implementation

- Through the Comprehensive Plan, goals, policies, existing landscaping and tree standards or through the stormwater regulations, require a percentage tree canopy cover and percentage understory vegetation for proposed development. Coordinate with watershed plan development and with vegetation management strategy development for wildfire and landslide hazard mitigation.
- Provide financial incentives or stormwater bill fee structure credits to retain trees; increase stormwater fees when trees are removed.
- Implement a graduated stormwater fee that encourages property owners to reduce/limit impervious surfaces and retain trees.

General Comments

- This action has been implemented in areas with environmental or greenway zones only; some elements of other hazard plans may impact vegetation retention and possibly exacerbate flooding or contribute to increased runoff.

Coordinating Organization:	Bureau of Planning, Bureau of Environmental Services
Internal Partners:	Bureaus of Development Services, Parks and Recreation; Fire & Rescue, Office of Neighborhood Involvement
External Partners:	Friends of Trees, Audubon Society of Portland, Nursery Associations, nursery owners
Level of Immediate Capability:	Low, no funding identified
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems; Build and support the capacity to continuously become less vulnerable.

LT-MH#5: Promote the development of TriMet communications and dispatch capability to 1) immediately implement changes to transit routes and service due to disruption of streets, roads, bridges and light rail transit tracks during and following a natural disaster, and to 2) immediately provide transit service change update information to the public, via improvements to TriMet service information systems including transit station changeable message sign displays, and telephone-based and internet-based systems.

Key Issues Addressed

- Capability for rapid recovery of the transit system can be developed through this communication and dispatch capability. This will assist in evacuation, maintaining essential transportation, crowd control and overall guidance for those traveling.

Ideas for Implementation

As of 7/05, this need has been designated top-priority for TriMet internal actions for transit system emergency preparedness, per an ODP assisted security assessment completed for TriMet 2/05 and as documented in TriMet's 7/05 Security and Emergency Preparedness Plan (SEPP). TriMet, with support of the Portland Urban Area Points of Contact (UAPOC), is seeking Transit Security Grant Program Urban Area Security Initiative(UASI) funding to implement replacement of its bus dispatch and bus radio system to achieve this response capability.

General Comments

- This item was recommended upon draft review post Council approval on the Draft "as amended" Dec. 2004

Coordinating Organization:	Portland Office of Emergency Mgmt.
Internal Partners:	Bureau of Emergency Communications
External Partners:	Tri-Met, Regional Emergency Mgmt. & communication centers
Level of Immediate Capability:	Low, no funding identified
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards. Implement activities to protect human life, property and natural systems.

LT-MH#6: Promote the coordination of emergency standard operating procedures and plans between natural disaster responder organizations in the Portland metro region and TriMet, to coordinate and expedite decision- making during emergencies.

Key Issues Addressed

This directly supports achieving capability of the transit system to rapidly recover from major events, to assist in evacuation, and maintaining essential transportation system.

Ideas for Implementation

This will be among the specific implementation action items included in the Portland Urban Area's(UA) Chemical, Biological, Radiological, Nuclear, Explosive (CBRNE)Plan. In addition, TriMet has been included as a partner agency with the Portland UA's 9-1-1 Communication Discipline group as it completes a Tactical Interoperability Communications Plan (TICP) required to be submitted to ODP by 5/1/06. Coordinated TriMet and responder SOPs will be tested in the Portland UA's CBRNE full scale exercise which ODP requires by 5/1/07.

General Comments

- This item was recommended upon draft review post Council approval on the Draft "as amended" Dec. 2004

Coordinating Organization:	Portland Office of Emergency Mgmt.
Internal Partners:	Bureau of Emergency Communications, & Portland Office of Transportation, Fire& Rescue, Portland Police
External Partners:	Tri-Met, Regional Emergency Mgmt.
Level of Immediate Capability:	Low, no funding identified
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Section 6
Plan Implementation, Maintenance and Public Participation

The plan maintenance section of this document details the formal process that will ensure that the City of Portland Natural Hazards Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing an updated plan every five years. This section also describes how the City will integrate public participation throughout the plan maintenance and implementation process. Finally, this section includes an explanation of how the City intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms and programs such as the City comprehensive land use planning process, capital improvement planning process, and building codes enforcement and implementation.

The plan's format allows the City to review and update sections when new data becomes available. New data can be easily incorporated, resulting in a natural hazards mitigation plan that remains current and relevant to the City of Portland.

Implementing the Plan

After the plan is adopted via resolution by the City Council, the Director of POEM will be responsible for submitting it to the State Hazard Mitigation Officer at Oregon Emergency Management. Oregon Emergency Management will then submit the plan to the Federal Emergency Management Agency (FEMA–Region X) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Portland will gain eligibility for the Pre-Disaster Mitigation Grant Program, the Hazard Mitigation Grant Program funds, and Flood Mitigation Assistance program funds. After the plan is formally adopted and FEMA recognized, the Hazard Mitigation Steering Committee will disband and reform as the Disaster Policy Council. The steering committee members who were not representatives of city bureaus (external partners) will become the External Review Board and will be called upon for comment, review, and advice as needed. The Disaster Policy Council will act as the coordinating body for implementation and plan update. This council's role is described in detail later in this document. The Portland Office of Emergency Management (POEM) will serve as the convener of this body.

The effectiveness of the City of Portland's non-regulatory Natural Hazard Mitigation Plan will be contingent on the implementation of the plan and incorporation of the outlined action items into existing City plans, policies, and programs. The Natural Hazard Mitigation Plan includes a range of action items that, if implemented, would reduce loss from hazard events in the City of Portland. Together, the action items in Portland's Natural Hazard Mitigation Plan provide the framework for activities that city bureaus can choose to implement over the next five years. The Hazard Mitigation Steering Committee has prioritized the plan's goals and identified actions, which will be implemented, as resources permit, through existing plans, policies, and programs.

Coordinating Body

The Disaster Policy Council (DPC) will be the coordinating body for the mitigation plan. The DPC has been established by ordinance (178616 effective July 21, 2004); it includes representatives from applicable city bureaus, including, but not limited to, the current Hazard Mitigation Steering Committee members. One of the DPCs roles will be to review the mitigation plan annually and to oversee the up-date process. The DPC consists of the following members:

The Mayor, Chair

Commissioner serving as President of the Council, vice chair

City Attorney

Chief of Portland Police Bureau

Chief of Bureau of Fire & Rescue

Director, Portland Office of Emergency Management

Director, Bureau of Emergency Communications

Director, Portland Office of Transportation

Director, Bureau of Maintenance

Chief Administrative Officer

Director of Human Resources

Director, Bureau of Technology Services

Director, Bureau of Development Services

Director, Bureau of Environmental Services

Director of General Services

Director, Bureau of Parks & Recreation

Director, Bureau of Water Works

To make the coordination and review of Portland's Hazard Mitigation Plan as broad and useful as possible, the DPC will engage additional stakeholders and other relevant hazard mitigation organizations and agencies to implement the identified action items. The members of this review board are (but not limited to):

A Neighborhood Coalition representative

An insurance industry representative

A professional organization representative such as the Home Builders, architect affiliate, or property management organization

A business community or major industry representative

Subject matter experts for specific hazards

State agency representatives such as Department of Geology and Mineral Industries

Representatives from environmental organizations, such as the Audubon Society of Portland

Representative from Tri-Met

The Disaster Policy Council will review the Portland Hazard Mitigation Plan once each year, after the plan is certified by FEMA and adopted by the Portland City Council. These meetings will provide an opportunity to discuss the progress of the action items in the plan, and maintain the partnerships that are essential for the sustainability of the City of Portland's Natural Hazard Mitigation Plan.

Convener

The City's Office of Emergency Management (POEM) and the Bureau of Planning will be jointly responsible for overseeing the plan's implementation and maintenance through the City's existing programs. The Emergency Management Director will work with the Disaster Policy Council Chair to facilitate Natural Hazard Mitigation Plan implementation and maintenance meetings. Plan implementation and evaluation will be a shared responsibility among all of the assigned Disaster Policy Council members. Upon advisement of the Disaster Policy Council and the Directors of the Bureau of Planning and POEM, the Portland Office of Emergency Management will be the main instigator of review, coordination, and promotion.

Implementation through Existing Programs

The Natural Hazard Mitigation Plan includes a range of action items that, when implemented, will reduce loss from hazard events in the City of Portland. Within the framework of the plan, FEMA requires the identification of existing programs that might be used to implement these action items. The City of Portland currently addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvement plans, mandated standards and building codes. To the extent possible, the City of Portland will work to incorporate the recommended mitigation action items into existing programs and procedures.

Portland's Comprehensive Plan is one possible venue for action item implementation. One component of the Comprehensive Plan addresses natural hazards. During the next Comprehensive Plan update, planners might consider the action items and detailed risk assessment (Appendix C) in the NHMP and evaluate them as they would any other potential issues to determine if they are appropriate for inclusion. However, because the NHMP is non-regulatory, there is no reason to expect that its action items will be included in the next Comprehensive Plan update.

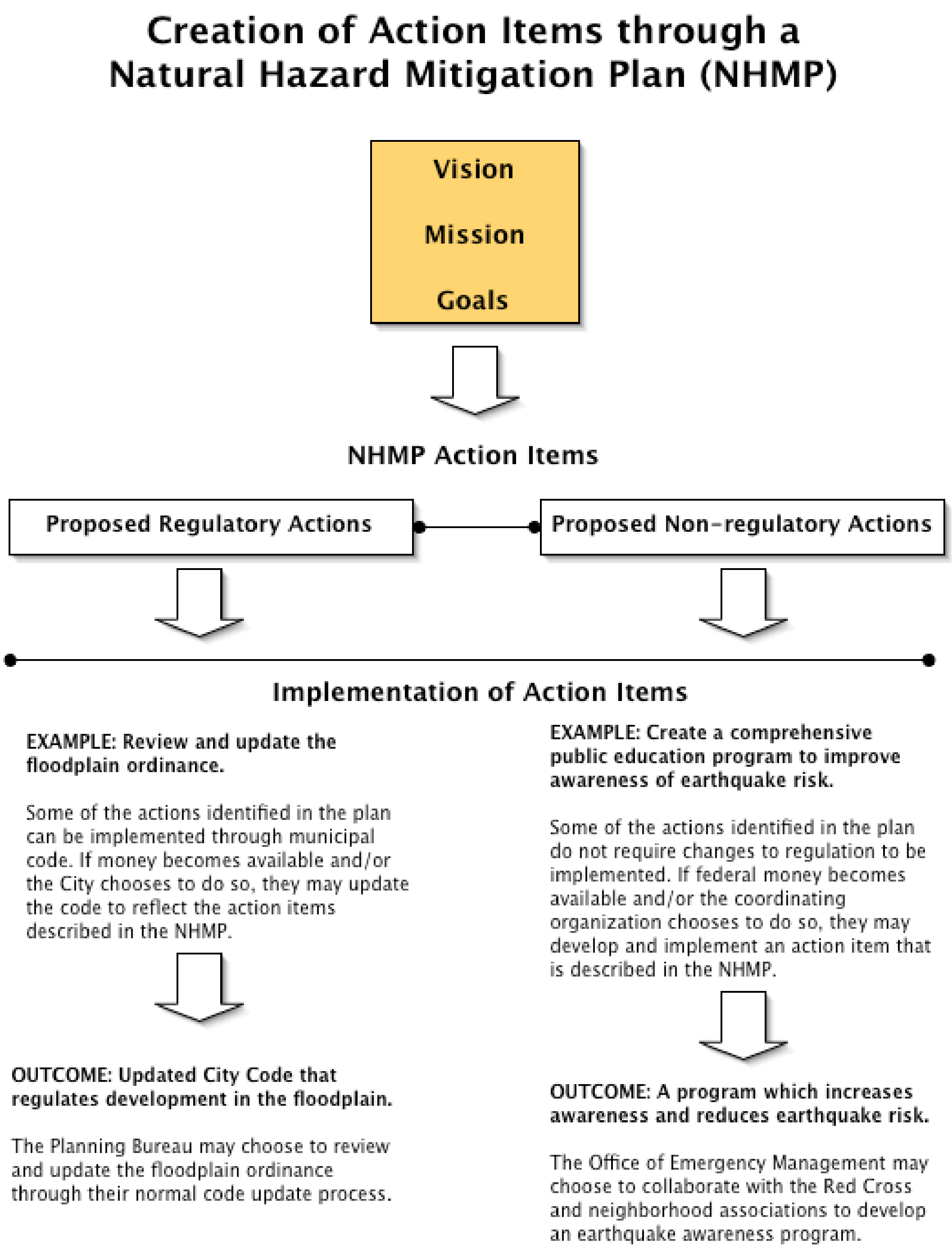
The goals and action items in the Natural Hazard Mitigation Plan will help the City of Portland address statewide land-use planning Goal 7, developed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards. Goal 7 requires that local governments base development plans on inventories of known areas of natural disasters and hazards and that the intensity of development should be limited by the degree to which the natural hazard occurs within the areas of proposed development.

Future capital improvement planning will also contribute to the goals in the Natural Hazard Mitigation Plan. Most City Bureaus develop Capital Improvement Programs (CIPs) and review them on an annual basis. The Disaster Policy Council will work with these bureaus to identify any relevant action items from the Natural Hazard Mitigation Plan and work to incorporate such actions into the appropriate sections of the City's CIPs.

After formal adoption of the City's Mitigation Plan, the policies listed above will be incorporated into the process of existing planning mechanisms at the City level as opportunities arise. The meetings of the Disaster Policy Council will provide an opportunity for committee members to report back on the progress made on the integration of mitigation planning elements into City planning documents, policies, procedures, and programs.

Some action items do not need to be implemented through regulation. Instead, these can be implemented through the creation of new educational programs, through continued interagency coordination, or through improved public participation.

The following graphic provides an example of the types of action items that are included in Portland's Natural Hazard Mitigation Plan, and describes how each of these types of plans might be implemented.



Economic Analysis of Mitigation Projects

FEMA's methods of identifying the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

The Disaster Policy Council (DPC) and Portland Office of Emergency Management (POEM) will use FEMA-approved cost benefit methodology as a tool for identifying and prioritizing mitigation action items when applying for federal mitigation funding. For other projects and funding sources, DPC and POEM will use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix A.

Methodology for Prioritizing Plan Action Items

To initially prioritize the plan's action items the City of Portland utilized a multi-tiered approach. First the plan goals were prioritized. Second, the natural hazards identified in the community were prioritized based on the hazard risk assessments used in the City of Portland HAZUS-MH project. Using the outcome of these two activities each action item was tallied according to a point system in a third step in order to determine its relative priority within the plan. The prioritized list of action items serves simply as a starting point for the implementation of mitigation activities; it does not dictate the order of implementation.

The Hazard Mitigation Steering Committee and the leadership of the City of Portland have the option to implement any of the action items at any time, (regardless or the prioritized order). This allows the committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of highest priority. This methodology used by the Hazard Mitigation Steering Committee to initially prioritize the plan's goals and action items will also be used by the Disaster Policy Council (DPC) and the Portland Office of Emergency Management (POEM) to maintain the list.

POEM will convene a committee to review the issues surrounding grant applications and shared knowledge and or resources. This process will afford greater coordination and les competition for limited funds.

Step 1: Prioritizing Plan Goals

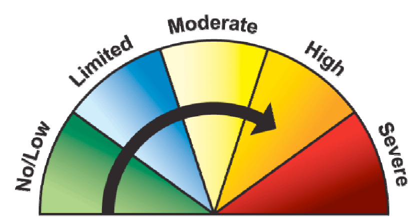
To accomplish this task the Hazard Mitigation Steering Committee examined and voted on the importance of each of the plan's five goals. The steering committee was led through a "dot prioritization" activity to determine the relative priority of each goal. Steering committee members were given 5 different colored adhesive "dots". Each "dot" had a number assigned to it ranging from 1 to 5 points (five being the highest value). They were asked to place a single "dot" on each of the plan goals, whereby ranking the importance of each goal in making Portland more disaster resilient.

The steering committee was reminded that goals are designed to drive actions and that they are intended to represent the general end toward which the City's efforts are directed. They do not specify how the City is to achieve the level of performance. They are the guiding principles for the specific recommendations that are outlined in the action items. The steering committee was asked to rank the goals regardless of how easy each goal would be to accomplish. After the vote, their priorities, the "dots" and their associated points were tallied and the results are as follows:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards
2. Implement activities to protect human life, property, and natural systems
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population
4. Establish a disaster resilient economy
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards

Each action item in the plan is associated with one or more of these goals.

Step 2: Prioritizing Community Hazards



The second step in prioritizing the plan's action items was to examine which hazards they are associated with and where these hazards rank in terms of community risk.

To rank the hazards, City of Portland's natural hazard risk assessment and its methodology was utilized. This risk assessment identified various hazards that may threaten Portland city facilities in a range from:

- No/Low
- Limited
- Moderate
- High
- Severe

The rank ordering of hazards by risk follows:

1. Earthquake
2. Landslide
3. Wildfire

4. Flood
5. Severe Weather

Each of the action items in the plan will address risk from one or more of these hazards.

A copy of the full risk assessment and its methodology can be found in Appendix C.

Step 3: Prioritizing and Implementing Action Items

Portland's Risk Assessment contains specific information about what infrastructure is most at risk from each hazard. This information is crucial to prioritizing the Natural Hazard Mitigation Plan's action items for implementation. The Disaster Policy Council will consider action items for implementation based on the following information:

1. *The prioritized Natural Hazard Mitigation Plan goals.* Does the action item address a highly prioritized goal? Does it address multiple goals?
2. *The degree of risk from the hazard.* Does the action item address a high-risk hazard? Does it address multiple hazards?
3. *The information in Portland's Risk Assessment.* Would the action item mitigate a high-risk area or piece of infrastructure?
4. *The Capability Assessment Matrix included in the plan.* This Capability Assessment is designed to assess the operations, readiness, and capabilities of those organizations associated with the plan's action items to assess which items in the prioritized list can be implemented using existing resources and which items require outside funding. It can be used to help the DPC answer the question, "Does the coordinating agency have the capability needed to implement the action item?" This matrix is intended to be used as part of the prioritization process. It is provided in Appendix D.

Portland's DPC and POEM will review, guide and promote the implementation of action items.

In examining the feasibility of the plan's prioritized action items benefit-cost analysis will be encouraged for all structural mitigation projects. See Appendix A for more information on this process.

Evaluating and Updating the Plan

Formal Review Process

The City of Portland has developed a method to ensure that a regular review and update of the Natural Hazard Mitigation Plan occurs. All

Disaster Policy Council (DPC) members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan and the Director of Portland Office of Emergency Management (POEM) is responsible for contacting the Committee members and organizing a plan review meeting at least annually.

The DPC will review the mission and each goal to determine their relevance to changing situations in the City, as well as changes in State or Federal policy, and to ensure they continue to address current and expected conditions. DPC will also review the risk assessment portion of the Plan to determine if this information should be updated or modified. The designated parties responsible for the various implementation actions will report on the status of their projects and will include which implementation process worked well, any difficulties encountered, how coordination efforts are proceeding, and which strategies should be revised.

The POEM will be responsible for incorporating the changes and updates to the plan before submitting the final document to the DPC members, and presenting it to the City Council for approval. The updated Plan will then be submitted to the State Hazard Mitigation Officer for review. If no changes are necessary, the State Hazard Mitigation Officer will be given a justification for this determination.

Additionally, the DPC will convene following any declared disaster in Portland to consider the mitigation plan in light of the impacts of the event and to strategize mitigation efforts.

Continued Public Involvement & Participation

The City of Portland is dedicated to involving the public directly in the continual reshaping and updating of the Natural Hazard Mitigation Plan. Although members of the Steering Committee represent the public to some extent, the public will have the opportunity to provide feedback about the Plan.

During plan development, public participation was incorporated into every stage of the plan development process. Representatives from key stakeholder organizations, including non-profits, industry, insurance, and state organizations served as members of the Steering Committee. While on the sub-committees, key community members reviewed and participated in discussions about needed City mitigation actions. Such experts represented utilities, universities, the Army Corp of Engineers, and Multnomah County Drainage District.

The subcommittees also suggested many potential reviewers. These experts, who are not affiliated with city bureaus, were invited to form an External Review Board meeting. This broad based board includes neighborhood, watershed, development, environmental, business, school and non-profit representation. Some of the specific organizations involved include:

- African American Chamber of Commerce
- Asian Chamber of Commerce

- Hispanic Chamber of Commerce
- Bonneville Power Administration
- Citizen Crime Commission
- Home builders Association
- Nature Conservancy
- Neighborhood business associations
- Rotary Club of Portland

POEM will convene a meeting of this group once the Steering Committee reviews a draft of the plan and approved it. POEM incorporated comments into the final version of the plan.

Public participation was also invited through a series of presentations to community organizations, such as neighborhood associations, the Business Continuity Planners, and watershed councils. POEM attended multiple meetings to describe the plan and invite comment. These comments were also incorporated into the plan.

Copies of the plan were also posted on the POEM website, and will be available there during update cycles. This website also contains an email address and phone number to which people can direct their comments and concerns. The web address is www.portlandonline.com/oem.

Section 7
Flood Hazards

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Why are Floods a Threat to Portland?

The City of Portland is located at the confluence of two major rivers, the Columbia and Willamette. The city has a long history of flooding and repetitive flood losses. Since its incorporation in 1851, the City has experienced dramatic changes through growth and development that have increased the risk of floods in some areas. This is especially true in the tributaries draining to the Willamette, where development has removed vegetation, increased impervious surfaces, and filled stream channels and floodplains. Ultimately, this combination increases storm water runoff and confines flows into a smaller area, thereby increasing downstream flow velocities. In both large and small watersheds, development in floodplains also puts more people and property in the path of floodwaters and increases the risk of damages even when flood levels are stable.

History of Flooding

Portland residents share a statewide concern regarding flood events. According to the National Flood Insurance Program (NFIP), Oregon has 256 flood-prone communities throughout the State's 36 counties.[1] That number includes Portland and most of Oregon's other 239 incorporated communities and counties. Flooding can cause severe damage to public and private property and poses a threat to life and safety; Oregon's largest economic loss from natural disaster resulted from flooding.[2] Damage during the Christmas Flood of 1964 totaled over $157 million dollars, and 20 Oregonians lost their lives.[3]

Flooding has greatly impacted Portland in the past and has the potential to do so in the future. In 1996—one of the more severe flood years on record—many rivers and creeks throughout the Willamette River watershed rose to 100-year flood levels. (For more information on the 100-year flood definition see section beginning on Page 7-5). On Friday, February 9, 1996, the Willamette River crested 10 feet 6 inches above flood stage, just inches from the plywood placed above Portland's downtown seawall. The Columbia River crested at 11 feet 2 inches above flood stage, causing concern about the levees that protect Portland International Airport and areas north of Columbia Boulevard. Johnson Creek crested at 6 feet 5 inches above flood stage. Each year, there is about a one in 25 chance of a similar storm; a more serious storm could bring floodwaters over the downtown seawall and into the central business district.[4]

High water in the Columbia River during the 1996 flood caused significant erosion along the levee on the Columbia River and the Lower Columbia Slough. Concurrently, heavy rain and high water in the Upper Columbia Slough and secondary slough systems caused 117 landslides and bank failures along these water conveyance systems. Marine Drive was closed due to levee saturation, and barge traffic was also stopped on the Columbia River due to wave wash erosion on the levee. These levee and water conveyance systems are managed and maintained to United States Army Corps of Engineer Standards by four Drainage Districts; Peninsula Drainage District #1, Peninsula Drainage District #2, Multnomah County Drainage District #1, and Sandy Drainage Improvement Company. The levees, pump stations, and conveyance channels make up a Federal Flood Protection System that protects approximately 12,764 acres of property within the managed floodplain. Repairs from the 1996 floods cost the Drainage Districts about $2.5 million. The City of Portland sought and received a Presidential Disaster Declaration to obtain federal assistance for its flood recovery effort in February 1996.

In general, floods in Portland are caused by spring snowmelt from the Columbia River and other basins and intense winter rainstorms. Local flooding also occurs as a result of winter storm run-off in tributaries such as Johnson Creek. The flood season for western Oregon (including the City of Portland) extends from late October through April. Historically, the majority of flooding has occurred in Portland during December, January, and February. The City has considerable areas of existing development in the floodplain, most of which was developed prior to the establishment of the existing floodplain-related development codes. Several of these areas have a high potential for new development and redevelopment, so flooding will continue to be a lengthy maintenance and cleanup issue for Portland.

The City's most recent flooding incident occurred during January 31, 2003, along Johnson Creek. The event was relatively small when compared to the 1996 events but nonetheless flooded nearly 131 acres and affected a total of 11 businesses and 39 residences. Between 1996 and 2004, Johnson Creek has exceeded its bank two times.

Repetitive Flood Losses in Portland

There are a total of nine "repetitive loss" properties in Portland. Repetitive loss is a term that is usually associated with the National Flood Insurance Program (NFIP); for Flood Mitigation Assistance (FMA) program purposes, the term refers to a structure that has suffered flood damage on two or more occasions over a 10 year period where the cost to repair the flood damage equals or exceeds 25% of the structure's market-value at the time of each flood event. Portland participated in the Community Rating System (CRS), which uses a slightly different definition of "repetitive loss" property. CRS uses the term for any property on which the NFIP has paid two or more flood claims of at least $1,000 in any give 10-year period. Repetitive loss structures are important to the NFIP since structures that flood frequently put a strain on the flood insurance fund. On a local level, the structures are also important because residents' lives are disrupted and may be threatened by the continual flooding.

The properties are dispersed throughout the City, though seven of the nine properties are located in the Johnson Creek Watershed. Properties tend to cluster in the following locations:

- In the east-side Willamette floodplain north of the Sellwood Bridge
- In the west-side Willamette floodplain near SW Miles Street
- In the Johnson Creek floodplain near SE Foster Road and 103rd Avenue
- In the Johnson Creek floodplain near SE Harold and 113th Avenue

- In the Johnson Creek floodplain near SE Brookside Drive and 122nd Avenue
- In the Johnson Creek floodplain near SE 143rd and 159th Drive

The Columbia River and Lower Columbia Slough also pose a potential (though unlikely) threat to property within the managed flood plain. Properties protected by the flood works are valued at more than $10 billion and include the Portland International Raceway, the Expo Center, the Portland International Airport, the Columbia Industrial Corridor, several residential neighborhoods, and the City of Portland's drinking water well system. Cost of replacing the infrastructure protected by the flood works would be devastating.

Protecting Portland from Flood Losses

The Federal Flood Protection System that protects the managed floodplain along the Columbia River consists of approximately 60 miles of ditches. The Columbia Slough, and a series of smaller sloughs protect the managed floodplain from flood damages. The ditches and sloughs were constructed and are maintained to accommodate a 100-year internal flood event. Storm water enters into these ditches and sloughs through a series of pipes that drain water from the streets and parking lots of Portland. Additionally, approximately 31 miles of federal levees protect the City from external flooding due to high water in the Columbia River and Lower Columbia Slough.

The system has been extensively improved since the flood of 1996. Pump station, levee, and conveyance system upgrades—as well as a series of computers, repeaters, and antennas that allow 24-hour real-time monitoring from remote locations—all make the system a very reliable means to protect the managed flood plain from catastrophic flooding. Continued management of the system insures future protection of the properties within the managed flood plain.

Factors That Create Flood Risk

Flooding occurs when climate or weather patterns, geology, and hydrology combine to create conditions that enable water to flow outside of its usual course. In Portland, geographic and climatological conditions combine to create a situation of chronic seasonal flooding.

Precipitation

Flooding is most common from October through April when storms from the Pacific Ocean can bring intense local rainfall. In fact, most of the area's average annual precipitation—nearly 42 inches—falls within these seven wettest months of the year. During this seven-month period, Portland receives an average 29.8 inches—or 88 percent—of its total 34 average annual inches of precipitation. By contrast, snowfall occurs a few days each year and depths seldom exceed six inches. Figure 7-1 illustrates Portland's average monthly precipitation.

The high level of rainy season precipitation saturates the ground and often fills rivers and streams to bank full conditions. Bank full conditions exist when rivers and streams rise and exceed their channel capacity; any additional water begins to fill the surrounding floodplain. The City typically experiences flooding after more than three days of heavy rainfall or when saturated conditions combine with significant rainfall or storms over short periods of time.

Figure 7-1. Average Monthly Rainfall, Portland, Oregon

Month	Average High	Average low	Warmest on record	Coldest on record	Average dew point	Average precipitation
January	45	34	65	-2	33	5.4
February	50	36	71	-3	36	4.1
March	56	39	83	19	38	3.7
April	61	42	93	29	41	2.5
May	68	48	100	29	46	2
June	73	53	102	39	50	1.6
July	80	57	107	43	53	0.5
August	79	57	107	44	54	0.9
September	74	52	105	34	51	1.6
October	64	46	92	26	47	3.1
November	52	40	73	13	40	5.5
December	46	36	65	6	36	6.5

Source: State Climatology Office

The City of Portland is located in the Willamette River Basin, which is approximately 11,460 square miles. The Willamette River Basin is the largest watershed in the State with 13 major tributaries joining it between the headwaters at Waldo Lake (southeast of Eugene) and the confluence with the Columbia River at Kelley Point. Though the City of Portland only occupies 1% of the drainage basin, the city's 17 miles are the most urbanized and heavily used along the entire basin length.

Soils

Soils on the west side of the Willamette River vary from clay loam with low permeability and relatively high erosion potential to gravelly loams that are relatively well drained and moderately permeable. Because of landslide potential, stormwater infiltration may not be advisable in many parts of the West Hills; however, soils that provide the opportunity to infiltrate stormwater are scattered around the area. The flat areas along the west bank of the Willamette River are urban and highly disturbed, and many consist of fill.

On the east side of the Willamette River, soils are highly variable; similar to the west side, however, they are generally urban and highly disturbed. Much of the area along the Columbia River has been filled with dredged sand that drains very well. In undisturbed areas along the Columbia River, percolation rates are very slow. Areas south of Columbia Boulevard also have soils that drain well. In the southeast areas of the City, soils vary from moderate to low permeability. In areas with well-draining soil, stormwater can be managed through infiltration.

Floodplain Terminology

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe (see Figure 7-2). See the Natural Hazards Map in this plan's Map Section for Portland's 100-Year Floodplain.

What is a Floodplain?

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. These areas, if left undisturbed, act to store excess floodwater. The floodplain is made up of two sections: the flood fringe and the floodway.

What is the Floodway?

The floodway is one of two main sections that make up the floodplain. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

What is the Flood Fringe?

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

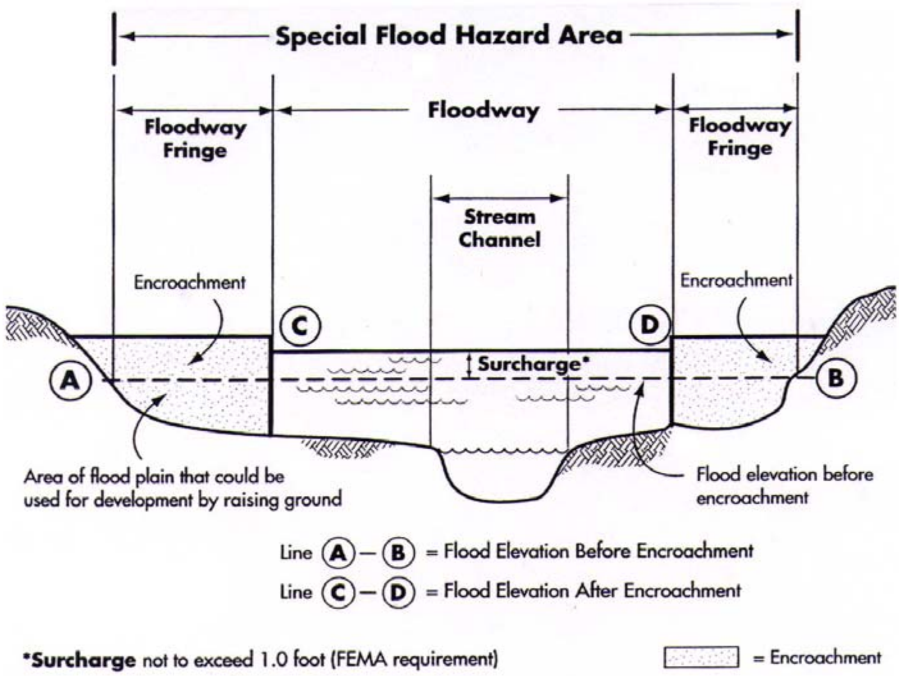
Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined only for regulatory purposes; unlike floodplains, floodways do not have a recognizable geologic feature or floodwater path. For National Flood Insurance Program (NFIP) purposes, the floodway is defined as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 100-year flood without cumulatively increasing the water surface elevation more than one foot (PCC 24.50.030.P). The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. Similarly, City of Portland regulations prohibit development in the floodway with certain exceptions. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe

The Floodway Fringe is the area of the floodplain lying outside the floodway that does not contribute appreciably to the passage of floodwater but serves as a retention area.[5] These outer portions of the floodplain begin at the edge of the floodway and continue outward. City of Portland regulations allow development within the flood fringe with several conditions. For example, structures must be protected by elevating or flood-proofing, and compensatory storage must be provided for fill placed below the base flood elevation. For NFIP purposes, development is defined as any man-made change to improved or unimproved real estate, including but not limited to buildings and other structures and mining, dredging, filling, grading, paving, excavation, fencing, landscaping, drainage facilities, or drilling operations (PCC 24.50.030F).

Figure 7-2. Floodplain Schematic



Source: Floodplain Management in Missouri. (March 1999) Missouri Emergency Management Agency

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the height of the base flood, usually in feet, relative to the National Geodetic Vertical Datum of 1929, the North American Vertical Datum of 1988, any other datum referenced in the Flood Insurance Study report, or the average depth of the base flood, usually in feet, above the ground surface.[6] Base flood elevations can be set at levels other than the 100-year flood; some communities choose to use higher frequency flood events as their base flood elevation for certain activities but use lower frequency events for others. For example, a 25-year flood event might serve as the base flood elevation for the purpose of storm water management while the 500-year flood event may serve as base flood elevation for the tie-down of mobile homes. NFIP regulations focus on development in the 100-year floodplain.[7]

Characteristics of Flooding in Portland

Flooding of developed areas may occur when the amount of rainfall and runoff exceeds a storm water system's (creek, ditch, or storm drain) capability to remove it. Two types of flooding primarily affect Portland: *urban* flooding and *riverine* flooding. In addition, any low-lying area has the potential to flood. Urban flooding impacts related to ongoing stormwater drainage problems are not a significant issue in Portland because major overflows of the system are repaired immediately by the City's Maintenance Engineering Department. The 1997 Surface Stormwater Facility Maintenance and Management Manual guides this group's work. The

Hansen 7.0 database is used to track and prioritize work orders related to the maintenance of the sewer and stormwater system in Portland.

Urban Flooding

Urbanization of the watershed changes the basin's hydrologic systems. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and then slowly release rainfall. Heavy rainfall also collects and flows faster on impervious concrete and asphalt surfaces. Water therefore moves from the clouds to the ground and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. The resulting high water volume and turbidity both contribute to erosion of stream banks.

> Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

A majority of land within Portland is urbanized and has a high concentration of impervious surfaces that either collect water or concentrate flow in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins can also back up with vegetative debris and cause additional, localized flooding.

Numerous areas are currently subject to urban flooding and the number of at-risk areas could increase as development continues throughout Portland. The continued increase of impervious surfaces related to development significantly contributes to Portland's future flood risk as increased runoff subsequently exceeds the capabilities of existing drainage infrastructure. Portland does not currently have a comprehensive policy regarding impervious surfaces in the 100-year floodplain or anywhere else. The Johnson Creek Plan District is the only area in the City where impervious surfaces are limited by the zoning code.

Riverine Flooding

Riverine flooding, or flooding that occurs along channels of rivers and streams, is the largest single form of flooding in Portland. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing floods in hundreds of smaller streams that drain into major rivers.[8] Terrain helps determine the dynamics of riverine flooding. In relatively flat areas, shallow, slow-moving floodwater may cover the land for days or even weeks. In hilly, mountainous areas, a flood could begin only minutes after a heavy rain. Such a flash flood gives short notice and can move so fast that it is particularly dangerous to people and property in the hills.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards in *"areas that are inundated by the 100-year flood with flood depths of only 1 to 3 feet*." These areas are generally flooded by low-velocity sheet flows of water.

What is the Effect of Development on Floods?

When structures or fill are placed in the floodway, water is displaced. Development raises the base flood elevation by forcing the river to compensate for the reduced flow space. When structures or materials are added to the floodway and no fill is removed to compensate for the addition, flood levels may increase beyond their historic floodplain areas both near the area of fill and downstream.

Local governments must manage development in floodplains and floodways to minimize such encroachments in the floodway or floodplain. Techniques include cut and fill balance and other methods used to prevent the rise of pre-development flood levels. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event and the inundation of many homes, businesses, and other facilities. Careful attention must be paid to development that occurs within the floodway to ensure that structures can withstand base flood events without exacerbating flood levels.

In the City of Portland, development encroachment on the floodway is prohibited unless a technical analysis from a registered engineer demonstrates that the development will result in no increase in the base flood elevation. Development in the flood fringe is permitted with conditions. For example, structures must be protected through elevation or floodproofing, and compensatory storage (cut and fill balance) must be provided for fill placed below the base flood elevation (PCC 24.50). Also, the zoning code section 33.631 requires land divisions to place the floodway in a flood hazard tract unless river-dependant uses are proposed.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event and can exacerbate potential flood hazards. Care should be taken in the development and implementation of stormwater management systems to ensure that these runoff waters are managed effectively.[9] Though there is no comprehensive policy to limit impervious surface in Portland, impervious surfaces in the Johnson Creek 100 year floodplain (where flooding is a frequent problem) can equal no more that 50 percent of a lot for all uses and development. This policy also applies in areas with steep slopes.

How are Flood-Prone Areas Identified?

Flood maps and Flood Insurance Studies are often used to identify flood-prone areas. The National Flood Insurance Program (NFIP) was established in 1968 as a means of providing low cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and what we have come to know as "sound floodplain management."[10] The City of Portland joined the NFIP and implemented the related codes and regulations in 1980. NFIP regulations

(44 Code of Federal Regulations (CFR) Chapter 1, Section 60.3) require that all new construction in floodplains be elevated at or above base flood level. The Oregon Building Code requires new construction to be elevated to one foot above the base flood elevation.

Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but they cannot adopt less stringent standards.[11] In Portland, all homes and other buildings legally constructed in the floodplain after January 1980 must be built to NFIP standards with the first floor being elevated at least one foot above base flood level, or in the case of non-residential buildings, flood proofed to at least one foot above the base flood level.

Development:

For floodplain ordinance purposes, development is broadly defined to mean "any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations or storage of equipment or materials." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level), which the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, using lower frequency events for others. For example, for the purpose of stormwater management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the National Flood Insurance Program focus on development in the 100-year floodplain and the City of Portland, has established the 100-year flood as the base flood event.

FIRM Maps and Flood Insurance Studies

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by the Federal Emergency Management Agency (FEMA) that delineates Special Flood Hazard Areas or floodplains where National Flood Insurance Program regulations apply. The maps are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

The City of Portland considers the 100-year (1% annual chance of flooding) flood to be the base flood event.

Water surface elevations are combined with topographic data to develop FIRMs. These maps illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases, they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.

Flood Insurance Studies and FIRMs produced for the National Flood Insurance Program (NFIP) provide assessments flood probability at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s; these studies and maps represent flood risk at the point in time when FEMA completed the studies. *They do not reflect changes within the study area that might affect flooding since the studies.* For example, many areas in the City of Portland have experienced significant urbanization and changes in hydrology during the past 20 years. The original study for the City of Portland was completed in 1979. The study has been revised on several occasions since 1979 to reflect updated conditions and improvements. Most recently, the study has been revised to reflect new hydrologic and hydraulic analyses for Johnson Creek, Fanno Creek, Crystal Springs Creek, and Peninsula Drainage District Number 1.

Flood Mapping Methods and Techniques

In general, the City of Portland relies upon the Flood Insurance Rate Maps (FIRM) devised by the FEMA to guide implementation of the City's floodplain ordinances. If a proposed property is within the floodplain delineated on the FIRM, the ordinances apply. In the Johnson Creek Plan district, additional regulations apply that are designed to reduce flood levels; these regulations limit tree cutting and impervious surfaces.

GIS (Geographic Information Systems) analyses are becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS for analysis of flood hazard areas. Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. However, the original mapping efforts by FEMA in the 1980's did not contain adequate horizontal controls; as such, any overlay is subject to potential error. Local communities have found that the only useful pieces of mapping information are the water elevation and cross section locations contained in the flood studies. This information can be added to topographic maps that more accurately define the areas prone to flood hazard. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request.

Coordination between FEMA and local planning jurisdictions is key to making a strong connection with GIS technology for the purpose of flood hazard mapping. FEMA and the Environmental Systems Research Institute (ESRI), a private company, have partnered to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcView© and ArcInfo©. The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site will assist communities in evaluating geographic information about natural hazards. Flood information for most Oregon communities is available on the ESRI web site. Visit http://www.esri.com for more information.

Community Flood Issues

Development in the floodplains of Portland will continue to be at risk from flooding. Flood damage occurs on a regular basis throughout the City, and property losses resulting from flood damage can be extensive. The City of Portland has experienced more than $200 million in flood damage to both private and public property in the past three decades.

Property loss resulting from Flooding Events

The type of property damage caused by flood events depends on the depth and velocity of the floodwaters. Faster moving floodwaters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive flood damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Surface water entering into crawlspaces, basements, or daylight basements is common during flood events not only in or near floodplains but also on hillsides and other areas that are far removed from floodplains.[12] Most flood damage is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). Most of the losses in the 1996 floods were related to saturation damage.

Private property flood issues

In 1996, flood damage to private property accounted for one-third of total damages statewide.[13] In Portland, damage occurred to structures in the floodplain, as well as structures impacted by localized urban flooding. The highest levels of damage from 1996 floods occurred for structures that were constructed prior to the adoption of floodplain management measures required by the National Flood Insurance Program. The concentration of damage clearly demonstrates the success of the mitigation measures required and implemented through the NFIP.[14]

Homes

Housing losses accounted for the largest share of private property damage during the 1996 flood events.[15] Homes with access to rivers and creeks may be located in areas especially at risk to chronic flooding. The City of Portland's flood ordinances provide baseline rules governing the construction of homes within identified floodplains. Flood damage problems may continue to arise for homes that were constructed prior to the implementation of city regulations.

Homes in frequently flooded areas can also suffer damage to septic systems and drain fields. Homes in rural floodplain areas often depend on private sewage treatment systems. Inundation of these systems may result in leakage of wastewater into surrounding areas. In many cases, flooding damage to homes renders them unlivable.

In the wake of the 1996 floods, the City of Portland received just over $1.5 million in Housing and Urban Development funds and FEMA Hazard Mitigation Grant Program funds totaling $1.5 million. This money was matched by local stormwater fees and regional bond measure funds and has been applied to the Willing Seller program in the Johnson Creek Watershed. The Federal Government provides disaster funding for people who cannot or should not live in their homes because of damage or other disaster-related reasons.[16]

Table 7-3 illustrates Multnomah County's rank as the third highest county in the State for total flood damage during the 1996 events and the fifth highest county for housing disaster assistance. Housing Assistance funds went primarily to urban counties with high populations and relatively high property values.[17]

Table 7-3. 1996 Oregon County Losses and Housing Program Fund Payments

County Losses	Housing Fund Payments to Counties
1. Tillamook	1. Clackamas
2. Clackamas	2. Marion (tied)
3. Multnomah	3. Columbia (tied)
4. Marion	4. Washington
5. Columbia	**5. Multnomah**
6. Lane	6. Tillamook
7. Washington	7. Linn

Source: 1996 Flooding and Landslides and Stream Erosion In the State of Oregon

Manufactured Homes

Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61% were mobile homes and trailers.[18] Many older manufactured home parks are located in floodplain areas. Manufactured homes have a lower level of structural stability than "stick-built" (standard wood frame construction) homes. Manufactured homes in floodplain zones must be anchored to provide additional structural stability during flood events. Because of confusion in the late 1980's resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements. Lack of enforcement of manufactured home construction standards in floodplains can contribute to severe damages from flood events.[19] In all areas of special flood hazards, Portland's Development Code requires that all new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure. Additionally, all manufactured homes must likewise be anchored to prevent flotation, collapse, or lateral movement and shall be installed using methods and practices that minimize flood damage (PCC 24.50).

Business/Industry

Flood events impact businesses by damaging property and interrupting transactions. Flood events can cut off customer access to a business and can close businesses for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. A recent risk assessment conducted for the City of Portland estimates potential damages totaling $258.7 million for commercial and residential general building stock due to a 100-year flood event.[20]

Public Infrastructure

Publicly owned facilities are a key component of daily life for all citizens of Portland. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the government's ability to deliver services. Government can take action to reduce risk to public infrastructure from flood events and can craft public policy that reduces risk to private property.

Buildings and Roads

Of particular importance during flood events are critical facilities located in flood hazard areas (i.e., facilities that are critical to government response and recovery activities). During natural hazard events or any type of emergency or disaster, dependable road connections are critical for providing emergency services. The roads in Portland are maintained by multiple jurisdictions depending on ownership and maintenance agreements. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Road networks often traverse floodplain and floodway areas, and transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges

Bridges are key points of concern during flood events for two primary reasons:

(1) They are often important links in road networks, crossing water courses or other significant natural features; and

(2) They can be obstructions in watercourses and can inhibit the flow of water during flood events.

There are an estimated 64 bridges (railway and highway) at risk in a 100-year flood event and 112 in a 500-year event.[21]

Storm Water System

Most ongoing local drainage problems have been addressed in Portland, but temporary problems can occur in recently developed areas. In some areas with local drainage problems, city maintenance crews must concentrate time and resources until a solution is determined.

Water/Wastewater Treatment Facilities

No major pumping or treatment facilities relating to water systems are likely to fail during flood events due to the elevation of pumping stations and other facilities. However, some portions of the delivery system including trestles and supply conduits in the Bull Run system and transmission mains across the Willamette are vulnerable to flood, landslide, and earthquake impacts.

Parks and Open Space

Current efforts to increase public open space in Portland have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property. In 1997, the City of Portland developed a Willing Seller Land

Acquisition Program to purchase frequently flooded properties. The program seeks to move people and property out of harm's way, minimize repetitive losses, and restore floodplain function. Willing sellers are offered fair market value for their property and are under no obligation to sell. Once the City purchases properties, structures and hard surface are removed. The City places deed restrictions on each property permanently designating it as open space.

The City is taking a particularly proactive stance in the Johnson Creek watershed. In 2001, the Johnson Creek Restoration Plan was published and identified the "nuisance" flood – the flood event that occurs about every 10 years – as the goal for flood management. The Restoration Plan also identifies project areas throughout the watershed to restore natural floodplain functions and provide long-term flood mitigation that is realistic in our modern, built environment. Historic projects to control or direct floods such as levees, dams, and channelization have proved ineffective over time. Restoring natural floodplain functions is ultimately less expensive, more effective, and more sustainable in the long term.

Floods and Natural Systems

Well-maintained or restored natural systems can mitigate the impact of flood events on the built environment. The watershed's natural system includes the soils, nutrients, water quality and quantity, and diverse species of plants and animals that exist in the areas between the water's edge and the higher ground adjoining flood-prone areas. These can be considered as natural infrastructure that, if present, can reduce the spread of flooding downstream. The distinctive attributes of soils in riparian ecosystems are directly influenced by the periods of water that engulf them which in turn affect the structure and function of the plan communities. This ecosystem is more biologically diverse than its neighboring systems and as such, the wildlife, small organisms, and trees and shrubs living within the watershed are varied.

Floodplains and wetlands can make an important contribution to the sources of water supply for human consumption. The slowing and dispersal of runoff and floodwater by floodplain vegetation allows additional time for this water to infiltrate and recharge groundwater aquifers. Floodplain soils and vegetation can also help to purify the water as it filters down to the aquifer. The ability of wetlands to contribute to groundwater recharge varies with geographic location, season, soil type, water table location and precipitation, and wetland type.[22]

Natural resources in floodplains interactively function to determine the distinctive attributes of soils, vegetation, habitat, and water. They also carry out valuable functions that provide benefits both to humans and to wildlife.

Title 3: (Metro Code 3.07.310-3.07.370), Water Quality and Flood Management Conservation[23]

The goal of the Stream and Floodplain Protection Plan (Title 3) of the Metro Regional Government Framework is to protect the region's health and public safety by reducing flood and landslide hazards, controlling soil erosion, and reducing pollution of the region's waterways. Title 3 implements Oregon Land Use Goals 6: Air, Water, and Land Resources Quality and 7: Areas Subject to Natural Disasters and Hazards, by protecting streams, rivers, wetlands, and floodplains by avoiding, limiting, or mitigating development impact on these areas.

Title 3 contains performance standards to protect against flooding. The standards limit development in a manner that requires balanced cut and fill and require floor elevations at least one foot above the flood hazard standard. The areas subject to these requirements have been mapped and adopted by Metro Council. The areas are the FEMA 100-year floodplain and the area of inundation for the February 1996 flood. Title 3 also contains performance standards related to streams, rivers, and wetlands.

These standards seek to protect and enhance water quality. The water quality areas are rivers and streams with a protected vegetated corridor whose width depends on the slope of the land adjacent to the water feature and the width of the property. The performance standards require erosion and sediment control, prohibit the storage of uncontained hazardous material in water quality areas, and require planting of native vegetation on the stream banks when new development occurs. The performance standards first require an alternative analysis to explain what other development locations were considered and how the proposed development location meets the performance standards and has the least detrimental impact on resources. Also, after demonstrating that there is no practicable alternative to the location proposal, the development must take action to reduce impact and must replace the ecological functions that are damaged or destroyed by the development. Portland currently complies with all of the adopted Title 3 elements. The water quality element is implemented via the environmental regulations of Title 33, Portland Zoning Code. Erosion control is regulated by Title 10.

Flood Hazard Assessment Overview

Hazard Identification

Hazard identification, the first phase of a hazard assessment, refers to the process of estimating the geographic extent of the hazard, its intensity, and its probability of occurrence.[24] This process usually results in a hazard map. Hazard maps can provide detailed information in a clear format and can assist in policymaking and land use decisions. For the purposes of this hazard identification process, FEMA's Flood Insurance Rate Maps (FIRM) of the 100 and 500-year floodplain were used to identify areas that could be impacted by flooding.

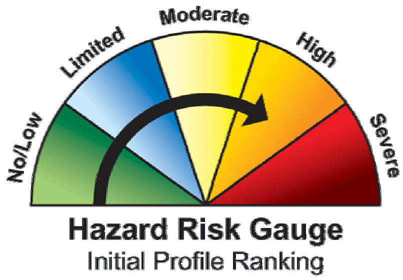
Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through landslide identification with an inventory of the existing development exposed to flood hazards. Vulnerability assessments help predict how different types of property and population groups will be affected by a hazard.[25] The optimal method for conducting this analysis at the county or jurisdictional level is to use parcel-specific assessment data on land use and structures.[26] Data that includes known flood locations can be used to assess the population and total value of property at risk from future landslide occurrences.

This plan uses the results of a pilot study for the Hazard US – Multi-Hazard software program. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates; these methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards and locations. Flood data from the HAZUS-MH software package was supplemented with local data for critical facilities and hazard areas. Inventory data were superimposed over the hazard areas to enable GIS queries to estimate the quantity of assets at risk (population, structures, critical facilities, etc.)

Flood ranked high in comparison to the other three severe ranked hazards, earthquake, landslide, and wildland fire. For a 100-year flood, 11,200 households could be exposed and 29,900 persons impacted, with commercial class occupancies accounting for 37% of the losses. Annualized loss from flood could reach $15.4 million.

More detailed results of the HAZUS-MH study for flood are listed on the following page. They provide an overall summary description of the jurisdiction's vulnerability to the hazards and address the impacts of the hazards on the jurisdiction. Additionally, they identify the extent of the hazard and document previous occurrences of landslide events in the Portland metropolitan area. A complete risk assessment for landslides is included in *Risk Assessment Pilot Project Results for DMA 2000 Plan*.



Multnomah County Hazard Analysis

Severity Score	Medium
History (2)	20
Vulnerability (5)	25
Maximum Threat (10)	60
Probability (7)	42
Total Score	147

Summary of Risk Factors

Period of occurrence:	October through April
Probability of event(s):	Highly likely
Warning time:	General flooding – 0 to 3 hours
Major contributor(s):	Intense precipitation, increase in impervious surface, vegetation loss
Cause injuries?	Yes, and risk of death
Potential facilities shutdown?	30 days or more

FLOOD HAZARD PROFILE

Background and Local Conditions

Flooding results when rain or snowmelt creates water flows that exceed the carrying capacity of river channels or other watercourses and storage facilities (for example, reservoirs). Flooding poses a threat to safety and can cause severe damage to public and private property. In Oregon, flooding is most common when storms from the Pacific Ocean bring intense rainfall (typically between October and April). The area's major rivers include the Columbia, Willamette, Clackamas, and Tualatin. There are also many streams in the area that drain to these rivers and can exacerbate riverine flooding primarily during prolonged wet periods. Local drainage flooding occurs on smaller streams, creeks, and drainage ways, and is more likely to result from heavy local storms and debris-clogged storm drain systems. This pilot project focuses on riverine flooding, which generally impacts larger areas at greater depths than drainage flooding.

Historic Frequency and Probability of Occurrence

Floods are a common and widespread hazard in Oregon. The Portland/Vancouver PMSA has been subject to major floods throughout recorded history. Flooding can be aggravated when heavy rains are accompanied by snowmelt and frozen ground. It was the combination of these factors that caused recent, disastrous floods in February and November 1996.

Flood risk or probability can be expressed by frequency of occurrence. It is measured as the average recurrence interval for a flood of a given magnitude and can be stated as the percent chance that a flood of a certain magnitude or greater will occur in any given year. FEMA's National Flood Insurance Program (NFIP) is based on the risk associated with a "100-year" or base flood; that is, a flood that has a one percent chance of occurring in any year.

Severity

Flooding can be a frequent, costly, and deadly hazard facing Portland; flash flooding also poses a significant danger. Many roads run through low-lying areas that are prone to sudden and frequent flooding during storms. Motorists often attempt to drive through barricaded or flooded roadways. Because it takes only 18 to 24 inches of water moving across a roadway to carry away most vehicles, this presents a significant potential cost and human health risk. The second largest impact on injuries results from people walking or playing in or near flooded areas. Warning times are short (0 to 3 hours, or less) depending on the nature of the flood event. Generally, floods kill people in two ways: when people ignore basic safety precautions (such as evacuations and warnings), or when a flash flood hits an area with no warning. Floods can be very damaging, and depend on the depth and velocity of the floodwaters. During a severe event, buildings can be washed off their foundations; however, most flood damage is caused by water saturating materials that are susceptible to loss (for example, wood, insulation, and furnishings).

Significant historic flooding has been recorded for the Willamette and Columbia River basins in 1861, 1880, 1881, 1894, 1909, 1913, 1927, 1928, 1942, 1946, 1948, 1961, 1964/1965, and 1996 (Oregon OEM 2000). Historic flood inundation levels for the Willamette River at Portland occurred in 1894 (35.1 feet above flood stage warning), 1948 (31.6 feet), 1964 (29.8 feet), 1974 (25.7 feet), and 1996 (30.2 feet) (Metro 1999). Major past events include floods in 1948 on the Lower Columbia River in the Portland/Vancouver PMSA that caused about 25 deaths; in December 1964 and January 1965 that forced the evacuation of thousands, destroyed scores of bridges and secondary roads, caused the Willamette River at downtown Portland to have a flood stage of 29.8 feet, caused $157 million in damages, and caused 17 deaths; and statewide floods in February 1996 that caused five deaths, forced thousands into shelter, destroyed hundreds of homes, caused damages in excess of $280 million, and forced the City of Portland to erect makeshift barriers to prevent flood waters from moving into the downtown area (Oregon State Police 2003). Twenty-seven counties, including Multnomah, were eventually covered by a disaster declaration due to the 1996 floods (Oregon OEM 2000).

Many residents who have suffered damage rebuild in the same vulnerable areas, only to be flooded again. These properties are termed repetitive loss properties, and are troublesome because they continue to expose lives and property to flooding (Clackamas County 2002).

Designated Hazard Areas

According to NFIP, Oregon has 256 flood-prone communities, including all 36 counties. Flood hazard areas are defined as areas that would be inundated by a flood of a given magnitude. The areas subject to riverine flooding have been mapped by FEMA under the NFIP and are illustrated on Figure 3-3 for the Portland study area for the 100-year and 500-year flood zones. These areas are determined using statistical analyses of flood discharge data and hydraulic and topographic analyses. A 100-year flood has a 1 percent chance of being equaled or exceeded in any one year. This flood event is also referred to as the base flood. A flood that has a 0.2 percent chance of being equaled or exceeded in any one year is called a 500-year flood.

Mitigation Plan Goals and Existing 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 Portland Natural Hazards Mitigation Steering Committee, and interviews with Portland stakeholders. Goals for this mitigation plan address four categories:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property, and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resistant economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

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. Personal stakeholder interviews were conducted with several Portland agencies to obtain existing mitigation activity information.

City Programs

1996 Flood and Landslide Mitigation Plan

After the 1996 floods, a flood and landslide mitigation plan was developed by a key group of city bureaus. Actions outlined by this group allowed for reimbursement funding from the federal government due to the floods. The sub-committee reviewed these actions to develop implementation strategies and determine the progress needed. Many of the items are carried over into the 2004 plan, but the following were implemented. This plan included recommendations to add flood and landslide maps to the GIS permit center, consider the cost/benefit advantage of applying for the National Flood Insurance Program Community Rating System, and to upgrade the river gauging system throughout the State, among others. This plan served as a starting point for the action items in the flood section of this natural hazard mitigation plan.

River Elevation Conversion Tables

One issue raised in the 1996 Flood and Landslide Mitigation Plan was the variation in data systems used among local and federal agencies. Based on the work of an interagency, intra-bureau team, the following Conversion Chart was developed but no one datum was formally chosen as the main reference of flood level.

River Elevation Conversion Tables

All elevations in feet, round to nearest 0.1'

Columbia River	NGVD/MSL	City of Portland	NAVD88
NWS Vancouver	**MCDD, ODOT**	**PDOT, BES**	**Water Bureau Map**
0.0	+1.8	+3.2	+5.3
1.8	0.0	+1.4	+3.5
3.2	-1.4	0.0	+2.1
5.3	-3.5	2.1	0.0

Willamette River	NGVD/MSL	City of Portland	NAVD88
NWS Morrison	**MCDD, ODOT**	**PDOT, BES**	**Water Bureau Map**
0.0	+1.6	+2.9	+5.0
1.6	0.0	+1.4	+3.5
2.9	-1.4	0.0	+2.1
-5.0	-3.5	-2.1	0.0

Community Rating System

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the

NFIP. Property owners within the City would receive reduced NFIP flood insurance premiums if the City implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website at http://www.fema.gov/nfip/crs.htm.

In Portland, the CRS program creates an incentive for the City to continue implementing proactive, long-term mitigation activities by bringing a discount to flood insurance policy holders. The City of Portland participates in this program and scored a #6 Rating within the CRS program, the highest rating in the State along with that of Tillamook County. A #6 rating delivers a 20% discount to flood insurance policy holders in the City. Through mitigation planning and the newly outlined actions, even more CRS points and therefore more deductions to homewners' flood insurance can be claimed.

City of Portland Codes

Chapter 24.50 Flood Hazard Areas

The purpose of this Chapter is to protect public health, safety, and welfare by restricting or prohibiting uses which are dangerous to health, safety, or property in times of flood or which cause increased flood heights or velocities, and by requiring that uses and structures vulnerable to floods be protected from flood danger at the time of initial construction. This code identifies flood hazard areas and limits or prohibits development where significant personal property loss can occur or where significant environmental damage can occur. The City of Portland currently:

1. Uses environmental zones to protect significant natural resources and limits the development impact by restricting the proximity of development to water bodies, minimizing the impervious footprint, retaining and restoring native vegetation.
2. Uses Plan District regulations to prohibit development within the Johnson Creek floodway, prohibit land divisions within the flood risk area, limit impervious surfaces within the 100-year floodplain, limit tree removal, and limit housing types in the multi-family zone that are within the 100-year floodplain.

Flood Management Projects

Kelley Creek

The Alsop-/Brownwood project was originally proposed as a single, 50-acre restoration project. The project involves removing fill and recreating historic meanders in Johnson Creek and Kelly Creek. Because of the complexity of the project and the cost of design, permitting, and construction, the project was broken into smaller projects and will be constructed in phases, as resources are available. The first phase, the Kelley Creek Floodplain Restoration Project, will cover the area between SE 159th and the Springwater Corridor where Kelley Creek meets Johnson Creek.[27] The Kelley Creek project was constructed during the summer of 2004 and provides more than 15 acre-feet of flood storage.

Johnson Creek

The “Willing Seller” program in the Johnson Creek area allows landowners in frequently flooded areas to sell their property at fair market price to the City.

In 1996, Portland Parks, Portland Environmental Services, Metro, and other federal partners began acquiring land and developing designs for large-scale floodplain, water quality, and habitat restoration projects in four target areas along Johnson Creek. These projects will provide flood management benefits while meeting open space, water quality, and habitat goals.

Columbia Slough Watershed

The Columbia Slough watershed in North and NE Portland is unique to Portland because it is protected from flooding by federally constructed levees and a series of pump stations managed by Multnomah County Drainage District #1, Peninsula Drainage District #1, and Peninsula Drainage District #2. The rest of the lower slough floodplain is not protected by levees. During the next five years, the City and the Drainage Districts will continue their partnership to re-grade, revegetate, and stabilize the slough banks.

Fanno Creek

Fanno Creek and its tributaries in Portland have steep slopes without a wide, well defined floodplain. Development, especially along the mainstem of Fanno Creek, has encroached extensively into the riparian corridors and in some cases into the floodway. About seven acres of riparian corridor in Fanno Creek and its tributaries are now permanently protected and are designated open spaces thanks to City of Portland and Metro acquisition programs.

Willamette River Corridor

The City has partially completed a five-year program partnering with public and private property owners to revegetate the Willamette River mainstream. These projects will reduce erosion along more than 7,000 feet of riverbank and bluffs and will restore 50-75 acres of riparian and oak habitat by removing invasive species and planting more than 75,000 native trees and shrubs. The City is also developing comprehensive plans to protect and enhance public and watershed health, while supporting multiple land uses in the river corridor and the watershed as a whole.[28]

Emergency Management Program

The Portland Office of Emergency Management (POEM) coordinates City departments, governmental agencies, and private networks to prepare, plan, equip, train, and exercise emergency response actions and to coordinate the implementation of mitigation and recovery plans.

The City has established POEM consistent with its authority under Oregon Revised Statutes (ORS) 401.305 to 401.335 and City Code 2.01.010 to 2.01.060 (cited as the "Emergency Management Code"). The Emergency Manager is part of the Mayor's Office and is responsible for managing the City's program in all four phases of Emergency Management.

State Programs

State of Oregon Floodplain and Floodway Removal/Fill Law

The Oregon Removal/Fill Law, which is administered by the Oregon Division of State Lands, requires a permit for activities that would remove or fill 50 or more cubic yards of material in state waters (e.g., streams, lakes, wetlands). Portland, Clean Water Services, and other partner cities must comply with the removal/fill laws when designing and building facilities and have related responsibilities when dealing with private development and other construction projects.[29]

Oregon's Wetlands Protection Program

Oregon's Wetlands Program was created in 1989 to integrate federal and state rules concerning wetland protection with the Oregon Land Use Planning Program. The Wetlands Program has a mandate to work closely with local governments and the Division of State Lands (DSL) to improve land use planning approaches to wetland conservation. A Local Wetlands Inventory (LWI) is one component of that program. DSL also develops technical manuals, conducts wetlands workshops for planners, provides grant funds for wetlands planning, and works directly with local governments on wetlands planning tasks.

Oregon Wetlands Joint Venture

The Oregon Wetlands Joint Venture is a coalition of private conservation, waterfowl, fishery, and agriculture organizations working with government agencies to protect and restore important wetland habitats.[30]

Federal Programs

National Weather Service

The National Weather Service provides flood watches, warnings, and informational statements for rivers throughout Washington County.

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance for clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and must generally benefit more that one property.

Federal Emergency Management Agency (FEMA) Programs

The Federal Emergency Management Agency (FEMA) resulted from the consolidation of five federal agencies that were dealing with different types of emergencies. Since then, many states and local jurisdictions have accepted this approach and changed the names of their organizations to include the words "emergency management." Portland is one of those local jurisdictions.[31] FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance.

National Flood Insurance Program (NFIP)

Flood insurance is available to citizens in communities that adopt and implement NFIP siting and building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, an area subject to inundation during a base flood event, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps that are available through the City of Beaverton. Oregon's Department of Land Conservation and Development is the state's NFIP-coordinating agency.

Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Portland can undertake to reduce risk and prevent loss from flood events. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that state agencies may implement with existing resources and authorities. *Long-term action items* (LT) require new or additional resources and/or authorities.

Short-term Action Items

ST-FL#1: A covenant is recorded with the deed of new development in the floodplain to ensure that space below the BFE is not converted to habitable space. This should be codified to improve compliance.

Key Issues Addressed

- Many areas below the base flood elevation (BFE), over time, are converted to habitable space; this puts more people and property in harm's way. An "unfinished enclosure covenant" is used, but is not codified.

Ideas for Implementation

- No code specifically references this covenant. Recommendation for action plan is to codify the covenant. Floodplain ordinance 24.50 is currently in discussion for revision.

General Comments

- New construction in the floodplain with high crawl spaces are required to complete a covenant agreeing to not convert the area into habitable space. This covenant is recorded with Multnomah County prior to permit issuance.
- This action was also recommended in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Bureau of Development Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 yr.
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#2: Continue to co-fund improvements to river and stream gauges in the Portland metropolitan area with the United States Geological Survey.

Key Issues Addressed

- River stage gauges are needed to accurately monitor and predict flood danger along a specific river. Many jurisdictions around the state reported that in 1996 they needed earlier warning and better information. Many gauges have been deactivated and not replaced due to lack of funding.

Ideas for Implementation

- Continue partnerships with USGS; assure that funding is in place with each budget cycle.
- Upgrade the river gauging system throughout the state, finding ways to ensure stable and ongoing funding for maintenance. It is recommended that the State Water Resources Department be the lead agency to work with local jurisdictions.

General Comments

- This action was identified in the *1996 Flood and Landslide Hazard Mitigation Plan*.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	none
External Partners:	USGS, Oregon Fisheries, Other adjacent jurisdictions may also gain from this information and can also become partners
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#3: Convene an interagency committee to determine which datum will be used when the City is responding to a flood event. This decision will not preclude agencies from using their own datum during non-flood times.

Key Issues Addressed

- The levels of the Willamette and Columbia rivers are measured using at least four different datum depending on which agency presents the data (An example of the multiple datum conversion chart is included in the Existing Programs section of this section). This difference caused considerable confusion during the 1996 flood.

Ideas for Implementation

- Formally acknowledge, possibly via City Council resolution, that one datum will be used when Portland's Emergency Operation Center is operational. Reconvene a committee to select the emergency datum as soon as possible.
- Conversion charts will be distributed before as well as during a disaster, and will include instructions for use.

General Comments

- Per recommendations in the *1996 Flood and Landslide Hazard Mitigation Plan*, an inter-agency committee was set up to select a datum to use across all agencies in both emergency and non-emergency situations, but they were unable to reach consensus regarding which datum to use.
- FEMA and NOAA each have their own measurement system, which is imbedded within all of their maps and reporting systems. One possible solution is to find a method of working with existing systems; agencies need to discuss how this would work. Conversion chart is available in card format for easy access and use.

Coordinating Organization:	Harbor Master, Fire Bureau
Internal Partners:	Bureau of Development Services, Portland Office of Emergency Management
External Partners:	Northwest River Forecast Center- NOAA
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#4: Secure the agreements necessary to design and implement the redevelopment of Freeway Land Company site (within the Lents Urban Renewal Area) to better manage floods.

Key Issues Addressed

- Freeway Land Company is a keystone parcel for flood management in the Lents area. Approximately one-quarter to one-third of the total area of this property needs to be available for flood storage and conveyance if long term plans for mitigation of the 10-year flood event in the Foster Road and 110th area are to succeed. Freeway Land Company is expected to redevelop this site in the next two to six years. These plans should include flood management in order to meet Lents area-wide goals.

Ideas for Implementation

- Portland Development Commission, Portland Office of Transportation, Portland Parks and Recreation, and Bureau of

Environmental Services collaborate with each other and developers via a development agreement; the City provides incentives to encourage developers to incorporate flood and open space plans for the site. The City should be prepared to do necessary design and construction to improve the open space for flood management and open space amenity value. This would combine the implementation of flood management goals with job-creation goals.

General Comments

- The current property owner and the Lents Urban Renewal Advisory Committee have endorsed a concept plan that includes flood management. However, since the property is currently for sale, the City must wait for an interested developer before detailed conversations can commence.
- Though there is a high level of interest from multiple internal agencies, the project will demand a high cost in both dollars and staff resources.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Portland Development Commission; Bureau of Planning, Portland Office of Transportation, Portland Parks and Recreation
External Partners:	Oregon Economic Development Department, site land owners
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#5: Acquire outside funding to hire a consultant to lead the application process for a Class 5 rating the next time the City submits for the Community Rating System certification.

Key Issues Addressed

- More favorable ratings result in increased discounts to flood insurance policy holders and create an incentive for the City to continue implementing proactive, long-term mitigation activities.

Ideas for Implementation

- Given current staffing levels, it will be necessary to acquire grant funding to hire a consultant (1/4 FTE) to coordinate multi-bureau staff and the overall application process.

General Comments

- Reapplication for the Community Rating System will occur in 2006.

- The largest barrier to implementation is the lack of staff time to coordinate multiple bureaus and assemble the complicated application. The 2001 application was funded through a grant.

Coordinating Organization:	Bureau of Environmental Services, Community Rating System Coordinator
Internal Partners:	Bureau of Development Services; Parks; Portland Office of Emergency Management; Bureau of Maintenance
External Partners:	Federal Emergency Management Agency, Department of Land Conservation and Development, Insurance Services Office, Inc. (ISO)
Level of Immediate Capability:	Medium
Estimated Timeline:	2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#6: Support MCDD in the continued calibration and updating of hydraulic models for conveyance and internal flood impacts to the four managed floodplains managed by Multnomah County Drainage District # 1.

Key Issues Addressed

- The hydraulic model identifies development-related impacts to the water flow and capacity of watersheds. The models could be used in conjunction with flood inundation modeling to predict flood levels and identify measures that would reduce impacts. Measures could include identifying high-risk areas, critical facilities vulnerability, and measures to mitigate vulnerability.

Ideas for Implementation

- Partner with the City and acquire funding for the action.
- Address this need for protection of life and property as part of the ongoing characterization of the Columbia Slough watershed.

General Comments

- This type of modeling could also be used for other watersheds within the City of Portland

Coordinating Organization:	Portland Office of Emergency Management, Bureau of Environmental Services
Internal Partners:	Bureau of Planning
External Partners:	Multnomah County Drainage District
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

ST-FL#7: Develop a multiple-agency plan for evacuation of the managed Columbia River floodplain in Multnomah County in the event of a potential levee failure.

Key Issues Addressed

- In the unlikely (though possible) event of levee failure, evacuation may be necessary for the protection of life.

Ideas for Implementation

- Coordinate with Law Enforcement, Fire and Rescue, and other appropriate agencies.
- Build on existing evacuation plans for overlapping geographic areas.

General Comments

- Multnomah County Drainage District would rely on river forecasting, weather forecasting, and on technical assistance from the Army Corps of Engineers regarding the need for evacuation during a flood event.

Coordinating Organization:	Mitigation Program Coordinator, Portland Office of Emergency Management
Internal Partners:	Portland Office of Transportation
External Partners:	Multnomah County Drainage District, Multnomah County Sheriff, Army Corps of Engineers
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#8: Identify funding for the design and construction of the Springwater Wetlands Complex, a 30-acre floodplain wetland restoration project in the Lents area of Johnson Creek.

Key Issues Addressed

- This project is located in the Lents Urban Renewal Area between SE 111th and SE 120th, an area that is known to experience problem flooding. Because it is near existing wetlands, the project has significant water and habitat quality benefits and would provide important flood storage. Between 15 and 20 homes adjacent to the project site will experience fewer floods, which have flooded three times since 1964. Without this project, these homes have a 71% chance of flooding over the course of a 30-year mortgage. This project can reduce that chance to 26%.

Ideas for Implementation

- Oregon Department of Transportation is a potential funder through their wetland mitigation bank program. The Corps of Engineers is a potential funder through their Section 206 Habitat Restoration Program.
- Continue discussions with these partners, package funding, finalize the predesign effort started through the Section 206 program, and design and construct the project.

General Comments

- This project was attempted previously but funding was eliminated in the middle of predesign due to changing federal priorities. It is currently on hold due to lack of available funding.
- Partnerships with Parks and Recreation will be important since the project is likely to also include passive recreation components such as interpretive signage and boardwalks.
- The project was identified as a high priority project in the Johnson Creek Restoration Plan, 2001.
- Implementation of this action also supports Urban Renewal objectives in the Lents area.

Coordinating Organization:	Johnson Creek Watershed Manager, Bureau of Environmental Services
Internal Partners:	Parks and Recreation, Portland Development Commission
External Partners:	Army Corps of Engineers, Oregon Department of Transportation
Level of Immediate Capability:	High, given the availability of funding
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#9: Secure funding to implement the passive flood management projects that are recommended in the Johnson Creek Restoration Plan. Coordinate with Portland Development Commission's urban renewal efforts in Lents and with other partners in other parts of the watershed.

Key Issues Addressed

- Four areas in Johnson Creek watershed flood frequently: Tideman-Johnson, West Lents, East Lents, and Lower Powell Butte. The most frequently flooded and highest priority area is East Lents along Foster road between SE 102nd and 112th. Flooding in this area impacts nearby residences and businesses.

Ideas for Implementation

- Secure more funding to complete willing seller land acquisitions.
- Secure funding for predesign and design of the flood management facilities recommended in the Johnson Creek Restoration Plan.
- Leverage outside funding and phase large projects into manageable pieces.

General Comments

- This action is an update of a recommendation that was included in the 1996 *Flood and Landslide Hazard Mitigation Plan*.
- In West and East Lents, all work has been coordinated through Portland Development Commission and the Lents Urban Renewal process. The Bureau of Environmental Services has completed a significant amount of flood analysis in the Lents area and has completed 10% designs for flood management. Design and construction of projects is pending funding and willing property sellers (approximately one-third of the property remains in private ownership).

Coordinating Organization:	Bureau of Environmental Services, Johnson Creek Watershed Manager
Internal Partners:	Portland Development Commission, Parks and Recreation
External Partners:	Army Corps of Engineers
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-FL#10: Improve definitions and refine standards for stormwater retention in the Stormwater Management Manual (SWMM).

Key Issues Addressed

- Stormwater retention assures that water does not leave the site, other than via infiltration and evapotranspiration. Detention holds back the water, but ultimately releases it. Detention and retention of stormwater on site will not prevent downstream flooding, but they will contribute to lessening flood impacts. Current SWMM standards require that stormwater is retained on the site to the "maximum extent practicable" (MEP) and the rest detained; this definition should be clarified through standards.

Ideas for Implementation

- Include this recommendation as part of the next 3-year update to the SWMM.
- Develop a stream map that identifies flashy streams where the regulations would apply.
- Clarify MEP standards to increase the amount of stormwater that is retained on site in those watersheds or sub watersheds.
- Additional funding may be necessary to assure that staff is assigned to focus specifically on this issue.

Coordinating Organization:	Development Services Division, Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards

ST-FL#11: Support development of a multiple-agency plan for Marine Drive closure coordination.

Key Issues Addressed

- During major flood events, it may be necessary to close Marine Drive so that flood fighting actions may be undertaken, and to reduce impact to the levee when it is saturated with flood waters.

Ideas for Implementation

- Coordinate with Law Enforcement and other appropriate agencies.

Coordinating Organization:	Portland Office of Emergency Management Mitigation Program Coordinator
Internal Partners:	Bureau of Water, Portland Office of Transportation
External Partners:	Multnomah County Sheriff; Oregon Department of Transportation, Army Corps of Engineers, Multnomah County Drainage District
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#12: Provide staff to participate in Flood Fight Trainings lead by the Multnomah County Drainage District.

Key Issues Addressed

- Readiness for levee monitoring and flood fight in the event of a high water event on the Columbia River.

Ideas for Implementation

- Multnomah County Drainage District has facilities for training and has trained US Army Corps of Engineers personnel, COP Water Bureau personnel, POP personnel, and private business personnel. Identify other relevant participants and encourage them to come to trainings.

General Comments

- Trainings are held annually. Other interested parties should contact the Drainage District.

Coordinating Organization:	Portland Office of Emergency Management, Mitigation Program Coordinator
Internal Partners:	Bureau of Maintenance, Police, Water Bureau
External Partners:	Multnomah County Drainage District, Army Corps of Engineers
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

.ST-FL#12: Install a river gauge in the vicinity of the bridge over Johnson Creek at 108th. The gauge should be able to send data to a remote monitoring site.

Key Issues Addressed

- This action provides an early warning system floods that occur in the right of way on both public and private property.

Ideas for Implementation

- Portland Office of Transportation and Bureau of Environmental Services should form a work team to research the following:
    - Determine proper instrumentation and compatibility with current systems.
    - Determine costs.
    - Determine remote telemetry configuration and site location.
    - Installation location of equipment to accomplish task.

General Comments

- The existing stream gauge that is closest to the one that is proposed is located at SE 148th. This location is not close enough to accurately predict whether and when Foster Road at SE 108th needs to be closed, or to provide warning to residents and businesses to prepare.

Coordinating Organization:	Bureau of Maintenance, Environmental Systems Division Manager
Internal Partners:	Bureau of Environmental Services; Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 year once funding is secured
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-FL#13 Install one-way valves on the outlet pipes of the storm inlets on SE Foster Road between 101st and 112th.

Key Issues Addressed

- This action would eliminate reverse flow in outlet pipes to street inlets to the right of way. This would significantly reduce the incidences of localized drainage system flooding before bank topping of Johnson Creek.

Ideas for Implementation

- Portland Office of Transportation and Bureau of Environmental Services team should research all potential sites and determine the most viable valve system for implementation.
- Determine installation costs.
- Prioritize identified sites.
- These should be engineered for optimum efficiency given the nature of inflow from the street and backflow from Johnson Creek when flow elevations reach a given point, even though creek banks have not been exceeded.

Coordinating Organization:	Environmental Systems Division Manager, Bureau of Maintenance
Internal Partners:	Bureau of Environmental Services
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 year once funding is secured
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-FL#1: Increase funding for the Johnson Creek Willing Seller Program; establish willing seller programs in other watersheds where flood hazard and priority restoration areas coexist.

Key Issues Addressed

- Willing seller programs help restore the natural functions of floodplains while also permanently removing the risk of flood damages to acquired properties. These natural functions provide extra benefit such as water storage, water quality improvement, and rare open space amenities for urban dwellers.

Ideas for Implementation

- Continue and increase funding for existing programs such as Johnson Creek Willing Seller Program.
- In other watersheds, delineate target areas based on high-risk areas. This action can achieve multiple objectives when high-risk areas are also high quality habitat and/or water quality protection areas.
- Purchase properties on a willing basis only using consistent and equitable procedures and policies

General Comments

- This program exists in the Johnson Creek watershed
- Interest and institutional capability are high, but funding is low
- This action item was identified in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Watershed Managers, Bureau of Environmental Services
Internal Partners:	Department of Parks and Recreation, Bureau of Planning, Water Bureau
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	long-term
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#2: Review and amend City Code to require that all facilities that store or handle hazardous materials (including large tanks), and which are located in the 500-year floodplain or landslide hazard areas, develop

a hazardous materials inventory statement. This statement will be made available for Fire Bureau review. Require that these storage tanks are either adequately protected or relocated outside of the 500-year floodplain.

Key Issues Addressed

- Storage of hazardous materials in the floodplain can cause hazardous materials spills during flood events. This is particularly dangerous because the spills occur in environmentally sensitive areas.

Ideas for Implementation

- The existing SARA Title III database contains data that are a good starting place for developing a database of hazardous materials storage locations.
- The Fire Marshal could adopt fire code appendices requiring "hazardous materials inventory statements" and "hazardous materials management plans." The Fire Marshal could then implement a program to evaluate and mitigate potential hazards.
- Identify funding sources for implementation.
- Develop options for funding assistance to affected business or property owners in the floodplain.

General Comments

- Underground tanks are anchored to keep them from floating during floods. Above ground tanks typically have secondary containment such as a dyke that can hold the contents of the largest tank within the facility. Small tanks are considered portable and have no anchors or protection from flood damage.
- This action was also recommended in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Chief Fire Marshal
Internal Partners:	Harbor Master, Fire Bureau, Portland Office of Emergency Management, Bureau of Development Services
External Partners:	State Fire Marshall Office
Level of Immediate Capability:	Low
Estimated Timeline:	3-5 years once funding has been identified
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#3: Develop a plan for addressing flooding in the Holgate Lake area.

Key Issues Addressed

- Localized groundwater flooding occurs after extensive periods of rain to the east of SE 128th and Holgate (called "Holgate Lake" although a lake only intermittently exists). Flooding occurs relatively infrequently, but has a high impact because of the amount of development that is located here. The area continues to develop, leaving more homes in harms way. Although finished floors of newer homes are protected from the flooding, access to and from the site can be a problem since the floods tend to have a long duration.

Ideas for Implementation

- Determine which agency would be most appropriate to take the lead on developing and implementing the plan.
- Secure funding for an area-specific plan. Establish a working committee. Gather Holgate-Lake specific data. Develop a plan that will be implemented through a combination of zoning code, building code, and land acquisition.

General Comments

- This action was also identified in the *1996 Flood and Landslide Hazard Mitigation Plan.*

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Parks and Recreation, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	5 + years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#4: Improve hydraulic bottleneck that prevents discharge of chlorinated effluent to the Willamette River during high river levels.

Key Issues Addressed

- Currently, during high river levels, chlorinated effluent is discharged directly into the Willamette River. This situation is undesirable for public health and environmental reasons. When this situation occurs, the City is temporarily in noncompliance with its sanitary system discharge permit.

Ideas for Implementation

- Design and construct a chlorinated secondary effluent bypass pump station at the Tryon Creek Wastewater Treatment Plant (TCWTP).
- Design and construct outfall pipe improvements at the Tryon Creek Wastewater Treatment Plant (TCWTP).
- Secure internal Bureau of Environmental Services funding for one of these projects in order to leverage federal funding for the other.

General Comments

- This project is already in an approved BES plan- Project No. 12 in the Tryon Creek Wastewater Treatment Plant Facilities Plan, 1999. The project was estimated to cost $870,000 (1999 dollars). Funding has not yet been identified.

Coordinating Organization:	Operating Manager Tryon Creek Wastewater Treatment Plant, Bureau of Environmental Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	2 years once funding has been identified
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#5: As Waterfront Park remodeling is designed, ensure that Portland's downtown property and critical facilities remain protected from floodwaters.

Key Issues Addressed

- Without the seawall in place, downtown Portland will be exposed to catastrophic flooding. The redesign of Waterfront Park has the potential to impact the function of the seawall. These impacts would include floodwater, debris, floating structures and vessels.

Ideas for Implementation

- Conduct engineering studies to determine whether property protected by the seawall would remain protected under the proposed new designs.
- Make funding of the design and construction of the improvements contingent on the inclusion of engineering studies that ensure the continued function of the seawall.
- Ensure that Fire Bureau Harbor Master reviews and comments on redevelopment projects for Waterfront Park, as recommended in the 2002 Master Plan.

General comments

- A Master Plan was completed in 2002 that made recommendations for altering the seawall along Waterfront Park.

Coordinating Organization:	Parks and Recreation
Internal Partners:	Harbor Master/ Fire Bureau, Bureau of Planning, Bureau of Development Services
External Partners:	none
Level of Immediate Capability:	High, pending project funding
Estimated Timeline:	5-10 years, dependent on funding
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#6: Support Multnomah County Drainage District (MCDD) as they develop a multiple-agency plan for initiation of traffic closure on the Columbia River as advised by MCDD and the Army Corps of Engineers.

Key Issues Addressed

- During the 1996 floods, significant damage resulted from wave wash erosion. Closing the Columbia River to river traffic to prevent wave wash erosion to the levee of flood is longer than for a Johnson Creek overland flood.

Ideas for Implementation

- Coordinate with Fire Bureau, Harbor Master and other appropriate agencies.

General Comments

- Recommended in the Consolidated Drainage District Flood Emergency Plan, 2002.

Coordinating Organization:	Mitigation Program Coordinator, Portland Office of Emergency Management
Internal Partners:	Portland Office of Transportation
External Partners:	Captain of the Port, Coast Guard; Multnomah County Sheriff; U.S. Army Corps of Engineers; Multnomah County Drainage District
Level of Immediate Capability:	High
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-FL#7: Partner with Army Corps of Engineers to conduct modeling of the Willamette River upstream of Portland to identify areas that, if acquired or restored, would contribute to mitigation of peak flows in

Portland or result in significant reduction of flood damages.

Key Issues addressed

- Portland is subject to increased flood risks due to development on up-stream properties. This action will determine whether there are areas upstream of Portland that could be protected or restored to reduce the flood risk in Portland. It is difficult for the City to influence land acquisition priorities in upstream, rural areas without contributing funding. Until we have information about the benefits of upstream acquisition, expenditures will not occur.

Ideas for Implementation

- Secure funding for the study.
- Inventory work that has already been done to model the Willamette River.
- Develop contract and scope of work with the Army Corps of Engineers (COE).
- Participate with COE to check assumptions and assure that modeling output is translated to issues significant to Portland.
- If the information is compelling and points to possibilities for significant reduction of flood impacts, create a committee to formulate recommendations for next steps.

General Comments

- The City has the modeling capacity to work with the COE; however, the scale of the Willamette basin upstream of Portland will make it difficult to identify specific areas with significant impact. Also, it will be difficult for the City to be the driver on this effort alone; it needs the full participation of the COE or other entity that has more of a basin wide jurisdiction. Related to Recommendation #15 in the 1996 Flood and Landslide Hazard Mitigation Plan.

Coordinating Organization:	Bureau of Environmental Services Systems Analysis Group
Internal Partners:	none
External Partners:	Corps of Engineers, United States Geologic Survey
Level of Immediate Capability:	Medium
Estimated Timeline:	5+ years
Plan Goals Addressed:	Identify risk level and evaluate Portland’s vulnerability to natural hazards.

LT-FL#8: Develop citywide, watershed or sub- watershed specific goals, policies, and provisions for amount of impervious surface that should be reduced. Develop implementation tools to meet these goals.

Key Issues Addressed

- Reduction of impervious surfaces within a watershed can decrease flood levels. While impervious surface limits are enforced within the Johnson Creek area, they apply only within the 100-year floodplain. Impervious surfaces in upland areas also contribute to flooding. Impervious surfaces in upland areas in Johnson Creek and other watersheds could also benefit from citywide limits on effective impervious areas.

Ideas for Implementation

- Develop watershed plans that include target goals for maximum impervious surface percentages; amend the comprehensive plan, the zoning code, and/or the stormwater manual to address maximum percentages of allowed imperviousness on a property and to address cumulative impacts on a watershed scale.
- Include the impervious surfaces created by roads, sidewalks, and parking lots within subdivisions and other large developments; give stormwater fee credits to properties that remove impervious surfaces.
- Identify design elements for low-impact development.
- Develop non-regulatory tools to provide incentive to minimize new impervious surfaces and/or removal of existing.

General Comments

- Bureau of Environmental Services is developing a watershed plan that will provide existing effective impervious surface data and recommended targets for reduction; it will be complete in 2005. This plan includes mitigation goals, but not for all areas of the city. The goals will be guidelines rather than requirements.

Coordinating Organization:	Bureau of Planning, Bureau of Environmental Services
Internal Partners:	Bureau of Development Services, Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	Low; not in current budget
Estimated Timeline:	5 + years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#9: Upgrade trestles that carry the main conduits of the water delivery system.

Key Issues Addressed

- Some trestles are vulnerable to floods, and should be upgraded to protect Portland's water supply.

Ideas for Implementation

- Rebuild/ upgrade or replace existing trestles to increase natural disaster survivability.

General Comments

- Several of these trestles are located in the Bull Run Watershed, which provides all of Portland's drinking water.
- Currently defined in the Water Bureau's 5-year CIP Plan; However, this does not guarantee funding

Coordinating Organization:	Water Bureau
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High, given availability of funding
Estimated Timeline:	3-8 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems. Establish a disaster resilient economy.

LT-FL#10: Create redundancy in the water delivery system at the three Sandy River crossings by burying conduits under the river.

Key Issues Addressed

- This action would remove the potential for flood-carried debris or water surges to damage or collapse existing trestles. The Sandy River has historically been the most problematic in terms of debris flow and landslide impacts to the conveyance system.

Ideas for Implementation

- Conduct an engineering feasibility study.
- Complete permitting, design and construction of the trestle.

General Comments

- This project is in the 5-year Capital Improvements Program, but funding is not guaranteed.

Coordinating Organization:	Water Bureau, Operations and Support Manager
Internal Partners:	none
External Partners:	River users groups
Level of Immediate Capability:	High, with funding
Estimated Timeline:	5-10 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-FL#11: Provide funding for and participate in the development of a flood inundation model for the managed floodplains and downtown seawall.

Key Issues Addressed

- The model would provide key information regarding impacts and inundation timing in the event of a Columbia River Levee or downtown sea wall breach at various flood stages. Information will be used to develop evacuation plans and assess impacts to critical facilities, develop action plans to protect critical facilities or remove them from harm's way.

Ideas for Implementation

- Hold presentations with interested partners to discuss the advantages to them for using the model. Incorporate other partners' requirements and adjust scope and budget.
- Determine funding sources and timeline.
- Construct model run.
- Review outputs with technical group to determine if the results meet the expected results.
- Write report on model findings.
- Develop action plan outline, scope of work and cost to implement.
- Fund and implement the project.

General Comments

- In September 2004, the Water Bureau developed a model presentation with scope of work and estimated budget.
- In the planning phase, the project needs commitment from other partners as well as funding.

Coordinating Organization:	Portland Office of Emergency Management Mitigation Program Coordinator
Internal Partners:	COP, Bureau of Environmental Services, Water Bureau
External Partners:	Multnomah County Drainage district
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Flood Mitigation Resources

County Resources

Multnomah County Emergency Management

Multnomah County Emergency Management is the central contact point for county resources prior to and during a disaster. Multnomah County Emergency Management is responsible for the coordination of resources within the unincorporated county and the cities of Gresham, Fairview, Troutdale and Wood Village. This also includes public health, county justice system and certain road networks. The City of Portland reports to Multnomah County in a disaster through the disaster declaration process and works to coordinate programs as much as feasibly possible.

Contact 1: Director, MCEM
Address: 501 SE Hawthorne Bldv, Room 600
Phone: (503) 988-4233
Fax: (503) 988-3093
Website: http://www.comultnomah.or.us/dbcs/emergnecy_mgmt

Regional Resources

Metro Regional Government

Metro is the directly elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington counties and 24 cities in the Portland metropolitan area. Chapter 5 of Metro's Regional Framework Plan addresses natural hazards. Metro's Natural Hazards Program is a service of the Growth Management Services Department's Data Resource Center. Their web pages relate to natural hazards that may impact the Portland metropolitan area. Their links provide information about natural hazards in the Portland metropolitan area and suggest tools for reducing potential damages before disaster strikes. Metro produced the *Regional Hazard Mitigation Policy and Planning Guide* in 1999 to assist local governments in planning for future natural hazard events.

Contact 1: Metro Regional Government
Address: 600 NE Grand Ave, Portland, OR 97232-2736
Phone: (503) 797-1839

Fax: (503) 797-1911
Website: http://www.metro.dst.or.us/metro/growth/gms.html
Email: 2040@metro-region.org

Contact 2: Metro Data Resource Center
Website: http://storefront.metro.dst.or.us/drc/nathaz/nathaz.cfm

Email: drc@metro.dst.or.us

REMG/REMTEC

Emergency Management professional from a 5 county urban area (Multnomah Co., Clackamas Co., Washington Co. ,Columbia Co. , Oregon and Clark Co. Washington and the cities and major agencies within the area concerned with emergency management) coordinate regional planning resources and resolve regional issues through the "hands on" technical committee which proposes and reports to the "public official level", REMG. Sub-committee research and create position papers on such issues as regional emergency transportation routes, debris removal, school safety planning.

State Resources

Department of Land Conservation and Development (DLCD)

DLCD administers the state's Land Use Planning Program. The program is based on 19 Statewide Planning Goals, including Goal 7, related to flood and other natural hazards. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance and conducts workshops, reviews local land use plan amendments, and works interactively with other agencies.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html
Oregon Floodplain Coordinator: (503) 373-0050 ext. 255

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

OEM administers FEMA's Hazard Mitigation Grant Program to provide post-disaster monies for acquisition, elevation, relocation, and demolition of structures located in the floodplain. OEM also administers FEMA's Flood Mitigation Assistance Program. This program provides assistance for NFIP- insured structures only. OEM also helps local jurisdictions to develop hazard mitigation plans. OEM is heavily involved in flood damage assessment and works mainly with disaster recovery and hazard mitigation programs. OEM provides training for local governments through workshops on recovery and mitigation. OEM also helps implement and manage federal disaster recovery programs.

Contact: Office of Emergency Management

Address: 595 Cottage Street NE, Salem, OR 97310
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: http://www.osp.state.or.us/oem/
OEM Hazard Mitigation Officer: (503) 378-2911 ext. 22247
Recovery and Mitigation Specialist: (503) 378-2911 ext. 22240

Oregon Department of Fish and Wildlife (ODFW)

ODFW's mission is to protect and enhance Oregon 's fish and wildlife and their habitats for use and enjoyment by present and future generations. ODFW regulates stream activity and engages in stream enhancement activities.

Contact: ODFW
Address: 2501 SW First Avenue, PO Box 59, Portland, OR 97207
Phone: (503) 872-5268
Website: http://www.dfw.state.or.us/
Email: Odfw.Info@state.or.us

Oregon Division of State Lands (DSL)

DSL is a regulatory agency responsible for administration of Oregon's Removal-Fill Law. This law is intended to protect, conserve, and make the best use of the state's water resources. It generally requires a permit from DSL to remove, fill, or alter more than 50 cubic yards of material within the bed or banks of state waters. Exceptions are in state scenic waterways and areas that are designated essential salmon habitat; in these areas, a permit is required for all in-stream activity regardless of volume.DSL and the US Army Corps of Engineers may issue these permits jointly.

Contact: Division of State Lands
Address: 775 Summer Street NE, Suite 100, Salem, OR 97301-1279
Phone: (503) 378-3805
Fax: (503) 378-4844
Website: http://statelands.dsl.state.or.us/
Assistant Director: (503) 378-3805, ext. 279
Western Region Manager: (503) 378-3805, ext. 244

Oregon Water Resources Department (WRD)

The WRD's mission is to serve the public by practicing and promoting wise long-term water management. The WRD provides services through 19 watermaster offices throughout the State. In addition, five regional offices provide services based on geographic regions. The Department's main administration is performed from the central office in Salem.

Contact: WRD
Address: 158 12th ST. NE, Salem, OR 97301-4172
Phone: (503) 378-8455
Website: http://www.wrd.state.or.us/index.shtml
http://www.co.washington.or.us/dptmts/wtr_mstr/wtr_mstr.htm

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission 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 Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov

To obtain FEMA publications:
Phone: (800) 480-2520

To obtain FEMA maps:
Contact: Map Service Center
Address: P.O. Box 1038, Jessup, Maryland 20794-1038
Phone: (800) 358-9616
Fax: (800) 358-9620

United States Geological Survey (USGS)

The USGS website provides current stream flow conditions at USGS gauging stations in Oregon and throughout the Pacific Northwest. The Oregon USGS office is responsible for water-resources investigations for Oregon and part of southern Washington. Their office cooperates with more than 40 local, state, and federal agencies in Oregon. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies.

Contact: USGS Oregon District Office
Address: 10615 S.E. Cherry Blossom Dr., Portland, OR 97216
Phone: (503) 251-3200
Fax: (503) 251-3470
Website: http://oregon.usgs.gov
Email: info-or@usgs.gov

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. The Bureau of Reclamation owns Scoggins Dam in Washington County and prepares emergency action plans for events at the dam.

Contact: Bureau of Reclamation, Pacific Northwest Region
Address: 1150 N. Curtis Road, Boise, ID 83706
Phone: (208) 378-5012
Website: http://www.pn.usbr.gov/contact/index.shtml

Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. In Oregon, joint permits may be issued with the Division of State Lands. The Corps is responsible for the protection and development of the nation's water resources including navigation, flood control, energy production through hydropower management, water supply storage, and recreation.

Contact: US Army Corps of Engineers-Portland District, Floodplain Information Branch
Address: P.O. Box 2946, Portland, OR 97208-2946
Phone: (503) 808-4874
Fax: (503) 808-4875
Website: http://www.nwp.usace.army.mil/

National Weather Service, Portland Bureau

The National Weather Service provides flood watches, warnings, and informational statements for rivers in Washington County. The majority of the County falls in the NWS "Willamette Tributary" region. The far western and northwestern portions of the County fall in the "SW Washington/NW Oregon" region. The NWS Portland office provides river level information online and by phone.

Contact: National Weather Service, Portland Bureau
Address: P.O. Box 2946, Portland, OR 97208-2946
Phone: (503) 261-9246 or (503) 261-9247
Fax: (503) 808-4875
Website: http://www.wrh.noaa.gov/Portland/public_hydro/

Washington County Soil and Water Conservation District (SWCD)

The SWCD works in partnership with the Natural Resource Conservation Service to promote soil and water conservation in Washington County. SWCD works with agricultural interests and landowners to provide information on natural resource conservation practices. The partnership blends individual member resources to offer technical and financial assistance in planning and applying natural resource conservation practices and systems. Areas of focus include: erosion management, wetlands preservation and restoration, resource inventories, watershed assessments, and conservation education.

Contact: Washington County Soil and Water Conservation District
Address: 1080 SW Baseline Building B, Suite B-2, Hillsboro, OR 97123
Phone: (503) 681-0953
Fax: (503) 640-1332
Website: http://www.swcd.net/

National Resources Conservation Service (NRCS), US Department of Agriculture (USDA)

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The

Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource or experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance for clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks. The measures taken under the EWP must be environmentally and economically sound and generally benefit more that one property.

Contact: USDA-NRCS
Address: 1080 SW Baseline, Bldg B, Suite B-2, Hillsboro 97123-3823
Phone: (503) 648-3174
Fax: (503) 640-1332
Website: http://www.swcd.net/

Additional Resources

The National Flood Insurance Program

The National Flood Insurance Program (NFIP) Website is a subsection of the Federal Emergency Management Agency (FEMA) site (http://www.fema.gov). The NFIP information is intended for both the general public and the many organizations and agencies participating in the program. It includes information about the NFIP and other flood disaster assistance available from the Federal Government. It also provides access to the newly revised NFIP booklet: *Answers to Questions about the National Flood Insurance Program*.

Contact: The National Flood Insurance Program
Phone: (888) FLOOD29 or (800) 427-5593
Website: http://www.fema.gov/nfip

The Association of State Floodplain Managers

The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.

Contact: The Association of State Floodplain Managers
Address: 2809 Fish Hatchery Road, Madison, WI 53713
Phone: (608) 274-0123
Website: http://www.floods.org

USGS Water Resources

This web page offers current US water news; extensive current (including real-time) and historical water data, numerous fact sheets and other publications, various technical resources, descriptions of ongoing water survey programs, local water information, and connections to other sources of water information.

Contact: USGS Water Resources
Phone: (503) 251-3200
Website: http://water.usgs.gov or http://water.usgs.gov/public/realtime.html
Email: info-or@usgs.gov

Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

Contact: Office of Hydrology, National Weather Service
Website: http://www.nws.noaa.gov/oh or http://www.nws.noaa.gov/oh/hic/

The Floodplain Management Association

The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues (with hypertext links if available), a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and, of course, an extensive catalog of Web links.

Contact: Floodplain Managers Association
Website: http://www.floodplain.org
Email: admin@floodplain.org

Northwest Regional Floodplain Managers Association (NORFMA)

This site is a resource for floodplains, fisheries, and river engineering information for the Northwest. This site provides technical information, articles, and Internet links in the field of floodplain and fisheries management.

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Contact: Northwest Regional Floodplain Managers Association
Website: http://www.norfma.org/

FEMA's List of Flood Related Websites

This site contains a long list of flood related Internet sites from "American Heritage Rivers" to "The Weather Channel" and is a good starting point for flood information on the Internet.

Contact: Federal Emergency Management Agency.
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/related.htm

Publications

Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides, including: flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can also write, call, or fax to obtain this document:

Contact: Natural Hazards Program Manager, Department of Land Conservation and Development
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

NFIP Community Rating System Coordinator's Manual. FEMA/NFIP. Indianapolis, IN.

This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system and the activities communities can pursue to earn points. These points then add up to the "rating" for the community, and flood insurance premium discounts are calculated based upon that "rating." The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.

Contact: NFIP Community Rating System
Phone: (800) 480-2520 or (317) 848-2898
Website: http://www.fema.gov/nfip/crs.htm

Floodplain Management: A Local Floodplain Administrator's Guide to the NFIP. FEMA-Region 10. Bothell, WA.

This document discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.

Contact: National Flood Insurance Program
Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/

Flood Hazard Mitigation Planning: A Community Guide, (June 1997), Massachusetts Department of Environmental Management.

This informative guide offers a ten-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

Contact: Massachusetts Flood Hazard Management Program
Phone: (617) 626-1250
Website: http://www.magnet.state.ma.us/dem/programs/mitigate

Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials, (February 1987), FEMA-116.

This guidebook offers a table of actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.

Contact: Federal Emergency Management Agency
Phone: (800) 480-2520
Website: http://www.fema.gov

Oregon Model Flood Damage Prevention Ordinance, (January 1999), FEMA/DLCD.

This is an example of how to write an ordinance that complies with NFIP/FEMA standards. Communities can simply adopt this ordinance, word for word, filling in the blanks specific to their community or jurisdiction.

Contact: Department of Land Conservation and Development
Phone: (503) 373-0050
Website: http://www.lcd.state.or.us/hazards.html

Flood Endnotes

[1] The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, June 2000).

[2] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[3] Ibid.

[4] Flood and Landslide Mitigation Work Group, Portland Bureau of Buildings. "Flood and Landslide Hazard Mitigation Plan: Based on lessons learned in February, 1996". October, 1996.

[5] Ibid.

[6] Federal Emergency Management Agency. (June 2003). http://www.fema.gov/fhm/fq_term.shtm#frequt4

[7] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 4.

[8] *Ibid.*

[9] *Ibid.*

[10] *Floodplain Management: a Local Administrator's Guide to the National Flood Insurance Program*. FEMA, Region 10.

[11] Ibid.

[12] February 1996 *Flooding and Landslides and Stream Erosion in the State of Oregon*. The Interagency Hazards Mitigation Team (1996) Oregon State Police – Office of Emergency Management.

[13] Ibid

[14] Ibid.

[15] Ibid.

[16] Ibid

[17] Ibid.

[18] Ibid.

[20] Portland Office of Emergency Management, "Portland, Oregon Hazard risk Assessment Using Hazus-MH." March, 2004.

[21] Portland Office of Emergency Management, "Portland, Oregon Hazard risk Assessment Using Hazus-MH." March, 2004.

[22] Protecting Floodplain Resources, Federal Interagency Task Force; Flood Plain Management, 2nd ed.; June 1996; page 11

[23] Title 3, Metro Regional Framework Plan, www.multnomah.lib.or.us/metro/growth/tfplan/funcsum.html (July 2001).

[24] Burby, R. (Ed.) *Cooperating with Nature* (1998) Washington D.C.: Joseph Henry Press.

[25] Burby, R. (Ed.) *Cooperating with Nature.* (1998) Washington D.C.: Joseph Henry Press.

[26] Ibid

[27] Kelley Creek Project Takes Off, Skendarian, Maggie; Johnson Creek Watershed Council, Within Your Reach, Volume XII,No. 2; Summer/Fall 2004

[28] Portland Floodplains 2003, past Present & Future, Living in a flood hazard area. What you can do. ; Environmental Services ; Dan Saltzman, Commissioner

[29] *Surface Water Management Framework*. (January 2001). Clean Water Services (formerly Unified Sewerage Agency.)

[30] Oregon Wetlands Joint Venture, Website: http://www.dfw.state.or.us/ODFwhtml/Wetlands/about.htm (May 2001).

[31] www.ci.Portland.or.us/departments/emergency/emergency_whatis.html

Section 8
Landslide
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Why are Landslides a threat to Portland?

Landslides are a serious geologic hazard that impacts nearly every U.S. state. Nationally, landslides cause 25 to 50 deaths each year and can pose a serious threat to human life.[1] The best estimates of the direct and indirect costs of landslide damage in the United States range between $1 billion to $2 billion annually.[2] In Oregon, a significant number of locations are at risk to dangerous landslides. Landslides have had an impact in Portland; they have created a number of problems in and around the City's hills. Although not all landslides result in private property damage, many impact transportation corridors, fuel and energy conduits, and communication facilities. [3]

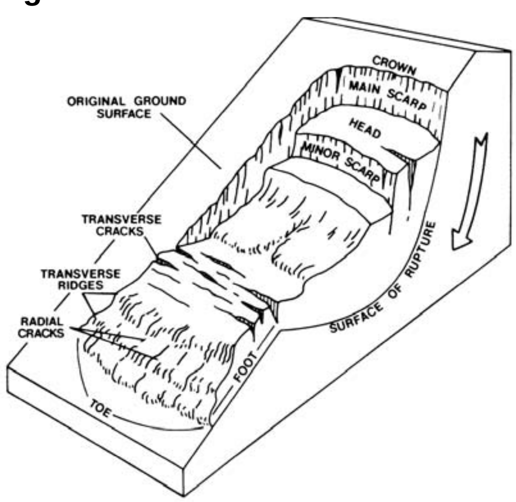
Landslides can be broken down into two categories: rapidly moving and slowly moving. Rapidly moving landslides (debris flows and earth flows) present the greatest risk to human life; persons living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide-related injuries and deaths in Oregon. A rapidly moving debris flow in Douglas County killed five people during the storms of 1996. Slow moving landslides can cause significant property damage but are less likely to result in serious human injuries. An example occurred in Kelso, Washington in 1998: 60 homes were destroyed by reactivated slow-moving landslides that caused $25 million in damages.

Landslide Characteristics

What is a Landslide?

Landslides are downhill or lateral movements of rock, debris, or soil mass. The size of a landslide usually depends on the geology and the triggering mechanism. Processes and conditions that can trigger slope failures include intense rainfall, earthquake shaking, volcanic eruption, and rapid snowmelt. Human alterations can also increase the potential for slope instability and can also trigger specific failures.[4] Landslides initiated by rainfall tend to be smaller, while those initiated by earthquakes may be very large.

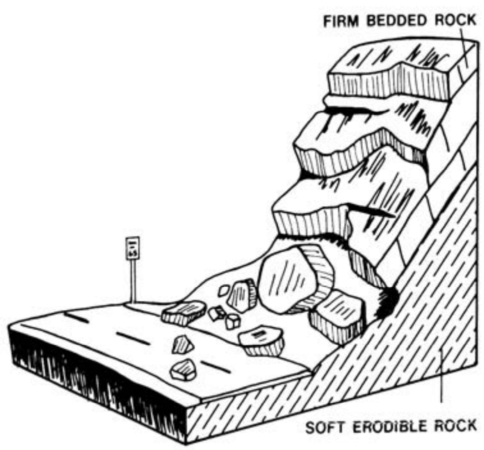
Figure 8-1. Rotational Slide



Slides associated with volcanic eruptions are typically large and can include as much as one cubic mile of material. Slides caused by erosion occur when ditches or culverts beneath hillside roads become blocked with debris. If the ditches are blocked, run-off from slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil and will, and in some cases, cause a slide. Usually the slides are small (100 – 1,000 cubic yards), but some have been known to be quite large.

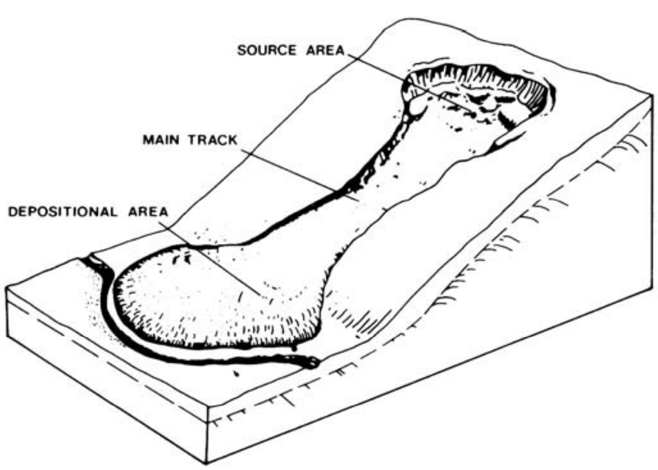
Landslides can vary greatly in the volume of rock and soil involved; the length, width, and depth of the area affected; the frequency of occurrence; and the speed of movement. Some of the characteristics that determine the type of landslide are the slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names depending on the type of failure and their composition and characteristics. Types of landslides include, but are not limited to, slides, rock falls, and flows.

Figure 8-2. Rock Fall



Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCD

Figure 8-3. Earthflow



Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCD

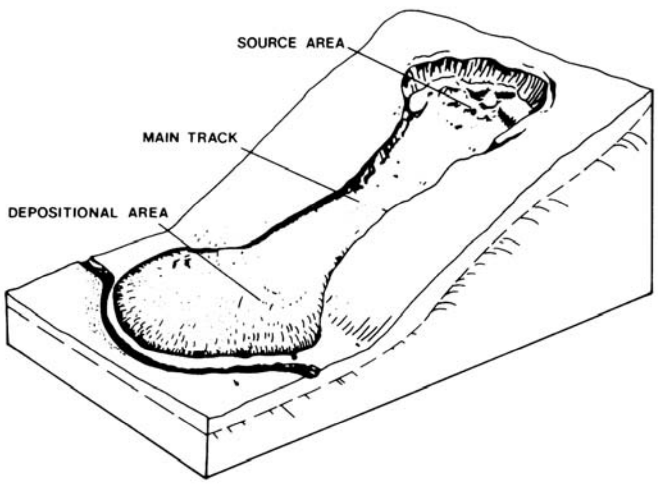
Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface and translational slides that occur along flat surfaces. These slides are generally slow moving and can be deep. Slumps are small, rotational slides that are generally shallow (See Figure 8-1). Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage but are far less likely to result in serious injuries than rapidly moving landslides.[5]

Rock falls (see Figure 8-22) occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations (such as those along highways) where the road has been cut through bedrock can cause falls. These slides are fast moving and materials free-fall or bounce down the slope. The total volume of material involved is generally small, but individual boulders or blocks of rock can be large and can cause significant damage.

Flows (see Figure 8-3) are landslides in which soil and rock breaks up and flows like a plastic or liquid. They are often categorized as debris flows or earth flows. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring, soils from the slope along its path. Debris flows are typically fast-moving and also tend to increase in volume as they scour out the channel.[6] Debris flows often occur during heavy rainfall, can move rapidly for large distances, and generally occur in stream valleys and on the fans at the edges of valleys. One dramatic example of a debris flow in Oregon is the Dodson debris flow that occurred in 1996. This debris flow started high on the Columbia Gorge cliffs and traveled far down steep canyons to form debris fans at Dodson.[7] In fact, I-84 was closed for several days as a result of the flow. As a landslide slows down, debris material falls out and is deposited. Debris fans are the depositional areas of debris flows. They are typically found at the base of steep hill slopes and at mouths of steep canyons.[8] Earth flows are slower landslides occurring on saturated slopes with weak soils. Earthquakes often trigger earth flows.

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt but earthquakes, volcanic activity, and excavations might also trigger them. Certain geologic formations are more susceptible to landslides than others. Human activities, including development on or near steep slopes, can increase susceptibility to landslide events. In general, landslides on steep slopes are typically more dangerous because they can occur with little warning and their movements can be very rapid.

What locations are at risk from landslides and debris flows?



Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills;
- Steep road-cuts or excavations into steep slopes;
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
- Steep areas where surface runoff is channeled, such as below ground in culverts, V-shaped valleys, canyon bottoms, and steep stream channels;
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons, large boulders (2 to 20 feet diameter) perched on soil near fans or adjacent to creeks; and
- Occurrences of logjams in streams.[1]

Landslide Conditions

Although landslides are a natural geologic occurrence, their severity and their impacts on people can be increased by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can also decrease a slope's stability by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include excavation, drainage and groundwater alterations, and changes in vegetation.[9]

Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. Steep, concave-shaped slopes with larger drainage areas appear to be more susceptible to landslides than other landforms. Rainfall-initiated landslides tend to be smaller but occur frequently while earthquake-induced landslides may be very large but are less frequent. Landslides are particularly common along stream banks, reservoir shorelines, large lakes, and the seacoasts. The removal of material supporting the shoreline by currents and waves or undercutting during construction at the base of a slope produces countless small slides each year. Seismic tremors can also trigger landslides on slopes historically known to have landslide movement. Earthquakes can cause additional failure (lateral spreading) on gentle slopes above steep streams and riverbanks. Landslides associated with volcanic eruptions can include volumes of more than one cubic mile of material. All soil types can be affected by conditions that trigger landslides.

Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading of these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. Additionally, the added weight of fill placed on slopes can result in an increased landslide hazard. Small landslides can be fairly common along roads in either the road cut or the road fill. Landslides that occur below new construction sites are often indicators of impacts stemming from excavation. A slope, when cut, is undermined. Without support, the soil/earth material may collapse and move.

Drainage and Groundwater Alterations

Water (either storm water or a natural drainage) flowing through or over the ground can trigger landslides. For proper drainage, water must either infiltrate into the ground, drain into a mechanized system, or run off to another area. Drainage can be affected naturally by the geology and topography of an area or by man-made activities such as excavation and grading (described above). Any activity that increases the amount of water flowing onto slopes can increase the potential of landslides. Channels, streams, ponding, and erosion on slopes are all indicators of potential slope problems. They can also be created by man-made activities.

Ineffective storm water management—including water retention facilities that direct water onto slopes—and excess runoff can cause erosion and generate landslides. Development that results in an increase in the amount of impervious surfaces impairs the land's ability to absorb water and may redirect the run-off into other areas. Unabsorbed water concentrates and gains speed and volume. As a result, more landslides could occur. Broken or leaking water or sewer lines can also be problematic as well as lawn irrigation and minor alterations to small streams in landslide prone locations. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.[10]

Changes in Vegetation

Vegetation is an important factor when discussing landslide trigger mechanisms. Vegetation plays a complex role in maintaining slope stability. Removing vegetation from very steep slopes can increase landslide hazards. The *Storm Impacts Study* conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of 10 years after timber harvesting.[11] Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may increase the severity of impacts from debris flows.[12] Woody debris in streams provides excellent habitat and other benefits.

Development

Development sites with the greatest risk from landslides are those located against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. While home development sites at the base of slopes do not cause landslides, they do put residents and property at risk of landslide impacts. The simplest mitigation measure for this situation is to locate the home out of the impact area or construct debris flow diversions for homes at risk (as diversions simply redirect the damaging material to another location, they can exacerbate the problem.) Three development-related actions that can put people at risk include:[13]

1. **Creating Steeper Slopes**. Excavation practices, sometimes aggravated by drainage, can reduce the stability of otherwise stable slopes. These failures commonly affect only a small number of

homes. Without these excavation practices, there is little risk of landslides in areas not prone to landslide movement.

2. **Development on or Adjacent to Existing Landslides**. Existing landslides are generally at risk of future movement regardless of excavation practices. Excavation and drainage practices can further increase risk of landslides. In many cases, there are no development practices that can completely assure stability. Homeowners and communities in these situations accept some risk of future landslide movement.

3. **Development on Gentle Slopes**. Development on gentle slopes can be subject to landslides that begin a long distance from the development.

The extent to which new residents, long-time homeowners, and developers are informed about the risks associated with landslides is a key factor in landslide location and occurrence. Developers who are uninformed about geological materials and processes may contribute to conditions that trigger landslide activity or increase susceptibility to landslide hazards.[14]

Community Landslide Issues

Landslides can affect utility services, transportation systems, and critical lifelines. In addition to the immediate damages and loss of service that communities may suffer, the disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities including potable water, wastewater, telecommunications, natural gas, and electricity are all essential to the community. Loss of electricity has the most widespread impact on the whole community and can even affect other utilities. For example, even landslide movements as small as an inch or two increase the potential for natural gas pipelines to break.[15]

Roads

Roads are subject to closure during landslide events. Since many Portland residents are dependent on roads for commuting to work, delays and detours generated by a landslide event will likely have an economic impact on residents and businesses. To evaluate the benefit of landslide mitigation activities for roads, the City should consider the number of vehicle trips per day over the identified section of road, the increase in travel time the detour around a road closure will cause, and whether the road is used for commercial traffic or emergency access.[16] Bridges are a critical part of road connections that may suffer extensive damage in landslide events.

Landslide Hazard Assessment

Hazard Identification

Hazard identification, the first phase of a hazard assessment, involves an estimation of the geographic extent of the hazard, its intensity, and its probability of occurrence.[17] This process usually produces a hazard map. Hazard maps can provide detailed information in a clear format and can assist in policy and land use decisions. Landslides in the Portland area occur primarily in four areas.[18] Severe weather events produced more than 700 landslides throughout Portland in 1996. More than half of the slides occurred in the Portland West Hills where weak, silt-rich soils become easily saturated and fail, resulting in earthflows. A second area of concern includes the steep slopes along the Willamette River such as Oaks Bottom and Swan Island. These landslides tend to be thin but numerous, and many are human-caused when garbage and yard debris are dumped over the edges of the slopes. In southeast Portland, reactivation of ancient landslides is a large problem on deposits of the fine-grained Troutdale Formation sediments. The fourth landslide prone area includes the steep creeks along the Columbia and north Willamette Rivers where debris flows occur. Examples are Dodson in the Columbia Gorge and Germantown Road in northwest Portland.

Landslides are common in Portland because the area has steep slopes, abundant precipitation, and in some areas, weak soils. Portland's two most famous landslides have occurred in the West Hills and were reactivated by construction activity. The Washington Park Landslide was reactivated in 1895 when the City built two new reservoirs. This phenomenal landslide has since slowed to four centimeters per year. The Children's Museum, World Forestry Center, and the Oregon Zoo also are built on a large landslide that was reactivated in 1957 by the widening of Highway 26 which also reactivated the slide area; this landslide is now stabilized.

While recent landslide events in Portland have not been rapidly moving debris flows, the potential for their occurrence exists. However, debris flows have caused most of the recent landslide-related injuries and deaths in Oregon.[19] They have been the catalyst for the creation of state law and the impetus for large mapping project undertaken by the Oregon Department of Forestry (ODF) and the Oregon Department of Geology and Mineral Industries (DOGAMI).

Metro and Portland State University have also generated a map documenting Landslide Locations (1996-1997) and Zones of High Landslide Potential in the Portland Metropolitan Region. The Portland study area has been subject to major and minor landslides. Hundreds of landslides (as many as 700) were recorded during the February and December 1996 flood events. In general, landslide recurrence intervals are highly variable. Some large landslides are continuous and slow moving. Others are triggered by acute conditions and occur sporadically.

Large-scale natural events typically occur infrequently while small-scale natural events occur more frequently. Frequency varies depending on the location of an event as well as the surrounding geology, climate, hydrology, and vegetation. Given the complex variables involved in triggering landslide events, it is unrealistic to expect to predict a specific date and time when that event will occur. Though these factors may suggest the likelihood of future events, even this likelihood will remain largely a function of climate, rainfall, and soil conditions.[20] Without specific interventions, landslide events are likely to continue to occur at rates that are similar to those experienced in the past.

Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through landslide identification with an inventory of the existing development exposed to landslide hazards. Vulnerability assessments help predict how different types of property and population groups will be affected by a hazard.[21] The optimal method for doing this analysis at the county or jurisdiction level is to use parcel-specific assessment data on land use and structures.[22] Data that includes known landslide and debris flow locations can be used to assess the population and total value of property at risk from future landslide occurrences.

This plan uses the results of a pilot study conducted for the Hazard US – Multi-Hazard software program. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates; these methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards and locations. Landslide data from the HAZUS-MH software package was supplemented with local data for critical facilities and hazard areas. Inventory data were superimposed over the hazard areas to enable GIS queries to estimate the quantity of assets at risk (population, structures, critical facilities, etc.)

Approximately 66,400 people (28,800 households) are potentially exposed to landslides in the Portland area. Special needs populations (the elderly and low income populations) are not disproportionately impacted. More than $8.8 billion dollars in commercial and residential property is exposed[1] to the impact from landslides. Some critical facilities are exposed to landslides; 46% of potable water treatment plants, 30% of hospitals, and 18% of fire stations in Portland are exposed.

More detailed results of the HAZUS-MH study for landslides follows. They provide an overall summary description of the jurisdiction's vulnerability to the hazards and address the impacts of the hazards on the jurisdiction. Additionally, they identify the extent of the hazard and document previous occurrences of landslide events in the Portland metropolitan area. A complete risk assessment for landslides is included in *Risk Assessment Pilot Project Results for DMA 2000 Plan*.

[1] Estimated exposure to a hazard is different than an estimated loss. However, when data were not adequate to estimate loss, exposure (or at-risk inventory) was estimated as a first step to evaluating the risk.

Multnomah County Hazard Analysis		Summary of Risk Factors	
Severity Score	High	**Period of occurrence:**	Fall, Winter, and Spring
History (2)	20	**Probability of event(s):**	Occasional
Vulnerability (5)	50	**Warning time:**	Hours to days
Maximum Threat (10)	100	**Major contributor(s):**	Topographic characteristics, terrain, and water saturation
Probability (7)	70	**Cause injuries?**	Yes, and risk of death
Total Score	240	**Potential facilities shutdown?**	30 days or more

Table 8-1. Historic Landslides for Portland (1996-2002) (DOGAMI 2002b)

Historic Landslide Type	Number of Occurrences in the City of Portland
Debris Flow	13
Debris Slide	56
Earth Flow	168
Earth Flow / Debris Flow	3
Earth Flow / Rockfall	1
Rockfall	11
Rockfall / Earth Flow	2
Rockfall / Mudflow	1
Slump	49
Slump – Earth Flow	89
Slump – Earth Flow / Debris	7
Slump – Earth Flow / Rockfall	1
Slump / Debris Flow	1
Translational (horizontal movement)	1

LANDSLIDE HAZARD PROFILE

Background and Local Conditions

Landslides are part of the natural, on-going process of smoothing topographical high points. Landslides occur when gravitational forces associated with slide mass exceed the resistance produced by the material holding that mass in place. Landslides are downhill or lateral movements of soil and rock that can include rock falls, slides, slumps, lateral spreading, earth and mudflows, and settlement. Landslides can result from ground saturation after intense or prolonged rainfall, erosion associated with surface water runoff, improper or poorly designed drainage systems or slopes, vegetation removal by land clearing, and shocks or vibrations from earthquakes. After wildland fires, landslides are more likely because resistance forces produced by roots associated with trees, shrubs, and grass are reduced. Many hillsides in the Portland/Vancouver PMSA are unstable and vulnerable to landslides and mudflows. Landslides associated with rainfall tend to be relatively smaller; earthquake-induced landslides may be much larger. The pilot project focuses on rain-induced landslides.

Historic Frequency and Probability of Occurrence

The Portland study area has been subject to major and minor landslides. Hundreds of landslides (as many as 800) were recorded during the February and December 1996 flood events. In general, landslide recurrence intervals are highly variable. Some large landslides are continuous and slow moving. Others are triggered by acute conditions and occur sporadically. Table 8-1 lists the types and number of landslides in the City of Portland from 1996 to 2002.

Severity

Existing mitigation and emergency directives for this risk in the Portland area evidence the high risk of this hazard. For example, the State of Oregon has a Debris Avalanche Action Plan that directs state agencies to seek solutions to reduce the loss of life from debris flow and landslides. The Multnomah County Hazard Analysis considered this hazard a high risk. Similarly, this hazard is considered a severe risk based on the Multnomah County hazard analysis and data reviewed by the risk assessment team as part of this project.

Historic Losses and Impacts

Hundreds of landslides occurred during the February and December 1996 flood events and accounted for 20 percent ($13 million) of the $64 million in damages associated with the February 1996 storms. During those events, 17 homes were completely destroyed and 64 were badly damaged due to landslides (Oregon OEM 2000). During the 1996 landslides, eight deaths were recorded statewide. During a March 1972 landslide, three motorists were injured in a mud and rockslide on Interstate 5 near Portland. Losses for the State of Oregon generally average less than one or two lives per year and between $1 million and $10 million annually (Oregon Department of Land Conservation and Development [LCD] 2003).

Designated Hazard Areas

Although the total area of land subject to a high potential for landslides is small, the consequences are serious when structures, roads, or lifeline systems are affected. Many hillsides in the study area are unstable and subject to slides and flows. Landslide losses most likely will increase because city-wide development is occurring on and near increasingly less stable land.

According to a study of the February 1996 storm, changes to slopes through cutting or filling increased the risk of landslides in 76 percent for the inventoried landslide areas in the Metro region (Burns and others 1998). The study also found that there are four dominant landslide areas: the West Hills Silt Soil Province; the debris flows in the Valley Bottoms Province along the Columbia River; the steep bluffs along Rivers Province on the Willamette and Clackamas Rivers, and the fine-grained Troutdale Formation Province (which was not analyzed for this pilot study). It is important to note that hazard maps only provide a general indication of landslide hazards. Figure 3-4 shows the dominant landslide hazard areas in the Portland study area as well as the locations of the 1996 landslides.

Mitigation Plan Goals and Public Priorities

The mitigation plan goals and action items are derived from review of regional and national natural hazard mitigation plans and planning literature and guidance from the Portland Natural Hazards Mitigation Plan Steering Committee. The goals for the City of Portland Natural Hazards Mitigation Plan are broad based to include all of the identified hazards addressed in the plan. Goals for the mitigation plan address five categories:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property, and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resilient economy.
5. Build and support the capacity and commitment to continuously reduce vulnerability to hazards.

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

Bureau of Development Services (BDS)

BDS has geotechnical engineering staff to review all building permits for new development in landslide-prone areas. As part of these building permit reviews, BDS can require geotechnical engineering or engineering geology reports to address landslide concerns. In addition, the Zoning Code requires geotechnical engineering/engineering geology reports to be submitted for land use review applications in some situations. In a land use review application, the land use planning staff and the geotechnical staff review the submitted reports to ensure that applicable approval criteria are met. Some of the relevant city code provisions include:

- Title 24, Chapter 70, covering grading and excavation work.
- Title 10, Erosion and Sediment Control, review erosion control plans for all development requiring a permit where ground is disturbed and inspect all of these sites for compliance.
- Title 33, Chapter 632 on Sites in Potential Landslide Hazard Areas. Potential Landslide Hazard Areas are shown on the city's Potential Landslide Hazard Area Map. This zoning code applies

to properties proposed for land division. BDS reviews geotechnical engineering and engineering geology reports submitted by applicants. The approval criterion ensures that lots are created where development can occur with the least likelihood of causing landslides on the site or adjacent properties.

- Title 33, Chapter 430, Environmental Zones. This chapter regulates development within environmental zones, which often include steep slopes. There are two types of environmental zones, the Environmental Protection Overlay Zone and the Environmental Conservation Overlay Zone. In the protection zones, new development is allowed only when there is a public need or benefit. Conservation zones allow only limited urban development. Tree removal requires a permit and replanting of the site is required to mitigate for impacts.

Bureau of Planning

The City of Portland Comprehensive Plan includes policies that relate to landslide hazards both implicitly and explicitly. These include:

- 8.13 Natural Hazards – Control the density of development in areas of natural hazards consistent with the provisions of the City's Building Code, Chapter 70, the Floodplain Ordinance and the Subdivision Ordinance.
- 8.16 Uplands Protection – conserve significant upland areas and values related to wildlife, aesthetics and visual appearance, views and sites, slope protection, and groundwater recharge. Encourage increased vegetation, additional wildlife habitat areas, and expansion and enhancement of undeveloped spaces in a manner beneficial to the city and compatible with the character of surrounding urban development.
- 8.16 B. Slope Protection and Drainage – Protect slope from erosion and landslides through the retention and use of vegetation, building code regulations, erosion control measures during construction, and other means.

Capital Improvement Plan

The City of Portland's Capital Improvements Program (CIP) is a dynamic document that is reviewed by a CIP development team who prioritizes projects to be scheduled into a 5-year citywide projected budget. Each bureau submits their projects after reviewing them through weighted criteria. Some landslide mitigation projects might be considered as part of the capital improvement plan.

Portland Office of Transportation (PDOT)

PDOT's importance in mitigation has been very under estimated. They coordinate the clearance of roads after a disaster, keep the street network free from cracks or sluffs, and maintain knowledge of the below and above surface infrastructure. If areas of greatest risk are identified prior to a disaster, mitigation efforts can be planned or response routes changed to accommodate the lack of thoroughfare due to the landslide effects.

The following programs are some of PDOT's projects that keep roads open and businesses operating.

- PDOT has a pavement maintenance system that tracks the condition of the city streets. In areas of potential landslides, PDOT monitors for cracks in the road. For example, Willamette Blvd had significant cracks. PDOT prioritized the road and did a grinding and asphalt overlay this year to seal the cracks to prevent water from infiltrating the top of the slope.
- PDOT uses the emergency routes identified in either the Snow and Ice Plan or the Seismic Response Plan. These pre-identified routes help to ensure that routes are restored to service.
- PDOT will put up barriers in areas that are prone to rock slides or debris falling. If a slope is considered to be a threat, the bureau may contact a geotech engineer for additional analysis, and a city engineer will make a final determination. Survey crews may set markers to evaluate whether a slope is stable. The area in question is then periodically measured. Once a site is identified at being at risk for a landslide, the bureau will consider a number of physical options including gabion baskets or rock screening to stabilize the slope.
- The Bureau's storeroom keeps several landslide mitigation products in stock including geotech fabric or visqueen. The fabric can be stapled onto an unstable slope to keep additional material from sliding. The fabric may contain seeds that would then serve to revegetate the hillside.
- The bureau tracks weather predictions annually to better prepare for potential events.
- Drainage and street design standards aim to minimize impacts of run off and channel water away from the top of slopes.

Bureau of Environmental Services (BES)

BES's work for ecosystem restoration and stabilization has many similarities to natural hazard mitigation. The natural systems are what make Portland and the region livable. With the increased development in the Portland Metro area, our natural habitat is at risk and being depleted. Ecological protection and mitigative actions go hand in hand to strengthen the endangered terrain, habitat, and wildlife. The following are actions taken by BES to secure this asset:

- Standards are being developed for the pump stations. Some sewers have been moved within the West Hills to avoid landslide problems. Developers are currently required to keep new sewers out of inaccessible areas even if they must build a pump station to make the system work.

- The Downspout Disconnection Program targets homes in the eastside Combined Sewer Overflow (CSO) area, assesses each home individually according to safety standards, and exempts pockets of properties within the target area due to steep slopes and other concerns. A change in the standard of sump installation has extended the placement of the sump from 200 ft from the edge of the slope to 500 feet from the edge of the slope; sometimes a pump is not installed at all.
- Watershed planning projects have been completed which revegetate slopes and repair stream banks. Onsite stormwater management has reduced overflow to creeks. BES has erosion control requirements and an erosion control inspector for CIP projects. The Stormwater Section of Operations and Maintenance has done 12-18 pilot projects with ditches along steep roadways that have included construction of swales with inlets to carry water to a safe location, use of perforated pipe to accept and carry excess water, and creation of swales with paving up the embankment. The purpose is to prevent erosion at the toe of the slope, allow less water to collect in ditches along the road, and prevent destabilization of the slopes.
- The third version of the Stormwater Management Manual has been completed. It requires developers of sites in the West Hills and deep SE hills (SE 162nd) to assess slope using a topographic map and submit a geotechnical report for any new development. Staff reviews the proposals. The Manual contains descriptions of stormwater facility types for use by all new development projects. The facilities have specific design standards that include % slope and soil type. In areas prone to slides, BES has specifications for pipe materials and joints.
- The Watershed Revegetation Program is managing more than a thousand acres. Projects have included stabilizing the slope along N Willamette Blvd where two major fires occurred in the past few years.
- Emergency permitting procedures have been developed for repairs and mapping has been developed of landslide hazard areas.

Landslide Coordination Committee

The Landslide Coordination Committee was established after the 1996 landslides. It consists of staff representing the Bureau of Development Services, the Portland Office of Transportation, the Bureau of Maintenance, the Bureau of Environmental Services, the Parks and Recreation Bureau, the Water Bureau, and Risk Management. It meets primarily in the fall through spring months to review landslide occurrences within the City, communicate details of the landslide event, and coordinate review, permitting, and mitigation activities. The group has developed a procedure for quickly alerting members by email with pertinent information on a landslide occurrence so that each bureau can determine actions that need to be taken. The group has also developed a procedure for processing landslide repair projects in environmental zones.

Water Bureau

The Water Bureau is an active partner in landslide mitigation. Since a 1996 report indicated that the Water Bureau should "Continue to mitigate landslide hazards to the conduits from Bull Run" the following mitigation projects have been conducted:

- Horizontal drains were installed at the Ditch Camp slide to mitigate ground movement. Since installation of the drain ground movement has nearly stopped.
- Two intertie facilities have been constructed (Larsons 2001, Hudson 2004). These intertie facilities allow the isolation of a section of conduit in case of damage by a landslide.
- The approach channel on Dam #2 was lined with a geomembrane to reduce leakage into the teardrop area. The teardrop area was formed after a landslide in 1995 severely damaged the conduits.
- The landslide in the teardrop area was repaired with a rock buttress. Damaged conduits were repaired and the bridge over the Bull Run River was rebuilt.
- The slide at Bowman's bridge was repaired with a rock fill buttress.
- Ten (10) vibrating wire piezometers have been installed to monitor the groundwater levels in the teardrop area.
- A landslide assessment was completed along the entire conduit corridor (2003). Additional monitoring equipment has been installed in the areas identified as having the highest landslide hazards (13 inclinometers and 6 piezometers).
- Over 50 inclinometers are installed throughout the Water Bureau system. These are monitored on a consistent basis.
- Six piezometers were installed in the Washington Park landslide area to monitor groundwater levels in the slide mass (2004).
- An annual assessment report of the landslide conditions in the system is completed.

Portland Office of Emergency Management (POEM)

Emergency Operation Center (EOC)

The Emergency Operations Center is an established facility from which command and control of events needing multi-disciplinary coordination occurs. The EOC is located out of the flood plain and away from landslide or earthquake fault line territory; although some think proximity to major transportation routes poses a risk, others deem it an advantage for accessibility.

State Programs

Statewide Planning Goal 7: Areas Subject to Natural Hazards

Goal 7 is one of the Statewide Planning goals established by the Oregon Legislature in 1973 to guide land use patterns throughout the State. Goal 7 requires local agencies to inventory hazard areas and adopt comprehensive plans that reduce risk to people and property from natural hazards.

Debris Avalanche Action Plan

Governor John Kitzhaber met with directors of state agencies after the 1996 storm events to develop a plan to address rapidly moving landslides (also known as debris flows). The plan, the Debris Avalanche Action Plan, was issued on March 4, 1997.

The governor's plan included specific recommendations that should be taken by state and local governments. For example, the plan directed LCDC to review Goal 7 and directed DOGAMI to support legislation requiring full disclosure of hazards on property on all property transactions. The plan directed DOGAMI to examine the conflict between resource (farm land and forest land) and residential use of steeply sloped land. In addition, Senate Bills (SB) 1211 and 12 prescribed work for DOGAMI. The Oregon Department of Forestry (ODF) and Oregon State University (OSU) were jointly directed by the plan to examine factors that might contribute to debris flows. In response, they specifically mapped rainfall intensity in Western Oregon.[23]

Senate Bill 1211

SB 1211, approved in 1997, required the establishment of a task force, the Joint Interim Task Force on Landslides and Public Safety; the Task Force was created as a direct response to the 1996 storm events that impacted all of Oregon. The Interim Task Force identified five areas to amend state statutes, and recommended that LCDC make changes to Goal 7 during the 1999-2001 biennium. Also of interest is the direction by the Interim Task Force to change the disclosure provisions of the statutes. Oregon Revised Statute (ORS) 105.465 describes a property seller's responsibility to disclose landslide hazard information to buyers.[24]

The provisions of SB 1211 include:

- Allowing the Oregon State Forester to prevent timber harvest or road construction in or below areas identified by the Department of Forestry as "high risk sites" and where homes or highways are in precarious locations.
- Allowing road officials to close roads that pose risk to human life because of landslides.

- Requiring State agencies and local officials to develop and distribute information about hazards of construction on sites that are vulnerable to landslides.
- Establishing a 10-member Task Force on Landslides and Public Safety to assess the problem and develop a solution. It includes legislators and representatives from state natural resource agencies, boards of commissions, local government, and the public.

Oregon State Senate Bill 12/Debris Flow Mapping

More changes to existing regulations occurred in 1999 when the Oregon legislature approved SB 12 (codified in ORS 195.250-195.275 and ORS 527.630-527.710). SB 12 directed DOGAMI to establish maps of hazard areas, termed “further review areas,” in which jurisdictions would apply more restrictive development ordinances to protect life and property. The DOGAMI report that corresponds to the maps of hazard areas described the most hazardous areas as mountainous terrain, particularly drainage channels and depositional fans. The DOGAMI report explicitly states that one goal of the State of Oregon is to protect citizens’ lives and property. The DOGAMI report also describes that the map can “help to assess the risk and prioritize risk-reduction activities.” According to SB 12, rapidly moving landslides present the greatest risk to people in those areas and mitigation for these types of landslides is limited. One of the most common types of rapidly moving landslides, a debris flow, is the primary focus of SB 12. DOGAMI attempted to characterize the geographic extent and location of rapidly moving landslides; the DOGAMI Map includes the estimated runout of a debris flow path. [25]

The Oregon legislature passed HB 3375 and it became effective on January 1, 2004. It eliminated portions of the state statute that were passed as SB 12. Specifically, HB 3375 eliminated mitigation measures (ORS 195.263), development rights and recording (ORS 195.266 and 195.270), and the moratorium on development (ORS 195.275).

Oregon Department of Forestry (ODF)

The Oregon Department of Forestry has developed a preliminary overview of debris flows (rapidly moving landslides) prone areas in western Oregon. Their debris flow maps include the general locations subject to naturally occurring debris flows and include the initiation sites and locations along the paths of potential debris flows (confined stream channels and locations below steep slopes). These maps do not consider the effects of management-related slope alterations (drainage and excavation) that can increase the hazard, nor do they consider very large landslides that could possibly be triggered by volcanic or earthquake activity. Areas identified in these maps are not to be considered “further review areas” as defined by Senate Bill 12 (1999).[26] In April 2000, the Board of Forestry adopted six guiding principles to guide development of the forest practice rules to meet the SB 12 requirements.

Information used to develop the ODF Debris Flow maps include:

- Based on US Geological Survey Data, digital elevation models at 30-meter resolution were used to derive slope steepness and then to develop polygons for assigned hazards. Note that actual slopes are steeper than these digitally elevated models.
- Mapped locations of Tyee soil formation and similar sedimentary geologic units.
- Oregon Department of Forestry *Storm Impacts and Landslides of 1996* study; debris flow initiation and path location data.
- Stream channel confinement near steep hill slopes based on US Geological Survey Digital Raster Graphics.
- Historical information on debris flow occurrence in western Oregon (from Oregon Department of Forestry, US Forest Service, DOGAMI, Bureau of Land Management, and the Oregon Department of Transportation).
- Fan-shaped land formations below long, steep slopes.
- Areas of highest intensity precipitation do not appear to be correlated with known areas of high and extreme debris flow hazard, so precipitation intensity was *not* used to develop risk (hazard) ratings.[27]

Prohibition of Certain Forest Operations

As part of the requirements of Senate Bill 12, ODF is currently deferring certain forest operations on landslide-prone sites above homes and roads. The Department's policy is that timber harvesting or road construction operations will be prohibited on land where landslides or debris flows pose a significant threat to human safety. Exceptions for salvage or other purposes are considered on an individual basis but have been infrequent in keeping with the goal of preventing significant risks to human life.[28]

Debris Flow Warning System

The debris flow warning system was initiated in 1997 and involves collaboration between ODF, DOGAMI, the Oregon Department of Transportation (ODOT), local law enforcement, NOAA Weather Radio, and local media.

ODF meteorologists are responsible for forecasting storms that may trigger debris flows. Information is broadcast over NOAA Weather Radio and on the Law Enforcement Data System. DOGAMI provides additional information on debris flows through the media. ODOT provides warning signs to motorists in landslide-prone areas during high-risk periods.[29]

Landslide Brochure

With the goal of reaching homeowners, DOGAMI developed a landslide public outreach brochure, "Landslides in Oregon: Protect Yourself and Your Property" in cooperation with several other state agencies. Forty thousand copies were printed in November 1997 and were distributed widely to building codes officials, county planners, local emergency managers, field offices of natural resource agencies, banks, real estate companies, insurance companies, and other outlets. The brochures are available from DOGAMI, OEM, ODF, and the Department of Land Conservation and Development (DLCD).[30]

Oregon State Building Code Standards

The Oregon Building Codes Division adopts statewide standards for building construction that are administered by state and local municipalities throughout Oregon. The One- and Two-Family Dwelling Code and the Structural Specialty Code contain provisions for lot grading and site preparation for the construction of building foundations.

Both codes contain requirements for cut, fill, and sloping of the lot in relationship to the location of the foundation. There are also building setback requirements from the top and bottom of slopes. The codes specify foundation design requirements to accommodate the type of soils, the soil bearing pressure, and the compaction and lateral loads from soil and ground water on sloped lots. The building official has the authority to require a soils analysis for any project where it appears the site conditions do not meet the requirements of the code or can require that special design considerations be taken. ORS 455.447 and the Structural Code require a seismic site hazard report for projects that include essential facilities such as hospitals, fire and police stations, emergency response facilities, and special occupancy structures such as large schools and prisons.[31]

Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that the City of Portland can undertake to reduce risk and prevent loss from landslide events. Each action item includes an estimate of the timeline for implementation. Short-term action items (ST) are activities that state agencies may implement with existing resources and authorities. Long-term action items (LT) require new or additional resources and/or authorities.

Short-term Action Items

ST-LS#1: Continue to maintain and improve internal City communications to facilitate coordination of landslide mitigation activities.

Key Issues Addressed

- Maintain and improve internal procedures that inform responsible staff in affected bureaus of responsibilities associated with landslide mitigation.
- Study and consider expanding the current scope of activities of the landslide coordination committee to develop and recommend policies and procedures that better prevent and mitigate landslide events.

Ideas for Implementation

- Add to the existing landslide coordination committee meeting discussions the possibility of additional areas of discussion related to landslide hazards. Gain these additional areas of discussion by considering input and participation by other key staff members and outside interested parties with the intent of landslide event prevention and improving internal procedures. Items to consider:
- Guidance and technical support on design of development on potentially hazardous sites.
- Information exchange with potentially affected parties, both internal and external.
- Review and consider improvements to existing public information practices all aimed at informing the public/designers/builders in best development practices in landslide areas.

- Establish and maintain an improved relationship with regional, state, and federal agencies equipped to respond to landslide events.

General Comments

- The Landslide Coordinating Committee could be a good place to begin. It is comprised of representatives from multiple city bureaus that oversee programs or policies that mitigate or prepare for and respond to landslides. Currently, they work to assure that all of these efforts are coordinated, to improve the efficiency of response and recovery from any event.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Bureau Of Environmental Services, Portland Department Of Transportation, Bureau Of Maintenance, Bureau of Water, Parks and Recreation, Risk Management
External Partners:	public
Level of Immediate Capability:	High
Estimated Timeline:	on-going
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-LS#2: Improve property owner awareness of the importance of proper maintenance of private drainage systems.

Key Issues Addressed

- Improve public awareness of maintenance responsibilities of drainage systems to reduce the impact that these systems have on landslide events.

Ideas for Implementation

- Provide continuing public outreach to property owners on how to maintain their systems.

General Comments

- Maintaining a private drainage facility keeps the facility at its optimum capacity, reducing the likelihood of water saturating the facility to saturate the earth outside of the facility and increasing the possibility of a landslide
- PCC 17 defines the responsibilities of city and property owners for improved and unimproved streets.

Coordinating Organization:	Bureau of Environmental Services

Internal Partners:	Bureau of Maintenance
External Partners:	Residents, property owners
Level of Immediate Capability:	Medium
Estimated Timeline:	Ongoing
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-LS#3: Mitigate Portland's water supply infrastructure from landslide hazards.

Key Issues Addressed

- The Portland water supply system delivers water from reservoirs in the Cascade foothills to downtown Portland. The water infrastructure passes through areas with significant landslide hazards.
- To improve the overall system reliability, mitigation projects need to be undertaken that reduce the vulnerability of the facilities to landslide hazards.

Ideas for Implementation

- Construct inter-ties between conduits to allow rerouting of water in times of need
- Harden or bury the conduit crossing at the Sandy River Crossing.
- Conduct a conduit condition survey
- Undertake a proactive landslide monitoring program in areas of high landslide hazard
- Harden or bury the conduits at the exposed/trestle locations
- Increase the capacity of the Groundwater Pump Station
- Develop design standards for new facilities that reduce their risk to landslide hazards
- Categorize how hazards identified from LIDAR survey effect water infrastructure

General Comments

- One intertie has already been completed, with another currently under construction.
- Significant elements of a landslide monitoring system are in place. An annual landslide condition report is prepared that outlines the state of the system relative to landslide hazards

from the previous season. Additions to the system will be installed as conditions mandate.

- The last conduit condition survey was done in Conduit #3 in 1987.
- Design has begun to mitigate approximately half of the exposed conduit locations. Construction is anticipated to begin in 2005 and last 2 years.
- Increased capacity at the Groundwater Pump Station allows for greater redundancy of the Bull Run system if it is taken out of service due to a landslide event. Additional wells and associated pipeline are being designed and constructed.
- Once the LIDAR survey is complete, it will be used to assess vulnerability of Water Bureau facilities.

Coordinating Organization:	Bureau of Water
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	On-going
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-LS#4: Initiate more operations and maintenance pilot projects along roads that inform the development of standards for managing stormwater in ditches in landslide prone areas.

Key Issues Addressed

- Utilize maintenance techniques to supplement landslide mitigation efforts already being implemented

Ideas for Implementation

- As opportunity arise, implement alternative stormwater ditch designs to mitigate landslide prone roadsides.

General Comments

- One technology that can be piloted is a swale that is filled with permeable material and a perforated pipe.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Bureau of Maintenance
External Partners:	public

Level of Immediate Capability:	High
Estimated Timeline:	on-going
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST -LS#5: Continue development of standards for small pump stations as an alternative to gravity sewers in inaccessible or high risk areas.

Key Issues Addressed

- As much as possible, sewers should be kept out of landslide prone areas to assure continuity of service and to protect public health.

Ideas for Implementation

- If necessary, require a small pump station for slide prone areas for development.

General Comments

- Small pump stations are another tool to help the engineer avoid slide prone areas with the sewer utility.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Bureau of Development Services
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	within one year
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-LS#1: Develop a comprehensive landslide map for the City of Portland to identify hazard areas and improve communication with the public.

Key Issues Addressed

- For hazard area maps to be useful, they must be mapped accurately and at an appropriate scale to be incorporated into land use decisions. In addition, public outreach is needed to provide the public with information about the potential risk.

Ideas for Implementation

- Partner with DOGAMI to fund LIDAR imaging work and use it to map landslides.
- Collect all landslide hazard maps with City of Portland information so that these maps can be analyzed, evaluated, and a determination made as to how each map can and should be used. The collected maps could be scanned into GIS to be used as individual layers or combined into a composite map. A comprehensive landslide hazard map could be developed for the City.

General Comments

- Mapping of landslide hazards was identified in the 1996 *Flood and Landslide Hazard Mitigation Plan*, Recommendation #4.

Information about existing maps:

- The *Potential Landslide Hazard Map* officially applies to all land use applications. It shows landslide hazard areas as slight, moderate, or severe. The geographic area covered by this map, because it is an older map, does not match the current boundaries of the City's planning jurisdiction (which includes the City and the unincorporated urban areas of Multnomah County).
- The Landslide Hazard Area Map (adopted June 1, 2002) applies to new land divisions but not to other land use applications.
- Rapidly moving landslide maps are available on the City of Portland web page at www.portlandmaps.com, but they are still draft maps. Final maps will be need to be developed in partnership with DOGAMI, but funding is not available to do this work.
- A small portion of Portland was included in a recent LIDAR study partially funded by the Bureau of Environmental Services. USGS and DOGAMI have just begun to analyze data to map landslide hazard areas. Additional funding is required to develop LIDAR coverage for the entire city to map landslides.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Planning Bureau, Water Bureau, Bureau of Environmental Services, Portland Department of Transportation, Bureau of Maintenance, Parks Department
External Partners:	Department of Geology and Mineral

	Industries (DOGAMI)
Level of Immediate Capability:	Medium
Estimated Timeline:	5 + years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards. Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

LT-LS#2: Acquire land or apply conservation easement for long term and permanent mitigation of risk.

Key Issues Addressed

- Some areas in the City may be such high risk they should not be developed. If there is not development, the City could avoid the provision of infrastructure in high-risk areas.
- Undeveloped land would also provide benefits including wildlife habitat, and valuable open space, and reduced erosion.

Ideas for Implementation

- Identify areas at high risk for landslides and consider acquisition and management as natural area parkland when resources are available and acquisition meets objectives of park system.
- Compare the location of high risk areas to areas the City has identified as high quality habitat and water quality protection areas so as to maximize the benefits achieved.
- Continue to work on watershed assessments to identify other relevant issues.

General Comments

- Implementation would occur as willing sellers chose to sell their landslide prone properties.
- This action was identified in the 1996 Flood and Landslide Hazard Mitigation Plan.

Coordinating Organization:	Bureau of General Services
Internal Partners:	Bureau of Planning, Parks and Recreation, Bureau of Development Services, Bureau of Environmental Services, Risk Management
External Partners:	Metro, non-profit land trusts
Level of Immediate Capability:	Medium (interest and institutional capability are high, funding is low)
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-LS#3: Complete a study of the West Hills drainage system that addresses the cumulative effects of development in the area.

Key Issues Addressed

- Many landslides have occurred in the West Hills.
- Development continues to occur with drainage addressed site by site, but little is known about the cumulative impacts of development. A study that identifies weaknesses in the overall system is needed.

Ideas for Implementation

- Assess/inventory drainage patterns and facilities
- Identify drainage facilities are that are used but not municipally controlled
- Assess the potential for the development of new drainage facilities to increase landslide risks
- Review the 1995 On-Site Drainage Design Manual for the West Hills

General Comments

- The study will be complex and difficult to do.
- The study should be coordinated with other watershed health activities

Coordinating Organization:	Bureau of Environmental Services, Planning and Modeling and Engineering Services
Internal Partners:	Bureau of Planning, Bureau of Development Services (Site Development)
External Partners:	Office of Neighborhood Involvement
Level of Immediate Capability:	Low (no funding, though staff

	capability exists)
Estimated Timeline:	3-5 years, dependent on funding
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-LS#4: Review the effectiveness of regulations related to development in identified landslide hazard areas.

Key Issues Addressed

- Existing regulations limit development in identified landslide hazard areas, but may not fully achieve the goal of protecting life and property.

Ideas for Implementation

- Discuss and determine what is acceptable risk for development in landslide hazard areas. Involve all bureaus in the discussion of whether the existing regulations are achieving goals of the natural hazard mitigation plan.
- Develop a landslide hazard map using the best available scientific information. This map should be used as a reference in policy discussions.
- Bureaus other than Bureau of Development Services could have approval criteria or standards for applicants if they are in a landslide prone area. All bureaus should review the need for approval criteria or standards.
- The Zoning Code has provisions that allow exceptions to minimum density requirements when a site is within an environmental zone, a Landslide Hazard Area, or a flood hazard area. Consider changing the Zoning Code provisions in the base zones to state that if the site is within a Landslide Hazard Area, the maximum density should be zero.
- Research how revegetation can address landslide prevention and contribute to stability on steep slopes and incorporate this into design practices and requirements. This should include: (1) literature review; (2) inventory and map natural areas with high landslide potential for vegetation needs; and (3) update revegetation operating procedures.

General Comments

- On-going implementation of existing regulations will occur through the existing development review process.
- The city requires geotechnical engineering or engineering geology reports for building permits on steep lots.
- City bureaus could use additional time to review applications for development in these areas to give full consideration to the

effects of constructing utilities and other facilities in these areas.

- It may take 1-2 years to research how revegetation can help to prevent landslides and contribute to stability on steep slopes.

Coordinating Organization:	Bureau of Development Services (Land Use Services and Site Development), Bureau of Planning
Internal Partners:	Bureau of Planning, Bureau of Environmental Services
External Partners:	Department of Geology and Mineral Industries, Oregon Department of Forestry, United States Geological Survey
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-LS#5: Update the Bureau of Environmental Services Sewer and Drainage Facilities Design Manual.

Key Issues Addressed

- There is a need to address the issue of where construction of sewers will be allowed and the type of materials and construction methods that are not acceptable in slide-prone areas.
- Clarify when it might be appropriate to use a small pump station.

Ideas for Implementation

- Determine appropriate design standards for both new pipes and rehabilitated pipes that consider risk, service level and construction methods in identified high-risk landslide areas.
- Establish pipe materials and joint specification standards for use in landslide prone areas.
- Consider options to gravity flow systems such as pump stations in areas subject to landslides.
- Add into the Design Manual a section for sewer designs in landslide-prone areas

General Comments

- City staff, developers and consultants use the Design Manual to assist in the design of drainage and sanitary sewer systems.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-LS#6: Employ alternate construction methods such as trenchless construction on City projects to reduce the impact that development can have in landslide prone areas.

Key Issues Addressed

- Design of sewers should take into account the risk of landslides due to the construction methods used.

Ideas for Implementation

- Train City design staff in appropriate design methods for landslide prone areas.

General Comments

- Alternative methods of construction (such as trenchless methods) can minimize the disturbance to the soil surface thereby minimizing the risk of a slide in that area. Bureau staff will work toward recommending this more often (as appropriate).

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	staff
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Landslide Resource Directory

City Resources

Portland State University, Department of Geology

Portland State University conducts research and prepares inventories and reports for communities throughout Oregon. Research and projects conducted through the Department of Geology at Portland State University include an inventory of landslides for the Portland metropolitan region after the 1996 and 1997 floods and a subsequent susceptibility report and planning document for Metro in Portland.

Contact: Portland State University, Department of Geology
Address: 17 Cramer Hall; 1721 SW Broadway, Box 751, Portland, OR 97207
Phone: 503- 725-3389
Website: http://www.geol.pdx.edu

Portland Office of Emergency Management (POEM)

Coordination of plan development, training, exercise and equipment procurement and or distribution. Emergency Management is responsible for updating plans as codified by Title 15 of the City Code and in alignment with federal and state standards.

Contact: Director
Address: 1001 SW 5th Ave. Suite 650
Phone: 503- 823-4375
Website: www.portlandonline.com
Email: Ascarrunz@ci.portland.or.us

Portland Bureau of Development Services

This department houses both the permit center and the engineering section that regulate development in landslide prone areas.

Address: 1900 SW 4th Ave
Phone: 503.823.7526 (Development Services Center)
Website: www.bds.ci.portland.or.us/dsc/dscmain.htm

Plans and Codes

City of Portland Flood & Landslide Hazard Mitigation Plan; October 1996; Portland Bureau of Buildings; Commissioner Gretchen Kafoury;

Master Slide List August 6, 1996;

Articles/ Public Outreach

Planning for Natural Hazards, Landslide Technical Resource Guide; Oregon DLCD & Community Planning Workshop; July 2000

Landslides in Portland, Oregon Metropolitan Area Resulting from the Storm of February 1996; Inventory Map, Database and Evaluation; Burns, Burns, James & Hinkle, Dept. of Geology, PSU; August 27, 1998

February 1996 Flooding, Landslide and Stream Erosion in the State of Oregon; FEMA DR-1099-OR; Prepared by the Interagency Hazard Mitigation Team;

Relationship between rainfall and debris flows in western Oregon; Oregon Geology, Volume 62, Number 2, March/April 2000;

Forestry, landslides, and public safety: an issue paper prepared for the Oregon Board of Forestry. Oregon Department of Forestry.

Homeowner's Landslide Guide, For hillside flooding, debris flows, erosion and landslide control; Oregon Emergency Management; FEMA Region X (pamphlet)

Map of rapidly moving landslide hazards for Western Oregon: GIS outputs and summary report (draft and final), Hofmeister, Jon R., Miller, Daniel J., Mills, Keith A., and Beier, Ann E., 2002,

Landslides in Oregon; DOGAMI, Oregon Department of Forestry and Oregon Emergency Management (pamphlet)

State Resources

Department of Land Conservation and Development (DLCD)

Oregon's Department of Land Conservation and Development administers a natural hazards program to assist local governments in meeting statewide Planning Goal 7: Areas Subject to Natural Disasters and Hazards. Activities relating to landslide mitigation include:

- Distribution of model ordinances through which hazards can be mitigated. DLCD advises local governments on which ordinance best meets their needs;
- Reviewing local land use plan amendments for consistency with state landslide programs and regulations and providing direct technical assistance;
- Providing a liaison between pertinent local, state, and federal agencies. DLCD representatives serve on a variety of commissions and ad hoc committees which deal with natural hazards;
- Adopting and amending statewide planning goals and administrative rules relating to natural hazards.

Contact: State Floodplain Manager, Natural Hazards Program Manager
Address: 635 Capitol Street NE, Suite 150
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Oregon Department of Forestry (ODF)

The mission of the Oregon Department of Forestry is to serve the people of Oregon through the protection, management, and promotion of a healthy forest environment, which will enhance Oregon's livability and economy for today and tomorrow. ODF regulates forest operations to reduce the risk of serious injury or death from rapidly moving landslides related to forest operations and assists local governments in the siting review of permanent dwellings on and adjacent to forestlands in further review areas.

Contact: Oregon Department of Forestry, Northwest Oregon
Address: 801 Gales Creek Road, Forest Grove, Oregon 97116-1199
Phone: (503) 359-7448
Website: http://www.odf.state.or.us

Oregon Department of Forestry Debris Flow Warning Page

The ODF debris flow warning page provides communities with up-to-date access to information regarding potential debris flows. As the lead agency, ODF is responsible for forecasting and measuring rainfall from storms that may trigger debris flows. Advisories and warnings are issued as appropriate. Information is broadcast over NOAA weather radio and on the Law Enforcement Data System. DOGAMI provides additional information on debris flows to the media that convey the information to the public. ODOT also provides warnings to motorists during periods determined to be of highest risk for rapidly moving landslides along areas on state highways with a history of being most vulnerable. Information is available on the ODF website at www.odf.state.or.us.

Oregon Department of Geology and Mineral Industries (DOGAMI)

DOGAMI is an important agency for landslide mitigation activities in Oregon. Some key functions of DOGAMI are development of geologic data, development of maps, and regulation of mining and drilling for geological resources. The agency also provides technical resources for communities and provides public education on geologic hazards. DOGAMI provides data and geologic information to local, state, and federal natural resource agencies, industry, and private groups.

Contact: DOGAMI
Address: 800 NE Oregon Street, Suite 965, Portland, Oregon 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
Website: http://sarvis.dogami.state.or.us
Email: info@naturenw.org

Nature of the Northwest

Oregon Department of Geology and Mineral Industries and the USDA Forest Service jointly operate the Nature of the Northwest Information Center. The Center offers a selection of maps and publications from state, federal, and private agencies.

Contact: The Nature of the Northwest Information Center
Address: 800 NE Oregon Street #5, Suite 177, Portland, Oregon 97232

Phone: (503) 872- 2750
Fax: (503) 731-4066
Website: http://www.naturenw.org
Email: Nature.of.Northwest@state.or.us

Oregon Department of Transportation (ODOT)

ODOT provides warnings to motorists during periods determined to be of highest risk for rapidly moving landslides along areas on state highways with a history of being most vulnerable to rapidly moving landslides. ODOT also monitors for landslide activity and responds to slide events on state highways.

Contact: ODOT Transportation Building
Address: 355 Capitol St. NE, Salem, OR 97310
Phone: (888) 275-6368
Website: http://www.odot.state.or.us

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

OEM coordinates state resources for rapid and effective response to rapidly moving landslide and other landslide-related emergencies. The Oregon Emergency Response System (OERS) of OEM is a key player in the dissemination of debris flow advisories and warnings. OEM chairs a group that develops and measures landslide hazard mitigation strategies. OEM also administers the FEMA Hazard Mitigation Grant Program, which provides a source of funding for implementing hazard mitigation projects. OEM also works with other state agencies to develop information for local governments and the public on landslide hazards.

Contact: Oregon Emergency Management
Address: 595 Cottage Street NE
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: http://www.osp.state.or.us/oem

Federal Resources

Federal Emergency Management Agency, landslide fact sheet

FEMA's website contains information on strategies to reduce risk and prevent loss from landslides and debris flows.

Contact: Federal Regional Center, Region 10
Address: 130-228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov/library/landslif.htm

Natural Resource Conservation Service (NRCS)

The NRCS produces soil surveys. These may be useful to local governments who are assessing areas with potential development limitations including steep slopes and soil types. They operate many programs dealing with the protection of natural resources.

Contact: NRCS, Oregon Branch
Address: 101 S.W. Main Street, Suite 1300, Portland, OR 97204

Phone: (503) 414-3200
Fax: (503) 414-3103
Website: http://www.or.nrcs.usda.gov

US Geological Survey, National Landslide Information Center (NLIC)

The NLIC website provides good information on the programs and resources regarding landslides. The page includes information on the National Landslide Hazards Program Information Center, a bibliography, publications, and current projects. USGS scientists are working to reduce long-term losses and casualties from landslide hazards through better understanding of the causes and mechanisms of ground failure both nationally and worldwide.

Contact: National Landslide Information Center
Phone: (800) 654-4966
Website: http://landslide.usgs.gov

Additional Resources

American Planning Association (APA)

The APA's research department embarked on a program to bring together solutions from multiple disciplines into a single source. It will help serve local planning efforts in identifying landslide hazards during the planning process so as to minimize exposure to landslide risks. The APA's website highlights planning efforts to reduce risk and loss from landslides.

Contact: Principal Investigator, Landslides Project
Address: Research Department, American Planning Association
122 S. Michigan Ave., Suite 1600
Chicago, Illinois 60603-6107
Phone: (312) 431-9100
Fax: (312) 431-9985
Website: http://www.planning.org/landslides
Email: landslides@planning.org

American Red Cross

The American Red Cross is a volunteer-led humanitarian organization that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area including disaster planning, preparedness, and education.

Contact: American Red Cross, Oregon Trail Chapter
Address: P.O. Box 3200, Portland, OR 97208-3200
Phone: (503) 284-1234
Fax: (503) 284-4247
Website: http://www.redcross-pdx.org
http://www.redcross.org/services/disaster/keepsafe/volcano.html
Email: info@redcross-pdx.org

Institute for Business & Home Safety (IBHS)

IBHS was created by the insurance industry to reduce damage and losses caused by natural disasters. Their website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

Contact: Institute for Business and Home Safety
Address: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
Phone: (813) 286-3400
Fax: (813) 286-9960
E-mail: info@ibhs.org
Website: http://www.ibhs.org/ibhs2

State of Washington, Department of Ecology

The Washington State Department of Ecology has a landslide website with tips for reducing risk, identifying warning signs, and using hazard maps.

Contact: Department of Ecology
Address: PO Box 47600, Olympia, WA 98504-7600
Website: http://www.ecy.wa.gov/programs/sea/landslides
Email: hshi461@ecy.wa.gov

Publications

Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides that cover flooding, wildfires, landslides, coastal hazards, and earthquakes. You can write, call, fax, or go on-line to obtain this document.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Mileti, Dennis, *Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press.

This book offers a way to view, study, and manage hazards in the United States that will help foster disaster-resilient communities, higher environmental quality, inter- and intragenerational equity, economic sustainability, and an improved quality of life. The volume provides an overview of what is known about natural hazards, recovery, and mitigation; reveals how research findings have been translated into policies and programs; and advances a sustainable hazard mitigation research agenda.

Olshansky, Robert B., *Planning for Hillside Development* (1996) American Planning Association.

This document describes the history, purpose, and functions of hillside development and regulation and the role of planning, and provides excerpts from hillside plans, ordinances, and guidelines from communities throughout the US.

Olshansky, Robert B. & Rogers, J. David, *Unstable Ground: Landslide Policy in the United States* (1987) Ecology Law Quarterly.

This is about the history and policy of landslide mitigation in the US.

Public Assistance Debris Management Guide (July 2000) Federal Emergency Management Agency

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Website: http://www.fema.gov/r-n-r/pa/dmgtoc.htm

USGS Landslide Program Brochure. National Landslide Information Center (NLIC), United States Geologic Survey

The brochure provides general information in simple terminology on the importance of landslide studies and a list of databases, outreach, and exhibits maintained by the NLIC. The brochure also includes information on the types and causes of landslides, rockfalls, and flows.

Contact: USGS- MS 966, Box 25046
Address: Denver, Federal Center, Denver, CO 80225
Phone: (800) 654-4966
Web: http://geohazards.cr.usgs.gov/

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[4] Hofmeister, Jon R., Miller, Daniel J., Mills, Keith A., and Beier, Ann E., 2002, Map of rapidly moving landslide hazards for Western Oregon: GIS outputs and summary report (draft and final).
[5] Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.
[6] Ibid.
[7] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 5.

[8] Hofmeister, Jon R., Miller, Daniel J., Mills, Keith A., and Beier, Ann E., 2002, Map of rapidly moving landslide hazards for Western Oregon: GIS outputs and summary report (draft and final).

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[12] *Planning for Natural Hazards: The Oregon Technical Resource Guide,* Department of Land Conservation and Development (July 2000), Ch. 5.
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[14] *The Citizens' Guide to Geologic Hazard* (1993) American Institute of Professional Geologists, American Institute of Professional Geologists.
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[19] Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.

[20] Sears, Tricia, June 2003, The sometimes discordant fusion of science and policy: an example of a land use planning study of a hazard area in Dodson and Warrendale, Oregon, 137 p.
[21] Burby, R. (Ed.) *Cooperating with Nature.* (1998) Washington D.C.: Joseph Henry Press.
[22] Ibid

[23] Sears, Tricia, June 2003, The sometimes discordant fusion of science and policy: an example of a land use planning study of a hazard area in Dodson and Warrendale, Oregon, 137 p.

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Section 9
Earthquake

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Why are Earthquakes a threat to Portland?

Oregon is rated third highest in the nation for potential loss due to earthquakes. This is due, at least in part, to the fact that until recently, Oregon was not considered to be an area of high seismicity, and the majority of its buildings and infrastructure were not designed for ground shaking at the magnitude now expected. Recent studies of geological records show that Oregon has a history of seismic events, and that the Cascadia Subduction Zone is capable of producing magnitude 9.0 earthquakes.

Within the City of Portland, there are more than 1,600 unreinforced masonry buildings and many other older structures that are not expected to fare well in a major seismic event. Within the city limits, $59 billion in residential and commercial assets are at risk. A major event could displace 2,000 households, cause 2,500 people to suffer major injuries, and result in as many as 200 fatalities. Many parts of the infrastructure, including pipelines, transportation routes, and utility lifeline systems, are also likely to experience heavy damage. The mitigation measures outlined in this plan are meant to reduce the loss of life and property, to sustain infrastructure and services to population, and to protect the economic welfare of the region.

Geologists scrutinizing soil layers in a 12-foot-deep trench in Milwaukie have uncovered more evidence that the Portland Hills Fault is still able to generate earthquakes. The fault runs in a northwest-southeast direction from 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." Deformation of soil suggests that the ancient earthquake may have measured about a magnitude 6.5, 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 is suspected. Where faults are known to exist, it is believed that they are capable of generating magnitude 7 earthquakes.

Earthquakes pose a serious threat to many Oregon communities. Projected losses in the Cascadia region could exceed $12 billion; 30,000 buildings could be destroyed and 8,000 lives lost in the event of a magnitude 8.5 Cascadia Subduction Zone earthquake. 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 Portland.[2]

Historical Earthquake Events

Several moderate earthquakes have affected Portland in the past century. Little damage has occurred in Portland as a result, but the earthquakes have rattled nerves and served to remind residents that their community is at risk of experiencing more damaging earthquakes. Multiple small quakes have been occurring in the Portland metro area over the past several years. Though most have been too small to be felt in Portland, the quakes demonstrate the seismic instability of the region. Recent small 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.[3] Larger earthquake events in the Portland region are described below.

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 and was felt throughout the Portland area. The quake was followed by seven aftershocks and smaller-deeper tremors were detected for several weeks after.[4] 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 large earthquake to be felt in Portland was the Nisqually earthquake, on February 28, 2001. This earthquake was centered northeast of Olympia, Washington, and measured a magnitude of 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.[5] In Portland, many employees evacuated in reaction to the quake, but the event ultimately caused no damage. 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."[6] 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.[7]

March 25, 1993, Scotts Mills Earthquake - Magnitude 5.6

In 1993, the Scotts Mills earthquake (also known as the "Spring Break Quake") shook Portland. 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 addition, the *Valley Times* reported that only 4% of Oregonians were insured at the time of this earthquake.[8] By comparison, the household survey indicated that 57% of respondents had earthquake insurance in 2003.

April 29, 1962, Puget Sound, Washington – Magnitude 6.5

On April 29, 1965, Portland residents felt an earthquake that was centered between Seattle and Tacoma, Washington. The quake caused 7 deaths in Washington.

November 5, 1962, Vancouver, Washington- Magnitude 5.5

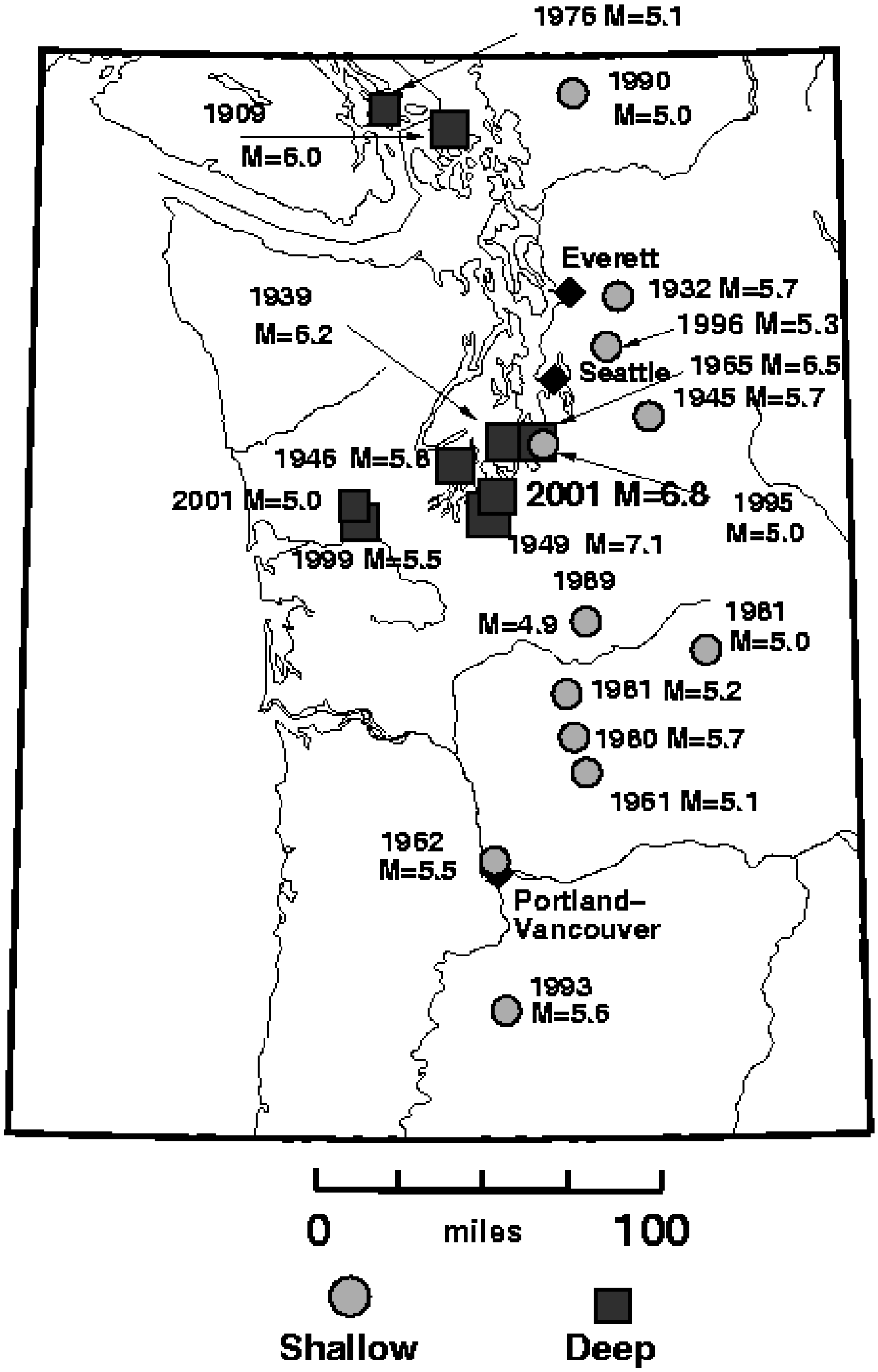
Three and a half weeks after the devastating Columbus Day Storm, an earthquake that measured approximately 5.5 on the Richter scale shook the Portland area. It was the largest quake to be generated by a fault under Portland and Vancouver.[9] This earthquake disappeared quickly from headlines, most likely because residents were still recovering from the Columbus Day Storm at the time of the earthquake.[10]

April 13, 1949, Olympia, Washington- Magnitude 7.1

On April 13, 1949, Portland residents felt an earthquake that was centered near Olympia, Washington. In Washington, this quake caused 8 deaths and caused extensive damage to buildings and infrastructure.

Figure 9-1 shows the location of selected Pacific Northwest earthquakes since 1872.

Figure 9-1. Selected Pacific Northwest Earthquakes since 1872



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

Causes and Characteristics of Earthquake in Portland

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 has at least three crustal faults beneath it that could generate an earthquake of magnitude 6.5 or larger.

Crustal Fault Earthquakes

Crustal fault earthquakes are the most common of earthquakes and occur at relatively shallow depths of 6-12 miles below the surface.[11] While most crustal fault earthquakes are smaller than magnitude 4.0 and generally create little or no damage, some 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.[12] This indicates that Portland and its neighbors could face future damages from a magnitude 6.5 or larger earthquake.[13]

> Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

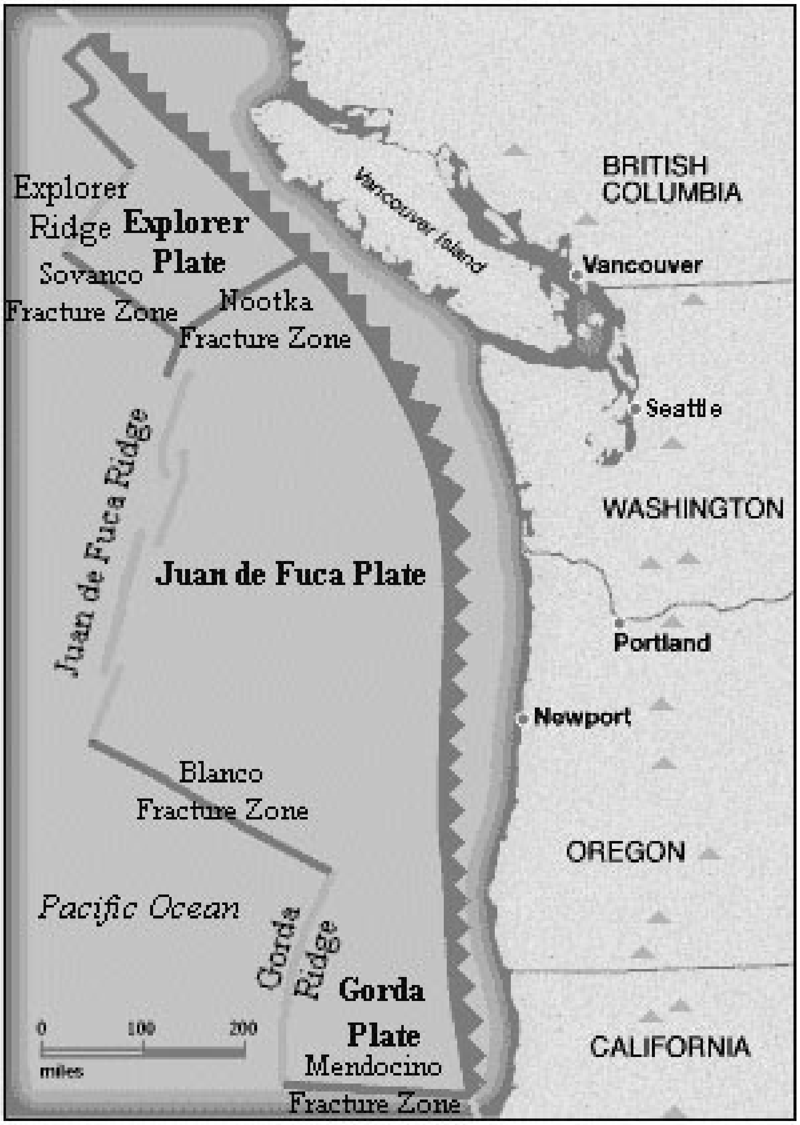
Deep Interplate Earthquakes

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.[14] 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 the Seattle-Tacoma International Airport caused seven deaths.[15]

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 9-2) and 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. The largest 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 1,000 years. Such earthquakes may cause great damage to the coastal area of Oregon as well as inland areas in western Oregon including Portland. It is estimated that shaking from a large subduction zone earthquake could last up to five minutes.[16]

Figure 9-2. 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 an 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.

Surface Fault Ruptures

Earthquakes are caused by the sudden movement, or rupture, of a fault. As the rupture zone progresses upward to the earth's surface it can cause surface fault ruptures. The result is often displacement or offset of the ground surface. Generally, the larger the earthquake, the greater the potential for surface fault rupture. It is generally considered impractical to design structures to withstand damage under the stress of surface fault rupture. Additionally, once a structure is located astride a fault, it is impossible to mitigate the surface fault rupture hazard unless the structure is relocated.[17]

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 Portland, are likely to encounter such risks, especially in areas with steep slopes. As sloped lands to the northeast and southwest are developed, 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 to a liquid state. This results in the loss of soil strength and three potential types of ground failure: lateral spreading, flow failure, and loss of bearing strength. Buildings and their occupants are at risk when the ground can no longer support buildings and structures.[18] Areas of susceptibility to liquefaction include areas with high ground water tables and sandy soils.[19]

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.[20] Amplification can also occur in areas with deep, sediment filled basins.

Community Earthquake Issues

Earthquake damage occurs because structures cannot withstand severe shaking. Buildings, airports, schools, and lifelines including water, sewer, stormwater 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 Portland must address.

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 State of Oregon Structural Specialty Code seismic zone rating for the Willamette Valley in 1990 and 1993 led to corresponding increases in the construction standards for buildings being built in Portland 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 Portland, many buildings were built before 1993 when building codes had less stringent seismic design standards. Upgrading existing buildings to resist earthquake forces is expensive. 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. Many buildings in the downtown area of Portland are more susceptible to earthquake damage because they are made of unreinforced brick or lightly reinforced concrete. Much work remains to be done to identify and plan for the risks to older structures.

Infrastructure and Communication

Portland is a hub for marine, rail, air and highway freight networks with two national railroads, an international airport, and the regional freeway system linked to I-5 and I-84. Residents in Portland 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 impacts 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

With the Willamette River traversing through the center of the City, Portland is a city highly dependent on ten bridges. These bridges provide access for everyday commuting for buses, autos, light rail, pedestrians, and bicyclists and provide railroad connections as well. Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion, though even minor damages can render some bridges unusable. Because bridges vary in size, materials, location, 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, liquefaction, 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. Damage to water systems can make a community particularly vulnerable to post-earthquake fires. 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.

Multnomah County Drainage District Levees

The US Army Corp of Engineers (Corps), in affiliation with the Multnomah County Drainage District No.1 (MCDD), studied the seismic performance of the Columbia River levee along NE Marine Drive. The MCDD maintains about 13 miles of levee along the Columbia River. The Columbia River levee system along NE Marine Drive is particularly important because it protects the airport, Interstate Highway 205, and many major roadways, municipal water pumping stations, treated wastewater outflow conduits, power and telecommunication lines, businesses, and homes. The levee’s waterfront portion is used for recreational facilities and provides access to commercial maritime facilities along the river. Damage or failure of the levee during a concurrent flood event and an earthquake could result in flooding of extensive infrastructure protected by the levee. As reported in an August 2001 study, the levees should be safe in an earthquake as large as magnitude 7.0 depending on the amount of water in the Columbia River.

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. In addition, only 24% correctly identified what to do during an earthquake.[21] Thirty-two per cent of respondents have not considered 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 obtaining earthquake insurance 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. It is also necessary that the water system be well protected so that water for fire fighting will be available if needed. In the San Francisco earthquake of 1906, 85% of the total damage was caused by post-earthquake structural fires that could not be effectively fought because of earthquake damage to the water system.

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. A 1999 study of the Metro region executed by the Department of Civil Engineering of Portland State University concluded that 1,117,433 tons of debris could be generated within the Portland city limits due to strong ground shaking. The fact that Portland contains about 20 times more unreinforced masonry and infill structures than the rest of the region contributes to the amount of potential debris.[22]

For more information on debris management strategies, refer to FEMA's Public Assistance Debris Management Guide. *(See resources at the end of this chapter.)*

Earthquake Hazard Assessment

Hazard Identification

Hazard identification, the first phase of a hazard assessment, refers to the process of estimating the geographic extent of the hazard, its intensity, and its probability of occurrence.[23] 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.[24] The Department continues to upgrade and improve earthquake hazard and risk information.

The Oregon Building Codes Division, through adoption of the State Building Code in 1990 and 1993, 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. An increase in zone number reflects increased risk of seismic activity. Many buildings in Portland were built prior to the imposition of the new seismic zone code requirements established in 1993.

Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through the hazard identification with an inventory of the existing development exposed to earthquake hazards. Vulnerability assessments predict how different types of property and population groups will be affected by a hazard.[25]

This plan uses the results of a pilot study conducted with the Hazard US – Multi-Hazard software program. HAZUS-MH applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates; these methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards and locations. Earthquake data from the HAZUS-MH software package was supplemented with local data for critical facilities and hazard areas. Inventory data were superimposed over the hazard areas to enable GIS queries to estimate the quantity of assets at risk (population, structures, critical facilities, etc.)

In general, all of the infrastructure of the City of Portland will be impacted by a major Cascadia Subduction Zone event, but some areas and buildings are more likely to be severely impacted than others. Buildings that are constructed of unreinforced masonry, bridges and overpasses that have not been seismically retrofitted, and buildings located on soils that are subject to liquefaction could experience serious damage. Utilities may also be impacted by a major event.

More detailed results of the HAZUS-MH study for earthquakes follows. They provide an overall summary description of the jurisdiction's vulnerability to the hazards and address the impacts of the hazards on the jurisdiction. Additionally, they identify the extent of the hazard and document previous occurrences of earthquake events in the Portland metropolitan area. A complete risk assessment for earthquakes is included in Appendix C, which contains *Risk Assessment Pilot Project Results for DMA 2000 Plan*.

Multnomah County Hazard Analysis		Summary of Risk Factors	
Severity Score	High	**Period of occurrence:**	At any time
History (2)	20	**Probability of event(s):**	Highly Likely
Vulnerability (5)	50	**Warning time:**	0 to 3 hours
Maximum Threat (10)	100	**Major contributor(s):**	Highly active seismic zone, local soil characteristics
Probability (7)	70	**Cause injuries?**	Yes, risk of death
Total Score	240	**Potential facilities shutdown?**	30 days or more

EARTHQUAKE HAZARD PROFILE

Background and Local Conditions

There are several different sources for hazardous earthquakes in the Pacific Northwest. Oregon sits on the Cascadia Subduction Zone where the Pacific / Juan de Fuca Plate is sliding under (or being pushed under) the less dense North American Plate. While earthquakes along this zone occur infrequently (none since records have been kept), plate movement can produce major earthquakes. In addition, the western part of Oregon is underlain by a large and complex system of faults (for example, the Portland Hills) that can produce significant and more frequent earthquakes.

Historic Frequency and Probability of Occurrence

The Metro 1999 study cites research indicating that "major geologic structures capable of magnitude (*M*) 7 earthquakes underlie the Portland study area. Since 1820, 7,000 earthquakes have been documented in Oregon. Fifty-six significant earthquakes occurred in or near the Portland study area between 1872 and 1999. Severe local earthquakes occurred in 1877, 1880, 1953, 1962, and 1993 (Metro 1999). Strong Pacific Northwest earthquakes also include an 1872 M 7.4 North Cascades event, an *M* 6.8 earthquake in 1873, a 1949 *M* 7.1 event near Olympia, Washington, a 1965 *M* 6.5 event in Seattle-Tacoma, and a 2001 Olympia, Washington event that caused over $2 billion in property damage (Oregon OEM 2000). Regional earthquakes, such as the deep, intra-plate Nisqually Earthquake of 2001(Olympia, Washington) are felt widely in northwest Oregon.

Severity

There is a direct relationship between a fault's length and location and its ability to generate damaging ground motion. In Portland, smaller, local faults produce lower magnitude quakes, but their ground shaking can be strong and damage can be high as a result of the fault's proximity. In contrast, offshore or distant subduction zone quakes can generate great magnitudes, but because of their distance and depth, may result in only moderate shaking in the Portland study area (Metro 1999). The Cascadia Subduction Zone fault could produce an earthquake of *M* 8.0 to 9.0 or greater. Geologic evidence shows that earthquakes of similar magnitude have occurred on average every 500 to 600 years in this area. Based on the Mutlnomah County analysis and pilot project data gathering and review, this hazard was given an initial profile ranking of severe.

Historic Losses and Impacts

Damage results from earthquakes because structures that cannot withstand the shaking, are situated on ground that amplifies shaking, or are located on soil that is subject to liquefaction. Structures can cause injury or fatalities and suffer content and functionality losses. The 2001 Nisqually event caused over $2 billion in losses. The two 1993 Klamath Falls earthquakes (*M* 5.9 and 6.0) caused damage to more than 1,000 buildings and $10 million in losses (DOGAMI 2002). Since 1872, there have been about 25 damaging earthquakes in Washington and Oregon (CREW 2003).

Designated Hazard Areas

The entire Pacific Northwest is subject to the earthquake hazard. However, certain local conditions can mitigate or amplify the effects. Figure 3-2 illustrates that the Portland study area has experienced earthquakes with various intensities of ground shaking. The figure shows major past earthquakes by moment magnitude.

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 and guidance from the Portland Natural Hazards Mitigation Steering Committee. The goals for the City of Portland 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 five categories:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resilient economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

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

Construction Review and Inspection

The City's Bureau of Development Services is responsible for enforcing the State of Oregon Building Codes, which incorporate seismic structural design considerations. The Bureau reviews plans and specifications and inspects construction of all new structures on private property to assure compliance with the State Building Code seismic provision. 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 they should contain.

Seismic Upgrades to Bridges – Portland Department of Transportation (PDOT)

PDOT completed a seismic prioritization study in the mid-1990's, and identified the City's most vulnerable structures in the event of an earthquake. Two of the top ten seismic retrofits have been completed. At this time, no additional seismic retrofits are planned due to lack of funding.

Fire, Police and Emergency Communication Facilities Seismic Status

A study of critical facilities was conducted for the Fire Bureau by Degenkolb Engineers in 1998; since then, the City of Portland has seismically upgraded most of the existing fire stations within the Portland area and has prioritized the building of new or upgrading of old over the next three years. DOGAMI and the State of Oregon Emergency Management have recently conducted a survey of Portland's essential facilities. All Police and Emergency Communications buildings are either retrofitted or built to a higher standard depending on time of construction.

City Title 24.85, Seismic Design Requirements for Existing Buildings – Bureau of Development Services (BDS)

The Bureau of Development Services is responsible for enforcing existing building retrofits under specific conditions as required by this title. Un-reinforced masonry buildings are strengthened when roof covering is removed and replaced or when the dollar cost of renovations exceeds a specified amount. All buildings are required to be strengthened when the occupant classification of the building is changed to a more critical level. A report on the risk assessment of existing buildings conducted by the Bureau of Development Services will be heard by City Council no later than January 1, 2006.

Portland Office of Emergency Management (POEM)

The City of Portland Office of Emergency Management is continuously upgrading the City's ability to survive an earthquake through preparedness activities, training, exercising, and planning. Earthquake exercises occur in one form or another every year. Exercises challenge multi-agency emergency responders, public officials, and community partners to work together to manage a disaster following pre-determined plans and protocols.

QuakEx

City personnel participated in QuakEx 2003 in April. This statewide drill simulated the occurrence of a magnitude 9.0 subduction zone earthquake off the coast of Oregon. The purpose of the drill was to train agencies throughout the State to cooperate and communicate during a large earthquake and to identify short and long term efforts needed to respond to a large-scale disaster.[26] In October of 2004, the City conducted a full-scale earthquake exercise incorporating partners in public health, mass transit, schools, and the business community as well as city respondents. The primary objectives of this drill were to test damage assessment reporting, search and rescue, communications and employee drop, and cover and hold response.

State Programs

State Building Codes[27]

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) prescribe seismic design requirements for new construction based on the seismology of the Portland region. These codes are State of Oregon amended additions of national model codes from the International Code Council. These codes are based on maps that identify the various seismic zones for Oregon. 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.[28]

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 Specialty 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.[29]

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

Signed by Governor John Kitzhaber on June 14, 2001, Senate Bill 13 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. 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. (Plans are subject to available funding.) All seismic rehabilitation or other actions to reduce seismic risk must be completed before January 1, 2032.

DOGAMI and the Oregon University System joined to design a pilot program to begin the process to fulfill ORS 455.400 (2001). Through university maintenance funds and FEMA Pre-Disaster Mitigation grants, they have initiated seismic safety surveys of university buildings and selected several particularly vulnerable buildings for seismic safety upgrades. Buildings on the Portland State University campus in downtown Portland have been selected for the pilot project and are slated for partial upgrades to be completed by 2007.

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. 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. (Again, plans are subject to available funding.) All seismic rehabilitations or other actions to reduce the risk must be completed before January 1, 2022.

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, the 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. Public schools are required to conduct periodic earthquake drills and educate students on how to respond when an earthquake event occurs (ORS 455.447 and 336.071). An example of voluntary compliance is St. Cecelia, a local private school, which performs earthquake drills along with fire drills.[30]

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.

DOGAMI and the U.S. Geological survey are conducting a NEHRP mapping project in the Portland area to better locate the Portland Hills fault zone.

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 International Building Code, to help establish the construction requirements necessary to preserve public health and safety in earthquakes.http://quake.wr.usgs.gov/prepare/factsheets/RiskMaps/HazMap.gif 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.

Other programs

Bonneville Power Administration

While BPA does not have many facilities within the city limits of Portland, it has completed Phase One hardening of 500kV substations that support local utilities in the Portland metro area. Non-structurally, BPA has installed seismic isolators on critical control cabinets.

Transmission towers and transmission lines generally have a good performance history during seismic events. During several past significant earthquakes some towers failed; however, those failures were foundation-related. Other towers bent but did not cause a critical situation and were repaired on a routine schedule.

BPA has investigated the performance of their tower designs and feels that the system should perform adequately with the following exceptions: liquefaction at river crossings and earthquake generated landslides. BPA has not yet addressed these concerns.

Another reason for the failure of a minimal number of towers during significant seismic events had to do with towers being located on hillsides and having un-equal legs. There has been some suggestion that this un-equal leg configuration contributed to tower failure. BPA is communicating with a Japanese researcher investigating this possible mode of failure.

BPA also continues education and awareness efforts for employees and their families along with frequent testing of emergency plans and procedures.

Earthquake Mitigation Action Items

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 that can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Short-term Action Items

ST-EQ#1: Using television and print media, educate the public about the importance of signs containing bridge identification information during an earthquake.

Key Issues Addressed

- In the past two years, the Office of Transportation participated with Oregon Department of Transportation to place identification signs on every bridge within the city limits. Each sign contains the structure's ID number and the phone number of the agency responsible for its maintenance. This was completed in an effort to help anyone calling in bridge damage to identify the structure, especially after an event such as an earthquake. Now that the signs are in place, the public needs to be made aware of the existence of the signs and their value during an earthquake. Calling the responsible agency instead of 911 will ensure faster response and keep the 911 lines clear for other emergencies.

Ideas for Implementation

- Design and implement a public education campaign regarding bridge ID signs.
- Consider using the next earthquake drill to increase press coverage.

Coordinating Organization:	Portland Office of Transportation
Internal Partners:	none
External Partners:	Oregon Department of Transportation, Multnomah County
Level of Immediate Capability:	High
Estimated Timeline:	1 month
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-EQ#2: Assess existing earthquake related mitigation plans and vulnerability studies to identify areas of conflict, duplication, or gaps.

Key Issues Addressed

- Multiple bureaus have multiple earthquake plans and studies in place; there is a need for increased coordination. The City needs the ability to quickly compile, access, and disseminate key information about city structure and operations.

Ideas for Implementation

- Create a committee of bureau representatives to catalogue existing plans. Run a gap analysis to begin filling in the holes.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Fire Bureau, Office of Transportation, Bureau of Environmental Services, Water Bureau, Bureau of Development Services, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1 year
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-EQ#3 Update the vulnerability analysis of Columbia Boulevard Wastewater Treatment Plant (CBWTP), Tyron Creek Wastewater Treatment Plant (TCWTP), and wastewater pump stations.

Key Issues Addressed

- Currently, the vulnerability analysis of CBWTP and TCWTP these pump stations is incomplete.

Ideas for Implementation

- Hire a structure consultant to update the current CBWTP and TCSTP vulnerability analysis, develop a comprehensive vulnerability analysis for wastewater pump stations.

General Comments

- CBWTP and TCWTP facilities have a number of known seismic deficiencies. CBWTP is especially vulnerable to liquefaction.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	3 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

ST-EQ#4 Prioritize the return of power to treatment plants (Tryon Creek and Columbia Boulevard) and pump stations.

Key Issues Addressed

- Should power be interrupted over a large area for long periods of time, the treatment plants may be unable to fully treat wastewater flow; raw sewage overflows to the Columbia Slough or Willamette River would occur. System pump stations are primarily fed from a single source and may have standby power. If power fails at the pump station, sewers would back possibly into streets, private property, or into streams and rivers.

Ideas for Implementation

- Coordinate with regional power companies to the CBSTP and TCWTP are on the list of high priority services requiring rapid response to re-establish power.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Portland Office of Emergency Management
External Partners:	Regional Utility Planning Group, REMTEC
Level of Immediate Capability:	High
Estimated Timeline:	1 year
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-EQ#5 Lobby to implement legislation of General Obligation Bonds to fund rehabilitation of critical structures.

Key Issues Addressed

- Oregon Law 797 requires seismic rehabilitation program for schools and life safety buildings and arranges for long term funding for upgrades through the state legislature.

Ideas for Implementation

- Develop partnerships with state and local stakeholders.

General Comments

- There will be funding and staff available in late 2003 to design a plan.

Coordinating Organization:	Governmental Relations
Internal Partners:	Bureau of Development Services, Portland Development Commission, Portland Office of Emergency Management, Office of Transportation, Parks and Recreation
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-EQ#6 Address earthquake-generated landslide issues.

Key Issues Addressed

- The failure of a critical transmission lines, distribution lines, and/or substations as a result of earthquake-generated landslides will affect the electric power lifeline system.

Ideas for Implementation

- Assess the potential for earthquake-generated landslides to damage critical transmission and distribution lines and substation sites.
- Recommend mitigation and/or recovery solutions.

General Comments

- Within the Portland Metro area, this may not be a significant issue; however, earthquake-generated landslides could significantly affect the cross-mountain transmission line system.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	none
External Partners:	Bonneville Power Administration
Level of Immediate Capability:	Low
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-EQ#7 Work with local jurisdictions to assess the capacity of landfills to accommodate earthquake debris; develop coordinated plans for disposal of debris in the aftermath of an earthquake.

Key Issues Addressed

- Earthquakes have the potential to generate a tremendous amount of debris that would need to be cleared from streets and homes quickly after the event. This influx of debris is likely to be beyond the capacity of local landfills. The failure to clear debris could result in slowed recovery from the event.

Ideas for Implementation

- Alternate disposal approaches (such as the use of debris as fill for berms) should be considered.
- Work with other cities and agencies to evaluate different scenarios and develop a coordinated plan.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Bureau of Maintenance, Office of Sustainable Development
External Partners:	Metro, neighboring cities and counties, Multnomah County
Level of Immediate Capability:	Medium
Estimated Timeline:	1 year
Plan Goals Addressed:	Establish a disaster-resilient economy.

ST-EQ#8 Study the feasibility of mandatory or voluntary installation of seismic shutoff valves on natural gas meters at commercial and residential buildings.

Key Issues Addressed

- Natural gas flow into structures from broken gas lines in the structure is a major hazard after an earthquake; it can lead to structure fires and threaten human life. The installation of excess flow valves at the meters might rectify this problem.

Ideas for Implementation

- Convene a committee of representatives from the Bureau of Fire, Bureau of Development Services, natural gas and utility providers, and other interested parties to look at practicality of the issue.
- This committee should complete a study that verifies the effectiveness, cost and reliability of such valves.

General Comments

- These valves are used in other areas of the country.

Coordinating Organization:	Bureau of Fire
Internal Partners:	Bureau of Development Services, Bureau of Fire, Portland Office of Emergency Management
External Partners:	NW Natural Gas
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years

Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-EQ#9 Develop emergency evacuation plans for residential areas that are near significant hazardous materials storage facilities and heavy industrial areas.

Key Issues Addressed

- During and earthquake, hazardous materials containment areas can be damaged affecting any nearby residential areas. The community of Linnton is situated between hazardous materials storage areas and other heavy industrial facilities, and is located adjacent to the alignment of the Olympic Pipeline. The majority of Linnton's residents live on the adjacent steeply sloping hillside, which is served by a substandard street system. Similar residential pockets in other heavy industrial areas, such as Guild's Lake, could be endangered if pipelines or hazardous materials' storage facilities ruptured in an earthquake event. Evacuation from these areas could be complicated by earthquake-related debris.

Ideas for Implementation, and General Comments

- Develop vulnerability studies and evacuation plans for residential and employment areas with highest risk

Coordinating Organization:	Fire Bureau
Internal Partners:	Portland Office of Emergency Management
External Partners:	Industrial users, utility companies, neighborhood associations
Level of Immediate Capability:	Medium
Estimated Timeline:	1 year
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards. Implement activities to protect human life, property and natural systems.

ST-EQ#10 Revise seismic design requirements for existing buildings.

Key Issues Addressed

- In October of 2004, the Council directed the Bureau of Development Services to condut a risk assessment of the City's inventory of un-reinforced masonry, plain concrete, and other older building types. The study should consider building types, occupancy uses, level of existing seismic strengthening, and costs to mitigate hazards, and the results shall be made available to augment the City's seismic safety policies and programs.

Ideas for Implementation, and General Comments

- An amendment to the Draft Plan as adopted in December, 2004 proposed by Commissioner Leonard.
- A Seismic Safety Committee shall be assembled to direct and review the study, and develop recommendations and potential revisions to Title 24.85.
- The Seismic Safety Committee shall report findings and make recommendations to the City Council no later than January 1, 2006.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Portland Office of Emergency Management
External Partners:	
Level of Immediate Capability:	Medium
Estimated Timeline:	1 year
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards. Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-EQ#1 Evaluate funding alternatives that might accelerate seismic retrofitting of the City of Portland's bridges.

Key Issues Addressed

- Portland's bridges are critical to the mobility of Portland's residents and to the economy of the region. The bridges don't reflect current seismic design and need to be retrofitted. Though a priority list exists for retrofitting, funds specific to these projects may not be immediately available. Instead, consider retrofitting bridges with existing funds as other repairs occur.

Ideas for Implementation

- Evaluate retrofit priority list and potentially match with proposed maintenance list; determine if opportunities exist to combine efforts.

General Comments

- While a retrofit priority list with estimated cost does exist, no retrofits have been accomplished to date.

Coordinating Organization:	Portland Office of Transportation
Internal Partners:	none
External Partners:	Oregon Department of Transportation
Level of Immediate Capability:	High
Estimated Timeline:	15 yrs.
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems. Establish a disaster-resilient economy.

LT-EQ#2 Conduct a vulnerability analysis of Portland's sewer system to identify elements with the potential for failure.

Key Issues Addressed

- Sewer line failure in an earthquake could impact emergency transportation routes and affect public health and safety.

Ideas for Implementation

- Update Environmental Services Sewer Map to show vulnerable sewers, and overlay them with critical transportation routes. Consider pump stations and standby power capability in the assessment.
- Develop mitigation plan for collection system most likely to be impacted by liquefaction.

General Comments

- Ruptured sewer pipelines could cause raw sewage to back up into private property or overflow into streets. Repair on large diameter sewers would be involved and take a significant amount of time.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Corporate Geographic Information Systems, Portland Department of Transportation, Fire Department, Police Department, Portland Office of Emergency

	Management, Bureau of Water
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	5 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-EQ#3Develop a plan to strengthen sewer infrastructure in areas where street overlays and sewers have potential to collapse in a seismic event.

Key Issues Addressed

- Sewer pipes cannot be readily assessed post earthquake; conducting a pre assessment could identify vulnerabilities in key routes.

Ideas for Implementation

- Convene key groups to review below level street systems.
- HAZUS mapping can be used. Maps of large diameter pipes are available through Portland Office of Emergency Management.
- Develop capital program to strengthen pipelines in/under critical transportation corridors (e.g. rail, light rail, streets).

General Comments

- Failure of large diameter sewers can cause large sink holes in the surrounding ground.

Coordinating Organization:	Portland Office of Transportation
Internal Partners:	Corporate GIS; Bureau of Maintenance, Bureau of Environmental Services, Bureau of Water, Portland Office of Emergency Management
External Partners:	none
Level of Immediate Capability	Low
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-EQ#4 Develop a sewer failure response plan.

Key Issues Addressed

- Currently, there is no plan in place to address response to failure of sewer lines as a result of seismic (or other) events,

Ideas for Implementation

- Develop a list of pre-qualified contractors to provide emergency response.
- Address public health and water quality issues that may result from sewer backups and overflows.

General Comments

- Action item should be dependent on completion of a vulnerability assessment.

Coordinating Organization:	Environmental Services
Internal Partners:	Corporate GIS, Maintenance, Environmental Services, Bureau of Water
External Partners:	Department of Environmental Quality, NOAA Fisheries, US Fish and Wildlife Service, Utilities, COMNet, Private industry
Level of Immediate Capability:	Low
Estimated Timeline:	5 + years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-EQ#5 Develop an educational program that targets homeowners, providing them with inexpensive methods that they can use to strengthen their homes against earthquake damage.

Key Issues Addressed

- Inexpensive methods (such as anchoring a home to its foundation and strapping water heaters to walls) are available to lessen the damage earthquakes can cause. Widespread implementation of these measures would reduce earthquake losses in existing residential developments, and will cost very little for the city.

Ideas for Implementation

- Convene a committee from City bureaus that have frequent contact with the public to discuss ways of increasing inexpensive in-home mitigation.
- Add an employee to develop public education materials that show home mitigation methods.
- Simplify the permit process required to perform in-home mitigation.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Bureau of Development Services, Bureau of Water, Fire Department
External Partners:	residential homeowners, neighborhood associations
Level of Immediate Capability:	medium
Estimated Timeline:	2 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population. Implement activities to protect human life, property and natural systems.

LT-EQ#6 Assess the vulnerability of the water distribution system to seismic events; work toward hardening the system.

Key Issues Addressed

- Portland's water system serves approximately a quarter of the State's population, and many parts of the system are more than 100 years old. The water system would not be able to withstand a significant seismic event without incurring substantial damage. Substantial damage to the water system could take months or even years to repair.

Ideas for Implementation

- Complete the Distribution System Master Plan and Condition Assessment to identify vulnerabilities in the distribution system, including seismic vulnerabilities in key components of the distribution system.
- Periodically update the Infrastructure Master Plan and System Vulnerability Assessment.
- Develop an asset management plan to prioritize long term maintenance and replacement of water system infrastructure
- Improve or replace facilities at Interstate in order to provide a seismically hardened site that will be functional after a seismic event.
- Replace one of the above ground conduit bridge crossings of the Sandy River with an underground crossing that will be hardened to withstand a seismic event.
- Replace conduit trestle crossings with underground piping, prioritize so that one conduit is hardened from Headworks into town.
- Increase the capacity of the secondary source of supply at Columbia South Shore Wellfield by 20 million gallons per day (MGD) to provide for adequate backup supply capacity during an emergency, and to complement previous seismic upgrades to the wellfield.
- Construct new conduit bypass to allow bypass of Powell Butte Reservoir in an emergency
- Seismically upgrade Powell Butte reservoir.

General Comments

- The Water Bureau has initiated several studies of the vulnerability of the water system to natural hazards, including seismic vulnerabilities. The most comprehensive assessment was completed in September 2000, and is known as the System Vulnerability Assessment (SVA). Several projects were identified in the SVA to harden the backbone water supply system to withstand a seismic event, and the Bureau continues to make progress implementing the SVA recommendations. The Bureau plans to identify and address vulnerabilities in the distribution system with a Distribution System Master Plan.

- In addition to infrastructure improvements, the Bureau has also investigated emergency connections and mutual aid agreements with other water districts.

Coordinating Organization:	Bureau of Water
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	Medium for current projects, low for longer-term projects
Estimated Timeline:	5-10 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards. Implement activities to protect human life, property and natural systems.

LT-EQ#7 Partner with DOGAMI and USGS to obtain funding for completion of fault mapping and improved technology for the transfer of data and information.

Key Issues Addressed

- The locations and ages of the fault strands that comprise the Portland Hills fault zone and the East Bank fault have not been well characterized. Subsequently, important information regarding land use in those areas cannot be made.

Ideas for Implementation

- Support ongoing geologic and geophysical research by DOGAMI and USGS through letters and in-kind matching funding when appropriate.

General Comments

- Scientific agencies have embarked on a five-year mapping project (2003-2008) focusing on the faults in the Portland Metro area, but have not yet secured complete funding for the project.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	none
External Partners:	Oregon Department of Geology and Mineral Industries
Level of Immediate Capability:	High
Estimated Timeline:	15 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-EQ#8Study development regulations and policies to ascertain if regulations can be made to limit development of high-risk facilities in known areas of earthquake hazards.

Key Issues Addressed

- Some areas of Portland are more prone to earthquake risk; they are more likely to experience landslides, liquefaction, and ground amplification. Policy and zoning requirements could be used to regulate buildings that house critical facilities, large public assembly spaces, or hazardous materials in such high-risk areas.

Ideas for Implementation

- Convene a committee of Bureaus that regulate development to study ways to revise regulations. Incorporate future known data such as earthquake fault locations when data becomes available.

General Comments

- Hazardous developments can be moved from the high-risk earthquake areas without large increases in development costs.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Bureau of Development Services, Bureau of Planning, Portland Department of Transportation, Bureau of Fire
External Partners:	Private developers, general public
Level of Immediate Capability:	Low
Estimated Timeline:	5-10 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

LT-EQ#9 Assess the stability of levees in the Columbia Corridor area, and develop appropriate emergency response plans to address potential levee failure and associated hazards.

Key Issues Addressed

- Much of the Columbia corridor (which contains a high concentration of industrial and employment uses) is protected by levees; the ability of these levees to survive an earthquake is not fully known.

Ideas for Implementation

- Work with the U.S. Army Corps of Engineers, the Port of Portland, and the Multnomah County Drainage District to assess levee stability.
- Based on these assessments, plans to (1) strengthen the levees against damage in earthquakes, (2) evacuate the area in the event of levee failure, and (3) mitigate potential ground or surface water contamination from hazardous materials should be developed.

Coordinating Organization:	Portland Office of Emergency Management
Internal Partners:	Bureau of Water, Fire Bureau, Bureau of Environmental Services, Bureau of Maintenance
External Partners:	U.S. Army Corps of Engineers, Multnomah county Drainage District, Port of Portland, Department of Environmental Quality.
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards. Implement activities to protect human life, property and natural systems.

Earthquake Resource Directory

City Resources

Portland Office of Emergency Management (POEM)

POEM coordinates citywide emergency management programs including citizens, businesses, employees, and partners of the City. As the largest city in the State, Portland's resources are extensive, without boundaries, and multi-faceted. To be effective, the City partners and collaborates across the region to ensure that activities of mitigation, preparedness, response, and recovery are intertwined with the greater region for greater citizen protection, greater economic stability, and greater in-depth coverage of our assets.

Contact: Director, POEM
Address: 1001 SW 5th Ave, Suite 650, Portland, OR 97204
Phone: 503-823-4375
Fax: 503-823-3903

Portland Fire & Rescue

The Portland Bureau of Fire & Rescue is the responding agency in charge of plan development for the coordination of an earthquake event. With 27 stations across the Portland area and many more regional partners in the fire service, the Bureau of Fire and Rescue lends a trained force that has familiarized itself with the buildings' plans, the street network, and the neighborhood of their fire management areas. With this knowledge they know where vulnerable people live and can work with the community to save lives and property expediently.

Contact: Chief
Address: 55 SW Ash; Portland, OR 97204
Phone: 503-823-3700

Bureau of Development Services

Bureau of Development Services issues building permits, performs land use reviews, and promotes compliance with the zoning codes and the state adopted construction codes.

Contact: Director
Address: 1900 SW 4th Ave; Portland, 97201
Phone: 503-823-7300

County/ Regional Resources

Metro

Metro manages the urban growth boundary and developed the 2040 growth concept. Metro provides land-use planning services and provides maps and data to businesses, local government, and citizens. Metro helps residents and governments protect fish and wildlife habitat. Metro's transportation planning section develops the regional transportation plan, sets transportation funding priorities, and leads the region's efforts to plan and implement roadway and transit improvements. Metro's programs provide travel options and design livable streets.

Contact:	Metro Regional Center
Address:	600 NE Grand Ave., Portland, OR 97232-2736
Phone:	(503) 797-1700

Regional Emergency Management Technical Committee (REMTEC)

Regional Emergency Management Group (REMG)

Emergency Management professionals coordinate regional resources and resolve regional issues through the "hands on" technical committee which proposes and reports to the "public official level" REMG. Recently, the committee has developed maps for regional emergency response routes.

Contact:	Committee Chair
Phone:	503-642-0371

Multnomah County Emergency Management

Responsible for the coordination of county programs such as Public Health, County Roads, Animal Control, libraries, county jails, and the cities within the un-incorporated areas of the county.

Contact:	Emergency Management Director
Address:	501 SW Hawthorne; Portland, OR 97214
Phone:	503-988-4233

State Resources

Department of Land Conservation and Development (DLCD)

DLCD administers the State's Land Use Planning Program. The program is based on 19 Statewide Planning Goals including Goal 7, the goal specifically related to flooding and other natural hazards. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance and conducts workshops, reviews local land use plan amendments, and works interactively with other agencies.

Contact:	Natural Hazards Program Manager
Address:	635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone:	(503) 373-0050
Fax:	(503) 378-6033
Website:	http://www.lcd.state.or.us/hazards.html

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 to reduce the future loss of life and property due to potentially devastating earthquakes, tsunamis, landslides, floods, and other geologic hazards. The Department has mapped earthquake hazards in most of western Oregon.

Contacts: Deputy State Geologist, Geohazards and Coastal Hazards Team Leaders
Address: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
Website: www.oregongeology.com

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
Phone: (503) 378-4133
Fax: (503) 378-2322
Website: http://www.cbs.state.or.us/external

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 disaster support to local governments and works with BCD to deploy additional building inspectors when needed for damage assessment.

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/

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
Email: Nature.of.NW@state.or.us
Website: http://www.naturenw.org/geo-earthquakes.htm

Federal 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 that reports to the President. FEMA's purpose is to reduce loss of life and property and to 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 coordinates the federal response and provides disaster relief funds following a natural hazard event and works most closely with Oregon Emergency Management (OEM).

Contact: Public Affairs Officer, FEMA, Federal Regional Center,
Address: 130 228th Street, St., Bothell, WA 98021-9796
Phone: (425) 487-4610
Fax: (425) 487-4690
Email: opa@fema.gov
Website: http://www.fema.gov/library/quakef.htm

US 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
Website: http://neic.usgs.gov

Building Seismic Safety Council (BSSC)

The Building Seismic Safety Council (BSSC), established by the National Institute of Building Sciences (NIBS), deals with 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
Phone: (202) 289-7800
Fax: (202) 289-1092
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 (British Columbia), and one Canadian Territory (Yukon). The organization has primarily sought 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.com
Website: http://www.wsspc.org/

Cascadia Region Earthquake Workgroup (CREW)

CREW provides information on regional earthquake hazards, facts, and mitigation strategies for the home and business office. 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. The workgroup seeks 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 provides, businesses and governmental agencies in order to improve the viability of communities after an earthquake.

Contact: CREW, Executive Director
Address: 1330A S. 2nd Street, #105, Mount Vernon, WA 97273
Phone: (360) 336-5494
Fax: (360) 336-2837
Website: http://www.crew.org/

Additional Resources

Publications

Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools and is written for local government employees and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides that cover flooding, wildfires, landslides, coastal hazards, and earthquakes. You can write, call, fax, or go on-line to obtain this document.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Special Paper 32: Geologic Hazards: Reducing Oregon's Losses, John D. Beaulieu and Dennis L. Olmstead, (1999) Oregon Department of Geology and Mineral Industries.

The authors summarize the more technical Special Paper 31 on mitigating geologic hazards in Oregon. The paper outlines the strategy to mitigate for natural hazards and offers specific information on geologic hazards and multi-hazard scenarios.

Contact: DOGAMI
Address: 800 NE Oregon St., Suite 965, Portland, Oregon 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
Website: http://www.oregongeology.com/

Special Paper 29: Earthquake damage in Oregon: Preliminary estimates of future earthquake losses, Yumei Wang and J.L. Clark, (1999) Oregon Department Of Geology And Mineral Industries.

The authors analyzed all young faults with a 500-year return interval and projected potential damage. The study notes that Multnomah, Washington, and Clackamas counties are among those with the highest risk due to located faults and large numbers of unreinforced masonry buildings.

Contact: DOGAMI
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

Land Use Planning for Earthquake Hazard Mitigation: A Handbook for Planners, 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.

Contact: Natural Hazards Research and Applications Information Center
Address: University of Colorado, 482 UCB, Boulder, CO 80309-0482
Phone: (303) 492-6818
Fax: (303) 492-2151
Website: http://www.colorado.edu/UCB/Research/IBS/hazards

Using Earthquake Hazard Maps: A Guide for Local Governments in the Portland Metropolitan Region; Evaluation of Earthquake Hazard Maps for the Portland Metropolitan Region Spangle Associates, (1998/1999) Urban Planning and Research, Portola Valley, California.

These two publications are useful for local governments concerned with land use in earthquake hazard areas. The proximity of Washington County to Portland and their interactive communities make these guides applicable to the County. The publications are written in clear and simplistic language and address issues such as the application of earthquake hazard maps to land use decisions.

Contact: DOGAMI
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

Public Assistance Debris Management Guide, Federal Emergency Management Agency (July 2000).

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, strong debris management should also be integrated into mitigation activities. The *Public Assistance Debris Management Guide* is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov/r-n-r/pa/dmgtoc.htm

City of Portland Earthquake Plan; Portland Office of Emergency Management; Portland Bureau of Fire & Rescue – January 2003

This plan lists the organizations and contacts that are partners in the response and recovery of an earthquake event. Updated every 5 years, this plan outlines the responsibilities of the City.

Contact: Director
Address: 1001 SW 5th Suite 650 Portland OR 97204
Phone: 503-823-2691
Website: portlandonline.com/oem

Earthquake Loss Estimation Pilot Study for the Portland Metropolitan Region; National Institute of Building Sciences; Federal Emergency Management Agency ; Metro Natural Hazards Mitigation Planning Workshop – March 13, 1997

Loss estimations in this report were generated by using the FEMA/NIBS Earthquake Loss Estimation Methodology. The loss estimation study was implemented using a software program called HAZUS. The study area included was the Portland Metro's Urban Growth Boundary with a population of 1.16 million people. This was the first use of HAZUS to study Portland's losses; the estimates cover fire losses, debris, and direct economic loss for buildings, shelter, transportation, and utilities.

Contact: METRO GIS Specialist
Address: Metro, 600 NE Grand Ave. Portland 97232
Phone: 503-797-1595

Earthquake Endnotes

[1] Northwest Geology News - Milwaukie trench yields evidence of ancient quakes, Oregon Department of Geology and Mineral Industries (DOGAMI), *http://www.oregongeology.com/news&events/MilwaukieTrench.htm*

[2] Interagency Hazard Mitigation Team, State Hazard Mitigation Plan (2000) Oregon State Police – Office of Emergency Management

[3] The Pacific Northwest Seismograph Network - Notable Pacific Northwest Earthquakes Since 1993, *http://www.geophys.washington.edu/SEIS/EQ_Special/pnwtectonics.html*

[4] Oregonlive.com, (May 14, 2003) http://www.oregonlive.com/search/index.ssf?/base/science/105291437197590.xml?oregonian?scg

[5] Hill, Richard. "Geo Watch Warning Quake Shook Portland 40 Years Ago." *The Oregonian*, October 30, 2002

[6] *The Valley Times* March 8, 2001 Vol.81 No.10

[7] ibid.

[8] ibid.

[9] Hill, Richard. “Geo Watch Warning Quake Shook Portland 40 Years Ago.” *The Oregonian*, October 30, 2002

[10] Hill, Richard. “Geo Watch Warning Quake Shook Portland 40 Years Ago.” *The Oregonian*, October 30, 2002

[11] Wong, Ivan G and Bott Jacqueline D.J. (November 1995). A look back at Oregon’s earthquake history, 1841- 1994. Oregon Geology 57 (6). 125.

[12] Wong, Ivan G and Bott Jacqueline D.J. (November 1995). A look back at Oregon’s earthquake history, 1841- 1994. Oregon Geology 57 (6). 125.

[13] DOGAMI Risk Perception Survey (1999)

Page 9-4 Community Planning Workshop, September 2001

[14] Wong, Ivan G and Bott Jacqueline D.J. (November 1995). A look back at Oregon’s earthquake history, 1841- 1994. Oregon Geology 57 (6). 125.

[15] Hill, Richard. “Geo Watch Warning Quake Shook Portland 40 Years Ago.” *The Oregonian*, October 30, 2002

[16] Community Planning Workshop, 2002

[17] California Department of Conservation, California Geological Survey, 2002; Guidelines for Evaluating the Hazard of Surface Fault Rupture, Note 49.

[18] Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000), Ch. 8, pp.7

[19] Personal Interview, Burns, Scott. Portland State University, Department of Geology, June 2003

[20] Ibid

[21] Community Planning Workshop, 2002

[22] Debris Quantity Analysis for a Far-Field Seismic Event in the Portland Metro Region; 5-1-99; Hasenberg, Rad, Delco; PSU DCE

[23] Burby, R. (Ed.) *Cooperating with Nature* (1998) Washington D.C.: Joseph Henry Press.

[24] Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000), Ch. 8, pp.7

[25] Burby, R. (Ed.) *Cooperating with Nature.* (1998) Washington D.C.: Joseph Henry Press.

[26] Quakex 2003, “Generic Player’s Handbook”
http://www.osp.state.or.us/oem/programs/earthquake/quakex%202003/quakex_2003.htm

[27] Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000), Ch. 8, pp.13

[28] Personal Interview, Peggy Collins, February 24, 2000

[29] United States Geological Survey, Geologic Division, Earthquake Information: reducing hazards, http://quake.wr.usgs.gov, October 19, 1999

[30] Personal Interview, St. Cecelia School

Section 10
Severe Weather

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This chapter is concerned with extreme and severe weather events and focuses on severe winter storms and windstorms. Flooding and landslide are not included in this chapter but are covered separately in Section 7 and 8.

Why is Severe Weather a Threat to Portland?

Severe storms can produce rain, freezing rain, ice, snow, cold temperatures, and high winds. High winds, especially when accompanied by ice storms, can destroy trees and power lines and potentially interrupt utility services. Because it can disrupt essential regional services such as public utilities, telecommunications, and transportation routes, severe weather events pose a significant threat to life, property, and the local economy in City of Portland.

Historical Extreme and Severe Weather

Regional Severe Weather Events

Destructive storms that produce heavy snow, ice, and high winds have a long history in northwestern Oregon. The region's largest winter storms occurred in 1937 and 1950, and the most destructive windstorm occurred in 1962.

The Columbus Day storm in 1962 was the most destructive windstorm ever recorded in Oregon in terms of both loss of life and property damage.[1] Damage was the most severe in the Willamette Valley.[2] The storm killed thirty-eight people and imposed more than $200 million in damages. Hundreds of thousands of homes were without power for short periods, while others were without power for two to three weeks. The storm left more than 50,000 homes damaged and nearly 100 destroyed. Entire fruit and nut orchards were destroyed and livestock killed as barns collapsed and trees blew over. Intense wind speeds were recorded in the metropolitan areas with gusts of 116 mph on the Portland Morrison Bridge and 90 mph peak gusts in Hillsboro.

While relatively rare, tornados can and do occur in the Portland metropolitan area. A small, short-lived tornado near Forest Grove in June 1966 moved from the southwest to the northwest through a corn field and prune orchard, uprooting 20 to 25 prune trees. The tornado occurred during the late afternoon, had a path length of one-fourth mile, and was 60 yards in width at the widest point. There was no other significant damage reported with the tornado. Heavy rain occurred at the same time, but no hail or lightning was reported.[3]

Three back-to-back storms in January 1950 severely affected infrastructure, residents, and businesses across the State. Deep snow drifts closed all highways west of the Cascades and through the Columbia River Gorge. Sleet that turned to freezing rain caused unsafe conditions on highways and damaged trees and power lines. During a severe sleet event on January 18, hundreds of motorists were stranded in the Columbia River Gorge. Freezing rain downed many trees and power lines, creating widespread power outages across northwestern

Oregon. Hillsboro reported 42.4 inches of snowfall during this event. [4.] Ultimately, hundreds of thousands of dollars worth of public and private property was damaged.

A serious storm in February 1937 resulted in the death of five people in the Portland area. Record snowfalls in Portland created snowdrifts up to 25 feet in height and a low temperature of 17 degrees Fahrenheit. Schools and businesses were closed and flood damage was reported in downtown Portland basements as the snow melted.[5] All major highways were closed, shutting off the main transportation arteries for travel and business.

A December 1919 snowstorm was the third heaviest snowfall-producing storm to hit Oregon. The Columbia River froze over, closing the river to navigation from the confluence with the Willamette River upstream. The snowstorm affected nearly every part of the State as heavy snow fell over a widespread area. [6]

A six-day storm in January 1909 brought many locations more snow than is normally accumulated in an entire year. [7] Finally, a storm between December 20 and 23 of 1892 produced substantial snowfall across most of northern Oregon. The greatest snowfall amounts were reported in northwestern Oregon where storm totals ranged from 15 to 30 inches.[8]

City Severe Weather Storms

Historically, Portland has been affected by severe weather including snow, ice, and high winds. The Columbus Day Storm of 1962 brought extensive damage to Portland and the rest of the State. The storm significantly damaged many other structures throughout the City and caused multiple injuries.

Another storm hit Portland on October 2, 1967. Again, this storm caused significant damage in the City due to high winds much like those of the Columbus Day Storm. Many of the same victims of the Columbus Day Storm were once again affected by the 1967 storm.

In January 1969 one of the fiercest winter storms in recent history caused heavy icing on Portland streets and sidewalks. Yet another major winter storm occurred in 2003. December 26 of that year began a 19-day cold snap that brought as much as 19 inches of snow in the Columbia Gorge. In the City of Portland, eight inches of snow followed and three inches of freezing rain covered the City. County personnel worked 24 hours a day in 12-hour shifts for 11 days de-icing, sanding, and plowing the roads of the area. A total of 11 county employees maintained the many moveable bridges in the City until accumulated snow and ice rendered the drawbridges inoperable.

The governor declared the storm a "significant event;" the county subsequently received $452,000 from FEMA, most of which was used to cover overtime costs for county employees.

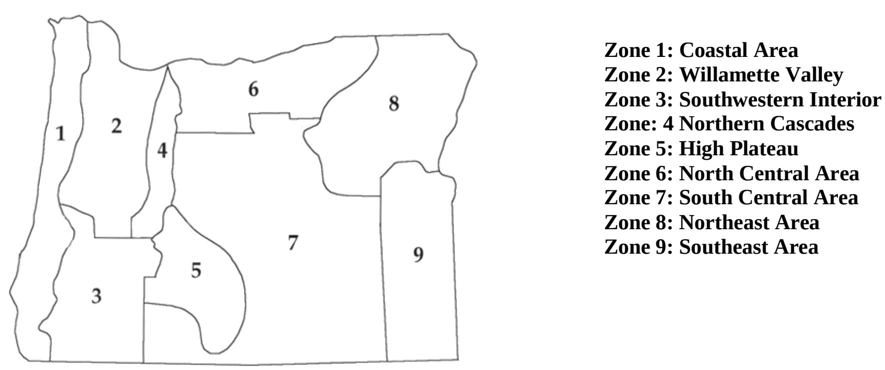
Characteristics of Severe Winter and Windstorms in Portland

Weather patterns

Severe storms affecting Portland with snow and ice typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from October through March.[9] A majority of the destructive surface winds in Oregon and, specifically, Portland, are from the southwest.[10] Some winds blow from the east but most often do not carry the same destructive force as those from the Pacific Ocean.

Portland average rainfall is approximately 37 inches a year.[11] The National Climatic Data Center has established climate zones in the US for areas that have similar temperature and precipitation characteristics. Oregon's latitude, topography, and proximity to the Pacific Ocean give the State diverse climates. Portland is in Zone 2 (see Figure 10-1). The climate in Zone 2, including Portland and surrounding areas, generally consists of wet winters and dry summers. In 2001, 89 percent of the precipitation occurred between October and May; 11 percent of the annual rainfall occurred between June and September, and 4 percent occurred in July and August.[12] There is an average of only five days per year of measurable snow with accumulations rarely measuring more than two inches.[13]

Figure 10-1. Oregon Climate Zones



Source: Taylor, George H. and Hannan, Chris, *The Oregon Weather Book*, OSU Press (1999)

Snow

While snow is relatively rare in western Oregon, the Columbia Gorge provides a low-level passage through the mountains. Cold air lying east of the Cascades often moves westward through the Gorge and funnels cold air into the Portland Area. If a wet Pacific storm happens to reach the area at the same time, larger than average snow events may result.[14]

An example of this type of snowstorm is the previously described storm of January 1980 where snow, ice, wind, and freezing rain hit Oregon statewide. In the Portland area alone, 200,000 customers were left without power or phone service for several days. More than 100 boats with a combined value in excess of $3 million sunk in the Gorge and Portland, resulting in one fatality.

Ice

Ice storms occasionally occur in northern areas of Oregon when cold air flows westward through the Columbia Gorge.[15] Like snow storms, ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation including freezing rain, sleet, and hail.[16]

Freezing rain can be the most damaging of ice formations. While sleet and hail can create hazards for motorists when they accumulate, freezing rain can cause the most dangerous conditions within a community. As described earlier, ice buildup can bring down trees, communication towers, and wires and create hazards for property owners, motorists, and pedestrians alike. The most common freezing rain problems occur near the Columbia Gorge. As noted above, the Gorge is the most significant east-west air passage through the Cascades. Rain arriving from the west can fall on frozen streets, cars, and other sub-freezing surfaces and create dangerous conditions.[17] Much of the damage from ice storms occurs when the ice thaws: although some tree limbs fall from the weight of the ice, many broken tree limbs are held in place by the frozen ice structure. Water lines that have frozen in the storm will begin to leak as the ice melts. As a result, storm emergency periods often extend beyond the freeze to include the thaw.

> Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

Wind

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Most of the winds that come from the west are subdued by the time they reach the Portland area because of the influence of the Coast Range. The most destructive winds are those which blow from the south, parallel to the major mountain ranges.[18] Windstorms affect areas of Portland with significant tree stands as well as areas with exposed property, major infrastructure, and above ground utility lines. The lower wind speeds typical in the valleys are still high enough to knock down trees, bring down power lines, and cause other property damage. The Columbus Day Storm of 1962 was a classic example of a southerly windstorm. The storm developed well off the coast of California and moved from the southwest, then turned and came directly from the south toward the Oregon Coast. Atmospheric pressure fell rapidly ahead of the storm center and rose rapidly once the storm center passed, creating very tight and sharp pressure gradients. When strong surface winds are further reinforced by upper airflow in the same direction (as was the case in the Columbus Day Storm), the surface wind speed is enhanced.[19]

Severe Summer Heatstorms

Portland occasionally experiences heatstorms, defined as periods where temperature exceeds 90 degrees Fahrenheit for more than three days, 6-day strings.[20] The severity of the storm increases when high temperatures are accompanied by warm winds. These conditions cause the tissue in trees to shrink and contract. The wood in trees twists and cracks, causing limb failures that damage property, disable systems, and cause personal injuries. In addition to tree failures, extreme summer heat causes pressure on the electrical system as people increase their use of air conditioners. Water supply systems can also become stressed. Older citizens and others who are medically compromised can experience increased rates of heat exhaustion and stroke. Heat storms usually result in stagnant air and air quality alert days.

Severe Weather Community Issues

Life and Property

Severe weather can be a deceptive killer. Storms—which bring snow, ice, and high winds—can have a significant impact on life and property. Many severe winter storm deaths occur as a result of traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold. Debris carried along by extreme winds can contribute directly to loss of life and indirectly through the failure of protective structures (i.e., buildings) and infrastructure.

Property is at risk due to flooding (see Section 7) and landslides (see Section 8) that result from heavy snowmelt. Additionally, ice, wind, and snow can affect the stability of trees, power lines, telephone lines, and television and radio antennas. Falling trees and limbs affected by these events and saturated soils can become hazards for houses, cars, utilities, and other property. These conditions can be major hindrances to emergency response and disaster recovery.

Windstorms have the ability to cause damage more than 100 miles from the center of storm activity. Wind pressure can create a direct frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. The forces applied by the wind to the building's protective envelope (doors, windows, and walls) can cause failure of some of the building's components and considerable structural damage. The effects of wind speed are shown in Table 10-1.

Table 10-1 Effects of Wind Speed

WIND SPEED (MPH)	WIND EFFECTS
25-31	Large branches will be in motion.
32-38	Whole trees in motion; inconvenience felt walking against the wind.
39-54	Twigs and small branches may break off of trees; wind generally impedes progress when walking; high profile vehicles such as trucks and motor homes may be difficult to control.
55-74	Potential damage to TV antennas; may push over shallow rooted trees especially if the soil is saturated.
75-95	Potential for minimal structural damage, particularly to unanchored mobile homes; power lines, signs, and tree branches may be blown down.
96-110	Moderate structural damage to walls, roofs and windows; large signs and tree branches blown down; moving vehicles pushed off roads.
111-130	Extensive structural damage to walls, roofs, and windows; trees blown down; mobile homes may be destroyed.
131-155	Extreme damage to structures and roofs; trees uprooted or snapped.
Greater than 155	Catastrophic damage; structures destroyed.

Source: Washington County Office of Consolidated Emergency Management

Infrastructure

Traffic

Severe weather can cause prolonged and extreme traffic disruptions. The importance of transportation is never more noticeable than in situations where travel is difficult or dangerous. Both property damage and loss of life are risks to those who must drive. Additionally, traffic delays or blockages can seriously hinder the ability of emergency service providers.

Economic concerns rise during storms that cause dangerous road conditions since many people choose to stay home in these situations. To address these concerns, Portland has participated in the designation of emergency transportation routes with Multnomah, Washington, Clackamas, and Columbia Counties as well as Clark County in

Washington State. These emergency transportation routes will receive high priority for assessment, clearance, and restoration following a natural hazard event. These routes will be used to move personnel and supplies throughout the region and to bring in support from outside the area.

Many of Portland's citizens rely on alternative modes of transportation such as public transit, biking, or walking for their daily commutes. During winter storms, buses will travel on designated snow routes, leaving portions of the City without access to public transit. Portland's light rail system can also be impacted; during the most recent ice storm, the rails were frozen and trains could not travel. Winter storms are dangerous for pedestrians as well. Sidewalks are not always prioritized for snow clearance, a situation that is worsened when snow plows clear snow and ice from the streets and push it onto sidewalks. Pedestrians are hereby forced to walk in the icy streets with traffic.

Utilities

Historically, falling trees have been the major cause of power outages resulting in interruption of services and damaged property. The issue of weather related power outages should be addressed as many Portland residents rely on electricity for heat. Even homes using natural gas typically require electricity for the system to operate and run circulation fans and thermostats. Natural gas distribution systems also rely to some degree on electrical service to keep the system operational and widespread power outages, can interrupt that service.

Power loss is also a concern economically as businesses may have to close during power outages. In a business survey completed in 2002 for the City of Beaverton, 78% of the City's business owners indicated that loss of electricity would have a serious or moderate impact on their business, and 92% claimed electricity was critical or very important to their business. There is no reason to believe that City of Portland business owners would respond differently.

Many overhead wires are at risk from snow and ice accumulations that are beyond the design specifications. High winds can create flying debris and down utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown more than 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events.

Increasing population and new infrastructure in the City mean that more lives and property are exposed to risk; this situation creates a higher probability that damage will occur from severe weather events.

Water Lines

The most frequent water system problem related to cold weather is a break in cast iron mainlines. Breaks frequently occur during severe freeze events as well as during extreme cooling periods through the months of October, November, and December. In almost every severe winter storm previously described, broken pipes led to the closures of schools and business throughout Portland. In normal weather years, 15 and 30 breaks in main lines occur annually. Extended cold snaps can produce large numbers of breaks; for example, the January 2004 storm produced 2 main breaks in the water system in less than one week. During freezes, the broken mains not only result in lost water service to customers but also cause extensive property damage from spilled water.

Severe weather can also affect the water system in other ways. In September 2000, the Bureau of Water Works completed a System Vulnerability Assessment (SVA) of the water system. One of the “Very High Risk” hazards identified was loss of power from ice and wind storms. The Bull Run Headworks, distribution pump stations, and groundwater wells are among the most vulnerable facilities. Power interruptions at these facilities can have dramatic negative consequences to the water system.

Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property.

Tree Failure and Resulting Power Line Outages

According to Portland General Electric (PGE), trees are the leading cause of storm-related power outages in PGE’s service area.[21] Tables 10-2 and 10-3 contain Tree Failure Profiles developed by PGE for two of the most common tree failures in the PGE service territory. The profiles are developed from the data collected and used by PGE foresters in targeting "at-risk" trees during routine vegetation maintenance cycles.

Table 10-2. Tree Failure Profile - Species: Douglas fir *(Psuedotsuga menziesii)*

Failed Part	Description of failure/ Tree characteristics	Associated defects/ Indicators	Environment	Management History
BRANCH Frequency: High	Small dia. branches from mature trees; can sail up to 75 ft & wrap lines. Overhanging branch failure from snow/ice loading.	Evidence of previous branch failures.	Exposure to winds/gusts greater than 40 mph. Line downwind.	Side trimmed trees.
TRUNK Frequency: Low	Failure of multiple tops.	Old topping cut, previous break, decay present.	Wind or ice storms.	Previous topping.
	Interior trees, 3-8" dia.	Intermediate/suppressed trees.	Wind, snow/ice loading, recent exposure.	Thinning of stand, exposure as edge tree.
	Dead tree of any size in close proximity to line.	Entire tree dead for some time.	Line downwind.	
ROOT Frequency: High	Trees of all ages.	Evidence of other root failures.	Slight to moderate wind.	Site disturbance; leave trees from logging or development.
	Small, interior trees.	Poor taper, low live crown ratio, aggravating site characteristics.	Slight to moderate wind.	Thinning of stand; overstocked, unmanaged stands.

Source: Portland General Electric, Forester's Office, 2001; © Portland General Electric Co.

Table 10-3. Tree Failure Profile - Species: Bigleaf Maple *(Acer macrophyllum)*

Failed	Description failure/ characteristi	Associate defects/ Indicator	Environme	Manageme Histor
BRANCH Frequency High	Mature scaffold or during full out.	Decay present multiple attachment. dominant with included	Heavy rains after out in spring; heavy rains. Exposure winds/gusts than 30 mph. downwind, ivy	Natural previously pruned; history side
TRUNK Frequency: Low	Trunk failure base of tree up 12	Decay present trunk or at	On a slope, downwind, or covered	In unmanaged natural

Source: Portland General Electric, Forester's Office, 2001; © Portland General Electric Co.

Severe Weather Hazard Assessment

Severe Weather Hazard Identification

Severe weather is generally a prolonged event involving snow, ice, or wind. The characteristics of severe weather are determined by a number of meteorological factors including the amount and extent of snow or ice, air temperature, wind speed, and event duration. The severe weather events that affect the City most typically come from the northwest, the southeast, and through the Columbia River Gorge.

Precipitation, an additional element of severe weather, is measured in addition to wind speed by gauging stations. The Portland Bureau of the National Weather Service monitors the stations and provides public warnings on storm, snow, ice, and wind events as appropriate. The HYDRA rainfall network (maintained by the City of Portland Bureau of Environmental Services) collects information from a total of 38 stations within Portland's city limits. This information is updated hourly and is accessible to the public on-line at: http://or.water.usgs.gov/non-usgs/bes/.

Vulnerability Assessment

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through severe weather identification with an inventory of the existing development exposed to this hazard to assess potential property and personal impacts. [22] Data including the areas exposed to severe weather in Portland can be used to assess the population and total value of property at risk from severe storms.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for Portland's severe weather storm events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Severe weather can cause power outages and transportation and economic disruptions and pose a high risk for injuries and loss of life. The events can also be typified by a need to shelter and care for adversely impacted individuals. Portland has suffered severe weather in the past that brought economic hardship and affected the life safety of City residents. Future severe weather events may cause similar impacts citywide.

Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. The analysis is conducting using mathematical models and relies on information compiled during hazard identification and vulnerability assessments. Factors included in assessing severe weather risk include population and property distribution in the hazard area, the frequency of severe weather storm events, and information on trees, utilities, and infrastructure that may be impacted by severe weather. When sufficient data is collected for hazard identification and vulnerability assessment, a risk analysis can be completed. Insufficient data currently exists to complete a thorough risk analysis, but some areas of risk are well known. A brief summary follows.

In Portland, the infrastructure and population at risk from severe weather events varies depending on the type of storm. In a heatstorm, those without air conditioning are most likely to be impacted. Older citizens and others who are medically compromised experience increased rates of heat exhaustion and stroke. Ice storms can severely impact transportation networks and public transit. Commuters may experience difficulties getting to work and commerce might slow as trucks and trains are impacted. Traffic accidents also increase when ice and snow cover the roadways. Hypothermia is also an associated risk. Ice storms and windstorms can impact power lines, disrupting electricity to businesses and residents. Areas with significant tree stands are most likely to experience electrical outages as a result of ice or windstorms.

Mitigation Plan Goals and Existing 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 and guidance from the Portland Natural Hazards Mitigation Steering Committee. Goals for this mitigation plan address five categories:

1. Identify risk level and evaluate Portland's vulnerability to natural hazards.

2. Implement activities to protect human life, property and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resilient economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Existing Mitigation Activities

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

City Programs

Capital Improvement Plan

The City of Portland's Capital Improvements Plan (CIP) is a dynamic document that lists and prioritizes improvements and expansions of the City's infrastructure necessary to maintain adequate service levels to existing City residents and businesses and to accommodate population growth and land development. The CIP reflects the needs and priorities established by the City and the resources available to the City. The CIP can be modified during the fiscal year (through the supplemental budget process) as needs, priorities, and resources change. The CIP can assist the City of Portland in mitigating against severe weather events by improving infrastructure most prone to damage.

Urban Forestry Program

Portland's Department of Parks and Recreation Urban Forestry Program has a number of ongoing educational efforts designed to mitigate damage from downed trees during storms. The Program also has authority to identify and eliminate known hazards. The following is a brief summary of related activities.

Portland's municipal code gives the City Forester authority to require permits for planting of trees on public rights of way. The permitting system provides an opportunity to specify failure resistant species of trees and to set standards that reduce losses from tree failure. The City Forester has the authority to remove trees that threaten public safety and to require property owners to perform street tree maintenance activities to correct hazardous situations.

The Urban Forestry Program also provides a free inspection service for public street trees. Property owners who request this service are visited by an Urban Forestry Inspector who is trained to pre-identify many tree related hazards and advise property owners. The Neighborhood Tree Liaison program recruits and educates interested citizens in each of

Portland's 96 neighborhoods. These trained citizens educate their neighbors in proper tree care and report hazards in the community. Additionally, the program has created a number of brochures and other educational materials designed for property owners.

The Department of Parks and Recreation also has an Urban Forestry Response Team and a plan for responding to down trees on an individual or large scale.

Portland General Electric

Through the Right Tree-Right Place program, Portland General Electric (PGE) educates homeowners, landscapers, and tree propagators on tree species that will not be subject to ongoing stress by constant trimming. PGE distributes brochures that list low-growing trees that fit within the utility right-of-way and are compatible with small urban planting strips. The brochure includes information on how to select the correct tree, the energy-saving benefits of trees, and proper planting and pruning techniques. PGE offers tree owners a certificate to help defray the cost of a new tree that replaces one that is inappropriate.

PGE also runs a tree-trimming program and keeps a database of information in order to build profiles of trees that cause power line outages. PGE foresters work with local government and the public to assess and identify situations in which trees or power lines put life and property at risk. Calls and faxes to PGE's tree-trimming program result in immediate response by PGE to clear roads of fallen trees. PGE's database of tree failures intends to identify those trees that are at an above average risk.

Portland Water Bureau

The Water Bureau reviewed and identified facilities at risk of winter storms and identified power outages as the highest threat. This System Vulnerability Assessment (SVA) made recommendations for improvements to Bureau facilities to mitigate snow/ice accumulations from winter storm events. Much has been done to date and further activities are scheduled in the Bureau's Capital Improvement Plan. Thus far,

- Four mobile power generators have been added and some existing generators have been upgraded to keep the system moving when power failures occur.
- Standards for new pump stations and other key bureau facilities now include back-up power supply.
- Pipe standards now provide freeze protection, and the distribution system includes redundancies that assure water will flow even in the even of a break.
- An emergency operations plan has been developed, and emergency crews are quickly activated when needed.

Portland Bureau of Maintenance

Portland's Bureau of Maintenance maintains several plans designed to reduce losses from severe weather. These include:

- **Public Works Emergency Plan**. This plan contains debris management elements related to wind events as well as surface transportation route planning elements designed to reduce the potential impacts of weather events.
- **Portland Flood Plan**. This plan contains some mitigation elements relevant to wind and snow events and flooding.
- **Snow and ice Operations Plans**. This plan addresses facilities and locations to help lessen impacts through preparedness; the Plans also contain emergency transportation routes.

Bureau of Environmental Services

Portland's Bureau of Environmental Services maintains several plans and programs that reduce the impacts of heavy rain on the stormwater management system. The Combined Sewer Overflow Program mitigates the environmental damage that can occur when rains cause untreated sewage to run into waterways. The Stormwater Management Plan minimizes the impact that storm run-off has on the stormwater management system and the street infrastructure.

Bureau of Development Services

BDS maintains and implements the International Building Code which includes minimum standards for weather-resistant construction.

Bureau of Planning

The Bureau of Planning maintains and regularly updates Portland's Comprehensive Plan which addresses land use elements relevant to severe weather mitigation.

Office of Sustainable Development

The Office of Sustainable Development's Multifamily Assistance Program works with property owners and managers to market the benefits of energy efficiency and simplify the process of weatherizing rental properties. OSD provides technical information on insulation and high-efficiency windows, maintains a list of qualified contractors, and assists property owners in applying for rebates, state tax credits, and low-interest financing that may be available for energy-efficiency projects. The resulting energy-efficiency projects increase the value of the property, reduce tenants' energy bills, and improve indoor comfort. During an extreme winter storm event, residents in weatherized properties have additional protection against cold if there is an electricity blackout, since most local multifamily properties have electric space heat.

International Building Code

The City of Portland and the State of Oregon have adopted the International Building Code which includes specifications for new development to withstand snow and wind loads.

Dangerous Building Code

Title 29.40.020 of Portland's Municipal Code defines "Dangerous Buildings" and requires abatement for them. Dangerous buildings are those with structures that are overstressed because of snow or wind loading or because they require maintenance.

Seismic Design Requirements for Existing Buildings

Title 24.85 of Portland's Municipal Code includes requirements for existing buildings to be retrofitted for earthquake resilience. By strengthening a building for seismic forces, the building is also strengthened for lateral wind forces and will be more resilient in severe weather.

Regional Programs

Emergency Transportation Routes Plan

Metro, in conjunction with the Regional Emergency Management Technical Committee, is currently writing an Emergency Transportation Routes Plan that identifies critical transportation networks to improve efficiency of response and reduce impacts on public safety and commercial traffic following a disaster. Severe weather frequently impacts the transportation system on a regional scale.

Federal Programs

National Weather Service

The Portland Office of the National Weather Service issues severe weather watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

Severe Weather Mitigation Action Items

The severe weather mitigation action items provide direction on specific activities that the City, organizations, and residents can undertake to reduce risk and prevent loss from severe weather events. There are two short-term and five long-term severe weather action items described below. Each action item is followed by ideas for implementation that can be used by the steering committee and local decision makers in pursuing implementation strategies. This section does not include action items related to flood.

Short-term Action Items

ST-SW#1: Develop an education/outreach program in collaboration with other bureaus regarding winter preparedness that targets Portland's neighborhoods.

Key Issues Addressed

- Individuals and businesses need to be prepared to reach defined snow routes, protect utilities, and care for themselves with limited City assistance during snow and ice events.

Ideas for Implementation

- Compile a list of contractors willing to undertake snow removal from residential streets and driveways compiled in current City snow plan and provided to neighborhood associations.
- Hold community meetings held to clarify expectations for City snow removal and private responsibilities for preparedness.
- Create a media packet for use during annual snow and ice dry run.
- Create an educational flyer for inclusion in utility (water/sewer) bills and/or City Bureau newsletters.
- Coordinate with Multnomah County social services and participate in the NET program to reach citizens.
- Coordinate with related efforts in an all-hazard program with seasonal shifts in emphasis.

General Comments

- Partially implemented already in City Emergency Operations Plan, Snow and Ice Annex.
- Education/outreach program needs development with additional internal and external partners, but substantial elements of it already exist or can be developed and implemented with little additional time and cost.

Coordinating Organization:	Bureau of Maintenance
Internal Partners:	Portland Office of Emergency Management, Water Bureau, Bureau of Environmental Services , Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1 year
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-SW#2: Acquire an additional facility for storage of anti-icing materials and expand anti-icing vehicle inventory

Key Issues Addressed

- There is a need to expand Portland's capability to pretreat key streets with an environmentally acceptable anti-icing agent. The expanded program would handle all critical routes for most minor snow/ice events without need for additional treatment after snow/ice formation, and would significantly reduce time to clear critical routes in more significant events.

Ideas for Implementation

- A facility has been identified for the storage of 40,000+ gallons of CMA, but the facility has not been acquired or put in use.
- Expansion of the application vehicle inventory is planned for a future budget cycle; it is important to assure that these plans are carried out.

General Comments

- An anti-icing (pretreatment) strategy is already in place using existing equipment. Storage expansion to be done over the next few months and fleet expansion to be phased in over several plan years.

Coordinating Organization:	Bureau of Maintenance
Internal Partners:	BGS/Facilities, Vehicle Services
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	3 months -- storage facility online 1- 3 yrs -- fleet expansion
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-SW#3: Manage the planting and maintenance of trees in the public right of way to minimize risk.

Key Issues Addressed

- Failing street trees and branches are a major contributor to power outages during storms and also contribute to street/road hazards. Assuring that appropriate species of trees are planted beneath electrical lines and in the right of way can minimize damage. Trees selected for planting beneath electrical lines should mature at a height that is below the level of the primary electrical lines. All street trees should be selected for their structural strength and durability.
- All street trees should be properly maintained to arboricultural standards to promote structural integrity and minimize failure.

Ideas for Implementation

- Control all planting and maintenance of trees in the right-of-way by City Ordinance and permit.
- Provide education, advice and free inspections to property owners to assure appropriate planting and maintenance of street trees.
- Provide for correction of violations and non-conforming situations through negotiations with property owner, penalties, and nuisance abatement procedures.

General Comments

- Implemented under Portland City Code, Urban Forestry Management Plan and Urban Forestry Emergency Response Plan.
- See narrative comments in framework draft.

Coordinating Organization:	City Forester (Parks and Recreation)
Internal Partners:	Bureau of Maintenance, City Attorney
External Partners:	Urban Forestry Commission, property owners, electrical utility companies, Friends of Trees (non-profit**)**
Level of Immediate Capability:	High
Estimated Timeline:	Immediate
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-SW#4: Visually assess overhead hazards during development permit reviews.

Key Issues Addressed

- Trees that show signs of structural defects, genetic defects, or deterioration are more likely to fail and cause damage to persons or property during severe weather events. Failing trees may also block roads impeding emergency vehicles and snow removal/sanding equipment.
- Many street tree defects and decay problems can be identified by a professional arborist's visual inspection.

Ideas for Implementation

- When urban forestry tree inspectors review remodeling and development projects for required street trees, they should also conduct a visual inspection of existing street trees. The urban forestry inspector can require defective trees to be repaired or removed and replaced.

Coordinating Organization:	Parks and Recreation, City Forester
Internal Partners:	Bureau of Maintenance, Bureau of Development Services
External Partners:	Permittee, Property owners
Level of Immediate Capability:	High
Estimated Timeline:	Immediate
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-SW#5: Develop, implement, and/or enhance strategies for debris management for severe winter storm events.

Key Issues Addressed

- During severe storms, downed trees and other debris can block roads that are crucial for emergency response. Debris removal is an important step in responding to a severe weather event and in recovering from one.

Ideas for Implementation

- Develop a coordinated management strategy for de-icing roads, plowing snow, clearing roads of fallen trees, and clearing debris from public and private property.

Coordinating Organization:	Bureau of Maintenance
Internal Partners:	Fire Bureau
External Partners:	Portland Office of Emergency Management
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-SW#6: Insulate residential buildings that house at-risk populations.

Key Issues Addressed

- Many at-risk populations (such as the elderly poor) are more susceptible to severe weather events because they live in poorly insulated housing. During severe weather events, these residents may suffer greater impacts than those who live in weatherized properties.

Ideas for Implementation

- Install insulation and other weatherization measures in single-family housing occupied by at-risk residents
- Minimize utility shut-offs by improving access to bill-paying assistance programs and providing self-help energy education to low-income and at-risk residents. In the past, the City has organized Energy Fairs and Fix-It Fairs, neighborhood-based events that connect residents with resource-conservation assistance, including weatherization and bill-paying assistance.

Participants are provided with technical information on insulation and energy-efficiency measures to lower energy bills, improve indoor comfort, and reduce the likelihood of losing utility service because of the inability to pay bills.

General Comments

- The existing Multifamily Assistance Program (implemented by the Office of Sustainable Development) could serve as a model for program development. Between 1987 and 2003, the City weatherized 2,800 homes through a similar program, Block-By-Block, that targeted low-income residents in single-family homes.

Coordinating Organization:	Office of Sustainable Development
Internal Partners:	none
External Partners:	Multnomah County, Energy Trust of Oregon
Level of Immediate Capabil	Low, no funding currently identified
Estimated Timeline:	1-2 years once funding is available
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-SW#7: Prioritize existing building stock for active review of Title 29 (Dangerous Building Code).

Key Issues Addressed

- Some buildings, especially older ones, may be “overstressed” and may be more severely impacted by severe weather events that include high winds or heavy snows. Portland’s municipal code provides a definition of “overstressed” and requires retrofit or repair. However, buildings are not actively reviewed for compliance with municipal code; some buildings that are dangerous may not be identified.

Ideas for Implementation

- Actively review existing building stock and require retrofit.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Fire Bureau
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Severe Weather Resource Directory

State Resources

Department of Land Conservation and Development (DLCD)

DLCD administers the State's Land Use Planning Program. The program is based on 19 statewide planning goals including Goal 7, the goal related to floods and other natural hazards. In order to help local governments address natural hazards effectively, DLCD provides technical assistance and conducts workshops, reviews local land use plan amendments, and works interactively with other agencies.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Oregon Department of Consumer and Business Services

The Building Codes Division of Oregon's Department of Consumer and Business Services is responsible for administering statewide building codes. Its responsibilities include adoption of statewide construction standards that help create buildings able to resist flood, wildfire, wind, foundation stability, and seismic hazards.

Contact: Building Codes Division
Address: 1535 Edgewater St. NW, P.O. Box 14470, Salem, OR 97309
Phone: (503) 373-4133
Fax: (503) 378-2322
Website: http://www.cbs.state.or.us/external/bcd

Oregon Climate Service

The Oregon Climate Service collects, manages, and maintains Oregon weather and climate data. OCS provides weather and climate information to those within and outside the State of Oregon and educates the citizens of Oregon on current and emerging climate issues. OCS also performs independent research related to weather and climate issues.

Contact: Oregon Climate Service
Address: Oregon Climate Service, Oregon State University
Strand Ag Hall Room 316, Corvallis, OR 97331-2209
Phone: (541) 737-5705
Website: http://www.ocs.orst.edu
Email: oregon@oce.orst.edu

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.

Contact: Office of Emergency Management
Address: 595 Cottage Street NE, Salem, OR 97310
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: http://www.osp.state.or.us/oem

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA's mission is "to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10
Address: 130-228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov/Reg-X/index.htm

National Oceanic and Atmospheric Administration (NOAA)

NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.

Contact: National Oceanic and Atmospheric Administration
Address: 14th Street & Constitution Avenue, NW, Room 6013, Washington, DC 20230
Phone: (202) 482-6090
Fax: (202) 482-3154
Website: http://www.noaa.gov
Email: answers@noaa.gov

National Weather Service, Portland Bureau

The National Weather Service (NWS) provides weather, hydrologic, and climate forecasts and warnings for the United States, its territories, and adjacent waters for the protection of life and property and the enhancement of the national economy. NWS data and products form a national information database and infrastructure that can be used by other governmental agencies, the private sector, the public, and the global community.

Contact: National Weather Service
Address: 5241 NE 122nd Ave, Portland, Oregon 97230
Phone: (503) 326-2340
Website: http://nimbo.wrh.noaa.gov/Portland
Email: clinton.rockey@noaa.gov

Additional Resources

American Red Cross

The American Red Cross is a volunteer-led humanitarian organization that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The Chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area including disaster planning, preparedness, and education.

Contact: American Red Cross, Oregon Trail Chapter
Address: P.O. Box 3200, Portland, OR 97208-3200
Phone: (503) 284-1234
Fax: (503) 284-4247
Website: http://www.redcross-pdx.org
http://www.redcross.org/services/disaster
Email: info@redcross-pdx.org

Institute for Business & Home Safety (IBHS)

IBHS was created by the insurance industry to reduce damage and losses caused by natural disasters. The IBHS website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

Contact: Institute for Business and Home Safety
Address: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
Phone: (813) 286-3400
Fax: (813) 286-9960
E-mail: info@ibhs.org
Website: http://www.ibhs.org/ibhs2

Publications

Public Assistance Debris Management Guide, Federal Emergency Management Agency (July 2000).

The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, strong debris management should also be incorporated into mitigation activities. The Public Assistance Debris Management Guide is available in hard copy or on the FEMA website.

Contact: FEMA Distribution Center
Address: 130 228th Street, SW, Bothell, WA 98021-9796
Phone: (800) 480-2520
Fax: (425) 487-4622
Website: http://www.fema.gov/rrr/pa/dmgtoc.shtm

Endnotes

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[5] Public Assistance Debris Management Guide, Federal Emergency Management Agency, 2000

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[22] Burby, R. (Ed.) *Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities*. Washington D.C. (1998), Joseph Henry Press.

Section 11
Wildfire
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Portland's Urban Forest

While many people think only of City parks and street trees when they think of an urban forest, it is actually a complex system of trees and smaller plants, wildlife, associated organisms, soil, water, and air in and around our city. The urban forest includes the trees along our streets, the landscaping around our homes and institutions, the vegetation in commercial and industrial areas, the multi-layered forests in our natural areas, and the trees and plants in our parks.

The urban forest is managed by many agencies for many objectives, specifically for healthy watersheds, prime wildlife habitat, excellent outdoor recreation, beautiful neighborhoods, water, air quality and exceptional trees. A healthy urban forest is essential to our quality of life and is an increasingly important part of the City's coordinated efforts to restore the quality of its rivers and streams and improve the local environment. Ultimately, a healthy urban forest is an asset that increases in value over time—one that provides beauty as well as essential service. More specifically, the urban forest has become a critical component in Portland's resource management strategy: the City has increasingly recognized the essential role of trees and vegetation to reduce the negative environmental impacts of urbanization and to rehabilitate areas with poor water quality and damaged wildlife habitat. The urban forest, or "green infrastructure," has also begun to replace built, or "gray" infrastructure: trees and vegetation can be used in place of pipes and generation plants to absorb stormwater from streets and developed areas. Many bureaus and agencies have recognized these practical benefits: Metro's *Green Streets* guidelines integrate transportation systems with resource protection, and Environmental Services' *Stormwater Management* requirements use vegetation to protect impervious surfaces.

And while efforts to conserve natural areas and environmental health, they can also encourage the placement of vegetation close to structures. During dry wildland fire seasons, this vegetative infill can pose a serious public safety risk. [1]

What are the roles and risks of wildfire in Portland?

Fires are an essential part of Oregon's ecosystem, but they can also endanger life and property in growing communities. Wildfires—a fire occurring on wildlands that requires a suppression response[1] —are most common in the arid eastern and southern sections of the State. However, wildfire risk still exists in Portland's wildland-urban interface

[1] Portland Urban Forestry Management Plan, 2004.

where homes and other structures are built into a densely forested or natural landscape.

If risks are left unchecked, fires in these areas can threaten lives and property.

The City of Portland's History with Wildfire

Portland covers 87,040 acres. Of these, 14,500 are categorized as natural areas and stream corridors and 4,000 are classified as developed parks and open spaces[2] A large proportion of the natural area consists of Forest Park, a 5,100-acre wildland reserve situated in Portland's West Hills. Other natural areas include Portland's East Buttes and the Willamette River's eastside escarpment. These natural areas have been identified as high risk by the Portland Fire and Rescue Wildfire Risk-Mapping Program because high-density commercial and residential development can often be found surrounding the wildland and open spaces.

> "The heightened awareness of the 2000 fire season attracted an unprecedented commitment from Congress to protect communities, watersheds, and species at risk, and will make fire management a top federal priority for years to come."
>
> The Nature Conservancy Magazine -May/June 2001

In the last century, Portland's largest wildland interface fire occurred in 1951; it charred 2,500 acres in and around Forest Park. Between 1998 and 2004, 1,302 incidents classified as natural vegetation fires were logged in Portland Fire & Rescue's incident system. Of these reported incidents, 595 were classified as grass fires, 657 were classified as grass and brush fires, and 50 were classified as forest, or woods, fires. Powell Butte Nature Park has also experienced several fires since 1998, but most have been small. Two 3-alarm fires, however, affected nearly 35 acres of parkland and required more than 70 firefighters—nearly half of the City's on-duty strength—and more than two dozen pieces of firefighting apparatus.

The most recent sizeable wildland fire was the Mocks Crest (or Willamette Bluffs) fire that occurred in August of 2001. The fire started when a two-mile section of grass and brush ignited along the railroad tracks by the Willamette River; the fire grew quickly in the grasses and fuels along the flood plane and heavier fuels along the escarpment—both indigenous brush species and invasive Himalayan blackberry—where quickly engulfed as the fire swept up the bluff. Fire companies set up along Willamette Drive eventually stopped the advancing fire, but the 5-alarm incident ultimately mobilized all off-duty members of Portland Fire & Rescue and mutual aid from five surrounding departments. Fortunately, the fire caused little structural damage[2]* yet still imposed significant costs:

Fire Suppression: $142,089

Erosion Control, Bureau of Environmental Services: $202,412

Estimated revegetation costs: $63,979

Deleted:

Probability of future Urban Interface Fires within the City of Portland

> "With more Oregonians than ever living in forests that have grown thicker than ever through decades of strict fire suppression, even modest fires can quickly consume lives, homes, and the millions of dollars it costs to fight them."
>
> The Oregonian, Feb. 26, 2001

As Portland's wild areas and vegetative models mature, and new development takes place within fire prone areas, risks of urban interface wildfire will likely grow. Portland's loss rate would multiply unless the City increases its mitigation efforts. As City officials begin these efforts, they should examine several important characteristics of wildfire. In order for fire to exist, the three components of the fire triangle—fuel, heat, and oxygen[3]—must be present. Most naturally occurring fires are initiated by lightning strikes, but human-caused fires, both accidental and deliberate, can ignite in a number of ways: campfires, chimneys, torches, matches, fireworks, cigarettes, vehicle fires, military ordnance, and smoldering slash piles can all start fires.[4] In either case, a fire occurring in a natural ecosystem begins at a point of ignition, burns outward into circles and, if it escalates, will spread in the prevailing wind direction.[5] When burning occurs on uneven terrain, the fire spreads upslope to eventually form broad ellipses.[6]

Effects of fire on ecosystem resources can include damages, benefits, or some combination of both. Ultimately, a fire's effects depend largely on the characteristics of the fire site, the severity of the fire, the time period of valuation, and the value placed on the resources affected by the fire.[7] The ecosystems of most forests depend upon fire to maintain various functions. Other benefits can include, where appropriate, reduced fuel loads, disposal of slash, thinned tree stands, increased forage plant production, and improved wildlife habitats, hydrologic processes, and aesthetic environments.[8] Despite these potential benefits for ecosystems, fire has been suppressed for years because of its real and/or perceived effects on timber harvest and threat to human life. In addition, new development along the wildland-urban interface has necessitated strict fire control.

[2] Direct fire damage was limited to decks, fences, a greenhouse, and scorched siding. The total sum of the private insurance claim was not immediately available.

The Interface

There are three categories of interface fire:[9] the classic wildland-urban interface occurs where well-defined urban and suburban development presses up against open expanses of wildland areas; the mixed wildland-urban interface occurs where isolated homes, subdivisions, and small communities are situated predominantly in wildland settings; and the occluded wildland-urban interface occurs where islands of wildland vegetation occur inside a largely urbanized area. Unlike most other natural hazards, the wildland-interface fire is not designated by geography alone: certain conditions must exist for significant interface fires to occur. The most common are hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation).[10] Once a fire has started, several other conditions—fuel, topography, weather, drought, and development—can also influence its behavior. Combined, these conditions are key indicators of increased wildfire risk: the severity of the wildfire is ultimately affected by the severity of these conditions. For example, if a steep slope (topography) is combined with extremely low humidity, high winds, and highly flammable vegetation, then a high–intensity wildfire may develop.

Many of the natural hazards definitions found in this plan come from existing state resources, including the *Planning for Natural Hazards: Technical Resource Guide,* the *Oregon State Natural Hazards Plan,* and FEMA-adopted local plans. For more information on existing resources for natural hazards and mitigation planning in the state of Oregon, please visit www.OregonShowcase.org.

Since the 1970s, Oregon's growing population has expanded further into traditional resource and forestlands. The interface between urban or suburban areas and the resource lands created by this expansion has significantly increased threats to life and property from fires and has pushed existing fire protection systems beyond their capabilities.[11] Property owners in the interface are often unaware of the problems and threats they face, so many owners have done very little to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

Fuel[12]

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. An important factor in evaluating wildfire risk is the availability of diverse types of fuels in the landscape; fuels can include natural vegetation (trees, grasses and shrub species), manmade structures, and other combustible materials. A house surrounded by unmanaged vegetation rather than a fire resistant landscape allows for greater continuity of fuel and increases the fire's ability to spread.

Historically, the Portland area was covered by heavy forests of Douglas fir, western hemlock, and western red cedar intermixed with deciduous bigleaf maples and red alders. Oregon ash, willows, and black cottonwoods grew along wetlands and streams, and lower growing vegetation included vine maple, western hazel elderberry, dogwood, sedges and rushes.[1] Early European settlers cleared the City, lending to Portland's early nickname, "Stumptown." Groupings of the early vegetative model, however, still exist in open spaces, parks, and private landscapes.

In many cases, immigrants brought seeds and seedlings from their homelands that for the most part flourished in Portland's climate. Some plants, however, displaced the beneficial native plant community: Himalayan blackberry, Scot's broom, wild clematis and English ivy are examples of non-native vegetation that degraded the health of the City's wild areas and could now act to intensify wildfires. After decades of fire suppression, "dog-hair" thickets have also accumulated and could enable high intensity fires to flare and spread rapidly.

Structures that are made of combustible material such as shake roofs and wood siding are especially susceptible to fire. Vegetation near these structures often serve as "ladder fuels:" the vegetation allows a slow moving ground fire to climb onto rooftops and into the crowns of trees. A crown fire is significantly more difficult to suppress than a ground fire and poses a much greater threat to structures in the interface. Wildfire at the upper end of the wildfire intensity spectrum is likely to spread into the tops of the tallest trees in violent and discontinuous surges.[13] At this severe end of the spectrum, fire responds to its own convective winds, and spreads rapidly as sparks from exploding trees ignite other fires many meters away.[14]

Ultimately, the wide variety of fuels found in a wildland interface can frustrate attempts to predict how a fire will react or spread.

Topography[15]

Topography influences the movement of air and thereby directs a fire's course. If the percentage of uphill slope doubles, for example, the rate of spread in wildfire will likely double as well. Gulches and canyons such as Portland's Sullivan's Gulch, Balch Canyon, and upper Tanner Creek can funnel air and act as chimneys that intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes such as the Willamette River's eastside escarpment produces upslope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. Given these conditions, hazard mitigation and education efforts should increase in these interface areas.

Weather[16]

Weather patterns, combined with certain geographic locations, can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches are extremely fire susceptible.[17] While Portland averages just over 36 inches of yearly rainfall, its close proximity to the Columbia River Gorge makes late-summer weather patterns highly dangerous. Western Oregon's fire season typically lasts from the last week in July through the end of September. During that season, hot, dry winds from Eastern Oregon often sweep down the

Columbia Gorge and empty into the Portland area. The dry winds significantly reduce fuel moisture levels and can fan sparks into a full-blown wildland fire.

Drought

The term *drought* refers to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters or significantly decreased rainfall can lead to relatively drier conditions and leave reservoirs and water tables lower. As it can also limit irrigation, drought can further contribute to fires and can make firefighting difficult. However, most fuel types (except grasses) require two or three years of drought to become dangerously dry. Overall, the patterns of drought and rainy seasons determine the frequency and intensity of fires: a February 2001 Oregonian article reported that:

> *…favorable weather last year helped the Northwest emerge largely unscathed from a fire season that scorched other parts of the West. But the forests remain thick with timber and with homes. And this winter has brought the Northwest far less snow and rain than usual, which could give a greater foothold to the flames that are sure to come.*[18]

This prediction proved accurate.

Development

Rapid growth and development in forested regions is increasing the number of human-caused wildfires in Oregon's interface areas. Wildfire has an effect on development, yet development can also influence wildfire. While naturally occurring wildfires have a distinct role in Oregon, homes in the interface can unduly increase the risk of human-ignited fires. Heavy development can also make firefighting efforts difficult: homeowners often prefer private, scenic lots with heavy vegetation and limited driveway access, all conditions that can make evacuation and firefighting difficult. The scenic views found along mountain ridges can also invite topographical risks, and the natural vegetation that provides scenic beauty may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself. [19]

Overall, the increase in human development and activity in the interface and the high content of fuels remaining from years of fire suppression can create a lethal combination.

Community Wildfire Issues

Characteristics of Growth and Development in the Interface

People living in or near Portland's wildland settings are vulnerable to the threat of wildfire. Portland is situated at the confluence of two major rivers, the Willamette and the Columbia, and a great expanse of the City is built upon the historic flood formed by these rivers. Portions of those flood plains—including Johnson Creek, Beggars Tick, Oaks Bottom, and Smith and Bybee Lake—still exist in their natural state. The natural grasses and low brush in these areas are susceptible to drought conditions, and limited access can complicate firefighting efforts.

Restoring natural vegetation to the banks of Portland's rivers and steams has been the focus of major work by the City and numerous community groups. Riparian and upland enhancement programs have replaced invasive vegetation with natural species to provide better shade and cooler water temperature for spawning fish and improved habitat for other wildlife. Generally, the riparian areas along the major rivers have good firefighting access from land and from Portland's fireboats. Firefighting access to streams and tributaries, however, is somewhat more limited.

Furthermore, grassy areas and oak savannas increase the risk of fast moving wildland fires. Powell Butte, Mocks Crest and Oaks Bottom are examples of this vegetative model; fortunately, the homes adjacent to these areas have good firefighting water supply through hydrant systems and generally acceptable emergency access and egress through gridded city streets.

The southeastern and western edges of Portland are rimmed with hills. Forest Park to the northwest is the largest forested park within the City limits in the United States. Steep topography, narrow roads with few connecting streets, marginal water supply (in some areas), high population, and the heavy fuel loads associated with dense forestland form Portland's greatest wildland urban interface challenge.

The vegetation in these interface areas consists of an assortment of grasses, shrubs, and deciduous and coniferous trees. Steep slopes are also a consideration in determining wildfire prone areas in the City. Interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation, and natural fuels. Where past wildland fires have caused damage in interface areas, several factors have allowed for increased destruction:[20]

- Combustible roofing material;
- Wood construction;
- Structures with no defensible space;
- Fire departments with poor access to structures;
- Subdivisions surrounded by heavy natural fuel types;
- Structures located on steep slopes covered with flammable vegetation;
- Limited water supply; and
- Winds over 30 miles per hour.

Road Access

Of particular concern to firefighters are older developments built upon what are presently considered substandard widths, grades, and connecting routes. Should the need for mass evacuation arise, sub-standard access routes can lead to dangerous bottlenecks. Current fire code mandates larger width of driving surface, lesser grades, turnarounds at the end of dead ends, and fire sprinklers in single-family developments with more than 18 units and one point of access. The Portland zoning code calls for greater connectivity where appropriate and practicable; street grids are often difficult to achieve on steeper slopes and therefore connectivity is not required.

Water Supply

Water supply is a critical factor in the ability to fight wildland fires. Developments lacking adequate water supply and hydrant taps create additional challenges for firefighting personnel. New developments in Portland's wildfire interface have hydrants every 500 feet. These hydrants are engineered to flow at least 1750 gallons per minute, but hydrants within older developments can be found at much greater spacing and often provide lesser flow rate capacity.

Wildfire Hazard Assessment

In a pilot program for the Federal Emergency Management Agency's (FEMA) loss estimation software HAZUS – (Multi Hazard) MH, the City of Portland has developed a method of analysis that will prove beneficial as the area's density reaches 2040 levels. The software program can superimpose demographic information and building stock levels over hazardous or forested areas and then calculate potential loss. The following chart profiles the wildland fire hazard; as the report indicates, 27,100 households are at risk, 7,500 of the people in the households are over 65, and 8,700 have an income of less than $20K. The program also calculates that a wildfire touching the exposed building stock could place $7,833.3M worth of structures at risk.

Over time, additional data added to the HAZUS-MH program will allow greater analysis of cost-benefit ratios, adjustments to water supply, and improved access and egress configurations or building and landscape guidelines. Overall, the analysis of the information can lead to a greater success in mitigation efforts.

Multnomah County Hazard Analysis

Severity Score	High
History (2)	12
Vulnerability (5)	35
Maximum Threat (10)	100
Probability (7)	56
Total Score	203

Summary of Risk Factors

Period of occurrence:	Any time, particularly summer or fall
Probability of event(s):	Highly likely
Warning time:	0 to 3 hours
Major contributor(s):	Lightning or human activities resulting in fire, fuel type and condition, vegetation, and slope
Cause injuries?	Yes, and risk of death
Potential facilities shutdown?	14 days or more

Interface is used to describe areas where homes and other structures have been built on or adjacent to forest and range lands. It is an intermingling of structures with natural cover at various degrees of growth and complexity.

WILDLAND FIRE PROFILE

Background and Local Conditions

Fire is a natural part of the ecosystem and plays an important role in shaping the environment. Wildland fires generally occur heavily wooded areas but can also impact metropolitan areas; for example, these fires occur at the interface of wooded and brush areas and developed areas. These fires can be triggered by fires in the home, fires resulting from industrial activities, fires resulting from natural hazards (for example, fires associated with lightning strikes), and other events. This hazard profile considers wildland fires in the Portland study area.

Historic Frequency and Probability of Occurrence

Wildland fires can occur at any time of the year but are especially likely during hot, arid periods. The probability of occurrence is high, with an occurrence probable each year. Specific historic or probable frequency data are not available for the Portland wildland fire hazard.

Severity

The risk of impact of major wildland interface fires can be high. Wildland fire events can cause multiple deaths, completely shut down facilities, and cause more than 25 percent of affected properties to be destroyed or suffer major damage.

Historic Losses and Impacts

To date, there have been no major losses due to wildland fires in the Portland study area since records have been kept. Thus, while the area has been spared the impacts of fires, it is prudent to expect that such a fire represents a threat and could occur in the Portland area (Metro 1999). While no specific events have impacted Portland a number of significant wildfires occurred during 2002 and 2003 in the national forests (Deschutes and Ochoco) west and south of Portland. These necessitated road closures on Highway 20. The recent severe wildland fires and subsequent landslides in Southern California (2003) illustrate the danger that is associated with this hazard.

Designated Hazard Areas

Residences have long occupied the heavily forested hillsides around Portland, and the trend of locating near undeveloped land continues to increase interface areas that in turn intensify the potential impacts of wildland fires and may increase ignition sources. Structures built in interface areas may be more vulnerable to wildland fires. Approximately 30 square miles of the 145 total square miles in the Portland study area (or 20 percent) is at risk from the wildland fire hazard. Figure 3-5 shows the at-risk regions within the Portland study area. These areas are considered to be at risk because of fuel types, vegetation, and slope characteristics. The figure shows that the western and southwestern regions of the Portland study area are at greatest risk from wildland fires.

Wildfire Hazard Identification

Portland has developed maps of the City's wildland fire hazard zones. As required by ORS 93.270, the Oregon Department of Forestry developed the criteria for determining wildfire hazard zones. The following four sets of "hazard factors" determine the hazard zone:

- Weather
- Topography
- Natural vegetative fuels
- Natural vegetative fuel distribution

Each hazard factor is assigned a value per geographic area, and an overall wildfire hazard rating is determined for certain parts of Portland. This map was adopted in 2003 by City Council, ordinance 24.51.030 (the map can be accessed at www.portlandonline.com). The immediate impact of the adopted map is a stricter standard for roofing materials. Entire structures and neighborhoods in the wildfire hazard zone can be hazard rated by one of several national standards. Generally, hazard identification rating systems are based on weighted factors of fuels, weather, and topography.

Mitigation Plan Goals and Existing Activities

The mitigation plan goals and action items are derived from a review of city, county, regional, state, and national natural hazard mitigation plans and planning literature and guidance from the Portland Natural Hazards Mitigation Steering Committee. The plan has five goals:

1. Identify risk levels and evaluate Portland's vulnerability to natural hazards.
2. Implement activities to protect human life, property and natural systems.
3. Promote public awareness, engage public participation, and enhance partnerships through education, outreach, and coordination of a diverse and representative group of the City's population.
4. Establish a disaster resilient economy.
5. Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Existing Mitigation Activities by City Bureau

Portland Fire & Rescue/Fire Marshal Office

Passed in 1993, ORS 93.27 asked jurisdictions to voluntarily establish Wildfire Hazard Zones and set standards for identifying these zones that relate to weather, topography vegetative fuel hazards, and fuel distribution. A multi-governmental effort was undertaken to map the

City based on these criteria, and in 2003, Portland City Council adopted the Wildfire Hazard Zones. Structures within the wildfire zones are required to meet the additional building requirements in the Uniform Building Code related to Appendix Chapter 5: Class A or B roofing and addressing visible from the public right of way. (see UBC. The International Residential Code requires class C roofing—fire-resistant wood shakes—or better.) The Uniform Fire Code and FMO Policy B1 set standards for water supply and emergency access in the City of Portland, but there are no current differentials between urban areas and wildland interface areas in these codes. FMO Policy B1 requires:

- Fire hydrants within 500 feet of any portion of a structure and 600 feet from a structure with sprinklers. Fire access is required within 150 feet of any door of a structure and within 250 feet for structures with sprinklers.
- Fire access is a substantially built roadway, 20 feet wide, 13. 5 feet high with provisions for turnarounds on dead ends longer than 300 feet. Access width can be reduced to 12 feet for roads servicing 2 or fewer single-family dwellings.
- Access roads can be on grades no higher than 15 percent for roads accessing single-family dwellings and 12 percent for all others.
- Residential developments with more than 18 single-family dwellings shall have two or more means of access.

Residential lots and developments that do not meet the standards of FMO Policy B1 sometimes appeal specific requirements and generally offer Standard 13D residential fire sprinklers in return. Residential fire sprinklers reduce wildfire hazard by helping contain fires in the room of origin to reduce the chance that a fire can break outside the structure and possibly igniting surrounding vegetation. Other agencies also provide rules and guidelines that help residential lots meet the appropriate standards:

- The Public Education section of the Fire Marshal's office has a City of Portland-specific wildfire safety brochure. The brochure covers items such as defensible space, fire resistive plants, wildfire hazard zones, structure maintenance, and emergency planning.
- The Department of Environment Quality (DEQ) prohibits outdoor debris burning within Portland's city limits. Portland Fire and Rescue administers these rules with a few exceptions: the Fire Marshal's Office does allow some outdoor burning activities including barbecues, ceremonial fires (by permit from the FMO), and recreational fires (campfires). In the case of adverse weather conditions (high winds/temperature, low humidity) the Fire Chief has the authority to ban all outdoor fires. Furthermore, any Fire Bureau officer or fire inspector has the authority to order an unsafe fire extinguished.

State law restricts the sale and use of fireworks that produce a loud report or travel more than 6 feet from the point of ignition. Inside the City, the Fire Marshal's Office administers those rules. Fireworks vendors are required to have a permit, and Fire Inspectors visit each fireworks stand.

Portland Fire & Rescue/Fire Suppression Companies

Fire Station 3 on NW Johnson, Station 16 at Highway 26 and Skyline, and Station 22 near the east end of the St. John's Bridge make fire patrols in Forest Park. These patrols continue through the fire season (which is determined by the C shift Deputy Chief) and are made on Tuesdays and Fridays. The patrols cover all the vehicular roads in the park to assess current fire danger and mitigate unsafe acts or activities that may contribute to the fire danger in the Park.

Bureau of Development Services

The Bureau of Development Services requires that areas under common ownership be subject to maintenance agreements that assign homeowners' responsibilities. Such responsibilities may involve vegetation management that includes removal of dead plants, reintroduction of native species, invasive plant species removal, and enforced watering schedules. Certain developments—Forest Heights and some sites on very steep slopes—have included conditions directly related to wildfire prevention. As part of the Land Use Review process, 2 wildland sprinkler systems were installed in the Forest Heights area beginning in 1998 and were completed in 2004. These systems consist of underground piping laid along the swales with risers spaced every 75 feet to fixed 50 GMP nozzles. In case of fire, these systems are activated when fire hoses link hydrants and streetside sprinkler connections.

Office of Neighborhood Involvement

Portland Housing Code, Title 29, (specifically 29.20) requires that property be kept in a safe manner that allows emergency ingress and egress and the removal of trash, debris, and vegetation that may increase fire danger. Portions of this code require that all vegetation within 10 feet of the house and 10 feet of the property line be removed; the code also requires that the lawn be kept shorter than 10 inches.

Bureau of Planning

The Portland Zoning code requires that rights-of-way and water supply are sufficient to support proposed development (e.g., land divisions). Provisions that pertain indirectly to wildfire mitigation include emergency development allowances and restrictions on bulk use of hazardous materials in environmental zones.

The Water Bureau

The Water Bureau tests all hydrants within the City on an annual basis and repairs any recognized deficiencies. Under Fire Bureau advisory, the Water Bureau designs new water supply systems within the Wildfire Hazard Zone that increase minimum flow to 1750 gallons per minute.

Urban Forestry

The Urban Forestry Plan requires permits to prune, plant, or remove trees in the public right of way. Generally, the Urban Forestry Division seeks to preserve and protect the City's trees.

Bureau of Environmental Services

The BES Watershed Revegetation Program works with public and private landowners to actively manage vegetation in natural areas. Vegetation management reduces the risk of catastrophic wildfire by replacing high fuel loads of non-native, invasive vegetation with lower fuel loads of native plant species. BES also partners with several community groups in the Naturescaping program, an organized effort to promote indigenous species in local landscapes.

Portland Parks and Recreation

The Forest Park Natural Resource Management Plan (February 1995) identifies existing and potential risks and hazards including fire. Pages 47–48 and 101-102 of the NRMP discuss fire hazard; while the Plan states that wildfire hazard is generally low, it makes several important observations. The hardwood stands in the park actually accomplish many of the same functions as a shaded fuel break: fires are unlikely to reach tree crowns, and ground fires will generally be of low intensity. Thus, most of the objectives of a shaded fuel break will be met by the present conditions in hardwood stands. Although conifer stands are somewhat more susceptible to wildfire, there is generally a low fire risk at present, and fuel breaks are not recommended. These conditions should be reassessed periodically for change on the same 10-year schedule recommended for monitoring vegetative change in the Park. The Forest Park NRMP, M-5, also asks that Parks continue to work with the Fire Bureau on their training exercises.

Much of the City's wildland area are administered and maintained by Portland Parks and Recreation. The following is a synopsis of Portland Parks' yearly fire control maintenance plan:

Forest Park Annual (May through July) Firelane and Powerline ROW maintenance tasks:

- Mow herbaceous vegetation [grasses, etc.] on edge of firelanes
- Control flammable invasive vegetation [e.g. Himalayan blackberry, Scot's broom, Reed canary grass, etc.]
- Prescribed Burns for Hazard Reduction, Vegetation Management and Habitat Enhancement on PP&R Natural Areas sites

Elk Rock Island Natural Area, Fall 1992 Objectives and Guidelines

- Control invasive plants and enhance Oak/Madrone woodland habitat
- Natural Resource Management Plan: see Mark G. Wilson
- Fire Plan: specified in Management Plan

- Partners: PP&R Natural Resource staff, Portland Fire Bureau, City of Milwaukie Fire Bureau

Oaks Bottom Wildlife Refuge, September 1993 Objectives and Guidelines

- Control invasive, non-native grasses and prepare side for seeding
- Natural Resource Management Plan: available from Mark G. Wilson
- Fire Plan: N/A
- Partners: PP&R Natural Resource staff, USFS, Portland Fire Bureau

Oaks Bottom Wildlife Refuge, September 1998 Objectives and Guidelines

- Control woody plants and invasive, non-native grasses before re-vegetating
- Natural Resource Management Plan: available from Mark G. Wilson
- Fire Plan: available from Mark G. Wilson
- Partners: PP&R Natural Resource staff, USFS, Portland Fire Bureau

Powell Butte Nature Park, September 1995 Objectives and Guideline

- Control invasive woody & herbaceous plants before re-seeding with native grasses
- Powell Butte Master Plan: available from Mark G. Wilson
- Fire Plan: available from Mark G. Wilson
- Partners: PP&R Natural Resource staff, USFS, Portland Fire Bureau

Regional Programs

Metro

State goals address natural hazards generally, but Metro's goals specifically include Wildland/Urban Interface Fire prevention. Metro's goal calls for collaboration with other agencies to evaluate risk and encourages local governments to adopt a range of appropriate mitigation measures (see Regional Framework Plan policy 5.5 and 5.5.1). Portland's Comprehensive Plan addresses Emergency Response through Transportation Goal 6 and controls development density through Environment Goal 8, policy 8.13.

Building Codes

City, county, state, and local jurisdictions work together to define and implement building codes. These codes apply to new development, dwellings and structures, retrofitting, and siding. The process begins with the establishment of code at the state level, and codes are then implemented locally.

The April of 2003 adoption of Portland's Wildfire Hazard Zone established specific requirements for roofing: the Plan requires Class A or B roofing on commercial structures (appendix chapter 5, UBC) and class C or better on residential structures (section R328, International Residential Code.)

State Programs

Oregon Revised Statute 215.730 (Additional Criteria for Forestland Dwellings) provides guidelines for approving dwellings located on lands zoned for forest and mixed agriculture/forest use. Under its provisions, county governments require that single-family dwellings on lands zoned as forestland meet specific requirements for approval.

States must have an approved hazard mitigation plan in place to receive either a Fire Suppression Assistance Grant or a Hazard Mitigation Grant.

Oregon Revised Statute 477.015-061

Provisions in ORS 477.015-061 (Urban Interface Fire Protection) were established through the efforts of the Oregon Department of Forestry, the Office of the State Fire Marshal, fire service agencies from across the State, and the Commissioners of Deschutes, Jefferson, and Jackson Counties. This innovative legislation addresses the expanding interface wildfire problem within Oregon Department of Forestry Fire Protection Districts. Full implementation of the statute will occur on or after January 1, 2002.

Senate Bill 360

Passed in 1997, Senate Bill 360 also addresses the growing wildland/urban interface problem. The bill has three purposes:

1. To provide an interface fire protection system in Oregon that minimizes cost and risk and maximizes effectiveness and efficiency;
2. To promote and encourage property owners' efforts to minimize and mitigate fire hazards and risks; and
3. To promote and encourage involvement of all levels of government and the private sector in interface solutions.[21]

The bill has a five-year implementation plan that includes public education and outreach and the development of rules, standards, and guidelines that address landowner and agency responsibilities. The success of Senate Bill 360 depends upon the cooperation of local and regional fire departments, fire prevention cooperatives, and the Oregon Department of Forestry. This cooperation is important in all aspects of wildland firefighting as resources and funding are often limited, and no single agency has enough resources to tackle a tough fire season alone. The introductory language of Senate Bill 360 states "…the fire protection needs of the interface must be satisfied if we are to meet the basic policy of the protection of human life, natural resources, and personal property. This protection must be provided in an efficient and effective manner, and in a cooperative partnership approach between property owners, local citizens, government leaders, and fire protection agencies."

Oregon Department of Forestry

ODF is involved with local fire chiefs and local fire departments to provide training. Local firefighters can get a range of experience from exposure to wildland firefighting. Local firefighters can also obtain their red card (wildland fire training documentation) and attend extensive workshops that combine elements of structural and wildland firefighting, structural defense, and operations experience. [22]

ODF has also been involved with emergency managers to provide support during non-fire events. Furthermore, ODF has worked with industrial partners (specifically large timber companies) to share equipment in the case of extremely large fires. [23]

Federal Programs

The proposed role of Federal land management agencies—the U.S. Forest Service and the Bureau of Land Management—in the wildland/urban interface is diverse. Their roles include reduction of fuel hazards on the lands they administer; cooperation in prevention and education programs; provision of technical and financial assistance; and development of agreements, partnerships, and relationships with property owners, local protection agencies, states, and other stakeholders in wildland/urban interface areas. These relationships promote action before a fire occurs and render structures and communities safer and better able to survive a fire occurrence. [24]

Federal Emergency Management Agency Programs

The Federal Emergency Management Agency (FEMA) is directly responsible for providing fire suppression assistance grants and, in certain cases, major disaster assistance and hazard mitigation grants in response to fires. The role of FEMA in the wildland/urban interface is to encourage comprehensive disaster preparedness plans and programs, increase the capability of state and local governments, and provide for a greater understanding of FEMA's programs at the federal, state, and local levels.[25]

Fire Suppression Assistance Grants

Fire Suppression Assistance Grants may be provided to a state with an approved hazard mitigation plan for the suppression of a forest or grassland fire that could threaten public or private lands. These grants are provided to protect life and improved property, encourage the development and implementation of viable multi-hazard mitigation measures, and provide training to clarify FEMA's programs. The grant may include funds for equipment, supplies, and personnel. A Fire Suppression Assistance Grant is the form of assistance most often provided by FEMA to a state for a fire, and the grants are cost-shared with states. Once the federal grant money is provided to a state, the state passes funds to local jurisdictions. Finally, FEMA's US Fire Administration (USFA) provides public education materials addressing wildland/urban interface issues, and the USFA's National Fire Academy provides training programs.[26]

Hazard Mitigation Grant Program

Following a major disaster declaration, the FEMA Hazard Mitigation Grant Program provides funding for long-term hazard mitigation projects and efforts to reduce the damages and costs associated with possible fire hazards.

National Wildland/Urban Interface Fire Protection Program

Federal agencies can use the National Wildland/Urban Interface Fire Protection Program to focus on wildland/urban interface fire protection issues and actions. The Western Governors' Association (WGA) can effectively involve state agencies, as well as local and private stakeholders, in the development of a uniform, integrated approach to hazard and risk assessment and fire prevention and protection in the wildland/urban interface. The program helps states develop viable and comprehensive wildland fire mitigation plans and performance-based partnerships.

US Forest Service

The US Forest Service (USFS) is involved in a fuel-loading program designed to assess fuels and reduce hazardous buildup on US forestlands. The USFS is a cooperating agency and, while it does not have jurisdiction in Portland city limits, it still has an interest in preventing fires in the interface as fires often burn up the hills and into higher elevation US forestlands.

"New data from National Forest Service fire ecologists shows that for every dollar spent on prescribed burning, forest thinning and the training of fire-management personnel, seven dollars worth of savings are realized in the costs of having to extinguish big fires. When that ratio is placed in the context of an average $1 billion spent annually over the past decade on fire suppression, the implications of foresighted fire management are profound."

The Nature Conservancy Magazine – May/June 2001

Other Mitigation Programs and Activities

Prescribed Burning

The health and condition of a forest will determine the magnitude of a wildfire. If fuels—slash, dry or dead vegetation, and fallen limbs and branches—are allowed to accumulate over long periods of time without intentional clearing, a fire can move more quickly and destroy everything in its path. Ultimately, the impacts are far more catastrophic than if the fuels are periodically eliminated. Prescribed burning is the most efficient method to get rid of these fuels. In 1998, 3,000 prescribed fires were used to burn approximately 163,000 acres statewide.[27]

Firewise

Firewise is a program developed within the National Wildland/ Urban Interface Fire Protection Program. Firewise is the primary Federal program addressing interface fire; the National Wildfire Coordinating Group administers the program and overseas its goal of empowering planners and decision makers at the local level. Through conferences and information dissemination, Firewise increases support for interface wildfire mitigation by educating professionals and the general public about hazard evaluation and policy implementation techniques. Firewise offers online wildfire protection information and checklists as well as listings of other publications, videos, and conferences. The interactive home page allows users to ask fire protection experts questions and helps them register for new information as it becomes available.

Wildfire Action Items

The wildfire mitigation action items provide direction on specific activities that organizations and residents in the City of Portland can undertake to reduce risk and prevent loss from wildfire events. Each action item includes an estimate of the timeline for implementation. *Short-term action items* (ST) are activities that state agencies may implement with existing resources and authorities. *Long-term action items* (LT) require new or additional resources and/or authorities.

Short-term Action Items

ST-WF#1: Consolidate unassigned and/or unmanaged vegetated areas owned by the City of Portland under a single land management umbrella.

Key Issues Addressed

- Many City owned natural areas are assigned to Portland's Bureau of General Services with no funds to manage vegetation. The management of other City-owned lands has not been assigned to any bureau portfolios.

Ideas for Implementation

- Map out all City-owned natural areas and clarify individual bureau responsibilities for management.

General Comments

- Funding is needed to bring this issue, which may be a high priority, forward.

Coordinating Organization:	Parks, Bureau of Environmental Services
Internal Partners:	Water, Portland Office of Transportation, Bureau of General Services
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#2: Procure funding for management of vegetated natural areas with high wildfire danger, including public and private properties.

Key Issues Addressed

- Many City owned and some privately owned lands are dominated by invasive plant communities and are at high risk for wildfire. Some homeowners in the interface may wish to manage vegetation but cannot afford it.

Ideas for Implementation

- Apply for FEMA grant to pay for vegetation management services that can utilize the services of the City's Watershed Revegetation Program and Portland Parks Natural Resources.
- Convene technical committee to identify vehicle for rating and ranking hazardous unmanaged land tracts. Look for State and Federal funds that may be available for low-income homeowners.

General Comments

- Will require outside sources of funding

Coordinating Organization:	Fire, Portland Parks and Recreation, Bureau of Environmental Services
Internal Partners:	Bureau of Planning, Portland Office of Transportation, Bureau of General Services
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#3: Review and index existing maps with pertinent wildfire information. Identify parameters and methods for new maps as needed to meet wildfire mitigation goals.

Key Issues Addressed

- The current wildfire hazard map is not accurate at a small scale and would be difficult to use for code enforcement. Overlaying vegetation and topographic maps would provide improved accuracy.

Ideas for Implementation

- Refine the existing map and ground truth it. Portland Parks and Recreation and Bureau of Environmental Services have staff that can highlight areas of the map that need refining.

General Comments

- Different mitigation goals and codes may require maps of more or less specificity; HAZUS-MH may be a good mapping tool to add to other City databases.

Coordinating Organization:	Fire, Bureau of Development Services,Corporate GIS
Internal Partners:	BIT, Planning, Parks, Bureau of Environmental Services, Bureau of Water
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

ST-WF#4: Provide wildfire management training for City staff.

Key Issues Addressed

- Facilitate better coordination and partnerships between the city bureau staff who may respond to wildfire, use prescribed burning for vegetation management, or are responsible for managing natural areas.

Ideas for Implementation

- Have S190 and S130 courses held by Portland Fire and Rescue with multi-bureau staff participants.

General Comments

- This would be especially helpful for setting up prescribed burning operations and post wildfire incidents when members from city bureaus other than Portland Fire and Rescue are involved.
- Fire and Rescue is currently well-positioned to lead additional personnel training.

Coordinating Organization:	Portland Fire and Rescue
Internal Partners:	Parks and Recreation, Bureau of Environmental Services, Bureau of Water, Bureau of Maintenance
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#5: Amend the Portland Plant List and other related City plant lists and landscaping guides to include/identify fire resistant native plants, and planting strategies that could be encouraged or required in local landscaping. Coordinate with Metro to seek consistency with regional plan list(s).

Key Issues Addressed

- This action will assist property owners in reducing wildfire risks. Additionally, it will improve consistency between multiple City plant lists (Portland Plant Lists, Title 10 Erosion Control, Stormwater Management Manual, Tree and landscaping standards) and enhance ability of specific public programs to meet multiple objectives (e.g., habitat conservation and wildfire risk management).

Ideas for Implementation

- Link implementation of this action to the upcoming Environmental Code Improvement projects, updates to Title 10, and the Stormwater Management Manual.
- Coordinate with Metro to update regional plant list(s).

General Comments

- Title updates can be amended to include this work.
- This is a key piece for many of the identified mitigation strategies. Funding/resources will be needed to 1) research plant list for species that could prove beneficial in fire prone areas; 2) develop recommendations for fire resistive landscaping designs.

Coordinating Organization:	Bureau of Planning
Internal Partners:	DS, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation
External Partners:	Metro, Regional Weed Group
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#6: Integrate, as appropriate, fire prevention goals and provisions into City policies, plans, and codes. Identify and address ambiguities or conflicts among city requirements.

Key Issues Addressed

- This project will enhance the ability of City programs meet multiple objectives and increase the efficiency of land use reviews and project permitting processes.

Ideas for Implementation

- This should occur during updates to the City's comprehensive plan, environmental zoning and Willamette Greenway programs, and other code titles.
- Identify provisions that could reduce fire risk while meeting other City goals (e.g., protecting important natural resources).
- Address building materials, pruning/thinning, removal of ladder fuels, planting requirements, tree removal, revegetation after a fire, incorporation of fuel breaks, and storage of hazardous materials.
- Include in upcoming policy packages and environmental code improvement.

General Comments

- Portions of this Action Item are in current Bureau of Planning work plans.
- Need resources to update natural resource management plans and Plan Districts Address issues such as street width requirements for transportation and fire access and provisions that new rights-of-way must minimize disturbance of natural resource areas in environmental zones.

Coordinating Organization:	Bureau of Planning
Internal Partners:	Bureau of Development Services, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#7: Identify conditions of approval and mitigation strategies that could be applied to new development or redevelopment in high fire risk areas.

Key Issues Addressed

- This action would provide a flexible tool to incorporate wildfire risk management measures into site and building design, taking into account site-specific characteristics.

Ideas for Implementation

- Develop a boiler set of conditions of approval and mitigation measures to use in land use reviews for development proposals in wildfire areas. This would create consistency in requirements that apply to landowners in these areas, and assist staff in identifying potential requirements at pre-application conferences that would apply to development proposals in wildfire areas.

General Comments

- This is currently used on a case by case basis by Bureau of Development Services.

Coordinating Organization:	Bureau of Development Services
Internal Partners:	Bureau of Planning, Fire and Rescue, Parks and Recreation, Bureau of Environmental Services, and Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-WF#8: Integrate wild land fire risk educational opportunities into existing City stewardship programs. Provide education for both internal and external partners.

Key Issues Addressed

- This action would assist property owners in reducing risk of wildfire, and would also enhance ability of existing programs to meet multiple objectives (e.g., habitat conservation and wildfire risk reduction).

Ideas for Implementation

- Identify and incorporate wildland fire risk reduction measures into City programs including Naturescaping for Clean Rivers, Water Conservation Landscape workshops, and Watershed Revegetation.
- Convene an ad hoc committee to generate proposed program/class update concepts and specifics.

General Comments

- Classes and symposiums are already in place for programs like Naturscaping and Clean Rivers that could provide a model.
- Implementation would depend on the ability to develop fire resistant plant list and design recommendations.

Coordinating Organization:	Bureau of Environmental Services
Internal Partners:	Fire and Rescue, Bureau of Water, Bureau of Planning, Bureau of Development Services, Parks and Recreation, Portland Office of Transportation, Portland Office of Emergency Management, Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-WF#9: Improve the system for identifying new construction in areas subject to wildfires and communicating this information to the affected land owners.

Key Issues Addressed

- While requirements for new construction in wildfire hazard areas exist, that information is not always effectively communicated during the permitting process. More effective use of two existing software programs, GARTH and TRACS[3], would place the required information into the hands of the plan reviewers who are tasked with calling out the strengthened building requirements in wildfire hazard areas.

Ideas for Implementation

- Integrate the Wildfire Hazard Map into the GARTH program; link the map to TRACS to automatically call out wildfire specific construction.

[3] TRACS and GARTH are computer programs used in the Building Department (BDS). TRACS (tracking review and construction system) documents building permits by address, the permit status , the reviewers/inspectors, notes, comments, and requirements about each building permit are archived here. GARTH is a planning department tool, which is also associated with the Building Department. GARTH is a GIS based computer program. Planners and plan reviewers can select specific locations in the city and chose among dozens of map overlays which are broken into five main categories: boundaries, environmental, land use reviews, code overlays, and transit overlays.

- Train Planning and Zoning/DSC staff to inform development applicants at the counter when their site is within a Wildfire Hazard Zone.
- Convene an ad hoc committee of City bureau staff to develop a training seminar outline and implementation schedule.

Coordinating Organization:	Bureau of Development Services,
Internal Partners:	Fire and Rescue; Bureau of Water, Portland Office of Transportation, Office of Neighborhood Involvement, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-2 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards; Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population**.**

ST-WF#10: Conduct systematic reviews of Portland's large, publicly owned, wildland tracts regarding fire safety and ecological health to inform land management decisions.

Key Issues Addressed

- As Portland's ecosystems evolve, occasional reviews are necessary to determine if and how changing conditions affect fire risk and mitigation opportunities/needs.

Ideas for Implementation

- Assess the condition of publicly managed natural areas on a five to 10 year basis. This assessment may include computerized fire modeling.

General Comments

- Portland Park and Recreation is currently working on natural area ecosystem management plans.
- Currently, reports are reviewed by internal partners; however, there is a need for more resources to implement the land review process.

Coordinating Organization:	Portland Parks and Recreation
Internal Partners:	Bureau of Environmental Services, Fire and Rescue, Bureau of Water, Bureau of Planning, Portland Office of Transportation, Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

ST-WF#11: Adopt the national "Fire Danger Rating System" and install the signs at key points in the City.

Key Issues Addressed

- This rating system is designed to remind citizens to be extra cautious during critical points in the fire season.

Ideas for Implementation

- Partner with State foresters for current readings on fire danger severity.
- Install signs at fire stations near interface areas.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population

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ST-WF#12: Implement a neighborhood wildland interface disaster planning program.

Key Issues Addressed

- The neighbors surrounding wildland interface areas are key partners in loss prevention. This program would involve them directly in disaster planning.

Ideas for Implementation

- Involve the existing Neighborhood Emergency Team[4] (NET) Coordinator in conducting wildland interface specific training along with further outreach to the homeowner's association.
- Recruit members of interface neighborhoods to act as block wardens, training them in the essentials of alerting the public, assisting neighbors with special needs, and commencing an orderly evacuation.

General Comments

- NET teams are presently in place trained to handle a number of wide ranging crisis situations. NET teams do not presently train on wildfire specific topics.
- NET team volunteers could possibly be used in a wide variety of wildfire mitigation measures, from educational outreach to vegetation management functions.

[4] Neighborhood Emergency Teams are composed of civilian volunteers who are trained to provide basic level disaster services in the event of an incident that outstrips the capacities of government agencies.

Coordinating Organization:	Portland Office of Emergency Management, Neighborhood Emergency Team, Office of Neighborhood Involvement
Internal Partners:	Fire and Rescue, Police
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

ST-WF#13: Review and potentially refine City contract specifications for machinery operations during "Red Flag" weather conditions.

Key Issues Addressed

- This action would reduce the fire risk associated with City sponsored projects.

Ideas for Implementation

- Review City contract specifications and provide guidance for contractors to halt the use of identified machinery during high fire danger weather conditions.
- Determine how bureau contractors could be alerted to high fire risk conditions.
- Review State and Federal guidelines for use of mechanized equipment inside of wild land areas during high danger periods of the fire season and determine if/how they might be applied in Portland.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Bureau of Environmental Services, Portland Parks and Recreation, Water, Bureau of Maintenance
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

ST-WF#14: Convene a standing wildland interface fire technical group.

Key Issues Addressed

- This technical group would provide an ongoing forum platform to discuss and coordinate implementation of wildfire mitigation actions across City bureaus, and ensure that such actions are reasonably and equitably applied.

Ideas for Implementation

- Key bureau representatives would convene on a regular basis to pursue priority actions such as those relating to management of City-owned lands, vegetation management policy and codes, mapping, education and training, and funding.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Portland Parks and Recreation, Bureau of Environmental Services, Portland Office of Emergency Management, Bureau of Water, Portland Office of Transportation, Bureau of Development Services, Bureau of Planning
External Partners:	Multnomah County, the Oregon Department of Forestry, US Forest Service, Oregon Department of Fish and Wildlife, the US Fish and Wildlife Service, State Parks, Metro
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#15: Index City wildfire mitigation plans and activities.

Key Issues Addressed

- Tracking current activities will help direct limited resources toward key priorities, eliminate program redundancy, and identify gaps that need to be addressed.
- Improving program efficiencies would show long term cost savings for a minimal initial investment in staff time.

Ideas for Implementation

- Index to be compiled and regularly reviewed by Wildfire Technical Group.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Portland Parks and Recreation, Bureau of Environmental Services, Portland Office of Emergency Management, Portland Office of Transportation, Metro, Bureau of Development Services, Bureau of Planning
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

ST-WF#16: Identify water grid engineering requirements for firefighting in wildfire areas.

Key Issues Addressed

- Presently, hydrants in new developments in the wildfire area are built to flow a minimum of 1750 gallons per minute. A large fire could cover an area that would encompass several hydrants; there is a need to identify grid-wide fire flow requirements.

Ideas for Implementation

- Representatives from the Bureau of fire should meet with Water Bureau representatives to identify State and Federal criterion/standards.

Coordinating Organization:	Bureau of Fire, Bureau of Water
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	1-3 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

Long-term Action Items

LT-WF#1: Improve public education and understanding about wildfire occurrence, risk, and prevention.

Key Issues Addressed

- The public is an important partner in fire resistance and protection; as such, it is important that they are knowledgeable about fire prevention and response.

Ideas for Implementation

- Create a website using easy to understand graphics.
- Along with current building maintenance, construction upgrades, and evacuation information, update Portland Fire and Rescue brochure with technical information regarding suggested plant species and vegetation structure and tree pruning specifications for reducing the risk of wildfire damage to structures.
- Update website and brochure periodically with new information

General Comments

- This action is currently in the workplan for Portland Fire and Rescue.

Coordinating Organization:	Portland Fire and Rescue
Internal Partners:	Parks, Bureau of Environmental Service, Portland Office of Transportation, Bureau of Planning, Bureau of Development Services
External Partners:	none
Level of Immediate Capability:	High
Estimated Timeline:	long term
Plan Goals Addressed:	Promote public awareness, engage public participation, and enhance partnerships through education, outreach and coordination of a diverse and representative group of the City's population.

LT-WF#2: Review the feasibility of adopting portions of nationally recognized wildfire interface codes to strengthen building standards in wildfire risk areas.

Key Issues Addressed

- The wildfire interface codes are a model for requiring stricter building standards for new structures in interface areas; application of these codes to Portland might reduce fire risk.

Ideas for Implementation

- Convene a multi-bureau committee to review documents such as the Urban Wildland Hazard Zone Report & Proposal, the Urban Wildland Interface Code, and other urban wildfire management approaches to identify creative management approaches for Portland.

General Comments

- This action would require local ordinance change to state building codes through the State Building Board

Coordinating Organization:	Portland Fire & Rescue, Bureau of Development Services
Internal Partners:	none
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Implement activities to protect human life, property and natural systems.

LT-WF#3: Design and conduct a study to determine the effectiveness of maintenance agreements that are established when new land divisions are approved to manage vegetation in open space tracts.

Key Issues Addressed

- This action would allow the City to determine if current maintenance agreement requirements that serve to reduce wildfire risk (e.g., vegetation management) are being implemented effectively.

Ideas for Implementation

- Consider partnership with Portland State University to conduct the study.
- Use information to update maintenance agreement specifications.

Coordinating Organization:	Bureau of Development Services, Fire and Rescue
Internal Partners:	Bureau of Planning, Parks and Recreation, Bureau of Environmental Services, Portland Office of Transportation, and the Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	Medium
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-WF#4: Complete an assessment to characterize high priority wildfire risk areas and recommend specific mitigation strategies.

Key Issues Addressed

- This action will provide information to help determine which wildfire mitigation activities will have the most beneficial impact.

Ideas for Implementation

- Develop a scope of work for the assessment and a list of mitigation activities to be evaluated including but not limited to vegetation management, construction materials, prescribed burning, etc.
- Identify potential funding sources.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Parks and Recreation, Bureau of Environmental Services, Bureau of Planning, Bureau of Development Services, Bureau of Water, Portland Office of Transportation
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Identify risk level and evaluate Portland's vulnerability to natural hazards.

LT-WF#5: Explore avenues for funding interface home construction upgrades to low income homeowners.

Key Issues Addressed

- Several Fire Districts pay a flat fee per acre to property owners to thin and prune to guideline standards. While this is important, it is possible that upgrading the fire resistance of structures in the interface area could be as or more cost effective over the long term than paying for vegetation upkeep. Plants grow back, but construction upgrades remain.

Ideas for Implementation

- Seek information from FEMA, HUD, etc. to support program development.
- Possibly tap into funding other parts of the state receive for low income assistance for vegetation management in the wildfire interface.

Coordinating Organization:	Fire and Rescue
Internal Partners:	Bureau of Development Services, Office of Neighborhood Involvement
External Partners:	none
Level of Immediate Capability:	Low
Estimated Timeline:	3-5 years
Plan Goals Addressed:	Build and support the capacity and commitment to continuously become less vulnerable to hazards.

Wildfire Resource Directory

City Resources

Portland Fire & Rescue

PF&R provides emergency services to the City that include wildland firefighting. Coordinated efforts have helped maintain Portland's historically low incidence of urban interface fires. The Public Education Office has developed a Portland specific wildfire safety pamphlet. Wildfire safety tips, including links to related wildfire sites, are also available on PF&R's website. Finally, the Oregon Department of Forestry and the Portland City Council developed and adopted a Portland wildfire hazard map that outlines strict building requirements in hazard zones. This map can be viewed at www.portlandmaps.com.

Contact: Chief Assigned to Wildfire Issues
Fire Inspector Assigned to Wildfire Issues
Address: 55 SW Ash, Portland, OR 97204
Phone: (503) 823-3700

Urban Forestry

Title 20.40 of City code requires a permit for any tree pruning or removal of trees on any City property or right-of-way. These permits are free and available from Portland Parks & Recreation Urban Forestry Division. Other code requirements may apply to trees on other properties.

Contact: Portland Parks & Recreation, Urban Forestry Division
Address: 10910 N Denver, Portland, OR 97217
Phone: (503) 823-4489

Bureau of Development Services

BDS promotes safety, livability, and economic vitality through efficient and collaborative application of building and development codes. BDS oversees new development within the City by ensuring that adequate fire equipment access and water supplies are planned for all new subdivisions. Further, BDS ensures compliance with specific building construction requirements within Wildfire Hazard Zones. The Bureau also administers zoning requirements including tree and vegetation protection within environmental zones typically associated with wildlland/ urban interface areas.

Phone: (503) 823-7310

Bureau of Environmental Services

The Bureau of Environmental Services serves the Portland community by protecting public health, water quality, and the environment. BES protects the water quality of surface and ground waters and oversees efforts to promote healthy ecosystems in our watersheds. BES provides sewage and stormwater collection and treatment services to accommodate Portland's current and future needs.

BES Wildfire Interface Mitigation

Through its Watershed Revegetation Program (WRP), the Bureau of Environmental Services addresses wildfire interface areas by minimizing wildland fire risk as an ancillary benefit on projects identified to improve watershed health. The WRP restores function to natural areas on both public and privately-owned revegetation projects throughout the Portland Metro area.

Contact: Watershed Revegetation Program Manager (currently vacant)
Watershed Revegetation Program Supervisor (Andi Curtis)
Phone: (503) 823-7740

Portland Office of Transportation

P.D.O.T. is responsible for providing guidance and oversight for the construction and maintenance of streets to accepted standards. The standards provide for widths, grades, and other features that will allow those streets to be used as ingress and egress routes for fire suppression activities.

Portland Bureau of Maintenance

The Bureau of Maintenance is responsible for providing Portland Fire and Rescue with Water Tenders to support fire suppression activities. BOM fulfills this requirement through six 4,000-gallon tankers that are primarily assigned to street cleaning activities. In the event of a callout from BOEC dispatch, these vehicles are equipped to provide water supply to fire apparatus. In addition, the vehicles have pump and roll capacity and can be tasked to distribute AFFF fire fighting foam.

Contact: Bureau of Maintenance
Address: 2929 N Kirby Ave, Portland, OR 97227
Phone: (503) 823-1700 (24 hour service)

Contact2: Public Works Supervisor II
Phone: (503) 823-1710

City of Portland Bureau of Planning

The Bureau of Planning sets goals and creates long range plans and strategies to guide Portland's future. The bureau is responsible for maintaining and coordinating the implementation of Portland's Comprehensive Plan. The Bureau works on citywide and area-specific projects that address a range of topics such as housing, urban design, industrial and economic development, natural resource conservation, and other issues of concern to Portland. The bureau also maintains and updates Portland's Zoning Code to ensure that development regulations support the City's goals and policies. The Bureau works in close collaboration with neighborhoods, businesses, community based organizations, other city bureaus, and regional partners.

Current Comprehensive Plan goals and policies and portions of the Zoning Code directly affect factors relating to wildfire. These include policies and codes that guide the protection of natural resources such as trees and vegetation, landscaping for new development and redevelopment projects, and provision of infrastructure such as water supply and road access when new lots are created. Future updates to the Comprehensive Plan and Zoning Code should address wildfire related issues when striving to meet multiple goals and objectives.

Contact: Environmental Division Manager
Address: 1900 SW Fourth Ave, Room 4100, Portland, OR 97201-5350
Phone: (503) 823-7700
Fax: (503) 823-7800
Website: www.planning.ci.portland.or.us

County Resources

Multnomah County Emergency Management

Multnomah County Emergency Management is the central contact point for county resources prior to and during a disaster. Multnomah County Emergency Management is responsible for the coordination of resources within the unincorporated county and the cities of Gresham, Fairview, Troutdale and Wood Village. This also includes public health, county justice system and certain road networks. The City of Portland reports to Multnomah County in a disaster through the disaster declaration process and works to coordinate programs as much as feasibly possible.

Contact 1: Director, MCEM
Address: 501 SE Hawthorne Bldv, Room 600
Phone: (503) 988-4233
Fax: (503) 988-3093
Website: http://www.comultnomah.or.us/dbcs/emergnecy_mgmt

Regional Resources

Metro Regional Government

Metro is the directly elected regional government that serves more than 1.3 million residents in Clackamas, Multnomah, and Washington counties and 24 cities in the Portland metropolitan area. Chapter 5 of Metro's Regional Framework Plan addresses natural hazards. Metro's Natural Hazards Program is a service of the Growth Management Services Department's Data Resource Center. Their web pages describe natural hazards that may impact the Portland metropolitan area and offer tools for reducing potential damages before disaster strikes. Metro produced the *Regional Hazard Mitigation Policy and Planning Guide* in 1999 to assist local governments in planning for future natural hazard events.

Contact 1: Metro Regional Government
Address: 600 NE Grand Ave, Portland, OR 97232-2736
Phone: (503) 797-1839
Fax: (503) 797-1911
Website: http://www.metro.dst.or.us/metro/growth/gms.html
Email: 2040@metro-region.org

Contact 2: Metro Data Resource Center
Website: http://storefront.metro.dst.or.us/drc/nathaz/nathaz.cfm
Email: drc@metro.dst.or.us

State Resources

Department of Land Conservation and Development (DLCD)

DLCD administers the State's Land Use Planning Program. The program is based on 19 Statewide Planning Goals including Goal 7, a standard related to natural hazards, specifically floods. DLCD serves as the federally designated agency to coordinate floodplain management in Oregon. They also conduct various landslide-related mitigation activities. In order to help local governments address natural hazards effectively, DLCD provides technical assistance and conducts workshops, reviews local land use plan amendments, and works interactively with other agencies.

Contact: Natural Hazards Program Manager, DLCD
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Oregon Department of Consumer and Business Services

The Building Codes Division of Oregon's Department of Consumer and Business Services is responsible for administering statewide building codes. Its responsibilities include adoption of statewide construction standards that help create buildings designed to resist flood, wildfire, wind, foundation stability, and seismic hazards. Information about wildfire-related building codes is found through this department.

Contact: Building Codes Division
Address: 1535 Edgewater St. NW, P.O. Box 14470, Salem, OR 97309
Phone: (503) 373-4133
Fax: (503) 378-2322
Website: http://www.cbs.state.or.us/external/bcd

Oregon Department of Forestry (ODF)

ODF's Fire Prevention Unit is involved in interface wildfire mitigation and provides information about Oregon's Wildfire Hazard Zones. The Protection From Fire section of the ODF website includes Oregon-specific fire protection resources. Wildfire condition reports can be accessed on the website as well. ODF's Protection from Fire Program works to do the following:

- Clarify roles of ODF, landowners, and other agencies in relation to wildland fire protection in Oregon;
- Strengthen the role of forest landowners and the forest industry in the protection system;

- Understand and respond to needs for improving forest health conditions and the role/use of prescribed fire in relation to mixed ownerships, forest fuels and insects and disease; and
- Understand and respond to needs for improving the wildland/urban interface situation.

Contact: Oregon Department of Forestry, Fire Prevention Unit
Address: 2600 State Street, Salem, Oregon 97310
Phone: (503) 945-7440
Website: http://www.odf.state.or.us/fireprot.htm

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

The purpose of OEM is to execute the Governor's responsibility to maintain an emergency service system as prescribed in Oregon Revised Statutes Chapter 401. These responsibilities essentially require 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.

Contact: Office of Emergency Management
Address: 595 Cottage Street NE, Salem, OR 97310
Phone: (503) 378-2911
Fax: (503) 588-1378
Website: http://www.osp.state.or.us/oem/

Office of the State Fire Marshal (OSFM)

The Prevention Unit of Oregon's Office of the State Fire Marshal contains 19 Deputy State Fire Marshals located in various regions. The responsibilities of these deputies include public education for local fire districts and inspection of businesses, as well as public education through schools, daycare centers, and adult foster homes. The State Fire Marshal's Community Education Services unit works to keep Oregonians safe from fires and injury by providing them with the knowledge they need to protect themselves and their property.

Contact: Oregon State Fire Marshal
Address: 4760 Portland Road NE, Salem, Oregon 97305-1760
Phone: (503) 378-3473
Fax: (503) 373-1825
Website: http://159.121.82.250/ Oregon Laws on Fire Protection: http://159.121.82.250/SFM_Admin/firelaws.htm
Email: Oregon.sfm@state.or.us

Federal Resources and Programs

Federal Emergency Management Agency (FEMA)

FEMA's mission is "to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon, and Washington.

Contact: FEMA, Federal Regional Center, Region 10

Address: 130-228th St. SW, Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: http://www.fema.gov/Reg-X/index.htm

Federal Wildland Fire Policy, Wildland/Urban Interface Protection

This is a report describing federal policy and interface fire. Areas of needed improvement are identified and addressed through recommended goals and actions.

Website: http://www.fs.fed.us/land/wdfire7c.thm

National Fire Protection Association (NFPA)

NFPA is the principal federal agency involved in the National Wildland/Urban Interface Fire Protection Initiative. The Association has information on the Initiative's programs and documents. Other members of the initiative include: the National Association of State Foresters, the US Department of Agriculture Forest Service, the US Department of the Interior, and the United States Fire Administration.

Contact: Public Fire Protection Division
Address: 1 Battery March Park, P.O. Box 9101, Quincy, MA 02269-9101
Phone: (617) 770-3000

National Interagency Fire Center (NIFC)

The NIFC in Boise, Idaho is the nation's support center for wildland firefighting. Seven federal agencies work together to coordinate and support wildland fire and disaster operations. These agencies include the Bureau of Indian Affairs, Bureau of Land Management, Forest Service, Fish and Wildlife Service, National Park Service, National Weather Service, and Office of Aircraft Services.

Contact: National Interagency Fire Center
Address: 3833 S. Development Avenue, Boise, Idaho 83705-5354
Phone: **(**208) 387-5512
Website: http://www.nifc.gov/

United States Fire Administration (USFA) of the Federal Emergency Management Agency (FEMA)

As an entity of the Federal Emergency Management Agency, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies through leadership, advocacy, coordination, and support.

Contact: USFA, Planning Branch, Mitigation Directorate
Address: 16825 S. Seton Ave., Emmitsburg, MD 21727
Phone: (301) 447-1000
Website: http://www.fema.gov/mit/wfmit.htm - Wildfire Mitigation Planning
http://www.usfa.fema.gov/index.htm - USFA Homepage
http://www.usfa.fema.gov/wildfire/- USFA Resources on Wildfire

United States Forest Service (USFS)

The USFS is a federal land management organization established to manage the nation's federally owned forests. As part of the Department of Agriculture, it provides timber for people; forage for cattle and wildlife; habitat for fish, plants, and animals; and recreation lands throughout the country. The USFS offers a possible link from local jurisdictions to federal grant programs.

Contact: USDA Forest Service - Pacific Northwest Region
Address: 333 SW First Avenue, Portland, Oregon 97204-3440;
P.O. Box 3623, Portland, OR 97208-3623
Phone: 503-808-2468
Webstite: http://www.fs.fed.us/r6/welcome.htm

Additional Resources

American Red Cross

The American Red Cross is a volunteer-led humanitarian organization that provides relief to victims of disasters and helps people prevent, prepare for, and respond to emergencies. The Oregon Trail Chapter was chartered as a Red Cross unit in 1917. The Chapter serves the residents of Clackamas, Columbia, Multnomah, Washington, Yamhill, and Tillamook counties. The Oregon Trail Chapter provides a variety of community services which are consistent with the Red Cross mission and meet the specific needs of this area including disaster planning, preparedness, and education.

Contact: American Red Cross, Oregon Trail Chapter
Address: P.O. Box 3200, Portland, OR 97208-3200
Phone: (503) 284-1234
Fax: (503) 284-4247
Email: info@redcross-pdx.org
Website: http://www.redcross-pdx.org
http://www.redcross.org/services/disaster/keepsafe/volcano.html

Institute for Business & Home Safety (IBHS)

IBHS was created by insurance industry to reduce damage and losses caused by natural disasters. This website provides educational resources and on-line publications for insurers, businesses, and homeowners who are interested in taking the initiative to minimize future damages and losses.

Contact: Institute for Business and Home Safety
Address: 1408 North Westshore Boulevard - Suite 208 - Tampa, FL 33607
Phone: (813) 286-3400
Fax: (813) 286-9960
E-mail: info@ibhs.org
Website: http://www.ibhs.org/ibhs2

FireFree Program to Promote Home Safety

In a pioneering effort to address wildfire danger in Bend, Oregon, four local agencies and a Fortune 500 corporation joined together to create "FireFree! Get In The Zone," a public education campaign designed to increase resident participation in wildfire safety and mitigate losses. Spearheaded by SAFECO Corporation, the partnership includes the Bend Fire Department, Deschutes County Rural Fire Protection District #2, Bend City Planning, and The Deschutes National Forest.

The Oregon Department of Forestry and a number of local government agencies and businesses have joined the program.

Contact: FireFree
Address: 63377 Jamison St., Bend, OR 97701
Phone: (541) 318-0459
E-mail: dcrfpd2@dcrfpd2.com
Website: http://www.firefree.org

Firewise – The National Wildland/Urban Interface Fire program

Firewise maintains a website designed for people who live in wildfire-prone areas, but it also can be of use to local planners and decision makers. The site offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences.

Contact: Firewise
Address: PO Box 9101, Quincy, MA 02269-9101
Phone: (617) 984-7056
E-mail: firewise@firewise.org
Website: http://www.firewise.org/

Publications

National Fire Protection Association Standard 299: Protection of Life and Property from Wildfire. National Wildland/Urban Interface Fire Protection Program, (1991). National Fire Protection Association, Washington, D.C.

This document, developed by the NFPA Forest and Rural Fire Protection Committee, provides criteria for fire agencies, land use planners, architects, developers, and local governments to use in the development of areas that may be threatened by wildfire.

Contact: National Fire Protection Association Publications
Phone: (800) 344-3555
Website: http://www.nfpa.org or http://www.firewise.org

An International Collection of Wildland-Urban Interface Resource Materials (Information Report NOR-X-344). Hirsch, K., Pinedo, M., & Greenlee, J. (1996). Edmonton, Alberta: Canadian Forest Service.

This is a comprehensive bibliography of interface wildfire materials. Over 2,000 resources are grouped under the categories of general and technical reports, newspaper articles, and public education materials. The citation format allows the reader to obtain most items through a library or directly from the publisher. The bibliography is available in hard copy or diskette at no cost and is also available in downloadable PDF form.

Contact: Canadian Forest Service, Northern Forestry Centre, I-Zone Series
Phone: (780) 435-7210
Website: http://www.prefire.ucfpl.ucop.edu/uwibib.htm

Wildland/Urban Interface Fire Hazard Assessment Methodology. National Wildland/Urban Interface Fire Protection Program, (1998), NFPA, Washington, D.C.

Contact: Firewise (NFPA Public Fire Protection Division)
Phone: (617) 984-7486
Website: http://www.firewise.org

Fire Protection in the Wildland/Urban Interface: Everyone's Responsibility. National Wildland/Urban Interface Fire Protection Program. (1998). Washington, D.C.: Author.

Contact: Firewise (NFPA Public Fire Protection Division)
Phone: (617) 984-7486
Website: http://www.firewise.org

Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development (July 2000).

Produced by the Community Planning Workshop for the Department of Land Conservation and Development, this is a natural hazards planning and mitigation resource for Oregon cities and counties. It provides hazard-specific resources and plan evaluation tools. The document was written for local staffs and officials. The Technical Resource Guide includes a natural hazards comprehensive plan review, a hazard mitigation legal issues guide, and five hazard-specific technical resource guides. The guides cover flooding, wildfires, landslides, coastal hazards, and earthquakes. This document is available online. You can also write, call, or fax to obtain this document:

Contact: Natural Hazards Program Manager
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

Burning Questions. A Social Science Research Plan for Federal Wildland Fire Management, Machlis, G., Kaplan, A., Tuler, S., Bagby, K., and McKendry, J. (2002) National Wildfire Coordinating Group.

The plan covers a wide range of topics and questions related to the human dimensions of federal wildland fire management. Both the beneficial and harmful affects of wildland fire are considered. The plan includes research in the social sciences or anthropology, economics, geography, psychology, political science, and sociology, as well as interdisciplinary fields of research. The plan is national in scale but recognizes the importance of regional variation in wildland fire issues.

Contact: Cooperative Park Studies Unit
Address: 635 Capitol St. NE, Suite 200, Salem, OR 97301-2540
Phone: (208) 885-7054
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/hazards.html

[1]Wildfire Endnotes

1 Colorado State Forest Service, (July 2001), http://205.169.13.227/depts/emmgmt/wildfireproblem.htm.

2 Portland Urban Forestry Management Plan 2004, page 55.

3 DeBano, Leonard; Neary, Daniel; Ffolliott, Peter, Fire's Effects on Ecosystems, 1998, pg. 21

4 Ibid 22

5 Ibid 22

6 Ibid 49

7 Ibid. pg. 304

8 Ibid

9 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development, Ch. 7.

10 Robert Olson Associates, Metro Regional Hazard Mitigation Policy and Planning Guide, (June 1999), Metro.

11 Introductory language in Senate Bill 360, (July 2001), ODF website, http://www.odf.state.or.us/fireprot/sb360.html.

12 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development, Ch. 7.

13 DeBano, Leonard; Neary, Daniel; Ffolliott, Peter, Fire's Effects on Ecosystems, 1998, pg. 59.

14 Ibid

15 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development, Ch. 7.

16 Ibid.

17 Ibid.

18 The Oregonian, Feb. 25, 2001.

19 Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development, Ch. 7.

20 Colorado State Forest Service, (July 2001), http://205.169.13.227/depts/emmgmt/wildfireproblem.htm.

21 Oregon Department of Forestry, (1999) Oregon Forests Report.

22 Personal Interview. Jim Wolf, Oregon Department of Forestry, February 28, 2001.

23 Ibid.

24 Federal Wildland Fire Policy, (July 2001), http://www.fs.fed.us/land/wdfire7c.htm.

25 Ibid.

26 Ibid.

27 Ibid.

Appendix A
Economic Analysis of Natural Hazard Mitigation Projects

This appendix was developed by the Oregon Natural Hazards Workgroup of the University of Oregon's Community Service Center. The appendix outlines three approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan,* (Oregon State Police – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigatio*n. This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce "ripple-effects" throughout the community, greatly increasing the disaster's social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

What are Some Economic Analysis Approaches for Evaluating Mitigation Strategies?

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories: benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the there methods is outlined below:

Benefit/cost Analysis

Benefit/cost analysis is a key mechanism used by the state Office of Emergency Management (OEM), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project worth pursuing will have a benefit/cost ratio greater than 1 (i.e., the net benefits will the exceed net costs).

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in public sector mitigation activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in private sector mitigation activities

Private sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Conducting detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practicle. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of these methods is the STAPLE/E Approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a systematic fashion. This criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's April How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E Approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process".

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?

- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: Consult the mayor, city council or county planning commission, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?

- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)?
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

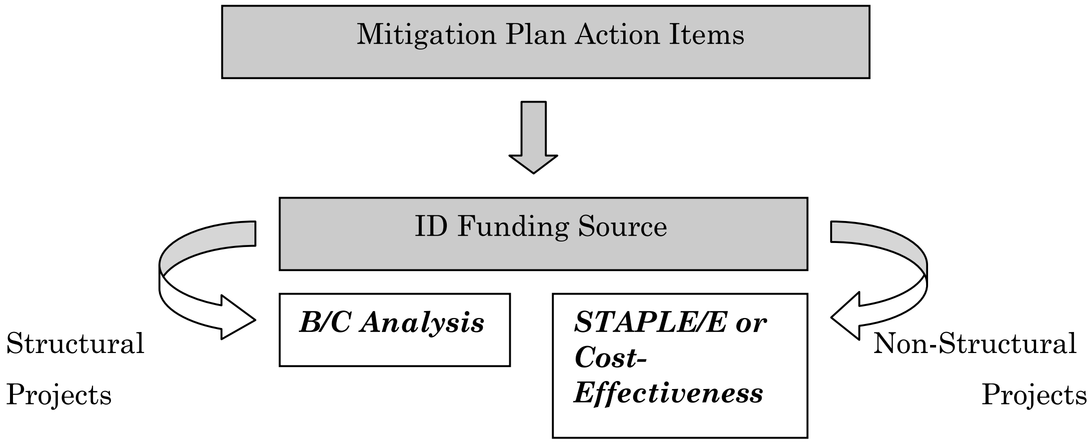
Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed Benefit/Cost Analyses.

When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.



Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation project can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- ***Determine the project cost.*** This may include initial project development costs, and repair and operating costs of maintaining projects over time.
- ***Estimate the benefits.*** Projecting the benefits, or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected.

Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

- ***Consider costs and benefits to society and the environment.*** These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.
- ***Determine the correct discount rate.*** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- ***Net present value***. Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.
- ***Internal Rate of Return***. Using the *internal rate of return* method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or landowner as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. Many communities are looking towards developing multi-objective projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies For Evaluating The Socio-Economic Consequences Of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997.

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics Inc., 1996.

Federal Emergency Management Agency *Report on Costs and Benefits of Natural Hazard Mitigation.* Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in The City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects* Volume V, Earthquakes, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert

Olson Associates, Prepared for Oregon State Police, Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000).

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency Management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

Appendix B
Documentation of the Planning Process

The development of Portland's Natural Hazard Mitigation Plan began in April of 2004. Portland Office of Emergency Management (POEM) provided oversight of the process with guidance from consultants at ECONorthwest. In addition to POEM, three groups provided significant input in the plan development process: a steering committee, five subcommittees, and the general public. These groups and their roles are described in detail in this appendix.

Steering Committee

A diverse steering committee took an advisory role in the process of creating the plan. Members of the steering committee came from government services, nonprofit organizations, public utilities, and businesses in the Portland area. Because of their role in the community of Portland, their knowledge about community issues helped make the plan specific and relevant to the community. The steering committee reviewed the work of all subcommittees, finalized the hazard specific chapters, developed the mission and vision, and finalized and developed all plan goals. The individuals below were involved in the steering committee:

- City of Portland Commissioner Dan Saltzman
- Dr. Ron Tammen, Steering Committee Chair, Portland State University, Hatfield School of Government
- Dr. Vicki McConnell, State Geologist, Department of Geology and Mineral Industries
- Bonny McKnight, Citywide Landuse Group and Neighborhood Coalitions
- Meryl Redisch, Executive Director, Audubon Society of Portland
- Don Eggleston, Principal, SERA Architects
- Myron Burr, Environmental Manager, Siltronic Corporation
- Dan Caufield, Planning and Operations Manager, Tri-Met
- Wade Lange, Sr. Property Manager, Ashforth Pacific Inc.
- Gil Kelley, Director, Bureau of Planning
- Ray Kerridge, Director, Bureau of Development Services
- Dean Marriott, Director, Bureau of Environmental Services
- Ed Wilson, Chief, Bureau of Fire and Rescue

- Jeanne Nyquist, Director, Bureau of Maintenance
- Mort Anoushirivani, Director, Bureau of Water Works
- Brant Williams, Director, Portland Office of Transportation
- Miguel Ascarrunz, Director and Elise Marshall, Assistant Director, City of Portland Office of Emergency Management

Steering Committee Meeting #1: June 29, 2004

This was the kick-off meeting for the project. POEM staff briefed the Steering Committee on the project and the Committee's role. The Committee was also briefed on the subcommittee process. Finally, POEM staff presented a draft vision, mission, and goals.

Steering Committee Meeting #2: August 19, 2004

The steering committee reviewed and made changes to the plan mission and goals. They also reviewed drafts of the plan's outline and Section 1: Introduction. The subcommittees provided updates on their progress to date.

Steering Committee Meeting #3: September 28, 2004

In this meeting, the steering committee reviewed and suggested changes to Section 6: Plan Implementation, Maintenance, and Public Participation. They also prioritized the plan's five goals and heard progress updates from subcommittees.

Steering Committee Meeting #4: November 16, 2004

The steering committee reviewed and suggested changes to the following sections:

- Section 2: Community Profile
- Section 5: Multi-Hazard Action Items
- Section 6: Plan Implementation, Maintenance, and Public Participation

They also heard an overview of the PDM grant application process from Dennis Sigrist, the State Hazard Mitigation Officer, and heard updates from the subcommittees. By this meeting, the subcommittees had completed final drafts of the hazard-specific sections.

Subcommittees

The City of Portland recognized the importance of establishing a collaborative planning process to develop both short-term and long-term risk reduction strategies with strong ties to the City existing programs and divisions of governance. Therefore, the City developed five hazard specific subcommittees comprised of individuals and specialists with natural hazard mitigation understanding and responsibilities from city bureaus, state agencies, and community organizations in and around Portland. The subcommittees were able to provide insight on community issues, policies and programs related to natural hazards and developed a list of current mitigation activities that are being implemented by the various organizations, in addition to identifying potential future actions items.

The subcommittees met regularly (some weekly, others every other week) to finalize the hazard-specific sections. Their primary responsibility was the development of action items for each of the hazards. For each action item, the subcommittees determined the coordinating body, internal and external partners, a timeline, and key issues addressed. Subcommittee members were also responsible for gathering and integrating comments from bureau management.

The committee consisted of representatives of public and private agencies and organizations in the City of Portland, including:

Severe Weather

Dave Harrington, Chair, Portland Office of Transportation and Maintenance

Ken Carlson, Eric Thomas, and Phil Burkart, Bureau of Development Services

Bryan McNerney, City Forester, Parks and Urban Forestry

John McGregor, Bureau of Environmental Services

Lt. Allen Oswalt, Bureau of Fire and Rescue

Michael Armstrong, Office of Sustainable Development

Mike Stuhr and Mary Leung, Bureau of Water

Steve Todd, National Weather Service

Dan Caufield, Tri-Met

Earthquake

Jed Sampson, Chair, Bureau of Development Services

Deborah Stein, Bureau of Planning

Mary Ellen Collentine, Bureau of Water

Gary Ott, Bureau of Environmental Services

Bruce Walker and Judy Crockett, Office of Sustainable Development

Mike Speck, Bureau of Fire and Rescue

Calvin Lee and Bill Long, Portland Office of Transportation

Kenny Asher, Portland Development Commission

Don Eggleston, SERA Architects

Dan Caufield, Tri-Met

Dr. Vicki McConnel, Department of Geology and Mineral Industries

Gail Dreckman, Bonneville Power Administration

Flood

Daniela Cargill, Chair, Bureau of Environmental Services

Chris Wanner, Bureau of Water

Bill Freeman, Bureau of Development Services

Fred Wearn, Portland Development Commission

Christ Payne, Harbor Master, Portland Fire and Rescue

Chris Scarzello, Bureau of Planning

Fred Burckhardt, Portland Office of Transportation

Dave Henricks, Multnomah County Drainage District

Wildfire

Richard Haney, Chair, Portland Fire and Rescue

Roberta Jortner, Bureau of Planning

George Helm, Rebecca Esau, Bureau of Development Services

Dennis Kessler and Chris Wanner, Bureau of Water

Andi Curtis, Bureau of Environmental Services

Mark Wilson and Charley Davis, Parks and Recreation

Kevin Williams, Portland Office of Transportation

Mitch Luckett, Audubon Society of Portland

Karen Trombley, Tryon Creek State Park

Louisa Evers, Bureau of Land Management

Landslide

Liane Welch and Tom Caulfield, Co-Chairs, Portland Office of Transportation

, Portland Office of Transportation

Tricia Sears and Bill Freeman, Bureau of Development Services

Deborah Lev, Parks and Recreation

Mark Braun and Barbara George, Bureau of Environmental Services

B.C. Bob Ferrington, Bureau of Fire and Rescue

Sallie Edmunds, Bureau of Planning

Tim Collins, Bureau of Water

Mitch Luckett, Audubon Society of Portland

Bonny McKnight, Neighborhood Landuse Committee

Dr. Scott Burns, Portland State University, Department of Geology

Public Participation

The City of Portland is dedicated to involving the public directly in the continual reshaping and updating of the Natural Hazard Mitigation Plan. Public Participation offers citizens the chance to voice their ideas, interests, and opinions. Oregon's land use system addresses the need for public process in Statewide Land Use Planning Goal 1: Citizen Involvement, which ensures the opportunity for citizens to be involved in the planning process. FEMA's Disaster Mitigation Act of 2000 includes requirements for involving the public in natural hazard mitigation planning. The Act requires:

"An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process."

During plan development, public participation was incorporated into every stage of the plan development process. The Portland Natural Hazard Mitigation Plan was developed with input from a variety of public participation techniques. The steering committee and five subcommittees each represented members of the public and key stakeholders. Representatives from key stakeholder organizations, including non-profits, industry, insurance, and state organizations served as members of the Steering Committee and sub-committees. While on the sub-committees, key community members reviewed and participated in discussions about needed City mitigation actions. Such experts represented utilities, universities, the Army Corp of Engineers, and Multnomah County Drainage District.

Portland Office of Emergency Management (POEM) also conducted outreach via existing community and business organizations and public review of the plan on their website.

In addition, the subcommittees suggested many potential reviewers. These experts, who are not affiliated with city bureaus, were invited to review and comment on the Plan. This broad based group includes neighborhood, watershed, development, environmental, business, school and non-profit representation. The individuals and organizations listed below will be asked to review the HMP, provide feedback and ask additional questions. POEM will invite presentations, meetings or interviews to discuss the HMP. This input will provide valuable guidance to the Steering Committee, as the plan will be updated at least annually.

- African American Chamber of Commerce
- Army Corp of Engineers

- Asian Chamber of Commerce
- Bonneville Power Administration
- BOMA
- Citizen Crime Commission
- City Club
- Citywide outreach through other existing opportunities through other city bureaus
- Community Rating System
- Department of Land Conservation & Development
- Environmental Protection Agency
- Hispanic Chamber of Commerce
- Hispanic Contractors
- Home Builders Association
- Government Affairs
- Johnson Creek, Tryon Creek, and Columbia Slough Watershed Councils
- Land Use Committee
- Local Emergency Management Committee
- Nature Conservancy
- Natural Resources Management Team from the Bureau of Environmental Services
- Neighborhood Business Associations
- Neighborhood Coalition Meetings
- Neighborhoods with specific hazard concerns
- Oregon Association of Minority Entrepreneurs
- Oregon Continuity Planners Association
- Portland Business Council
- Portland Development Commission
- Portland Metropolitan Assn. of Realtors
- Portland Public Schools
- Port of Portland
- PSU Geology Dept
- Regional Emergency Management Technical Committee
- Rotary Club of Portland
- Tri-Met

POEM has developed a worksheet to use for gathering comment from the above individuals. It is provided on the following page.

Review Guidelines

You are welcome to give us as much feedback as you would like to but we really would like to know the following:

Does the plan adequately address the needed mitigation actions for each of the five hazards included?

Wildfire	□ yes □ no
Flood	□ yes □ no
Earthquake	□ yes □ no
Extreme Weather	□ yes □ no
Landslide	□ yes □ no

If not, explain what you would add.

____
____
____

In what way will the plan affect your organization?

More aware of mitigation	□ yes □ no
Change in operating procedures	□ yes □ no
Integration of Action items into your Emergency Management or agency plan	□ yes □ no

Comments?
____
____
____

Optional Information

Name____

Phone &/or email____

Would you like to be contacted for committee involvement?	□ yes □ no
For future review of documents?	□ yes □ no
Would you like a Mitigation Presentation for your organization?	□ yes □ no

If YES – what organization? contact?

____

Appendix C
HAZUS-MH Risk Assessment

This appendix provides the full text of the Hazard Risk Assessment using HAZUS-MH, produced in by Tetra Tech EM Inc. for the Portland Office of Emergency Management. It provides important background for the action items and hazard assessments included in this natural hazard mitigation plan.

Portland's risk assessment was completed in 2001 as part of a pilot project initiated between the Federal Emergency Management Agency and the City of Portland. The project was designed to demonstrate the applicability of using Hazards U.S. Multi-Hazard (HAZUS-MH) software to address the risk assessment requirements of the Disaster Mitigation Act of 2000 (DMA 2000). The risk assessment project was conducted to evaluate priority hazards of primary concern to the community, and to estimate potential damages and losses. The risk assessment provides a foundation for the community's decision makers to evaluate mitigation measures that can help reduce the impacts of future hazard events.

Two methodologies were used to assess potential exposure and losses associated with priority hazards for this pilot project. For flood and earthquake, specific hazard parameters (ground motion for earthquake and discharge velocity for flood) were compared to a variety of infrastructure inventory parameters (for example, first floor elevations and building types). These were modeled to determine potential impact to humans, buildings, roads, and other assets. For landslide and wildland fire, historic data were not adequate to support the estimation and modeling of future events and losses. Instead, HAZUS-MH inventory data, professional judgment, and hazard area data regarding the geographic scope of each hazard were used to estimate exposure. Over the long term, Portland will collect additional data to assist in estimating potential losses for these hazards.

The value of such a study in the City of Portland is three-fold. First, it provides a basis for mitigation decision making through a federally recognized quantitative methodology. Second, it estimates potential loss from a disaster through GIS mapping and consistent, defensible data that is accepted in applications for expedited disaster recovery reimbursement requests. Third, it provides risk information in the form of maps and statistics that appeal to planners, engineers, and program developers who might not ordinarily consider disaster management in their planning.

INSERT HAZUS-MH RISK ASSESSMENT HERE

Appendix D
Capability Assessment Matrix

The example Capability Assessment on the following page is designed to assess the operations, readiness, and capabilities of those organizations associated with the plan's action items to assess which items in the prioritized list can be implemented using existing resources and which items require outside funding. It can be used to help the DPC answer the question, "Does the coordinating agency have the capability needed to implement the action item?" This matrix is intended to be used as part of the prioritization process.

Agency Name	Related Internal Partners	Action Item Associated With	Local Point of contact	Level of Immediate Capability			Comments from Agency Regarding Capability	Status
				High (Can Immediately Implement)	Medium	Low (Need for Great Deal of funding, Staff, time)		
Example – City of Portland, POEM	Bureau of Environmental Services, Planning	Example – ST-EQ #1, Identify funding sources for implementing earthquake mitigation.			X			