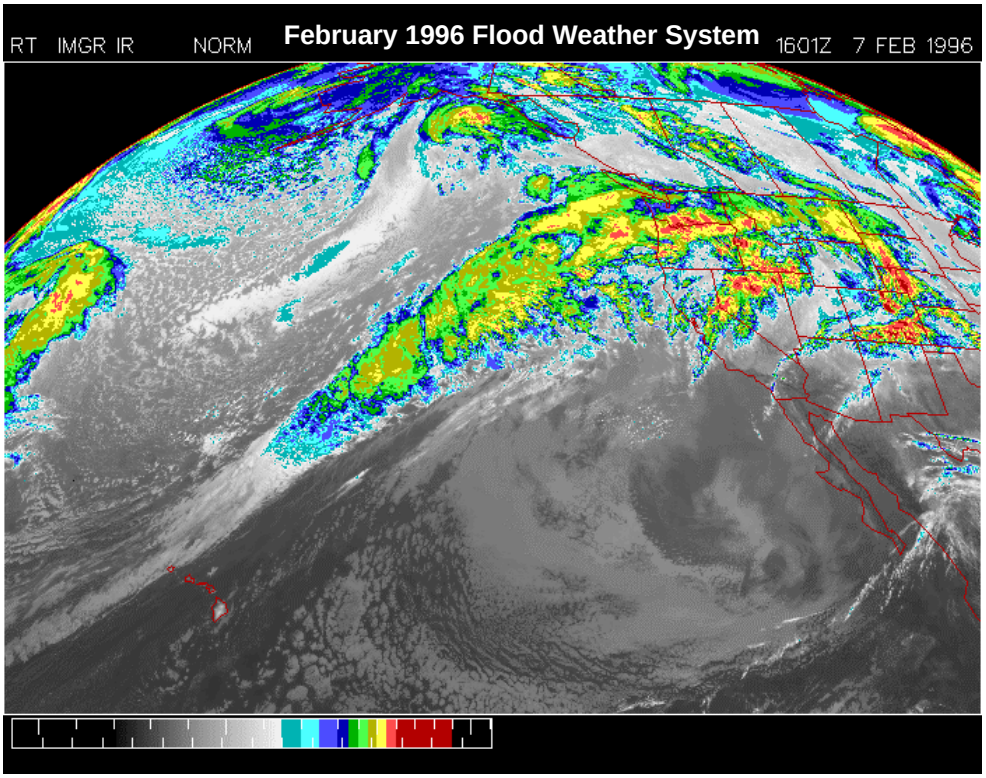
METRO

Regional Hazard Mitigation Policy and Planning Guide

Reducing Disaster Losses



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Chapter 1
Introduction

1.1. Background

Residents of the Portland metropolitan area have many reasons to be proud of the region. Human development has capitalized on the climate, water and land resources to make this area one of the most desirable places in the country to live, work and play. Metro, the regional government for the three-county Portland area, has done its share to maintain and improve on these advantages through growth management planning and technical assistance to the region's local governments.

While the Metro area benefits from its natural setting, it is also subject to natural hazards. Volcanic and seismic activity created Mount Hood and the Cascade Range, and such activity can be expected to continue. Heavy precipitation can result in floods in the valleys and mudflows and landslides on the hillsides. Combinations of weather extremes of strong winter storms and long, dry and hot summers can create extensive economic loss over time or trigger disaster events such as flooding or wildland-urban interface fire.

It is now a well-accepted tenet that natural activities, such as rain, cold and heat are by themselves beneficial or, at worst, benign. They are part of the natural order of things. Floods replenish floodplains with nutrients and recharge aquifers. Wildfires help preserve and restore appropriate plant life. These "hazards" do not cause problems except where humans are affected.

Disasters result when natural hazards destroy human development. More and more, we see the negative impacts from occupying hazardous areas, such as floodplains and steep hillsides, and the damages caused by inadequate construction practices that do not account for natural activities, such as earthquakes, erosion, wind and wildfires.

This lesson was brought home to the Metro region during the winters of 1996 and 1997 when floods, landslides, ice storms, and high winds caused extensive damage throughout the northern and western parts of the state. In the February 1996 flood, all three counties in the Metro region were declared disaster areas by the Governor and the President. As the region's leader in growth management, Metro has a special duty to ensure that natural hazards that threaten people, buildings and infrastructure are considered during the planning process.

There are two approaches to this: manage the hazard and manage the development. In some cases, especially when it affects existing development, managing the hazard may be more appropriate and/or more efficient. For example, drainage improvements can control small scale flooding and keep developed areas dry. Wildfires that threaten structures can be controlled with fire suppression techniques.

In other cases, it makes more sense to manage development. It is easier (and less disruptive to the environment) to avoid high velocity floodplains and slide-prone hillsides than to build structures to control flooding or landslides. It is safer to construct earthquake-resistant buildings than to ignore the threat and suffer unacceptable impacts from occasional moderate to great earthquakes occurring on local (e.g., Portland Hills Fault) or more distant (e.g. Cascadia Subduction Zone) faults.

Together, these two approaches are called hazard mitigation. The Federal Emergency Management Agency (FEMA) defines mitigation as "sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects."

There are a variety of mitigation strategies and measures that can manage the hazards and manage development. Some will find useful application in the Metro region while others will not be

applicable, depending on the hazard and the abilities of organizations and people to implement the protective measures.

The Regional Natural Hazard Mitigation Planning Guide (RNHMPG):

- Establishes regional goals and objectives;
- Reviews the hazards and what can be done to avoid or minimize their impacts on people and development; and;
- Identifies potential future actions to implement those measures that appear to be effective and appropriate for the area.

1.2. Purposes

This document is the hazard mitigation planning guide for the Metro region. No planning guide can identify all the potential hazards that could impact the region or all the measures that might reduce damage. This regional planning guide, therefore, has been designed to complement Metro's growth management planning efforts by providing an overview of key natural hazards, possible measures to mitigate future losses from them, and a basis for more action-oriented local mitigation plans which could focus on specific measures and activities that are or could be applied at the county, city, and special district levels of government.

Moreover, this planning guide is Metro's effort to identify what can be to prevent loss in all communities and encourage development of a disaster resistant region. The planning guide is also intended to address the State of Oregon's planning Goal 5: "To protect life and property from natural disasters and hazards." The RNHMPG also addresses Metro's charter authority to consider the metropolitan aspects of disaster planning and response coordination.

The planning guide acknowledges and recognizes the various mitigation efforts already existing in many of the area's local governments. Appendix Four, *Survey of Natural Hazard Mitigation Practices of Cities and Counties in the Portland Oregon Metropolitan Region* (June 1998), shows that of the 25 surveys returned, the majority of jurisdictions had adopted at least one natural hazard mitigation policy. Ordinances and other measures were also in place for most jurisdictions. A few jurisdictions adopted codes or administrative rules related to hazard mitigation. Most jurisdictions had mitigation policies related to earthquake, flood, landslide, windstorm, winter storm, and wildland fire. A few jurisdictions had adopted policies for drought or volcano."

There are six primary purposes of this planning guide:

- Minimize the loss of life among the region's residents and visitors.
- Meet state and federal requirements for hazard mitigation funding programs:
- Review the natural hazards of the region:
- Review a range of possible approaches to reduce risk:
- Identify the highest priority regional mitigation strategies and policies:
- Provide a background document for local mitigation action plans:

1.3. Process

This planning guide is the product of a standard planning process that reviews the problem, analyzes alternative solutions, and identifies potential future actions. It builds on past plans and existing federal, state, local and private mitigation programs.

The planning guide has been reviewed extensively by technical and professional experts, regional public policy committees and the public. Groups which have reviewed the planning guide include:

- Metro Natural Hazards Technical Advisory Committee
- Regional Emergency Management Group
- Technical Workshop of October 30, 1998 (attended by more than 60 persons)
- State of Oregon Office of Emergency Management
- State of Oregon Department of Geology and Mineral Industries
- State Department of Land Conservation and Development

A complete description of the public involvement schedule is provided as Appendix Four.

1.4 Metro Mitigation Activities

In 1992, Metro created a natural hazards program using federal grant funds. This program provides regional coordination, outreach, data management services and technical assistance in developing regional strategies for identifying natural hazards, thereby helping communities and residents prepare for disasters.

Metro created a partnership with the Oregon Department of Geology and Mineral Industries (DOGAMI) and Portland State University (PSU) to collect and analyze seismic risk data in the region. Metro has collaborated with local and state emergency management agencies with the intent to develop a comprehensive emergency management plan and system in the region. In 1994 Metro assisted in creating the Regional Emergency Management Group (REMG), an intergovernmental agreement organization whose membership includes Metro, counties and cities in the region.

In 1995, an ad hoc committee, the Metro Advisory Committee on Mitigating Earthquake Damage (MACMED), brought together planners, building code authorities, and engineers from state and local agencies and the private sector to explore ways that evolving hazard data could be used to improve the growth management process. The resulting report, “Using Earthquake Hazard Maps for Land Use Planning and Building Permit Administration” provides local governments in the region an opportunity to include hazard considerations in the planning process.

In 1997, Metro adopted the Urban Growth Management Functional Plan to provide guidance to local governments on various growth management issues, including Title 3 related to water quality and floodplain management. Title 3 was adopted by the Metro Council in 1998 and is attached here as Appendix Five.

Also in 1997, Metro adopted the Regional Framework Plan (RFP) to guide growth management planning in the region through the year 2040. Chapter Five of the RFP addresses natural hazards, and is attached here as Appendix Two.

In the process of developing the Regional Framework Plan, Metro recognized the need to address hazard mitigation measures beyond the discussion in Chapter Five. This planning guide is one result of that recognition.

To create the regional natural hazards mitigation planning guide, three activities were pursued concurrently in the first half of 1997. A Natural Hazard Mitigation Workshop was attended by 100 people from throughout the region. Second, the Natural Hazards Technical Advisory Committee (HAZTAC) was created to advise the Metro Council and Executive Officer on natural disaster planning and response coordination. Third, Metro contracted with a nationally recognized planning

consultant to prepare this Regional Natural Hazards Mitigation Planning guide.

The firm of Robert Olson Associates, Inc. began work on this planning guide and a complementary pilot local mitigation action plan in the summer of 1997. Past studies and reports on the hazards and mitigation programs were reviewed. Numerous federal, state and local agencies were contacted and staff were interviewed.

1.5. Local, State and Federal Mitigation Programs

This planning guide has been coordinated with, or meets the guidelines of, the following programs and activities. Additional references used as a basis for this Regional Natural Hazards Mitigation Planning guide are listed at the end of the RNHMPG.

- FEMA's National Mitigation Strategy, 1996.
- State of Oregon Interagency Hazard Mitigation Team Report for the February 1996 Flooding, Landslides and Stream Erosion, 1996.
- National Earthquake Hazards Reduction Program (NEHRP).
- The Federal Interagency Floodplain Management Task Force's Unified National Program for Floodplain Management, 1994.
- Floodplain management planning credit criteria for FEMA's Community Rating System.
- Planning regulations of FEMA's Hazard Mitigation Grant and Flood Mitigation Assistance programs.
- State of Oregon, Natural Hazards Mitigation Plan, 1992
- The Department of Land Conservation and Development's Statewide Planning Goal 7.
- The State's Action Plan for Protecting Rural/Forest Lands from Wildfire, November 1988.

Chapter 2.
Regional Natural Hazards

This section summarizes the principal natural hazards in the region, which includes earthquakes, floods, landslides and mudflows, wildland-urban interface fires, severe weather, and volcanic activity. The descriptions draw heavily on Chapter Five of the Regional Framework Plan and on other materials reviewed for this planning guide, which are noted in the references. Several maps are available in the Natural Hazards section of the Metro Internet web site (primary locator address: www.metro-region.org) which individually or in combination portray the extent of these hazards and their relationships to various portions of the Metro region.

The purpose of this short tutorial section is to inform the planning guide's readers and users about the nature and extent of natural hazards capable of affecting the region and to provide a basis for Section 3's policies, goals, objectives and measures to minimize future losses from the effects of such hazards.

2.1. Earthquakes

Source of the hazard: Oregon sits on the Cascadia subduction zone where the Pacific Plate is sliding under the North American Plate. While earthquakes along this zone occur infrequently, plate movement can produce major to great earthquakes. In addition, the western part of Oregon is underlain by a large and complex system of faults (e.g., Portland Hills) that can produce damaging earthquakes. There is a direct relationship between a fault's length and its ability to generate damaging ground motions: smaller nearby faults produce lower magnitude events, but their ground shaking can be strong and damage can be high because of the fault's proximity. In contrast, offshore subduction zone events can generate great magnitudes, but because of their distance and depth may result in only moderate shaking in the Metro region.

Earthquakes can trigger other geologic and soils failures that contribute to damage. While surface fault rupture can produce damage to facilities and infrastructure astride the fault, losses from this are minor compared to those due to strong ground shaking and associated ground failures. These include, for example, landslides and slope failures, lateral spreading and slumping, and liquefaction of soils.

Area affected: The Relative Earthquake Hazard Map (available in the Natural Hazards section of the Metro Internet web site, primary locator address: www.metro-region.org) illustrates that the Metro region is subject to various intensities of expected ground shaking. The relative earthquake hazard map categorizes seismic hazard based on an area's susceptibility to liquefaction, slope instability or ground motion amplification during earthquakes. Simply, higher hazard areas (shown in red) are susceptible to two or more seismic hazards.

Threat to life and safety: The unpredictability and instantaneous nature of earthquakes has resulted in enormous losses of life and property and economic disruption. It is clear that such losses can be reduced by following prudent mitigation practices related to locating, designing, and constructing structures, facilities, and systems to codes and standards containing effective seismic design requirements. Seismic rehabilitation or retrofit of existing structures and systems represent potential strategies that can greatly reduce potential losses because the incremental addition of new buildings and other structures to the local stock is only a small percentage of the community's total infrastructure.

Property Damage: Unreinforced masonry buildings (URMs) typically perform very poorly in earthquakes. There are several other types of earthquake hazardous buildings as well (e.g., non-ductile concrete frame, tilt-up wall). A few buildings will cause casualties in earthquakes, but it is

likely that property damage will be widespread. Moreover, there are other types of structural, non-structural, contents and functionality losses that contribute to large property losses. Examples include:

- failures of older dwellings, especially if not bolted to their foundations;
- fallen ceiling tiles and light fixtures;
- broken water pipes and other utility services in buildings;
- loss of inventories; and
- business interruption.

To these can be added losses experienced by utilities, transportation, and related systems and networks serving the region.

History: The historical record shows that more than 56 earthquakes have occurred in or near the greater Portland area. The more severe earthquakes occurred in 1877, 1880, 1953,1962 and 1993. The estimated magnitude 5 (lower end of the moderate range of earthquakes) of the November 5, 1962 event, was felt in Portland and over 150 miles away. In Portland, numerous chimneys were destroyed, windows broken, large cracks occurred in plaster, dishes rattled and furniture moved, and advertising signs fell off buildings**.** The March 25, 1993 Scotts Mills moderate shallow crustal earthquake (5.6 magnitude with aftershocks continuing at least through April 8) occurred in a previously recognized fault zone. It shook portions of the Metro region, and in the three county area (declared as a major disaster by the President), it was reported that:

More than 30 public buildings sustained damage which was concentrated in old masonry buildings. Several buildings require rebuilding. At least 4 fire stations, 1 telephone facility handling the area's 911 capabilities, 16 schools, 5 city halls, 1 medical center, 1 police station, 1 correctional facility, and 1 library were damaged... [Hazard Mitigation Survey Team Report, FEMA-985-OR, 4]

To put this event into context, the above report noted that this earthquake is "the tip of the iceberg concerning Oregon's earthquake potential" [3], and "Recent research shows evidence that major geologic structures capable of magnitude 7 earthquakes run through some our metropolitan areas including Portland..." [33].

2.2. Floods

Source of the hazard: Flooding results when rain or snowmelt create water flows that exceed the carrying capacity of river channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean bring intense rainfall. Flooding can be aggravated when rain is accompanied by snowmelt and frozen ground. It was the combination of these factors that produced the most recent disastrous flood in February and November 1996.

The Metro region, in general, is subject to two principal types of flooding: riverine and local drainage. The area's several major rivers (e.g., Columbia, Willamette, Clackamas, Tualatin) plus many streams in the area are the sources of riverine flooding. Riverine flooding on the larger rivers and streams usually results from large storms or prolonged wet periods. Local drainage flooding occurs along the smaller streams, creeks, and drainage ways, and is more likely to result from heavy local storms and debris-clogged storm drain systems.

Area affected: The areas subject to riverine flooding have been mapped by the Federal Emergency Management Agency(FEMA) for the National Flood Insurance Program (NFIP). The national and

state flood mapping standard is the 100-year or base floodplain. The FEMA 100-Year Floodplain provides an overview of riverine flooding potential in the Metro area. The map is available in the Natural Hazards section of the Metro Internet web site (primary locator address: www.metro-region.org). In the February 1996 floods, for example, some 200 households were in the area of inundation and the direct costs of damage have been estimated at $60 million.

Overbank flooding occurs at various locations and can be very damaging where structures exist. For example, in Oregon City 87 buildings are subject to overbank flooding where two rivers and Abernethy Creek converge. Some of this flooding is due to backwater flooding from the Clackamas and Willamette Rivers. Critical facilities (such as water and wastewater treatment plants and solid waste facilities) located along the rivers and in the floodplains can be damaged.

Not all flood prone areas in the region are subject to damage. Undeveloped areas are still in or near their natural state. Flooding of such areas causes no damage to human development and aids the riparian habitats. For example, Newell Creek Canyon is the second largest natural forest area in public ownership in the Metro area, and is undergoing a major master planning effort to preserve it. Excluding development from the floodplain is a possible mitigation strategy.

Local drainage problems are common throughout the region. Several communities have drainage master plans, and local public works staffs often know of local drainage threats. For example, Oregon City's plan noted that 44 percent of the local drainage structures could not carry the estimated five-year peak flow. The problems often are present where open ditches enter culverts or go underground into storm sewers. In addition, high water tables in some areas can mean wet crawl spaces, yards, and basements after storms because the accumulated water does not drain quickly into a stream or storm sewer. Such problems often are compounded by the filling of ditches and swales near buildings or the dumping of debris that can inhibit or prevent the flow of water. Inadequate maintenance, especially following leaf accumulation in the fall, can also contribute to the flood hazard in urban areas.

Threat to life and safety: Generally, floods kill people in two ways: when people ignore basic safety precautions (e.g., warnings, evacuation) or when a flash flood hits an area with no warning. Flash floods can occur on smaller streams during or soon after a severe local storm or on any river or stream when a dam is breached. Reservoir or other impoundment failures also are possible. Regardless, it is the speed of onset, lack of advance warning, and depth of flooding that make flash floods deadly events.

While the probability of dam failures is remote, they have occurred under a variety of circumstances (e.g., earthquakes, landslides into the impoundment area, terrorism, geologic failures at the abutments, etc.). There are numerous dams in the Metro area belonging to several agencies (e.g., Portland General Electric, Portland Water Bureau, federal Bureau of Reclamation), some of which are subject to dam safety and warning requirements of the Federal Energy Regulatory Commission (FERC).

The depths and velocities associated with local drainage flooding are usually not life threatening, but even such shallow flooding can cause casualties if proper safety precautions are not followed. Typical examples include electrocution due to downed power lines or entering a flooded building; drowning of drivers who ignore warning signs or barriers or who try to cross flooded bridges or roads; and exposure to contaminated water due to the flooding of hazardous materials sites and wastewater treatment plants.

Property damage: Floods can be very damaging, and several reports listed in the references contain specific information. The types of flood damage depends on the depth and velocity of the flood

waters. For example, faster moving flood waters can wash buildings off their foundations and sweep cars downstream. System elements (e.g., pipelines, bridges) can be damaged. Most flood damage, however, is caused by water saturating materials susceptible to loss (e.g., wood, insulation, wallboard, fabric, furnishings, floor covering, appliances). Most of the losses in the 1996 floods were due to saturation damage.

History: The Metro region has been subject to major floods throughout recorded history. For instance, the Willamette and Clackamas Rivers flooded in January 1997 after severe winter storms. The following table, taken from Chapter 5 of the Regional Framework Plan, summarizes the past history of the Columbia and Willamette Rivers at Portland and Vancouver. In Oregon City, for example, the Willamette River flooded areas of the city in 1861, 1890, 1924, 1943, 1964, and 1996 while the Clackamas River flooded portions of Oregon City in 1923, 1931, 1960, 1964, and 1996.

Flood Date	Flood Inundation Level[1] Willamette at Portland	Flood Inundation Level Columbia at Vancouver
February 1996	30.2 ft.	28.8 ft.
December 1977	17.6 ft.	Not available
January 1974	25.7 ft.	25.0 ft.
December 1964	29.8 ft.	29.5 ft.
June 1956	26.4 ft.	26.8 ft.
May 1951	Not available	21.5 ft.
June 1950	Not available	25.1 ft.
June 1948	31.6 ft.	32.8 ft.
January 1943	21.8 ft.	Not available
June 1894	35.1 ft.	36.0 ft.

2.3. Landslides and Mudflows

Source of the hazard: Many hillsides in the Metro region are unstable and vulnerable to landslides and debris and mudflows. These can result from ground saturation, runoff, improper or poorly designed drainage systems or earthquakes. A map showing landslide locations from the 1996 flood is described in the Natural Hazards section of the Metro Internet web site (primary locator address: www.metro-region.org).

Landsliding is a natural process that tends to reduce the height and slope of mountains and ridges and is part of the normal on-going process of smoothing topographical high points. Slides occur in natural materials and in placed fill materials. The process is simple: a mass of earth slides when the forces from the weight of the slide mass exceeds the strength of the material holding it is place. Determining specifically when and where sliding will occur is difficult. Enough is known, or can be determined, however, to support an effective risk reduction effort.

Landslides and mudflows occur especially when prolonged heavy rainfall saturates the soil and rock, and when human activities steepen the slopes, remove the toes, or add weight or water to the slopes. Grading for road construction and other purposes and erosion are examples of how slopes can be

[1] River heights are measured by National Geodetic Vertical Datum

steepened. Adding fill materials to a slope or increasing the saturation of a slope by removing vegetation, altering drainage and runoff flow patterns are examples of increasing the weight of the slope. Water can also weaken the materials' abilities to resist sliding.

The cause and effect relationships are not necessarily confined to an immediate area (i.e., conditions or actions on one parcel of land can cause slides on other parcels). Although the total area of land with a high potential for landslides is small, the consequences are serious when structures, roads, or utility system components are in their paths.

Landslides are downhill or lateral movements of soil and rock. Slides vary greatly in the volumes of rock and soil involved; the length, width and depth of the area affected; frequency of occurrence, and speed of movement. These characteristics are determined by the slope of the hillside, moisture content, and the nature of the underlying materials (e.g., strength, degree of weathering and fracturing, angle of bedding). They are given different names depending on the type of failure and its composition and characteristics:

- **Rock Falls** are fast moving with the materials free falling or bouncing down the slope. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage. They occur on steep slopes.
- **Slides** are jumbled failures of rock or soil that slip on a surface below the mass of sliding material. They generally are slower and can be deep.
- **Slumps** are similar to slides except that the sliding mass remains largely intact. The movement often rotates on a spoon-shaped failure surface unless the failure surface is influenced by bedding planes, faults, or joints in the material.
- **Lateral Spreading** is a slide-like failure along a nearly horizontal surface. Lateral spreading is common following earthquakes, and is often associated with liquefaction of saturated sandy deposits.
- **Earth and Mud Flows** resemble the movement of viscous fluids. They generally are shallow, seldom have a slip surface and can move rapidly. Although water is not necessary, flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances. These can be triggered by earthquakes.
- **Settlement** of sites can result from settlement of the fill materials due to saturation or earthquake shaking. It can seriously damage overlying structures. Cut and fill is a technique used to create flat sites on hillsides for construction purposes (e.g., roads, dwellings). Differential movement between the cut area where natural materials remain in place and the placed fill may be subtle, but can still cause expensive structural and systems damage. Cumulative losses can be quite large because of the number of these sites and the poor manner in which many sites may have been constructed.

Area affected: Many hillsides in the Metro region are unstable and subject to slides and flows. Hundreds were recorded during the events of February 1996 and December 1996. DOGAMI has noted that slide losses most likely will increase because city "expansion and densification are forcing developments on increasingly less stable land. Engineering and drainage management practices suitable for good land will not work on less stable land."

According to *Landslides in the Portland, Oregon Metropolitan Area Resulting from the Storm of February 1996*, a report produced for Metro by the Portland State University Geology Department, there are four dominant landslide provinces. The four are 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 in the southeastern area. Another reference noted that within the Metro region, 60 percent of the existing landslides on the steepest slopes could be triggered by earthquakes. Within this area, commercial and multi-family residential buildings are located on about 132 acres. The safety of these structures cannot be guaranteed by any construction methods, according to geotechnical experts.

Threat to life and safety: Most slides begin slowly enough for analysis and monitoring to be done. If the slide continues, time is generally available for warning, removal of goods, and evacuating occupants from threatened structures on or below the sliding area. While sudden slides are rare, they can cause casualties because of the speed of onset (similar to flash flooding).

Property damage: Landslides destroy or damage anything on the sliding hillside or in its path, including buildings, houses, streets, and utility lines. Therefore, total structural loss is nearly always experienced. This can be mitigated if it is feasible to contain the slide, provide shoring for structures partially damaged, or relocate the structure. Nevertheless, these are expensive, and perhaps only temporary, measures. It is not uncommon for property values to decline, at least for a short period, in recent landslide areas.

History: Landslides are active processes and are a frequent hazard in the Metro region. For example, approximately 20 percent ($13 million) of the $64 million in damages associated with the February 1996 storms has been attributed to landslide losses. Two famous landslides in the West Hills area noted: (1) the reactivation of an ancient slide in 1894 when two reservoirs were built for the city at Washington Park, and (2) the reactivation of a slide at the sites of the Portland Zoo during widening of Canyon Road in the 1950s. According to a report, “Every winter small landslides are found along road cuts in the West Hills and along steep slopes in east Multnomah and Clackamas Counties.”

2.4. Severe Weather Hazards

This broadly defined hazard category includes windstorms, severe winter hazards (e.g., snow, ice, prolonged cold), thunderstorms, tornadoes, drought, prolonged extreme heat and other weather conditions that disrupt vital regional systems and threaten lives and property.

Source of the hazard: The Metro area experiences harsh weather events almost annually. While severe events occur only rarely, there is enough regularity to make these a primary concern of county emergency managers.

Wind and ice storms are caused by severe weather conditions. Wind storms can occur at any time of the year while ice storms are confined to the winter months. Wind storms, occasionally associated with Pacific Coast hurricanes migrating north, usually do not exceed 90 miles per hour, but wind speeds of 119 miles per hour were recorded in Portland during the October 1962 Columbus Day storm. Ice storms can be accompanied by high winds, and they have similar impacts, especially to trees, power lines, and residential utility services.

Area affected: These events can affect the entire Metro region. Severe ice storms occur more frequently in areas exposed to east wind patterns through the Columbia River Gorge, particularly eastern Multnomah and Clackamas counties.

Threat to life and safety: The usual predictability of these events reduces their risk to life because people can take precautionary measures. Nevertheless, casualties can occur because of damage to buildings, falling trees and other objects, blowing debris, fallen power lines, icy streets, and similar effects. For example, over 50 deaths occurred throughout Oregon because of the 1962 storm. The loss of communications services can be a major problem for public information and emergency services purposes. Icy roads may hamper the responses of emergency vehicles such as ambulances

and fire apparatus while power outages may disrupt the functioning of critical facilities (e.g., hospitals). Exposure to prolonged cold or heat can be a public health concern.

Property damage: Little regional data exists, but event summaries have identified frozen water pipes, destroyed or damaged buildings, fallen trees, business interruption, electrical system outages and impassable roads and bridges, as common effects.

History: Wind and ice storms have occurred many times in the Metro region. In addition to the 1962 storm noted above, a December 1995 event having wind speeds of over 154 miles per hour along the southern Oregon coast caused the loss of power to over 250,000 people, some for up to one week. Windstorms and ice storms in 1996 and 1997 caused significant damages and power outages of up to one week in certain areas of the region. A January 1998 winter storm dropped freezing rain and snow in the Oregon City area for two days, causing power outages, treacherous driving conditions, and the need to open one emergency shelter.

Tornadoes are relatively rare, although 56 have been documented primarily in the Willamette Valley and eastern Oregon. In 1957, the most significant tornado to strike the Portland area occurred near Sandy. It twisted and snapped off 18 to 36 inch diameter tress; lifted, carried, dropped and demolished a barn under construction; tore off roofs; and destroyed several outbuildings.

A Metro document notes that “The cost of severe weather events has not been well documented because they are usually not of the duration, extent or intensity to trigger a federal disaster declaration, thereby requiring accurate damage assessment estimations and disaster assistance funding. It is reasonable to assume, however, that the direct and indirect costs of a severe event can be high.”

2.5. Wildland-Urban Interface Fires

Source of the hazard: While more common to the arid areas of eastern Oregon, the potential for losses due to wildland-urban interface fires in the Metro region should not be ignored. The heavily treed hillsides around Portland have long been occupied by residences, and the trend of people locating in or near forested lands continues. Fires in such heavily wooded areas are natural occurrences, and the threat increases when subject to more human activity. The State of Oregon has noted that such interfaces really are an intermingling of homes and other structures at various densities and complexity within areas of heavy natural cover or forest lands. When buildings burn in or close to areas of heavy vegetation, especially during the dry months, the risk increases.

Area affected: Areas where structures are built in proximity to dense vegetation may be vulnerable to wildland-urban interface fire. Of particular concern are areas with narrow roadways with few routes of egress and ingress.

Threat to life and safety: The threat of such fires in the Metro region has not been extensively analyzed. Initial opinions indicate that the relative scarcity of tracts of forested land coupled with well trained and equipped fire protection personnel may help reduce the threat of interface fires. Nevertheless, as a Metro document notes, “There may be isolated developed areas of region...where more intensive analysis of the hazard may be required. And as future development occurs in more rural areas, criteria should be established for defining when additional interface hazard mitigation measures...may be considered.” Building standards, for example, may or may not deal with this threat in some interface areas (e.g., roofing materials, exterior finishes).

State law authorizes jurisdictions to identify wildland-urban interface fire vulnerability and describes the factors contributing to that vulnerability. The Tualatin Valley Fire and Rescue District and the City of Portland have produced wildland-interface fire maps in conjunction with Metro. Data to

develop a regional map is not available.

Recent concerns about the effects of climate change, especially regarding less rainfall in some areas, is adding to the concern about wildland-urban interface fires. Thus, while the Metro area has been spared the impacts of fires such as that which occurred in 1991 in the Oakland-Berkeley hills area of northern California (destroying about 3,400 dwellings) or the 1998 fires in Florida, it is prudent to anticipate that such a fire threat could exist in the Metro region. The enclosed figure taken from a 1988 state task force report portrays this complex relationship, including the relationships of the various fire protection agencies likely to be involved (e.g., wildland, rural fire district, city fire department).

Certain conditions must be present for major interface fires to occur. The most common are hot, dry, and windy weather; the inability of the initial attack fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and an existing fuel load. In such fires, it is difficult for fire protection personnel to predict fire behavior because of the mixture of structures, the development patterns, ornamental vegetation, and natural fuels found in the interface areas. Developments in such areas often have narrow, winding or dead-end roads that inhibit access by emergency vehicles, and small diameter pipe water systems, inadequate to provide sustained fire flows, are common. A compounding problem for many urban fire departments is their lack of experience, training, and appropriate apparatus for suppressing interface fires.

Property damage: To date, no major losses due to wildland-urban interface fires have been reported in the Metro region.

History: The Metro area has no history of such fires, at least since records have been kept.

2.6. Volcanic Activity

Source of the hazard: Several volcanoes, especially nearby Mt. Hood, could pose problems for the Metro region. Under relatively unusual, but not extremely rare meteorological conditions, ash fall from Mts. Hood, St. Helens, Adams, and possibly Rainier will pose a greater hazard to the metropolitan area than other effects.

Mt. Hood, one of the active volcanoes comprising the Cascade Range, is located 75 kilometers east-southeast of downtown Portland. The eastern boundaries of Clackamas and Multnomah counties lie high on the western slope of Mount Hood. Volcanic hazards affect the Metropolitan area in different ways and the resulting risk can be addressed by different strategies. Studies of the eruption history of Mount Hood and the geology of the surrounding area, and observations of other active volcanoes provide the insight for describing the hazard. Future events, their frequency and effects likely will be similar to those of the past. The Portland region can be affected by ash from more distant volcanoes. For example, small amounts of ash from the 1980 eruptions at Mt. St. Helens temporarily closed the Portland International Airport.

- **Lava Flows:** Lava flows are streams of molten rock. Lava flows from vents on Mount Hood can be up to 200 feet thick and travel up to seven miles down valleys. The more viscous types of lava do not flow away, but instead form steep domes over the erupting vent.
- **Pyroclastic Flows:** Pyroclastic flows are avalanches of hot, dry rock fragments and hot gases that can move up to ninety miles an hour away from where they were erupted. Most flows consist of coarse fragments that move along the ground following rivers and valleys, and a turbulent cloud of ash, called an ash-cloud surge, that rises above and in front of the flow. Flows can be triggered by an explosive eruption, or when a dome or thick lava flow collapses down a steep slope. Mount Hood flows have moved seven miles from their point of origin,

but also have triggered lahars (see below) that traveled further. The ash-cloud surge can travel a few miles further than the heavier material on the ground, and can also create a column of ash extending into the atmosphere and drift hundreds of miles. Pyroclastic flows can also trigger violent eruptions.

- **Lahars:** Lahars are fast moving mixtures of water and rock fragments that flow down the slopes of a volcano and/or river valleys. They include mixtures of rock and soil that range in size from clays to boulders over thirty feet in diameter. Lahars can be triggered when pyroclastic flows or lava flows melt snow and ice, or by heavy rainfall, lake breakout, or landslides. Stratovolcanoes like Mount Hood tend to create lahars because they erupt explosively, have tall steep cones, often have snow and ice or crater lakes, and are composed of easily erodible and weakly consolidated rock debris or materials weakened by hot hydrothermal fluids.

  Lahars can occur without warning triggered by events unrelated to rising magma. Landslide initiated lahars can be triggered by earthquake shaking. Lahars can flow more than sixty miles down streams and valleys, and may reach speeds up to fifty miles per hour in steep areas, but slow to ten to 20 miles an hour in more gentle sloping terrain. The momentum can cause the flowing mass to surge up river banks when the river valley narrows, at the outer side of bends and over islands that would deflect fast flowing water. Their momentum can cause the material to slosh up to 100 feet above the river beds. Lahars in the Sandy River drainage have reached as far as the Columbia River. Most smaller lahars have been limited to within nine miles of the Mt. Hood region.

- **Tephra:** Tephra, fragments of rock and lava blasted into the air by volcanic explosions, pyroclastic flows, lava-flow and lava-dome eruptions, and lahars, is carried upward by hot gases in an eruption column. Tephra includes ash and ranges in size from 1/10 of a millimeter to more than one meter in diameter. The larger and heavier fragments, called blocks, fall close to the volcano (within three miles). Ash, the smallest form of tephra, can drift thousands of miles. Although prevailing winds should carry most of the tephra ejected from Mount Hood away from the metropolitan region, deposits of about a tenth of an inch are expected. The threat to the Metro Region from more distant volcanoes is less significant because of the distance and direction of prevailing winds. However, distant eruptions may affect aircraft and airports and other forms of transportation and electric transmission networks serving the region.

- **Volcanic Gas:** Dissolved gases in magma are released into the atmosphere during and between eruptions. The gas is predominately steam, carbon dioxide and compounds of sulfur and chlorine. Some of the gases, such as sulfur dioxide gas, can lead to acid rain downwind. Carbon dioxide gas is heavier than air and can collect in dangerous concentrations in low areas posing a danger of suffocation to humans and animals, and can collect in soil and kill vegetation. Fluorine compounds associated with ash fall can kill or deform grazing animals. The concentration and distribution of the gas is controlled by wind. Although they are rapidly diluted downwind, the odor can be noticeable and plants and some animals can be harmed tens of miles downwind.

- **Lateral Blast:** A lateral blast, or explosion, occurs with the sudden release and expansion of magma gases and the generation of steam from superheated ground water around the magma. An explosion can be triggered when a dome collapses, or a landslide or pyroclastic flow depressurizes the underlying magma and ground water. A lateral blast can propel rock and magma for up to six miles.

- **Volcanic Landslides:** Volcanic landslides, or debris avalanches, are large masses of rock and soil that fall, slide or flow rapidly under the force of gravity. The materials can be wet, dry or both. Landslides are common because of the steep slopes and weak rock and soil. Slides can be triggered by rainfall, glacial floods, steam explosions, earthquakes or intruding magma. Large debris avalanches originating on steep slopes can reach a speed of 100 miles per hour and move tens of miles and leave deposits hundreds of feet thick. Depending on the water content, a landslide may transform into a lahar and travel even greater distances.

Area affected: Reliably predicting volcanic hazards due to dome collapses, pyroclastic flows, lateral blasts and lahars is not yet possible. Scientists monitor Mount Hood to observe the processes that indicate changes in magma delivery and processes that may lead to triggering these phenomena. Warnings will be limited to statements that a dome collapse is more likely, or perhaps imminent. Studies of Mount Hood and the geology of the surrounding area, as well as observations made of active volcanoes worldwide, are helpful in identifying the hazards and their aerial extent. Hazard maps for Mount Hood depict the locations threatened by these hazards and facilitate the adoption of policies and practices that will limit the risk.

The US Geological Survey Open File Report 97-89, Volcano Hazards in the Mount Hood Region, includes a map delineating areas of relative volcanic hazard that should be used for Portland Metro planning. Zone boundaries are estimates and not intended to imply a separation between hazardous and hazard free areas. Hazard severity varies because of a number of factors such as distance, magnitude of event and uncertainty in making estimates. Zones can be used to guide loss reduction policies and practices. Two major zones based on the degree of hazard are depicted:

- The Proximal Hazard Zone includes areas from the Mount Hood summit out 15 miles in major valleys where several types of rapidly moving and devastating flows are possible and seven miles in between these valleys. Pyroclastic flows and surges can reach a distance of seven miles in as little as 10 minutes while lahars and debris avalanches can reach a distance of 15 miles within 30 minutes. Areas within three miles of a vent could be showered with ballistic fragments within a few minutes of an explosion. The probability of events affecting Proximal Hazard Zone B (PB) is about ten time less or one chance in 300 within 30 years. Because of the high speeds and potentially devastating effects of these hazards, survival within these zones is problematic. Evacuation prior to the onset of these hazards is the only means to protect lives with assurance.
- The Distal Hazard Zone includes areas lying beyond the proximal zone and include those areas that will be affected from one half to several hours after an event begins on the slopes of Mount Hood. Given adequate warning, escape is possible in the Distal Hazard Zone.

Threat to life and safety: The largest population concentrations near Mount Hood are situated along the floors of the Zigzag and Sandy River valleys. These valley floors are threatened by future eruptions and lahars originating on the west slope of Mount Hood. The community of Government Camp and Highways 26 and 35 lie atop an area created by past pyroclastic flows. The threat to the metropolitan region is primarily from ash fall and acid rain. Pyroclastic flows and lahars spilled into the rivers that emanate from the mountain. These flows and ash falls pose a direct threat to the communities near the volcano and adjacent to these rivers, while pyroclastic and lava flows, lahars, tephra and gaseous emissions affect areas on and adjacent to the cone.

Insofar as the larger Metro region is concerned, severe disruption of the community is not expected from the direct effects of an eruption of Mt. Hood. The prevailing westerly winds most likely will carry the ash eastward. However, there is concern about nearby watersheds (e.g., Bull Run) and

associated facilities that store, transmit, and treat water for communities in the area. Prolonged water outages could have severe social and economic impacts.

Property damage: Except for the possibility of ash fall and acid rain, property damage from future eruptions will be limited to the areas discussed above. If sufficiently severe ash fall occurs, vehicles, air conditioning and other air inducting systems may be damaged, and roofs (especially flat ones) may collapse.

History: The most recent eruption episode lasted about 100 years and ended 200 years ago. An episode also occurred from 1,500 to 1,800 years ago. Emissions occurred in 1859, twice in 1865 and in 1903 when steam and fragments of rock and lava were ejected. Mount Hood is composed of lava flows, several domes and volcanic deposits.

Crater Rock is a 200-hundred year old lava dome standing 100 meters above the crater floor over the conduit through which molten rock emerges from below. During the past 2000 years earlier domes at this site have grown and collapsed creating hundreds of pyroclastic flows extending six or seven miles down the southwest flank. The most recent eruptive episodes were associated with the growth and collapse of lava domes. The repeated growth and collapse of lava domes extruded near the site of Crater Rock caused pyroclastic flows and lahars on the southwest flank of the volcano. The emergence and collapse of lava domes remains an active process on Mount Hood and will trigger hazard events in the future.

2.7. Concurrent Hazards and Compound Disasters

When considering the impacts of natural hazards on current and future development, it is important to understand that depending on the triggering event (e.g., earthquake) many other problems may result from the event. A few examples are noted above. It is important, therefore, in developing mitigation programs that all relevant hazards be considered, including the potential for their interactions to have combined effects on the area. For example, landslides and floods are associated with heavy rainfall. Debris avalanches and avalanche-induced lahars could also occur simultaneously. Earthquake shaking could trigger the collapse of a volcanic dome, followed by an eruption, pyroclastic flows, and lahars. Volcanic eruptions and tephra columns can initiate lightning, and their strikes can produce wildfires that may grow into conflagrations. Earthquakes can also cause wildfires.

Flooding can be caused by failures of water impoundment structures (e.g., dams, debris basins), when rain or snow melt runoff washes over an embankment crest, or when earthquake shaking damages such structures. A major landslide could destroy a road, damage utility systems, isolate an area, and block a stream or river resulting in localized flooding. Such illustrative combinations have implications for emergency response and recovery planning as well as loss prevention (mitigation) related to land use and development decisions. While not all combinations or variables can be controlled via effective mitigation programs, it is important to consider how various hazard-specific mitigation measures might be combined to avoid compound disasters.

Of particular concern, perhaps, are secondary emergencies created by the initial disaster event, such as incidents at facilities that store or use hazardous materials. These incidents have potential for extensive harm, especially when first responders are likely to be busy with disaster response activities.

Earthquake aftershocks create special problems for responders and the community. Special prior planning can reduce the physical and emotional harm created by aftershocks.

2.8. Other Hazards

There are many other hazards that are not addressed specifically in this planning guide, either because of the low probability of occurrence or the low potential consequences in the event of a hazard event. Examples include asteroid impact (unknown, but historically low probability with high consequence) and rain storms (high probability, low consequence).

The planning guide does not address technological hazards that could cause loss of life, environmental degradation and property damage. Examples include automated systems potentially degraded by poor programming practices related to dates (Y2K), hazardous material incidents, air crashes and multi-casualty accidents. Other human-caused hazards that could impact the region severely are not addressed include energy shortage, terrorist attacks and war.

Biological hazards that may be created as a result of population growth and development should be addressed in future revisions of this planning guide. Biological hazards would include potential transfer of disease from wildlife to humans that may occur as a result of developing in rural areas. Additionally, the planning guide should identify potential mitigation measures related to epidemics, including means for identifying and controlling the spread of disease.

Chapter 3.
Mitigation Goals and Objectives

The Regional Natural Hazards Mitigation Planning Guide is designed to help achieve a Regional Framework Plan commitment that states in part that "Our definition of personal safety extends...to mitigation and preparation for and response to natural disasters." Metro's policy commitment suggests several related goals and objectives that have as their overall aim the reduction of exposure to potential human, built environment, and economic losses.

This planning guide's goals and objectives are also designed to support related private sector and local, special district, regional, and state government goals, policies, and programs guiding and governing hazard mitigation, emergency preparedness, new development, renewal and rehabilitation, environmental and resources protection, and public and private capital investment decisions. This includes, for example, State of Oregon statutes relating to development in floodplains and geologic hazard areas, wetlands management, and specifically Oregon Revised Statutes 401 which states in part that the general purpose of the law is to "reduce the vulnerability of the State of Oregon to loss of life, injury to persons and property, human suffering, and financial loss resulting from emergencies."

In general, and as noted elsewhere in the planning guide (Chapter 4. Mitigation Classes, Strategies and Measures), six general classes of actions are available to mitigate the potential impacts of natural hazards. They are (1) prevention, (2) property protection, (3) emergency services, (4) critical facilities protection (5) structural projects, and (6) public education. The following goals and objectives are designed to reinforce the appropriate regional application of these types of actions.

Regional Hazard Mitigation Goals and Objectives

The following goals and objectives have been organized into one of the six classes of mitigation actions. While several possibly could support more than one class of activities, their inclusion in one class is considered the "best fit" for purposes of the regional natural hazards mitigation program.

Prevention

Goal 1: Avoid exposing new development to unacceptable risks.

Goal 2: Avoid creating new or increasing existing risks.

Goal 3: Integrate natural hazard risk mitigation policies into communities' comprehensive plans and related land use management measures.

Goal 4: Govern the use of land in ways that minimizes the exposure to the hazard or that reduces existing risk.

Goal 5: Regulate the location, design, and construction of new facilities in relation to proximity to identified hazards.

Goal 6: Ensure that recent hazard mitigation knowledge is reflected in all building codes and standards governing new construction, and ensure that these standards are effectively administered.

Objective 1: Ensure that land use and growth management plans and regulatory processes include evaluations of potential natural hazards, and where technically and economically feasible, require the application of appropriate mitigating measures, or avoid such hazards where mitigation is not feasible.

Objective 2: Engage in regular planning and update processes that include means for considering the widest range of potential hazard mitigation measures including but not limited to land use, structural protective measures, designation of open spaces, and others either singly or in combination.

Objective 3: Prepare capital improvement plans and maintenance budgets that give priority to replacing, retrofitting, or relocating vulnerable buildings, facilities, and system components so that risk is lessened as new facilities are constructed and existing ones are maintained or improved.

Objective 4: Ensure that all jurisdictions responsible for regulating design and construction of new facilities adopt and effectively enforce building, fire protection, and other codes and standards designed to assure a minimum level of life safety for the occupants of all structures.

Property Protection

Goal 1: Minimize the impacts of hazards on the existing built environment.

Goal 2: Reduce the existing risks by adopting and implementing a long-term strategy.

Goal 3: Reduce existing risk to lives, property, and economic activity.

Goal 4: Prevent unacceptable losses to the regional and local economies.

Objective 1: Identify areas subject to repeated losses from one or more hazards and evaluate the potential for acquiring and relocating such properties as part of a long-term mitigation program or when funds are available for such purposes after disasters.

Objective 2: Design and implement voluntary and/or regulatory retrofit or rehabilitation programs and measures to reduce property vulnerability, displacement of occupants, economic losses, and other impacts.

Objective 3: Identify sources of funding (e.g., operating funds, grants, incentives) appropriate to each retrofit or rehabilitation project to accomplish the desired mitigation activity.

Objective 4: Review the capital improvement programs of major public and private property owners in the region to determine when inadequate facilities and structures are to be improved or replaced, and when new investments are scheduled so that effective hazard mitigation measures can be included in the earliest planning and design of such facilities and structures.

Objective 5: Where sufficient warning time exists (e.g., floods, lava flows) take effective property protection measures so that losses are minimized during the emergency period.

Emergency Services

Goal 1: Reduce the immediate response and short term recovery demands on emergency services providers.

Goal 2: Improve emergency response to mitigate the impacts of hazard-caused emergencies.

Goal 3: Strengthen emergency response and recovery capabilities.

Goal 4: Enhance regional and local long-term recovery and reconstruction processes.

Goal 5: Facilitate recovery and reconstruction without recreating or increasing the risks

Objective 1: Be consistent with, support, and help implement hazard mitigation plans, programs, and projects within the three-county Metro region, especially those plans adopted pursuant to federal statute, so that they meet all legal and permit requirements.

Objective 2: Ensure that all local jurisdictions responsible for issuing hazards warnings are properly equipped to receive and effectively disseminate warnings as far in advance as possible so personal and property protective actions can be taken.

Objective 3: Even if special standards and review processes are needed, ensure to the extent feasible that structures and facilities important for emergency response are located, designed, and constructed to effectively withstand the impacts of natural hazards and remain functional.

Objective 4: Prepare disaster recovery plans and procedures that address short and long term recovery and reconstruction issues, including procedures for incorporating effective mitigation measures in such processes.

Objective 5: Ensure that post-disaster mitigation plans are prepared promptly after events and that they define priorities and to the extent possible, specific projects that could be eligible for federal or special funding.

Protecting Critical Facilities

Goal 1: Avoid locating regionally important critical facilities and utility and transportation system elements in high hazard areas, or when located in such areas, take actions to reduce their vulnerability and to increase the likelihood of their post-event functionality.

Goal 2: Retrofit or rehabilitate existing critical facilities so they are more disaster resistant.

Goal 3: Follow, or if needed, establish special requirements, standards, and review and inspection processes for the design and construction of facilities and systems deemed regionally or locally critical.

Objective 1: Develop, adopt and implement effective voluntary, regulatory, or mixed programs to rehabilitate, retrofit, remove, or replace unacceptably hazardous buildings, facilities, and systems in a timely manner.

Objective 2: Develop, adopt and implement special standards, processes, and programs governing the location, design, construction, replacement, and maintenance of critical facilities, utilities, and network systems so their continued functionality is enhanced.

Objective 3: Because of their importance, ensure that owners and operators of critical facilities have, maintain, and exercise emergency plans and operating procedures so that the staffs are fully capable of rapidly performing their emergency duties.

Structural Projects

Goal 1: Protect developed areas with effective structural projects where needed and cost effective.

Goal 2: As part of regular growth management planning processes, evaluate the need for new structural projects to help minimize future losses.

Goal 3: To the extent feasible, ensure that new or existing structural protection projects serve multiple purposes (e.g., recreational, open space).

Objective 1: Ensure that all existing damage prevention structural projects (e.g., catch basins, floodwalls, etc.) are regularly and properly maintained, especially if they are used only seasonally.

Chapter 4.
Hazard Mitigation Classes, Strategies and Measures

As identified by participants in the March 1997 Metro Hazard Mitigation Workshop, measures to reduce vulnerability to natural hazards generally fall within six classes of mitigation: (1) prevention; (2) property protection; (3) emergency services; (4) critical facilities protection; (5) structural projects; and (6) public education.

4.1. Prevention

Preventive measures are designed to keep the problem from occurring or getting worse. They ensure that future development is not exposed to damage by one or more hazards. Preventive measures are usually administered by planning, building and/or zoning agencies, or they can be taken voluntarily.

4.1.1. Land use planning

Comprehensive plans and land use plans identify how a community should be developed (and where development should not occur). Use of the land can be tailored to match the land's hazards, typically by reserving hazardous areas for parks, golf courses, backyards, wildlife refuges, natural areas, or similar compatible uses.

Generally, a plan by itself has limited authority. In general, these plans reflect what the community would like to see happen. The utility of these plans and the planning process is that they guide other local measures, such as capital improvement programs, zoning ordinances, and subdivision ordinances.

Oregon state law requires every city and county to adopt a comprehensive plan and land use regulations. Once the state acknowledges (i.e., approves) a plan’s consistency with statewide goals, Oregon law deems many land development decisions “ministerial” and, therefore, not subject to procedural requirements because the major decisions have already been made. Local plans are subject to review by the state’s Department of Land Conservation and Development (DLCD) at four-year to 10-year intervals.

Potential land use planning mitigation measures

All-hazard

- Continue to develop public support for Oregon's growth management and land use planning laws.
- Encourage those entities exempt from regional and local land use and building safety regulations (e.g., federal, state, and local agencies and utility and transportation system operators) to adopt and adhere to similar risk management policies and procedures.
- Develop a system of incentives for building in safer areas, including credits for avoiding development in sensitive or hazardous areas.
- Establish fee schedules for developing hazardous land to provide funds for geotechnical review.
- Expand the definition of constrained land to include all high-hazard locations, including earthquake, flood plains, etc. Allow denser development on non-hazardous areas.

- A central agency, such as Metro or the state, should maintain centralized hazards and risk databases that can be queried by the public. The site should be publicized, and staff should be available to provide hazard mitigation planning technical assistance.
- Encourage the State of Oregon to establish administrative rules to implement Goal 7 statewide.

Earthquake

- Continue to prepare and provide peer-reviewed earthquake maps at useful scales that delineate faults, show expected ground motions, define areas subject to liquefaction and other permanent ground deformations. Such baseline information should be accompanied by demographic and built environment data. Periodic revisions should be made as new information is gathered.
- Identify and map all gas, water and sewer utility mains, telephone toll cables, electrical transmission lines, petroleum pipelines, roads and bridges, and critical facilities located in the region and subject to any level of expected ground motion or deformation. Provide those maps to emergency management and other appropriate agencies.
- Perform periodic loss estimations to evaluate the effectiveness of these policies and measures and to provide realistic information for mitigation and preparedness measures.
- Within the context of regional planning, ensure that land use plans effectively address earthquake and geologic hazards at the local level.
- Require site-specific geologic reports and provide recommended mitigation measures prior to approving the subdivision of existing parcels or permits for construction of major structures and facilities, and maintain such reports for the public record.
- Limit development in areas threatened by high ground motions, liquefiable soils and other earthquake-triggered geologic hazards (e.g., landslides) by establishing restrictions on locations, population density, and allowable activities (e.g., recreational areas but not hospitals).
- Employ qualified government or retain independent personnel to review geotechnical reports and to advise the respective jurisdictions on policy and project matters relating to earthquake and related hazards.

Flood

- Continue to use NFIP maps and, if needed, prepare flood maps for local streams that show the expected frequency and level of flooding, including areas subject to inundation, that can be used for planning, risk analysis and emergency management purposes. Periodic revisions should be made as new information is gathered.
- Identify and map all natural gas and petroleum pipeline, water and sewer utility mains, local telephone and toll lines, electrical transmission lines, roads and bridges, and critical facilities located in flood hazard areas.
- Establish floodplain development standards for building at least one-foot or two-feet above base flood elevation or the flood of record, whichever is greater.

- Adopt cut-and-fill requirements leading to no net loss of waterway carrying capacity, as in Metro's Title 3 ordinance, or to actually increase carrying capacity.
- Within the context of regional planning, ensure that land use plans effectively address flood risk and appropriate mitigation measures at the local level.
- Qualified government or independent personnel should be employed or retained to review technical reports and to advise the respective jurisdictions on policy and project matters relating to flood hazards.
- Create dam failure inundation maps for use in land use planning decisions.

Landslide

- Prepare maps at a scale of 1:24,000 delineating landslide prone areas that include existing landslides and conditions that create the likelihood of landslides. Periodic revisions should be made to reduce or expand mapped areas as new information is gathered.
- Limit development in areas threatened by landslides by establishing restrictions on location, population density, and appropriate activities based in part of the ability to detect landslide hazards and the time needed to inform and evacuate those at risk.
- Establish standards to ensure an appropriate percentage of mature vegetation is retained on the land parcel.
- Require site specific reports prepared by an engineering geologist and or geotechnical engineer before approving new construction in landslide prone areas. These reports should be maintained as public records, and they should describe how the hazard affects the site, and provide recommendations on site improvement and design and construction criteria to minimize risk.
- Qualified government or independent personnel should be employed or retained to review geotechnical reports and to advise the respective jurisdictions on policy and project matters relating to landslide hazards, including inspecting grading practices.

Severe Weather

- Encourage adoption and implementation of vegetative and landscape standards related to debris reduction, electric line damage and other mitigation measures.
- Establish permit requirements near trees to reduce vulnerability to power outages, perhaps by burying transmission lines, installing breakaway insulators and ensuring setbacks of taller vegetation from electric and telephone lines.

Volcanic Activity

- Use the US Geological Survey’s hazard map contained in Open File Report 97-89 as a basis for managing volcanic risk. As scientific information improves, periodic efforts should be made to update the mapping of the "proximal" and "distal" hazard zones and to disseminate the information to users.
- Establish appropriate development guidelines in areas threatened by volcanic landslides, pyroclastic flows, ash-cloud surges, lahars, and lateral blasts, perhaps by establishing restrictions on location and population density. Development criteria

may include the ability to detect imminent hazards and the time needed to inform and evacuate those at risk.

- Prohibit the construction of new structures within the Proximal Hazard Zone, except for those needed to support volcano research and monitoring and to provide safety for recreational users of the area.
- Require site specific reports prepared by an engineering geologist and or geotechnical engineer before approving new construction in areas of the Distal Hazard Zone potentially affected by pyroclastic flows, lahars and landslides. These reports should be maintained as public records, and they should describe how each hazard affects the site, and provide recommendations on setbacks and design and construction criteria to minimize risk.

Wildland-Urban Interface Fire

- In areas at-risk to wildland-urban interface fire, require storage of water (ponds, tanks, etc.) for fire suppression, installation of fire suppression equipment (sprinklers in and on homes, apartments and critical facilities) and installation of outdoor sprinklers.

Example of land-use planing mitigation:

Local land use plans must be consistent with the state's 19 land use planning goals. State Goal 7, "Areas Subject to Natural Disasters and Hazards", calls on communities to evaluate areas subject to natural hazards, to minimize the density or intensity of development in such areas, and to evaluate the beneficial impact on natural resources of allowing events to naturally reoccur. Thus, Metro's Regional Framework Plan contains an entire section (Chapter 5) on regional natural hazards mitigation.

4.1.2. Capital improvements planning

A community's capital improvement program identifies where major public expenditures will be made over the next five to 20 years. Capital expenditures may include acquisition of land for public uses (such as parklands, wetlands, or natural areas), extension or improvement of roads and utilities and the rehabilitation or construction of buildings and other structures. Capital planning is also done by private organizations. To the degree that capital improvement plans consider hazard mitigation opportunities, the region's vulnerability to losses from natural hazards can be reduced.

Capital improvement plans contribute to hazard mitigation by securing hazardous areas for low risk uses, realigning or replacing roads and utilities, strengthening or replacing existing potentially unsafe structures, and prescribing standards for the design and construction of new facilities.

Potential capital improvement planning mitigation measures

All-hazard

- Encourage public agencies, businesses, and other organizations to include in their maintenance and capital outlay budgets specific remediation or relocation plans for facilities and system elements located in high risk areas.
- Ensure that public art is designed to withstand all hazards and perhaps add hazard mitigation measures as a criteria for the one-percent for art funding requirement.

Flood

- Relocate traffic control devices above flood elevations.

Wildland-Urban Interface Fire

- Establish fuel reduction programs in areas vulnerable to wildland-urban interface fire

4.1.3. Zoning

A zoning ordinance regulates development by dividing the community into zones or districts and setting development criteria for each district. Floodplains, hazardous slopes, natural areas, liquefaction zones and other sensitive locations can be designated as areas in which development is prohibited or allowed only if mitigation measure are taken to avoid damage.

Zoning decisions may dedicate areas for public use, conservation, agriculture, cluster development or planned unit development to control construction in areas that are not appropriate for intensive development. Density of development can also be regulated, through slope-density formulae on hillsides, for example, and by transfers of development rights from sensitive locations to allow higher densities where more appropriate.

Example of zoning mitigation:

Metro's draft Title 3 Model Ordinance identifies Water Quality Resource Areas, which are closely related to floodplains, as deserving special protection. The ordinance also encourages density transfers to reduce the density of floodplain development (Section 5.A).

4.1.4. Subdivision regulations

Subdivision regulations govern how land will be subdivided into individual lots. These regulations set construction and location standards for the infrastructure built by the developer, including roads, sidewalks, utility lines, storm sewers and drainage-ways. Hazard protection standards can be required on the subdivided lots and the infrastructure such as: (1) Ensure that every lot has a buildable area above the flood level; (2) Ensure that roads are wide enough to allow maneuvering of fire apparatus; (3) Require geotechnical investigations in identified high hazard areas to avoid or mitigate geologic and soils hazards; (4) Ensure that roads are high enough to be used by emergency vehicles when flooded; (5) Size culvert and bridge openings to pass larger water flows; (6) Limit street inclines so they are passable when icy; (7) Establish grading and cut-and-fill limitations on slopes; and (8) Prescribe earthquake standards for bridges and utility lines.

Potential subdivision regulation mitigation measures

All-hazard

- Require or encourage the consolidation of subdivided parcels in high hazard areas into larger holdings to enhance opportunities to locate and construct new facilities in ways that lessen the risk.
- Require a hazard analysis prior to allowing the subdivision of land or issuing a permit to construct new facilities. Assure that its results are used in the subsequent design and construction processes. These reports should be maintained as public records,

should describe how each hazard affects the site, and should provide recommendations on design and construction criteria to minimize risk.

- Monitor compliance for phased developments, perhaps annual monitoring of mitigation activities.

Flood

- Require and review site-specific hydrologic and geotechnical reports and recommended mitigation measures prior to approving the subdivision of existing parcels or permits for construction of major structures and facilities, and maintain such reports for the public record.
- Require or encourage the consolidation of subdivided parcels in high flood hazard areas into larger holdings to enhance opportunities to locate and construct new facilities in ways that lessen the risk (e.g., on higher ground).
- Require a flood hazard analysis prior to allowing the subdivision of land or issuing a permit to construct new facilities. Such analyses should include NFIP considerations and the potential benefits of reduced premiums from the CRS. Assure that its results are used in the subsequent design and construction processes. These reports should be maintained as public records, should describe how floods affect the site, and provide recommendations on design and construction criteria to minimize risk and to meet NFIP requirements.

Landslide

- Require or encourage the consolidation of subdivided parcels in high hazard areas into larger holdings to enhance opportunities to locate and construct new facilities in ways that lessen the risk.
- Require site-specific geologic and geotechnical reports and provide recommended mitigation measures prior to approving the subdivision of existing parcels or permits for construction on landslide prone areas, and maintain such reports for the public record.
- Require a landslide hazard analysis prior to allowing the subdivision of land or issuing a permit to construct new facilities. Identify landslide hazard on subdivision plats.
- Require land use permits to discourage development of utility systems on areas prone to landslides to lower risk associated with slope failures (fires, outages, indirect damage, etc.).

4.1.5. Building codes

Hazard protection standards for all new and improved or repaired buildings can be incorporated into the state and local building codes, or they can be established by special legislation or local ordinances. Some federal assistance programs require adherence to codes and standards as a condition for using federal funds on various construction projects. Most building codes, however, deal with new construction or major remodeling projects when such projects trigger code compliance.

In Oregon, the state building code is composed of specialty codes (e.g., plumbing, structural, mechanical, elevator, boiler and pressure vessel, electrical). All building in Oregon must conform to

the state's codes. Cities choose to enforce all or part of the code in their jurisdictions. If they choose not to enforce parts of the codes, the counties may assume the responsibility, or in areas of Oregon where neither the city or county assumes the function state staff handles the plan checking and inspection functions. Building officials, plan examiners, and inspectors are all certified by the state, and permit revenue finances the process.

Hazard mitigation criteria that are sometimes found in codes and related standards and procedures include: (1) ensure that the foundation will be deep enough (or supported by pilings) to survive a landslide or other soil failures; (2) locate the lowest floor above flood levels; (3) install automatic fire detection and sprinkler systems; (4) use fire resistant roofing materials; and (5) design the structure to withstand expected ice, snow or ash loads, and ground shaking.

The Oregon Structural Specialty Code, which is the most recent edition of the Uniform Building Code (UBC), contains many earthquake safety provisions. In the last few years as earthquakes have occurred in Oregon and as knowledge about the Cascadia Subduction Zone and crustal earthquakes has increased, changes in the code-related "Seismic Risk Zones" have been made or are being considered. When an area's seismic risk zone number is increased (e.g., from zone three to zone four), it means that stronger expected earthquake motions will have to be taken into account in the design and construction of buildings.

Some other important code-related provisions exist. In 1994, the legislature amended Section 2905 of the Structural Code to require "seismic site hazard investigations" for "essential facilities, hazardous facilities, major structures and special occupancy structures." For structures not listed in one of the categories, the local building official may require that a qualified geotechnical engineer determine the engineering properties of the soil. Thus, for listed buildings building officials must require a site investigation, and for non-listed buildings they have the discretion to require an investigation.

Oregon Revised Statutes 455.447, dealing with site and foundation requirements for specific types of structures, prescribes the scopes of geotechnical reports and seismic hazard reports and proper independent review standards. If adopted by local governments, the appendix to Chapter 33 of the UBC gives building officials the discretion to require geotechnical or engineering geologic investigations of sites whenever they determine the need.

Most communities with a flood problem participate in the National Flood Insurance Program (NFIP). The NFIP sets minimum requirements for new buildings in the participating communities' floodplains. New residential buildings (and substantial improvements) must be elevated above the base flood elevation. New and substantially improved nonresidential buildings must be elevated or floodproofed. No new obstructions are allowed in mapped "floodways," the areas closest to the stream channels where floodwaters are deepest and fastest. However, national floodplain management standards are minimums and do not always protect properties from the type of flooding experienced in the Metro area.

Potential building code mitigation measures

All-hazard

- Require appropriate bracing and tie-downs for mobile homes.

Earthquake*:*

- Ensure that all applicable building codes adequately address expected earthquake motions and that the enforcement of such codes includes adequate plan checking and periodic construction inspection.

Flood

- Considering both structural and bio-engineering techniques, develop and implement appropriate stream bank stabilization measures and sediment control projects that also give due attention to the natural migration patterns of rivers and streams. This may involve reclaiming from development previous natural areas that served these purposes.
- Ensure that all applicable building codes and flood protection regulations adequately address the expected flood levels and forces, and that the enforcement of such codes and standards includes adequate plan checking and periodic construction inspection.

Landslide

- Regulate the location and design of new facilities in landslide prone areas, including regulating excavating, drainage and grading practices (e.g., UBC Appendix Chapter 33), and prohibit construction on unstable sites when effective mitigation measures are not feasible.

Wildland-Urban Interface Fire

- Incorporate special code requirements in areas identified as susceptible to wildland-urban interface fire, including: (1) street widths to accommodate needed fire fighting equipment; (2) special construction materials to reduce risk, such as prohibition of wood shake roofing; (3) buffer zones between structures and vegetation; and (4) water source requirements adequate to meet fire suppression needs.

Example of building code mitigation:

Metro's Title 3 "Model Water Quality and Floodplain Management Model Ordinance" has additional standards, including: (1) no net filling and excavation restrictions (Sections 4.C - G), (2) a minimum floor elevation of one foot above the base flood or flood of record (4.H), and (3) restrictions on parking in flood hazard areas (4.I).

4.1.6. Mobile home installation regulations

Mobile or modular houses are particularly susceptible to damage because they are lighter and less resistant to natural forces. They can more readily float, they are not very strong when facing high winds and they fall from their post-and-pier type foundations in earthquakes. Their lower costs also mean that it takes less to make a mobile home a total economic loss. Because of these factors, many states and communities have construction or installation regulations specifically for mobile homes.

Although mobile homes represented only 12 percent of the total residential units damaged by the 1996 floods and landslides, mobile homes and trailers accounted for 60 percent of all residential units destroyed, according to the state Interagency Hazard Mitigation Team Report for that disaster.

- Brace mobile homes to resist seismic forces.

Example of mobile home mitigation:

In Oregon, mobile homes must be tied down in all designated flood areas and braced for wind in two areas: the Columbia River Gorge and along the coast. There are no tie-down or bracing requirements for earthquakes. However there are standards for commercial bracing systems that are sold for voluntary installation. This standard is modeled on a California consumer protection law.

4.1.7. Open space preservation

Keeping a hazardous area free from development is an obvious approach to preventing damage from that hazard. Land use and capital improvement plans identify areas to be preserved by acquisition and other means, such as purchasing an easement. When an easement is granted, the owner is free to develop and use his or her property, but the owner agrees not to build on the area set aside by the easement. As a result, the owner enjoys reduced property taxes or receives direct payment for the easement.

Open space lands and easements do not always have to be purchased. Developers can be required to dedicate parkland and easements. These are usually floodplains or areas subject to landslides. Maintenance easements also can be provided by streamside property owners in return for a community channel maintenance program.

Potential open space mitigation measures

Flood

- Acquire and improve greenways and containment basins to provide natural floodwater controls. This could involve the purchase of properties located in area subject to severe stream bank erosion.

4.1.8. Stormwater management

Development outside a floodplain can contribute significantly to flooding and landslide problems. Runoff is increased when natural ground cover is replaced by urban development. Unconstrained watershed development often will aggravate downstream flooding and overload the community's drainage system. Similarly, development uphill can increase the likelihood of a landslide downhill. Effective stormwater management policies require developers to control the amount of runoff that leaves their properties.

Usually part of a subdivision ordinance, these regulations require developers to build retention or detention basins to minimize the increases in runoff caused by impervious surfaces and new drainage systems. Generally, each development must not let stormwater leave at a rate higher than it did before development.

Many developments utilize wet basins as landscaping amenities. In some cases, watershed planners identify the most effective location for a basin. Communities then require developers to contribute funds for a regional basin in lieu of constructing on-site detention facilities.

- Regulate trenching (utility); i.e. “french draws” so they don’t induce water-caused landslides
- Establish stormwater management plans that include partnerships between local government and community for maintenance of the systems.

- Encourage building standards that minimize stormwater runoff, such as "green" roofs and parking surfaces that use space to retain or dissipate water.
- Open ("daylight") covered waterways, i.e. remove culverts that channel streams, returning them to natural states.
- Modify existing stormwater drainage systems to reduce street flooding.

4.1.9. Watershed and forest practices

Stormwater management focuses on the impact of urbanization on runoff. Other factors can aggravate hazards in undeveloped watersheds. Crop farming replaces ground cover with bare land for part of the year, as do timber clear cutting practices and forest fires. These allow more runoff and contribute to erosion, landslides, and sediment problems in flood protection facilities. It is important, therefore, that watershed and forest practices be viewed in light of their potential impacts on urban area natural hazards.

Potential watershed and forest practices mitigation measures

Landslide

- Regulate logging and agricultural practices.
- Regulate or encourage management of stream maintenance to eliminate debris flow potential.

Example of forest practices mitigation:

The City of Portland master plan for Forest Park contains many elements designed to preserve and enhance the forest in an urbanized area. Measures to control and reduce erosion are included in the plan.

4.1.10. Drainage system maintenance

Channels and detention basins guide surface waters and catch overflows and landslide debris. If these facilities are not maintained, they cannot do their job. Maintenance is an ongoing function required to clean out blockages caused by overgrowth or debris.

Many people do not realize the consequences of their actions. They may, for example, fill in the ditch in their front yard not realizing that it is needed to drain street runoff. They may not understand how regrading their yard, filling a wetland, or discarding leaves or branches in a watercourse can cause problems.

Therefore, an effective program of drainage system maintenance includes regulations preventing dumping in or altering watercourses or storage basins. Regrading and filling activities are regulated to avoid adverse impacts on neighbors. Public information materials explain the reasons for the rules as well as the penalties. Regular inspections are scheduled to identify and discourage violations.

4.2. Property Protection

Property protection measures are used to modify buildings to protect them from the hazards. In the case of flood risk, these can be inexpensive measures because often they are implemented by or cost-shared with property owners. To reduce earthquake risk, however, protective measures can mean major and expensive rehabilitation projects for larger buildings. However, bolting homes to their

foundations is a relatively inexpensive measure that provides a high degree of earthquake protection. Changing roofing materials to avoid fire risk also is a relatively inexpensive measure. Some measures do not affect the building's appearance or use, making them particularly appropriate for historical sites and landmarks.

Non-structural mitigation measures have proven to be among the most easily implemented and cost-effective strategies for various hazards. Non-structural mitigation includes actions that are not specifically related to the foundation, frame or other component that is required to maintain the structure's integrity. Non-structural mitigation may include: (1) tie-downs to prevent office equipment from crashing to the floor in an earthquake; (2) protective film to prevent injury from shattered windows; and (3) elevating furnaces and water heaters to prevent loss through flooding.

4.2.1. Acquisition and relocation

Where a natural hazard is localized, such as with flooding, landslides and volcanic lava flows, getting damageable property out of the way is the surest and safest way to protect it. While almost any building can be moved, the cost goes up for heavier structures and for large or irregularly shaped buildings.

The major difference between acquisition and relocation is that the former usually is undertaken by a government agency, so the cost is not borne by the property owner, and the land often is converted to public use, such as a park. Acquiring and clearing buildings from a hazardous area is one of the best protection measures available, as long as the risk is not recreated by adding new unsafe structures, for example. Acquisition, a fairly common flood mitigation technique, is also a way to convert a problem area into a community asset and obtain environmental benefits (e.g., restored habitat).

Acquisition or relocation measures are most appropriate in areas subject to flash flooding, deep-water flooding, landslides, liquefaction, lava flows or other high hazards. On an individual site basis and if feasible, relocation of structures to a safer area is preferred for large lots with portions outside of the hazardous area.

Voluntary acquisition projects may create a "checkerboard" pattern in which nonadjacent properties are acquired. This can occur when some owners prove reluctant to leave a location, no matter how unsafe. Creation of a checkerboard in a community can add to public maintenance costs.

Potential relocation mitigation measures

All-hazards

- Encourage public agencies, businesses, and other organizations to include specific remediation or relocation plans for facilities and system elements located in high-risk areas in their maintenance and capital outlay budgets.
- Work with state and federal elected officials, the state Office of Emergency Management and the Federal Emergency Management Agency to eliminate requirements related to local government cost-share of post-disaster acquisition and relocation projects. Cost-share requirements should relate to property owners, insurers and others who would benefit from relocation.

Landslide

- Remove or relocate buildings, facilities, and infrastructure components located within high landslide hazard zones or mitigate the hazard.

Volcanic Activity

- Remove or relocate buildings and facilities located within high hazard zones affected by lateral blast, pyroclastic flows, and lahars.
- Consider the use of federal Hazard Mitigation Grant Funds to relocate public and private facilities from areas at high risk from debris avalanches and lahars.

4.2.2. Retrofitting/rehabilitation

Depending on the nature of risk and the expected performance of the buildings and systems under defined hazard conditions, and especially where the hazard is not severe, it may be cost effective to modify ("retrofit" or "rehabilitate") buildings rather than acquiring, replacing, or relocating them. Often, these two terms are used interchangeably, but for managing earthquake risk "retrofit" usually means strengthening a damaged building beyond its pre-event capacity while "rehabilitate" usually means strengthening an undamaged building so it will perform better in future earthquakes.

Typical hazard-specific retrofitting/rehabilitation measures include: (1) adopting and enforcing minimum life safety standards to govern the rehabilitation of existing earthquake hazardous buildings within a specified time; (2) elevating smaller buildings above flood levels and "floodproofing" them by making the walls watertight or altering the interior so water does not cause any damage; (3) stabilizing landslides by installing retaining walls and improving drainage; (4) insulating water pipes to prevent their freezing and bursting due to severe cold weather events; (5) installing appropriate roofing and siding materials on structures and adding spark screens on chimneys for fire protection; and (6) installing special filters to trap volcanic ash and strengthening roofs to help carry the additional weight (e.g., similar to snow loading factors).

Geographic issues are not usually addressed in these forms of mitigation. For example, although a building may have been retrofit to remain above flood waters, the building may be isolated and without utilities during high water.

Retrofitting is not limited to buildings. Bridges, pipelines, and other facilities can be modified to strengthen, elevate, or otherwise engineered for protection from the effects of various hazards. Freeway overpasses and bridges can be strengthened to resist earthquakes; shut-off valves can be installed on pipelines crossing landslides, faults, and other poor ground areas; and water systems can be replaced to perform better and to deliver needed fire flows.

The retroactive improvement of structures and facilities is sometimes mandated or permitted by law or regulation, or it can be done voluntarily. Structural improvement requirements often are based on "triggers," items in codes and standards that "kick in" when specified project criteria are met (e.g., percentage of market value; square footage involved, modification of load-bearing elements, etc.).

For instance, the National Flood Insurance Program requires that substantially damaged or substantially improved buildings must be elevated above the flood level (nonresidential buildings can be elevated or floodproofed). A building is substantially damaged if the cost of repairs exceeds 50 percent of the building's pre-damage value (no matter what caused the damage). A substantial improvement is a project that exceeds 50 percent of the building's current value.

Retrofit or rehabilitation requirements can be especially difficult to enforce after a flood or other disaster that affects many buildings. In many cases, this class of mitigation has been successful when financial assistance is provided to disaster victims to help them repair the damage, and bring their buildings up to code or other standards.

Potential retrofit mitigation measures

All-hazard

- Conduct systematic inventories of earthquake vulnerable structures (e.g., unreinforced masonry, non-ductile concrete frame) located within high risk zones to provide a basis for developing programs and methods to abate such hazards by strengthening, removing, replacing, or relocating them. Where feasible, create abatement districts, financial incentives, and other measures (e.g., federal Hazard Mitigation Grant Funds) to support the implementation of effective remedial measures.
- Ensure that federal, state and local historic preservation standards are accommodated in hazard mitigation measures.

Earthquake

- Limit the expansion of existing facilities and structures currently located in defined high groundshaking areas or ones subject to other earthquake-induced soils and geologic hazards.

Flood

- Limit the expansion of existing facilities and structures currently located in defined flood prone areas or those subject to other flood-induced hazards (e.g., landslides).

Landslide

- Limit the expansion of permanent facilities currently located in designated landslide hazard zones unless appropriate mitigation is completed.

4.2.3. Property maintenance and incremental retrofitting

The incremental approach to mitigation can be effective over the long term by using maintenance and capital funds to address vulnerabilities while other work is done to maintain structures (e.g., securing parapets and roof diaphragms to walls for earthquake protection when new roofing is installed). Such measures may be contained in codes (which can be enforced on an individual permit basis over a period of time), at resale or when a property owner applies for a permit to substantially alter or improve the structure. In other cases, incremental mitigation can be done voluntarily by owners as part of their normal property maintenance practices.

4.2.4. Drainage or site improvements

Rather than modify a building or facility, it is may be safer to modify the ground or surroundings to protect a property. A berm in the backyard can keep shallow floodwaters from reaching a building. Clearing brush away from buildings is an effective wildfire protection measure. Surface and subsurface drainage facilities can keep water from building up in landslide prone areas. Geotechnical measures (e.g., compacting, pilings) to improve soil conditions prior to construction can play a major role in a building’s performance when subject to ground shaking. Measures such as these should be prescribed in laws, codes, and standards established by states and localities.

4.2.5. Insurance

Insurance has the advantage that the property is financially protected, and no human intervention is needed, beyond keeping the policy in force. Damage is not prevented, but the financial impact is

mitigated. Often, claims payments are sufficient to help the property owner to retrofit or otherwise mitigate against a re-occurrence. Insurance companies may require that current codes and standards be met when repairing or rebuilding damaged structures, or the policyholder may choose to pay for such coverage.

There are several types of property insurance coverage: (1) the standard homeowner's insurance policy that covers against the perils of wildfire and the effects of severe weather, such as frozen water pipes; (2) earthquake insurance, which usually is offered only as a rider on homeowner's policies or separately for major commercial properties; and (3) flood insurance.

A community must join the National Flood Insurance Program (NFIP) to make flood insurance available to its residents. Community participation allows any local insurance agent to sell a separate flood insurance policy under rules and rates set by FEMA. Rates do not change after claims are paid – they are set on a national basis. A federal all-hazards or earthquake insurance program has been debated by Congress at various times, but agreement on the scope of the program has not been reached.

Potential insurance mitigation measures

All-hazard

- Establish relationships with the Institute for Business and Home Safety and other insurance industry groups to develop incentives to implement hazard mitigation. Examples may include reduced premiums for nonstructural mitigation retrofit and identifying disaster-resistant products and materials.

Flood

- The National Flood Insurance Program (NFIP) has been one of the most successful hazard mitigation programs, providing funds to help flood victims and requirements for rebuilding designed to reduce future flood vulnerability.

Landslide

- Landslide insurance is very hard to obtain, although it is available through special and expensive policies underwritten by very few insurers (e.g. Lloyds of London). In rare circumstances, the NFIP has covered mudflows in connection with flood damage. But the distinction between "mudflow" and "landslide" is highly technical, and may not provide a clear standard to allow use of insurance as a landslide mitigation strategy.

4.3. Emergency Services

Emergency services protect people during and after floods and other disasters. All three counties and most cities in the Metro area have emergency management offices to coordinate public safety agency preparedness, warning, response, and recovery planning. In addition, states are responsible under current federal procedures to prepare hazard mitigation plans after declared disasters. These plans define actions to reduce the impacts of future events. Failure to complete and implement hazard mitigation plans may jeopardize eligibility for future disaster assistance, if recent FEMA policy statements are ultimately implemented.

4.3.1. Warning

Response to disaster begins with understanding that a damaging event will occur. The next step is to notify public safety agencies, the public and managers of key facilities and vital systems. Early and

accurate warning, increases the number of people who can implement protective measures (e.g., evacuation, placing sandbags, positioning resources).

Warnings may be disseminated in a variety of ways, including via sirens, radio, television, cable TV, mobile public address systems, telephone "trees," and even door-to-door contact. Multiple or redundant systems are most effective: if people do not hear one warning, they may still get the message from another part of the system. However, the warnings must be clear on what type of hazard is expected and what protective measures to take.

The nature of the warning system is related directly to the ability to anticipate and predict an event. Fire suppression agencies often base predictions and warnings on weather conditions. The National Weather Service issues severe weather warnings. Landslide warning techniques exist using ground motion instrumentation. Tsunami warning systems exist and are being improved for coastal areas. Volcano warning systems have proven effective prior to several eruptions. Earthquake warning systems are still experimental.

One southern California earthquake warning system is designed to provide warning based on ground motion. The intent is to provide managers of critical facilities (such as nuclear power plants) to initiate protective actions in seconds or a few minutes, prior to arrival of damaging ground motion. But the effectiveness of this earthquake warning system is not well documented, and there is no credible earthquake warning capability that would allow for protective actions to be taken near the earthquake epicenter.

Potential warning mitigation measures

All-hazards

- Ensure that all warning systems meet state and federal standards.
- Utilize technology for instantaneous communications for warning of severe weather, dam failure, etc. Examples may include reverse 9-1-1, improved NOAA weather radio use in partnership with AT&T, U.S. West and other private networks.

Earthquake

- Damaging aftershocks often follow a major earthquake. Procedures to ensure coordination among emergency management agencies and geologic agencies at the state and federal agencies can improve transmittal of post-earthquake protective information.

Flood

- The National Weather Service River Forecast System issues flood watches and warnings for rivers in Oregon. River Forecast Centers coordinate to varying degrees with state and local agencies. In California, for example, close coordination with the state Department of Water Resources results in very specific and accurate flood forecasts. Accurate flood forecasts for Oregon rivers with federal flood control projects result from close coordination among the National Weather Service and other federal agencies such as the U.S. Army Corps of Engineers. Procedures for providing local information related flood inundation vulnerability can improve protective action decisions.

Landslide

- Include requirements for landslide detection, landslide warning systems and evacuation planning as part of the land use planning process in areas vulnerable to landslide.

Severe Weather

- Seasonally or if sufficient pre-impact time exists, issue appropriate warnings and information about protective measures that can be taken to reduce damage (e.g., wrap above ground water pipes, install plywood over window and door openings).
- Use enhanced technology such as geographic information system software to provide advance forecasts of rain intensities in specific locations.

Wildland-Urban Interface Fire

- Establish procedures to monitor the lightning maps issued daily by Oregon's Department of Forestry during the high fire season (approximately June 1 through October 15) as a basis for implementing warnings and emergency plans.

Volcanic Activity

- Provide specific information on the health risks and threats to equipment and buildings associated with ash fall, especially upon the issuance of warnings or upon the occurrence of actual events.

Example of warning mitigation:

On the Columbia and Willamette Rivers, the National Weather Service operates a flood threat recognition system, based on gages and reports from upstream. On smaller rivers, flood warning requires a locally operated network of rain and river gages. No local systems exist in the Metro region. One example in Oregon is in the town of Hepner.

4.3.2. Disaster Response Planning

Once warning is received or, in the case of disasters without warning, the event has occurred, the emergency service agencies act to prevent or reduce further damage or injury. Such actions typically include: (1) rescuing people and fighting fires; (2) activating the emergency operations center and coordinating response operations; (3) closing streets or bridges; (4) shutting off power to threatened areas; (5) releasing children from school to return home; (6) ordering an evacuation and opening shelters; (7) monitoring and reporting on changing conditions (e.g., water levels, weather, eruptions, aftershocks); and (8) evaluating buildings to determine if they are safe and functional.

An emergency action plan is the best way to ensure that all needed actions are defined and that the response activities are appropriate for the expected threat. Plans are developed in coordination with the agencies or offices that are given various responsibilities. Drills and exercises should be conducted to ensure that key participants understand their duties and become familiar with operating under adverse conditions. The result should be a coordinated effort implemented by people who have experience working together so that available resources will be used most efficiently.

Potential emergency response planning mitigation measures

All-hazards

- Develop and implement a statewide agreement that allows all public employees to report to the nearest jurisdiction during an emergency.
- Establish tax or other revenue source to supplement FEMA funds related to emergency management (preparedness, mitigation, response and recovery).
- Expand neighborhood preparedness by aggressive outreach, training programs and emergency exercises.
- Public safety authorities and utilities should information about share the locations of critical system components (key natural gas and water pipeline shut-off valves, etc.) that may cause secondary emergencies.
- Review and exercise emergency procedures and systems on a regular basis.
- Ensure that emergency plans and supporting documentation are regularly updated to include risk and loss estimation information.
- Use appropriate technology, such as geographic information system software to integrate emergency management planning with hazard and risk data.
- Establish mechanisms to ensure that hazard and risk data is maintained over time so planning retains currency.
- Identify public health codes and measures to reduce the transmission of disease after disaster.

Earthquake

- Ensure that organizations and individuals owning or operating facilities are aware of the risk and are prepared to act under emergency conditions to abate situations that threaten public safety or disruption.

Flood

- Perform periodic flood loss estimations to evaluate the effectiveness of floodplain management efforts and to provide realistic information for further mitigation and preparedness measures.
- Discuss with public safety decision makers the uncertainties associated with loss estimates, probabilities, and flood hazard forecasts so they can anticipate how to deal with this information when flood warnings are issued.
- Identify and document the ownership, maintenance and capital improvement plans, response resources, and other information for all publicly or privately owned floodwalls, dikes, and levees in the Metro region so this information can be used to develop effective or monitor existing flood mitigation measures.
- Review recent flood studies and mitigation reports to identify specific measures to reduce future flood risk. Identify a wide variety of specific measures that may be more or less applicable to localities within the Metro region. Metro could assist by synthesizing these specific measures and providing this information to support the RNHMPG.

- Ensure that local agencies' emergency response plans are regularly updated to include: (1) measures to limit access to flood hazard areas at times when warnings are announced; (2) information about the expected impacts of floods on their communities; (3) procedures and communications methods for notifying and evacuating residents and visitors from flood threatened areas; and (4) identification and posting with signs of flood evacuation routes.
- Review and exercise emergency procedures and systems on a regular basis (e.g., annually in advance of the winter and spring seasons).

Landslide

- Perform periodic landslide loss estimations to evaluate the effectiveness of these policies and measures and to provide realistic information for mitigation and preparedness measures
- Ensure that organizations and individuals owning and operating facilities located in landslide prone areas are aware of the risk and are prepared to act under emergency conditions to abate situations that threaten public safety, community disruption or economic loss.
- Discuss with public safety decision makers the uncertainties associated with landslide loss estimates, probabilities, and other risk information so they can anticipate how to deal with this information when landslides are considered within the context of their broader responsibilities and when warnings are issued.
- Review recent landslide and related studies and mitigation reports to identify specific measures to reduce future risk.
- Identify areas where public or private landslide abatement activities are needed to reduce the risk, such as improved drainage, installation of de-watering systems, and the construction of retaining structures and debris dams and basins.
- Monitor the Oregon Department of Forestry's debris flow advisories and warnings during the period of about November through February as a basis for issuing warnings, implementing emergency plans, and taking other measures.

Wildland-Urban Interface Fire

- Map regional wildland-urban interface fire areas using remote sensing or other data showing current and future development and urban reserves.

Volcanic Activity

- Ensure that local agencies' emergency response plans are regularly updated to include: (1) measures to limit access to hazardous areas at times when volcanic events may be triggered or when warnings are announced; (2) contain information about the communities and approximate and general locations of visitors in the proximal and distal hazards zones; (3) procedures and communications methods for notifying and evacuating residents and visitors; (4) identify and post signs of evacuation routes; and (5) review and exercise these procedures and systems on a regular basis.

4.3.3. Health and safety

Preventing dangers to health and safety is a critical function after a disaster. Emergency response plans should identify appropriate measures to take to mitigate the impacts of the events on the affected population. Examples include: (1) securing evacuated areas to prevent unauthorized entry; (2) providing safe drinking water; (3) offering public health services to victims, such as vaccinations; (4) clearing streets; (5) cleaning up debris; and (6) providing emergency shoring to allow limited use of key facilities.

4.3.4. Post-disaster mitigation activities

Mitigation activities can be taken after a disaster to help prepare people and property for the next one. They are implemented during recovery before a community returns to "normal". These measures may include: (1) regulating reconstruction to ensure that it meets all code requirements, including the NFIP substantial damage regulations; (2) advising residents about mitigation measures they can incorporate into their reconstruction work (e.g., using waterproof or fireproof materials, elevating utilities above flood level, securing large items that will fall during ground shaking); (3) acquiring substantially or repeatedly damaged properties by default or from willing sellers and removing or strengthening them; (4) planning for long term mitigation activities; and (5) applying for post-disaster mitigation project funds.

Potential post-disaster mitigation measures

All-hazards

- Develop appropriate disaster recovery plans and procedures that address short, middle, and long term actions to support recovery and the restoration of important community functions and activities, while taking advantage of opportunities to increase the future resilience of the damaged areas, structures, facilities, and systems.

4.4. Protecting Critical Facilities

Mitigating the exposure of, responding quickly to, and restoring the services and functioning of critical facilities is central to recovery from disaster. Critical facilities are generally accepted as buildings, structures, systems, or resources upon which virtually everyone depends to either provide important services (e.g., hospitals) or knit the region together (e.g., bridges). Various hazards can affect critical facilities in different ways, but if damaged they can have serious impacts on the region's abilities to respond and recover. Therefore, critical facilities often are highlighted as a focus for mitigation and preparedness measures.

Critical facilities fall into two principal categories: (1) buildings, facilities, or locations vital to the emergency response effort, and (2) those that, if damaged, could cause secondary or compound disasters. Examples of the first group include hospitals, emergency operations and communications centers, police and fire stations, selected roads and bridges, evacuation or supply routes, potable water systems, designated shelters, commercial broadcast facilities, and possibly some suppliers of needed resources. Examples of the second group include hazardous materials storage and processing facilities, water treatment plants, fuel and energy production facilities and transmission lines, schools and other large occupancy structures, and wastewater treatment facilities.

4.4.1. Dam and levee safety

Large structures (such as dams and levees) that protect areas from floods or provide water can become hazards themselves if they fail. An earthquake, landslide into the impound area, excessive load, or poor design or maintenance can cause dam and levee failures. Sometimes these are gradual, allowing time for warning, evacuation and protective measures, but they may also occur with little or no notice. The resulting flash flood can be more devastating than a slow onset natural flood.

Potential dam and levee safety mitigation measures

All-hazard

- Establish strong coordination between state and federal agencies that regulate dam safety and local land use and emergency management agencies.

Example of dam safety mitigation:

Dams that produce electric power must have dam failure plans approved by the Federal Energy Regulatory Commission. All dams higher than 10 feet and with more than 9.2 acre feet impoundment are required to be appropriately engineered and have a dam safety program. These dams and their safety programs are reviewed by the Oregon Department of Water Resources on a scheduled basis.

4.4.2. Special design and construction standards and review and inspection procedures

The siting, design, construction, and inspection procedures for critical facilities can be governed by special requirements, codes, laws, ordinances and other measures, or special precautions may be taken voluntarily by the owners and operators of such facilities. For example, the federal government regulates nuclear power generating plants, and the State of California enacted laws governing the construction of new public schools and hospitals.

Potential design and construction standards mitigation measures

All-hazards

- To complement existing hazard mitigation efforts, create and enforce special standards and review procedures for facilities defined as critical to the region (e.g., fire stations, hospitals, bridges, water treatment plants). Such measures may have to be adopted by the state and enforced directly or at the local level.
- Support state planning Goal 11 so it includes mitigation of existing utility and other critical facility structures.
- Mandate nonstructural mitigation procedures for all educational facilities, health facilities and public facilities with capacities greater than 750 people (e.g. hotels, sports arena and theaters).
- Establish "tertiary care hospital" standards for nursing homes and other care facilities such as dialysis centers, particularly in relation to requirements for adequate emergency electrical power.

4.4.3. Special standards and processes governing the retrofitting and rehabilitation of existing critical facilities

Similar in concept but less common are programs that aim to strengthen or otherwise retrofit existing critical facilities so they are more resistant to hazard events. Standards may be expressed through government action or taken voluntarily. They may focus on the activities performed by or in the structure, the criticality of the item to the larger community, location, occupancy or other factors. Structural retrofit or rehabilitation usually is expensive and can have a wide array of functionality, community and financial impacts. Some of the most notable of such projects are those undertaken after disasters as part of the federal government's Hazard Mitigation Grant Program.

Example of special retrofit standards:

Federal funds are being used to seismically strengthen a building on the Oregon State University campus, and partial seismic retrofitting of a downtown Portland office building was done voluntarily. Both buildings will meet higher earthquake standards when completed.

4.4.4. Relocation, consolidation or closure of critical facilities

As with other structures, critical facilities may be relocated to safer locations (e.g. pipelines, roadways), consolidated by perhaps reducing the number of such sites (e.g., hazardous waste handling facilities), or discontinuing their usage (e.g., obsolete power generating plants). These measures can be implemented when such facilities reach the end of their useful lives, are defined as especially vulnerable or risky, are replaced by newer technologies, or for other reasons.

4.4.5. Requiring special emergency plans and preparedness measures

Emergency plans and other preparedness measures (e.g., warning systems) can play major roles in mitigating the on-site and community impacts of damage to critical facilities. Such measures do not prevent physical damage to the site or structures involved, but planned and rehearsed responses can facilitate safe shutdowns, notify the wider community to take protective actions, and allow time for the mobilization and commitment of response resources.

Potential special emergency plan mitigation measures

All-hazards

- Ensure that organizations and individuals owning and operating facilities at-risk to disruption by natural disaster are aware of the risk and are prepared to act under emergency conditions to abate situations that may threaten public safety, cause community disruption or create significant economic loss. Awareness of risk is most readily demonstrated by production of adequate emergency management plans.
- As part of critical facility emergency planning, alternate locations should be identified if the primary facility becomes uninhabitable. Written agreements should be developed to ensure alternate site availability.
- Ensure emergency plans provide adequate staff ratios and that business resumption plans specify procedures to facilitate travel by staff to the facility.

- Emphasize nonstructural mitigation measures in critical facility emergency plans.

Example of special emergency management plan mitigation:

Businesses and public agencies that use, store or transport extremely toxic materials are required by federal law to develop risk management and emergency prevention plans based on a "worst-case" scenario in terms of impact to the community.

4.5. Structural Projects

Structural projects are used to prevent the hazard from reaching or damaging developed areas. These measures are "structural" because they involve construction of facilities to control water, debris, landslides, or lava flows.

Most structural projects can be very expensive to construct and maintain. While often necessary, they have other shortcomings including: (1) disturbing the land and disrupting natural water flows, often destroying habitats; (2) requiring regular maintenance, which if neglected, can have disastrous consequences; and (3) creating a false sense of security. Examples of the latter include residents who are protected by a flood-control project who may believe that a flood cannot harm them and individuals who believe they live or work in an "earthquake-proof" building because it meets current building codes. Some of the more common structural projects, primarily to mitigate flood losses, are discussed below.

4.5.1. Reservoirs and catch basins

Reservoirs control flooding by holding high water flows or debris flows behind dams or in storage basins. After a flood peaks, water is released or pumped out slowly at a rate that the downstream river can handle. After a landslide, crews must excavate the debris basin to restore its capacity. Reservoirs and wet or dry basins can serve multiple uses by doubling as parks or other open space uses. However, some may have been built for navigation or water supply and do not provide any flood protection benefit.

4.5.2. Levee or floodwall barriers

Probably the best known structural flood control measure is a barrier of earth (levee) or steel or concrete (floodwall) erected between the watercourse and the property to be protected. Barriers and retaining walls can also be built to protect areas against landslides and lava flows. One problem with this measure is that it may redirect the hazard onto other properties.

Example of floodwall mitigation:

The Willamette River floodwall has protected downtown Portland from floods, most recently the 1996 February flood. Additional protective actions were taken to provide additional flood hazard mitigation to the city. Although those measures were not tested, the effectiveness of the seawall was dramatically demonstrated by protecting the downtown area from flood waters, while other areas of the region reached or exceeded 100-year flood levels.

4.5.3. Diversions

A diversion is simply a new channel that sends floodwater or other flow to a different location, thereby reducing damage to property that would otherwise be in harm's way (e.g., keeping landslide

areas drier). Care must be taken to ensure that the diversion does not cause a new problem. Even the appearance of transferring the hazard to someone else greatly complicates -- and often halts -- a prospective diversion project.

4.5.4. Channel modifications

By increasing the conveyance or capacity of a stream channel or drainage ditch, more water is carried away. However, care must be taken to not increase a flooding problem downstream. Channel modifications include making a channel wider, deeper, smoother or straighter. Some smaller channels can be lined with concrete or even put in underground pipes.

Dredging is one form of channel modification. Dredging is often cost prohibitive because the dredged material must be disposed of somewhere, and the stream will usually fill back in with sediment in a few years. Dredging is usually undertaken on larger rivers only to maintain a navigation channel.

Drainage modifications include constructed ditches and storm sewers that help drain areas where the surface drainage system is inadequate or where underground drainageways may be safer or more attractive. Particularly appropriate for depressions and low spots that will not drain naturally, drainage and storm sewer projects usually are designed to carry the runoff from smaller, more frequent storms. In larger events, their capacities can be exceeded.

4.6. Public Education

Mitigation-oriented public education activities advise the general community and specific sub-groups in the community about hazards, and describe protective actions to reduce exposure to loss. Public information officers often manage these activities, with subject matter assistance being provided by technical personnel.

4.6.1. Outreach projects

Outreach projects are a proactive approach to public education, designed to give people hazards information, even when they do not ask for it. A variety of topics may be covered, such as the nature of the hazard and risk, insurance, ways to prevent or reduce damage, warning procedures, protective measures, and construction regulations. Outreach projects are designed to encourage people to seek out more information and take steps to protect themselves and their properties.

There are many types of outreach projects. These can include: (1) mass mailings or newsletters to all residents; (2) notices directed to residents of hazardous areas; (3) displays in public buildings, shopping malls, and other locations; (4) newspaper articles and special sections; (5) radio and television news releases, feature stories, and interview shows; (6) videos for cable television programs or to loan to organizations; (7) detailed handbooks tailored for local conditions for property owners; and (8) presentations at meetings of neighborhood, trade, civic, and professional groups.

Research has proven that outreach projects work. However, awareness of the hazard is not enough – people need to be told what they can do about it (i.e., empowered), so projects should include information on property protection measures. Research has also shown that a properly run local information program is more effective than national advertising or publicity campaigns. Therefore, outreach projects should be locally designed and tailored to meet local conditions.

In addition to providing generic information from an “all- hazards” perspective, hazard-specific education materials can be very effective. Some information may be prepared on a stand-by basis for use when the “time is right” and audience receptivity is higher than normal. Examples include seasonal information related to fires, floods, or severe weather events; earthquake and volcano safety

information upon occurrence – even at distant locations (e.g., the major earthquakes in Kobe, Japan and Northridge, California). Public education opportunities may also occur during specially designated times for hazard awareness (e.g., Fire Prevention Week); and as part of community land-use planning process.

Potential public outreach mitigation measures

All-hazards

- Identify groups and facilities with special needs (e.g. nursing homes, art institutes, museums, etc).
- Employ new technologies for hazard information, such as a CD-ROM library, object oriented web programming and other information on the web.
- Improve state participation in the hazard mitigation process at the local level in terms of technical assistance, regulations, and other means.
- Establish an Internet site that discusses hazard issues, including pictures, maps, and related information.
- Include all hazards (e.g. technological hazards), not just natural hazards.

Volcanic Activity

- Provide all persons (visitors and residents) entering a "Proximal Hazard Zone" for recreational or other purposes with information about the hazards, indicators of imminent activity, and protective actions to take in case of the onset of an event.

Severe Weather

- Develop annual information programs to explain the limitations of public resources to reduce flooding, and the importance of people cleaning streets in their neighborhoods and their homes' gutters. The campaigns should explain the importance of personal responsibility in support of public agencies.
- Develop outreach campaigns to encourage development of business plans, including the potential for telecommuting during storms and other hazardous periods. Establish safe areas to go to work.

4.6.2. Technical assistance

Measures to encourage and assist property owners can be implemented at the community level. Technical assistance can be provided in one-on-one sessions with property owners. Community officials can provide advice and information on matters such as identifying the hazards at the site, correcting local problems, retrofitting, dealing with contractors, and funding mechanisms. One of the most important of these is providing hazard information from flood, earthquake and other hazard maps and other available descriptive data. Other efforts include even loaning appropriate tools to do the work, providing classes on proper methods, waiving permit fees for mitigation work and providing free inspection services.

4.6.3. Real estate disclosure

Disclosure provides information to more fully inform prospective purchasers of real property about the property's condition or situation. Many times after a flood, landslide or other event, people say they would have taken steps to protect themselves if only they had known they had purchased a

property exposed to such hazards. Over time, property owners may better understand vulnerability to hazard as a result of disclosure requirements.

While disclosure often does not stop a sale, it can affect the sale price or lead sellers and buyers to agree on some mitigation actions. The purchase price may thus include the cost of retrofitting, insurance, or other needed protective measures, better reflecting the true cost of occupying a property in a hazardous area. An often-used model is the requirement for a pest inspection as a condition of a property transfer.

Federally regulated lending institutions must advise applicants for a mortgage or other loan that is to be secured by a building that the property is in a floodplain as shown on the Flood Insurance Rate Map. Because this requirement has to be met only five days before closing, often the applicant is already committed to purchasing the property when he or she first learns of the flood hazard.

Potential public education mitigation measures

All-hazards

- Require disclosure of all known hazards during real estate sales transactions prior to non-refundable "earnest" money payments by buyers. Disclose natural hazards, and any known construction elements that may contribute to increased hazard conditions (e.g. improper drainage systems).

Flood

- Require the disclosure of flood hazard information and the vulnerability of property to flood damage prior to the sale of all real property lying within the defined flood hazard zones.

Landslide

- Require the disclosure of the landslide hazard and the property’s vulnerability prior to the sale of all real property lying within the hazard zones.

Chapter 5.
Recommendations

The following measures and initiatives have been identified to be an initial action plan for Metro. Some are specific, others reinforce existing efforts, and additional items may need further research and development. Functional plans and other Metro mechanisms may be needed to fully develop them, but the initial list includes:

5.1. Maintain HAZTAC as a permanent body so the group responsible for assuring hazard mitigation issues are addressed on a continuing basis is built into Metro.

5.2. As in the Title 3 document on water quality and floodplain protection, systematically review other Metro materials and assure appropriate hazard mitigation considerations are incorporated .

5.3. Continue to improve hazard identification and mapping programs to provide better and more information.

5.4. Continue to have Metro's planning, technical, and GIS assistance support community mitigation programs (e.g., as it did in the case of Oregon City). Metro is a critical link in gathering, "translating," and portraying scientific and technical information into regionally and locally useful materials.

5.5. Maintain an active role in educating and training local officials and others by continuing to provide materials, sponsor workshops (e.g., Mitigation Planning Workshop, 1997) and conferences, and engaging in similar activities to help promote hazard mitigation.

5.6. Lead and support citizen outreach and educational efforts.

5.7. Work with the private sector and other levels of government to obtain financial support for various mitigation measures, and explore various strategies and measures beyond the capabilities of its local agencies (e.g., establishing and managing a retrofit loan program or proposing the creation of various financial incentives).

5.8. Capitalize on regional laws and institutions to define, initiate, and support new or existing state laws that will help achieve hazard mitigation.

5.9. Seek to influence local law changes by providing example legislation and model ordinances, and engaging in similar activities related to hazard mitigation.

5.10. Take primary responsibility for developing specific regional plans that help implement this RNHMPG. Examples may include a regional flood control plan and others wherein a multijurisdictional approach is appropriate.

Chapter 6.
Planning guide implementation and maintenance

Reducing future losses from natural hazards is a long-term process, but one that begins as early as possible so hazards are avoided and future exposures are not increased beyond acceptable risk levels. This Regional Natural Hazards Mitigation Planning Guide, just as any plan, requires periodic review and maintenance so it remains current, reflects recent information, and provides a platform for sustained policy development and action.

6.1. Implementation

- Metro should formally adopt this planning guide as a guidance document for use throughout the region by county governments and others.
- Metro should provide the model local mitigation plan and related documents to its members and constituents so they help stimulate the development and implementation of local action plans.
- Metro should maintain the roles of the Natural Hazards Technical Advisory Committee (HAZTAC) to help Metro deal with implementation-related issues, to monitor hazard mitigation activities in the region, and to be a resource and central point of contact for local agencies, special districts, the private sector and others interested in and responsible for hazard mitigation.

6.2. Maintenance

- Metro should assign internal responsibility for the planning guide's maintenance and periodic revision to the Growth Management Division.
- Every five (5) years, undertake a formal review and revision process leading to republication of this mitigation planning guide.
- Continue to link this mitigation planning guide to Chapter 5 of the Regional Framework Plan (RFP) or other appropriate chapter so the relationship between overall regional policy and local implementation is maintained.
- Monitor, maintain and analyze data about hazard mitigation activities in the region by updating the information every three years in the Survey of Natural Hazard Mitigation Practices of Cities and Counties in the Portland Oregon Metropolitan Region (Appendix Three). This document provides a natural link between regional planning and local implementation.

Chapter 7.
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