PLANNING FOR NATURAL HAZARDS:
Landslide TRG

July 2000

Oregon Department of Land Conservation & Development
635 Capitol Street NE, Suite 150
Salem, OR 97301
503-373-0050

Community Planning Workshop
Community Service Center
1209 University of Oregon
Eugene, OR 97403
541-346-3889

Special Acknowledgements to:

Community Planning Workshop Researcher:

Kathy Lynn — *Community and Regional Planning Masters Candidate*

Special thanks to the following persons for their guidance in the development of this chapter:

Sterling Anderson — *Marion County*
Scott Burns — *Portland State University*
Mike Byers — *City of Bend Community Development Department*
Peter Gutowsky — *City of Salem*
Jon Hofmeister — *Oregon Department of Geology and Mineral Industries*
Keith Mills — *Oregon Department of Forestry*
Dennis Olmstead — *Oregon Department of Geology and Mineral Industries*
Patty Rueter — *City of Portland Fire and Rescue*
Lester Sasaki — *Marion County*
Phil Stenbeck — *Douglas County Planning Department*

Table of Contents

Section 1:
Introduction to the Landslide Technical Resource Guide

Landslides pose a significant threat to many communities in Oregon and create challenges to development in steep terrain, coastal regions and other landslide-prone areas. The purpose of this guide is to help planners, local decision-makers, and community leaders reduce risk to life and property from landslides. The guide is designed to help your local government address landslide hazard issues through effective comprehensive plan inventories, policies and implementing measures.

1.1 The Threat of Landslide Hazards to Oregon Communities

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause in excess of $1 billion in damages and 25 to 50 deaths each year.[1] Landslides threaten transportation corridors, fuel and energy conduits, and communication facilities.[2] In Oregon, a significant number of locations are at risk to dangerous landslides. While not all landslides result in property damage, many landslides impact roads and other infrastructure, and can pose a serious life-safety hazard. A rapidly moving landslide in Douglas County, for example, killed five people during the storms of 1996.

Growing population and the resultant increased demand for home ownership has caused development to occur more frequently in hazard areas. Landslide-prone areas are easily identified; they often exist in highly desirable locations, such as beachfront or hillside property. In planning for development, landowners and developers alike should be aware of the implications of siting and building homes and other structures and uses in landslide areas. The number of potential injuries and deaths is directly related to exposure — the more people in areas of known risk, the greater the risk of injury or death. Policies that regulate development in areas of identified risk are essential to reduce risk from landslide hazards. By regulating development in areas of known risk, communities can better protect life and property.

Sidebar

Organization of the Natural Hazards Technical Resource Guide

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

1.2 How to Use the Landslide Technical Resource Guide:

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

Section 2:
Is Your Community Threatened by Landslide Hazards?

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

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

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

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

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

Section 5:
How are Oregon Communities Addressing Landslide Hazards?

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

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

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

Section 2:
Is Your Community Threatened by Landslide Hazards?

Landslide hazards can cause severe property damage and loss of life. Identifying hazard areas is a key step in developing effective plan policies and implementing measures. This section assists local planners and decision-makers in understanding how landslides may affect future and current development. An overview of the causes and characteristics of landslides is included, along with information on identifying landslide hazards in your community.

2.1 What is a Landslide Hazard?

Landslides are relatively common, naturally occurring events in some parts of Oregon. Landslides include any detached mass of soil, rock, or debris that moves down a slope or a stream channel.[3] Landslides are classified according to the type and rate of movement and the type of materials that are transported.[4] Landslides occur when earth materials fall, slide, or flow down a slope. Two types of forces are at work: (1) driving forces combine to cause a slope to move, and (2) friction forces and strength of materials act to stabilize the slope. When driving forces exceed resisting forces, landslides occur.[5]

2.2 Where do Landslides Occur?

Landslides occur as "on-site" hazards and "off-site" hazards, and should be distinguished to effectively plan for future hazard situations. Decision-makers who are familiar with "on-site" landslides often may not be aware of the effects that "off-site" hazards can have on homes and communities.

- "On-site" hazards occur on or near the development site and are typically the slower moving landslides that cause most of the property damage in urban areas. Most existing landslide hazard maps deal with "on-site" hazards. On-site landslide hazards include features called slumps, earthflows and block slides.[6]

- "Off-site" landslide hazards typically begin on steep slopes at a distance from homes or developments, and are often rapidly moving. Recent events highlight the importance of "off-site" landslide hazards. In 1996, "off-site" landslides in Douglas County began a long distance away from homes and roads, traveled at high velocity, killed five Oregonians and injured many others.[7]

Tip Box

Hazard Inventories

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

Tip Box

Steep Slope Ordinances

Many communities in Oregon address landslide hazards through ordinances regulating development on steep slopes and in steep ravines. Section 5 of this guide presents examples of several communities addressing steep slopes in their ordinances, including techniques to help calculate the percentage slope and degree of the hazard.

2.3 What are the Different Types of Landslides?

Landslides are classified by causal factors and conditions, and include falls, slides and flows, which are described below. A combination of characteristics can also contribute to an increased risk of landslide hazards.

2.3.1 Falls

Falls move through the air and land at the base of a slope. In falls, material is detached from a steep slope or cliff and descends through the air by free fall or by bouncing or rolling downslope. Rockfall, the most common type, is a fall of detached rock from an area of intact bedrock. Rockfalls are common along Oregon highways where the roads are cut through bedrock.

2.3.2 Slides

Slides move in contact with the underlying surface. Slides include rockslides – the downslope movement of a rock mass along a plane surface; and slumps – the sliding of material along a curved (rotational slide) or flat (translational slide) surface. Slow-moving landslides can occur on relatively gentle slopes, and can cause significant property damage, but are far less likely to result in serious injuries. Two examples of slow moving landslides are the subdivision landslide in Kelso, Washington and the slide occurrence in 1998 at The Capes development in Tillamook County.[8]

2.3.3 Flows

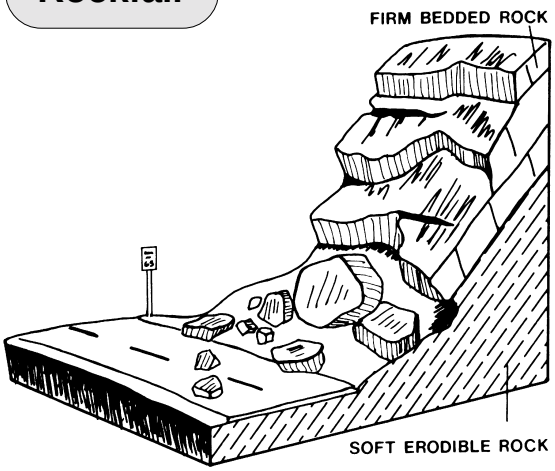
Flows are plastic or liquid movements in which mass (e.g., soil and rock) breaks up and flows during movement. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapidly moving and also tend to increase in volume as they scour out the channel.[9]

Landslide Key

Section 6 of this guide provides references to documents that provide more detailed information on the nature and types of landslide hazards.

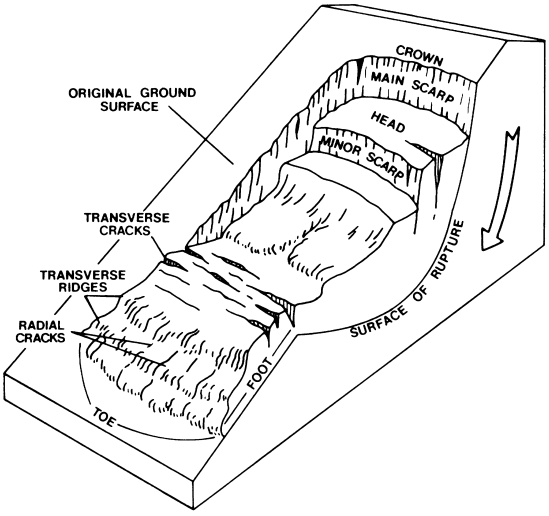
Types of Landslides: Earthflow, Rockfall, Rotational Landslide

Rockfall



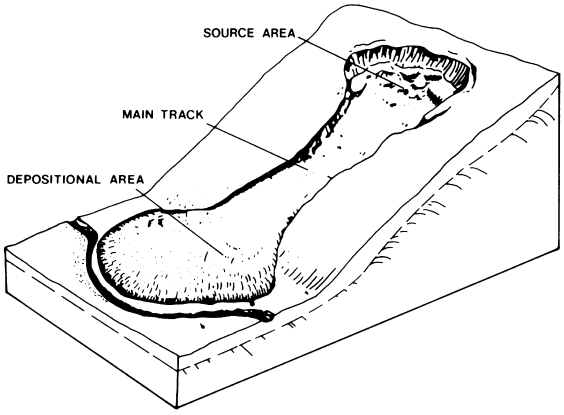
Source: *Federal Emergency Management Agency. FEMA 182, Landslide Loss Reduction. FEMA (1989) p. 11.*

Rotational Landslide



Source: *Federal Emergency Management Agency. FEMA 182, Landslide Loss Reduction. FEMA (1989) p. 12.*

Earthflow



Source: *Federal Emergency Management Agency. FEMA 182, Landslide Loss Reduction. FEMA (1989) p. 15.*

Debris Flows in Oregon

Debris flows (also referred to as mudslides, mudflows, or debris avalanches) are a common type of rapidly moving landslide that generally occur during intense rainfall on previously saturated soil. *"Rapidly moving landslide" is the term used in Senate Bill 12 (1999 ORS section 195.250), Oregon's statewide policy applied to rapidly moving landslides.*

Debris flows commonly start on steep hillslopes as soil slumps or slides that liquefy, accelerate to speeds as great as 35 mph or more, and flow down hillslopes and channels onto gently sloping ground. Their consistency ranges from watery mud to thick, rocky, mud-like, wet cement — dense enough to carry boulders, trees and cars. Debris flows from different sources can combine in canyons and channels, where their destructive power can be greatly increased.[10]

The debris flows occurring during the 1996 Oregon storm events included mud, water, logs, and boulders up to 20 feet in diameter that traveled significant distances. Debris flows are difficult for persons to outrun or escape, and they present the greatest risk to human life. Debris flows have caused most of the landslide-related property damage in rural areas, and have caused most of the recent landslide-related injuries and deaths in Oregon.[11]

Based on Oregon Department of Forestry's (ODF) Storm Impacts Study,[12] the highest debris flow hazard occurs in steeply sloped areas in the Tyee geologic formation (or similar sedimentary rocks) in western Douglas County, Coos County, and western Lane County. The debris flow hazard is also high in much of eastern Tillamook County and the Columbia Gorge.

Most slopes steeper than 70 percent are at risk from debris flows.[13] While these types of debris flow hazards are usually not in located in developed areas, homes that lie in the path of the debris flow are at risk, even those on gentle slopes or those located a significant distance from the initiation point. Landslides can move long distances, sometimes as much as several miles. The Dodson debris flows in 1996 started high on Columbia Gorge cliffs, and traveled far down steep canyons to form debris fans at Dodson.[14] Slope alterations can also greatly affect the number of times channelized debris flows occur, and cause landslides in areas otherwise not susceptible to landslides.

Slide in the Portland Metro Area from the 1996-1997 Landslide Events

Photo: *Federal Emergency Management Agency*

Very large, high-velocity landslides are rare, though there is evidence that the Bonneville landslide was a rapidly moving landslide about 300 years ago. This landslide covered an area of several square miles, apparently damming the Columbia River and creating the "Bridge of the Gods" near Cascade Locks, Oregon.[15]

2.4 What are the Conditions that Affect Landslides?

Natural conditions and human activities can both play a role in causing landslides. Certain geologic formations are more susceptible to landslides than others. Locations with steep slopes are most susceptible to landslides. The landslides occurring on steep slopes tend to move rapidly and are therefore more dangerous than other landslides. Although landslides are a natural geologic process, the incidence of landslides and their impacts on people and property can be accelerated by human activities.[16] Developers who are uninformed about geological materials and processes may create conditions that trigger landslide activity or increase susceptibility to landslide hazards.[17] This subsection will describe four conditions affecting landslides: natural conditions, slope alterations, grading and drainage.

2.4.1 Natural Conditions

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

2.4.2 Excavation and Grading

Slope excavation is generally needed in order to develop home sites or build roads on sloping terrain. Grading these slopes results in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Road associated landslides are good indicators of the potential impacts of excavation on new construction.

2.4.3 Drainage and Groundwater Alterations

Water flowing through the ground is often the factor that finally triggers many landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn

Tip Box

Landslides and debris flows are triggered or accelerated by:

- Intense or prolonged rainfall, or rapid snow-melt;
- Undercutting of a slope or cliff by erosion or excavation;
- Seismic activity or shocks and vibrations from construction;
- Concentration of runoff onto slopes;
- Alternate freezing and thawing;
- Improper management of surface and ground water;
- Vegetation removal by fires, timber harvesting, or land clearing;
- Placing fill (weight) on steep slopes; and
- Any combination of these factors.

Tip Box

How is Landslide Severity Determined?[19]

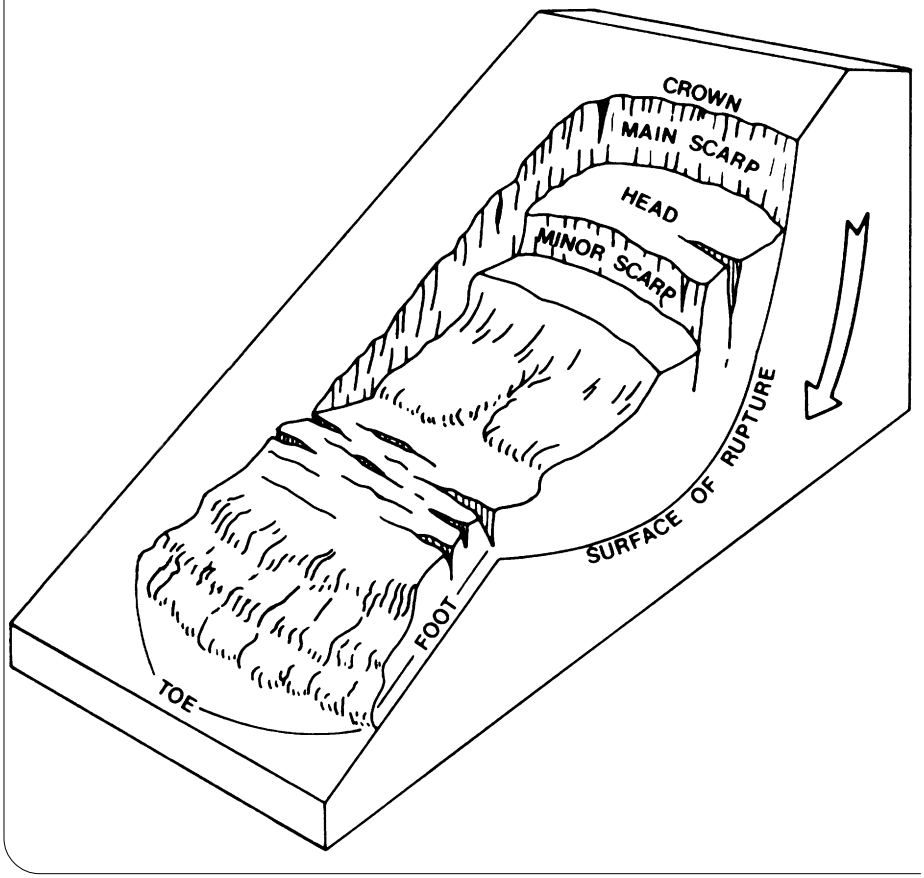
Oregon Statewide Planning Goal 2 requires cities and counties to develop a factual base (including inventories) as part of their comprehensive plans. Statewide Planning Goal 7 requires communities to inventory known hazards. Inventories contain facts about land use, natural resources, public facilities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

irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology of an area, but development that results in an increase in impervious surface will impair the ability of the land to absorb water.[18]

2.4.4 Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. A recent study by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of 10 years after timber harvesting. Areas that have experienced wildfire and land clearing for development can be expected to have longer periods of increased landslide hazards than after timber harvesting because forest recovery may take a very long time, or may never occur. In addition, woody debris (both natural and logging slash) in stream channels may cause the impacts from debris flows to be more severe.

Rotational Landslide Showing Scarps and Lobe-Shaped Deposits



Source: *Federal Emergency Management Agency. FEMA 182, Landslide Loss Reduction. FEMA (1989) p. 12.*

Landslide Key

Refer to the discussion on evaluating site-specific development in Section 4 for further information on geotechnical reports.

2.5 How do Landslides Affect New and Existing Development?[20]

Landslides are a naturally occurring event and their effect on new and existing development in our communities can be devastating. Three conditions may put people and property at risk of landslide damage:

2.5.1 Creating Steeper Slopes

Excavation practices, sometimes aggravated by drainage, can reduce the stability of otherwise stable slopes. These failures commonly affect one or a few homes. Without these excavation practices, there is little risk of landslides in areas not prone to landslide movement.

2.5.2 Development on or Adjacent to Existing Landslides

Development on or adjacent to existing landslides is generally at risk of future movement regardless of excavation practices. Excavation and drainage practices can further increase risk of landslides, which can be very large. In many cases there are no development practices that can completely assure stability. Homeowners and communities in these situations accept some risk of future landslide movement. Slopes can be very gentle (under 10 percent) on some portions of existing landslides.

2.5.3 Development on Fairly Gentle Slopes

Development on fairly gentle slopes can be subject to landslides that begin a long distance from the development. The sites at greatest risk are against the base of very steep slopes, in confined stream channels (small canyons), and on fans (rises) at the mouth of these confined channels. Home siting practices do not cause these landslides, but rather put residents and property at grave risk of landslide impacts. The simplest mitigation measure for this situation is to locate the home out of the impact area, or construct debris flow diversions for homes that are at risk.

Landslide Alert and Hillside Drainage Problems

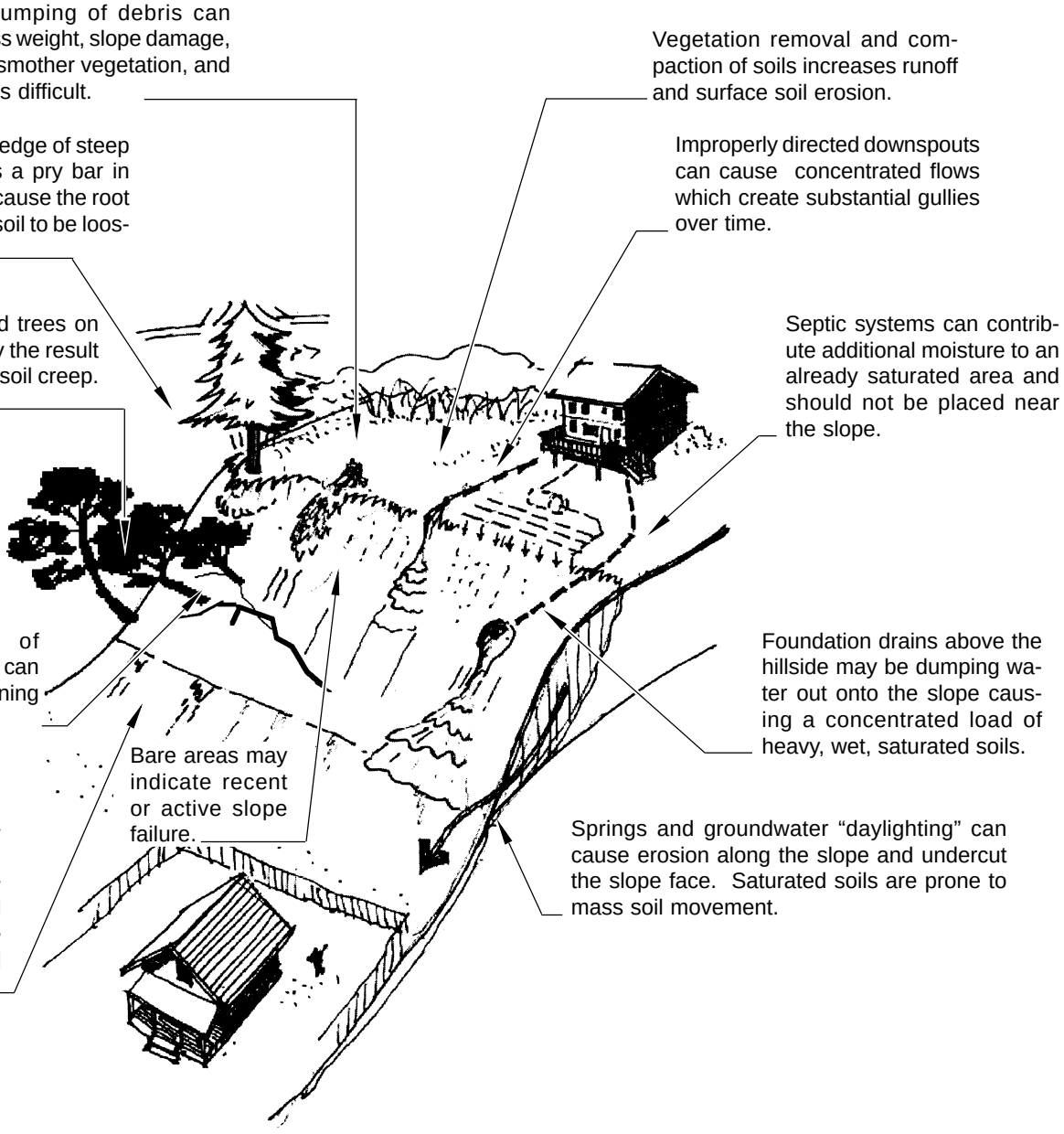
LANDSLIDE ALERT

AND HILLSIDE DRAINAGE PROBLEMS

Many landslides are triggered by improper drainage of water from different sources uphill from the slide. These sources can cause concentrations of extremely heavy saturated soils. When the saturated soils become heavier than the soils surrounding them, they can easily trigger a landslide.

Source: *Federal Emergency Management Agency. Hillside Drainage Flyer. Bothell, Wash.: FEMA Region 10 (2000).*

Seek the assistance of a geotechnical engineer for site specific design or consultation. Before undertaking any construction on your slope, check with your local permitting agency.



Hillside Drainage Flyer 3/12/97 **Federal Emergency Management Agency**

2.6 How can My Community Identify Landslide-Prone Locations?

Communities can identify landslide-prone locations by knowing the geologic and geographic factors of their environment, and through mapping and inventories.

2.6.1 Geologic and Geographic Factors

Geologic and geographic factors are important in identifying landslide-prone locations because of their influence on landslide processes. Stream channels, for example, have major influences on landslides, due to undercutting of slopes by stream erosion and long-term hillside processes.

Deep-seated landslide hazards are high in parts of Josephine and Curry Counties, and are fairly common in certain rock units of the western Cascade Mountains, and in fine-grained sedimentary rock units of the Coast Range. Infrequent, very large landslides and debris flows may occur in any of the larger mountains or in deep gorges in the Cascade, Wallowa, Elkhorn, or Siskiyou mountain ranges.[21]

The Oregon Department of Forestry (ODF) Storm Impacts Study, conducted after the 1996-97 landslide events, found the highest probability for the initiation of shallow, rapidly moving landslides was on slopes of over 70 percent to 80 percent steepness (depending on landform and geology). A moderate hazard of shallow rapid landslide initiation can exist on slopes of between 50 percent and 70 percent.[22]

In general, slopes over 25 percent, or a history of landslides in or very close to your community means there could be some level of landslide hazard within your jurisdiction. The steeper the slopes, or the greater the history of landslides, the more severe the landslide hazard. While some drier areas may not have hazards at slopes of 25 percent or greater, existing landslides at slopes under 15 percent may still be subject to movement. In otherwise gently sloped areas, landslides can occur along steep river and creek banks. At natural slopes of under 30 percent, most landslide hazards are related to excavation and drainage practices, or re-activation of preexisting landslide hazards.[23]

TRG Key

The first step of hazard assessment is hazard identification, estimating the geographic extent, intensity and occurrence of a hazard. More information on the three levels of hazard assessment can be found in Chapter 2: Elements of a Comprehensive Plan.

2.6.2 Soil Type

Soil type may, in some cases, be useful in identifying landslide-prone locations. The U.S. Natural Resources Conservation Service (NRCS) produces a number of useful soils map products including paper copy county soils reports and digital State Soil Geographic (STATSGO) and Soil Survey Geographic (SSURGO) databases. STATSGO soil surveys are more generalized statewide digital soils maps and the SSURGO data sets are typically more detailed (1:24,000 scale) and often follow county boundaries. Both STATSGO and SSURGO products can be incorporated into Geographic Information Systems (GIS). NRCS soils maps determine slope very roughly, and do not identify existing landslide hazards. The maps are based on agricultural soil properties and do not reflect underlying geology or engineering properties of the soils.[24]

Landslide Key

Contact information for the Natural Resources Conservation Service can be found in Section 6.

Landslide Key

Refer to Section 6 of this guide for ODF and DOGAMI contact information.

The STATSGO database is already available for Oregon and the NRCS is expanding the SSURGO coverage. Much of western Oregon has been completed or is within the certification process. Field mapping methods using national standards are used to construct the soil maps in the SSURGO database and they incorporate the most detailed level of soil mapping done by NRCS.[25] To utilize the full capabilities of this system, GIS software and expertise is required. NRCS is also developing a Soil Data Viewer to facilitate use of the technical soil information.[26]

2.6.3 Mapping and Inventories

Mapping of landslide hazards in Oregon began in the early 1970s when the Oregon Department of Geology and Mineral Industries (DOGAMI) mapped existing landslides in much of coastal Oregon. These maps are found in DOGAMI's Environmental Geology Bulletins. Particular types of landslides are mapped in portions of some counties, including most of the Oregon coast. The Oregon Department of Forestry (ODF) produced debris flow maps for Western Oregon that are accessible from the ODF website. DOGAMI began conducting field investigations in 2000 to further refine the ODF debris flow maps and determine "further review areas" to address rapidly moving landslides as required by Senate Bill 12, 1999 Oregon legislature.[29] Local planners and the public can access the Nature of the Northwest Information Center through the DOGAMI Website, or contact DOGAMI directly to find out whether or not landslide maps are available for their community.

Tip Box

Landslide and debris flow-prone locations can include:[28]

- V-shaped valleys, canyon bottoms, and steep stream channels
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons
- Areas with large boulders (2 to 20 feet diameter) perched on soil near fans or adjacent to creeks
- Steep hillslopes above a home or lot
- Logjams in stream above a home or lot
- Steepened roadcuts
- Areas that have been extensively disturbed by excavation into steep slopes
- Existing landslides or places of known historic landslides
- Moderately steep slopes that are exposed to high water flow

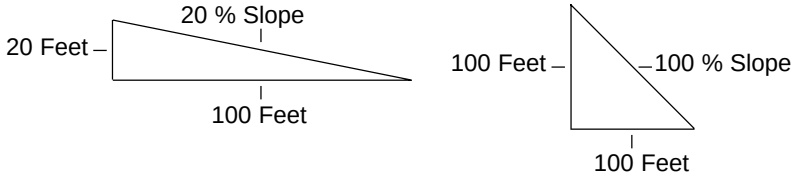
Tip Box

Calculating Percent Slope[27]

Engineers describe slope steepness using percent slope. This number is calculated by taking the vertical distance from the bottom to the top of the slope and dividing that distance by the horizontal distance from the bottom to the top of the slope. The result of this division is the slope. The slope is multiplied by 100 to give the percent slope.

An example would be a slope that rises 20 vertical feet over a horizontal distance (not distance along the slope surface) of 100 feet. The slope would be represented as 20 divided by 100 equals 0.20. Multiplying by 100 gives 20% slope.

A very steep slope that rises 100 vertical feet over 100-foot horizontal distance is 100 divided by 100 equals 1. Multiplying 1.00 by 100 gives a 100% slope, the same as a 45-degree angle slope.



Data collected on landslide occurrences associated with the severe storms of 1996 demonstrate the wide distribution of the landslide hazard, particularly in the western portion of the state. A three-year study by ODF took a close look at landslides that occurred in eight forestland study regions. Within the eight study sites (45.8 square miles total), ODF surveyed over 500 landslides. A study conducted by Portland State University showed that in the Portland metropolitan area, 17 homes were completely destroyed and 64 were badly damaged in over 700 landslides associated with the 1996 storms.

FEMA provided funds to generate a statewide inventory of known landslide occurrences associated with the major storm events of 1996 and 1997. DOGAMI collected evidence of over 9000 landslide and slope failure locations in the state. The study helped to gather and consolidate the available data on landslide occurrences from both public and private sources. The generation of the statewide landslide inventory is intended to provide a means for developing and verifying hazard models as well as to facilitate various efforts aimed at minimizing risk and damage in future storm events. The database includes a digital Geographic Information System (GIS) file with slide locations, a digital database with details on each slide, and an accompanying report. Communities need appropriate software and expertise to make full use of this GIS product. These products are available from DOGAMI by requesting: Database of Slope Failures in Oregon For Three 1996/97 Storm Events. Hofmeister, R.J., (2000) Oregon Department of Geology and Mineral Industries Special Paper. The database can also be accessed on the Internet at **http://sarvis.dogami.state.or.us/landslide/inventory/project.htm#Project.Summary.**

Tip Box

Maps only provide a general indication of a landslide hazard. The ODF Storm Impacts Study found that forest canopy obscures the ability to identify or accurately measure landslide areas, specifically for debris flows, and that coarse-scale digital elevation models underestimate slope steepness, especially in areas with irregular, steep slopes. Ground-based investigation has provided the most reliable information on landslide occurrence and characteristics in the forests of Western Oregon.

Tip Box

Debris flow maps developed by the Oregon Department of Forestry can be accessed on the web at: **http://www.odf.state.or.us/gis/debris.html**, or by contacting ODF. ODF's Debris Flow Geographic Information System maps exist for the following counties: Benton, Clackamas, Columbia, Coos, Curry, Eastern Douglas County, Western Douglas County, Hood River, Jackson, Josephine, Eastern Lane County, Western Lane County, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington and Yamhill.

2.7 Summary: Resources to Help Your Community Identify Landslide Hazards

- *Landslide maps and identification of landslide-prone areas*, including the type, conditions, history and severity of landslide hazards, can help your community strengthen the factual base of your comprehensive plan.
- *Technical assistance*, including mapping, soil surveys, and calculating percent-slope, that can assist in identifying landslide-prone locations. DOGAMI and ODF are the principal state agencies providing technical assistance for identifying landslide-prone locations. Soil surveys provided by the Natural Resources Conservation Service can also provide limited assistance.
- *Local comprehensive plans* should include landslide identification and vulnerability assessment as a part of their inventory. Existing maps and information on historic slides can help you update the natural hazards component of your comprehensive plan.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

The factual base of your community's comprehensive plan should reflect a current inventory of all natural hazards and a vulnerability assessment. The inventory should include a history of natural disasters, maps, current conditions and trends. A vulnerability assessment will examine identified hazards and the existing or planned property development, current population, and the types of development at risk. A vulnerability assessment will set the foundation for plan policies.

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

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

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

TRG Key

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

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

The state of Oregon passed landslide legislation in response to the property damage and fatalities from the 1996 flood and landslide events. The Debris Avalanche Action Plan, established by an Executive Order issued by Oregon Governor John Kitzhaber, March 4, 1997, was the initial state response.

The Governor's Debris Avalanche Action Plan included specific recommendations for state and local governments to reduce the occurrence of debris flows and reduce the risk to the public when debris flows occur.[30] The Executive Order calls for specific actions to be taken by state agencies, including Oregon Departments of Transportation, Forestry, Land Conservation and Development, Geology and Mineral Industries; Oregon State Police (OSP)-Office of Emergency Management (OEM); Building Codes Division; and the Governor's office. Outcomes from this action plan included development of ODF debris flow maps, brochures, forest practices deferral, the debris flow warning system (see the ODF Website), the 1998 review of Statewide Planning Goal 7, and creation of the Governor's Interagency Hazard Mitigation Team.

3.1 Oregon Laws Related to Landslide Hazards

3.1.1 Goal 7: Areas Subject to Natural Disasters and Hazards

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

3.1.2 Senate Bill 12 – Debris Flows

TRG Key

For information on Goal 17 and coastal shorelands, refer to Chapter 6: the Coastal Hazard Technical Resource Guide and Appendix A.

Following the flood and landslide events of 1996, legislation was drafted to reduce risk from future landslide hazards. The legislature passed Senate Bill 1211 in 1997, which dealt with rapidly moving landslide issues around steep forestlands, and not in typical urban or community settings. Senate Bill 1211 granted authority to the State Forester to prohibit forest operations in certain landslide-prone locations, and created the Interim Task Force on Landslides and Public Safety. SB 1211 charged the Interim Task Force with developing a comprehensive, practicable, and equitable solution to the problem of risks associated with landslides.[31]

The Interim Task Force developed the legislative concept that resulted in Senate Bill 12 in the 1999 session. Senate Bill 12

directs state and local governments to protect people from rapidly moving landslides. The bill has three major components affecting local governments: detailed mapping of areas potentially prone to debris flows (i.e., "further review area maps"); local government regulating authority; and funding for a model ordinance. The legislature allocated funding to the Department of Geology and Mineral Industries (DOGAMI) to prepare the "further review area maps," and provided $50,000 for a grant to a local government to develop a model program to address rapidly moving landslides. *Senate Bill 12 applies only to rapidly moving landslides, which are uncommon in many communities, but are very dangerous in areas where they do occur.*

Local Government Responsibilities under Senate Bill 12

In order to reduce the risk of serious bodily injury or death resulting from rapidly moving landslides, Senate Bill 12 requires local governments to:[32]

- Exercise all available authority to protect the public during emergencies;
- Decide when to require a geotechnical report and, if a report is required, provide for a coordinated review of the geotechnical report by DOGAMI or ODF, as appropriate, before issuing a building permit for a site in a Further Review Area;
- Regulate through mitigation measures and site development standards the siting of dwellings and other structures designed for human occupancy in Further Review Areas where there is evidence of substantial risk for rapidly moving landslides; and
- Maintain a record, available to the public, of properties for which a geotechnical report has been prepared within the jurisdiction of the local government.[33]

Further Review Area Maps

Senate Bill 12 requires mapping of areas with potential for rapidly moving landslides. The language defines "Further Review Areas" as: an area of land within which further site specific review should occur before land management or building activities begin because either DOGAMI or ODF determines that the area reasonably could be expected to include sites that experience rapidly moving landslides as a result of excessive rainfall.[34]

DOGAMI will prepare further review area maps that include at a minimum all regions in Western Oregon mapped by ODF as high or extreme hazard debris flows by 2002. Communities can contact the Nature of the Northwest Information Center to access the DOGAMI maps or existing ODF maps (See contact information in Section 6 of this Guide). Developers may be required by local government to attain a geotechnical site report if the property is determined to be in a Further Review Area. However, local governments can request that a site report be prepared prior to granting a building permit, regardless of

whether the site has been determined to be in a further review area. Local governments may need to include language in their ordinances requiring such site reports. Some of these "further review areas" may lie within Urban Growth Boundaries. Cities and counties may therefore need to modify their comprehensive plans and ordinances to meet requirements of Senate Bill 12 if DOGAMI maps show a landslide hazard in their community.

Forest Practices Public Safety Regulations

Senate Bill 12 requires the Oregon Board of Forestry to adopt regulations that reduce the risks associated with rapidly moving landslides which will replace the interim prohibition of certain forest operations. This bill also recognizes, however, that rapidly moving landslides can and do commonly occur on steep slopes regardless of past timber harvesting, therefore it will take the combined actions of homeowners, road users, forestland owners, and state and local government to protect the public.

Development of Model Ordinances

Senate Bill 12 also provided for a pilot program, under the guidance of the Department of Land Conservation and Development, to develop model ordinances, regulations and procedures for mitigation of hazards and for allowing the transfer of development rights. The grant of $50,000 for the pilot program was awarded to Douglas County. Douglas County began development of a model ordinance in February 2000 and can be contacted at (541) 440-4289 for more information.

Senate Bill 12 can be obtained online from the State of Oregon Home page at **http://www.leg.state.or.us/billsset.htm.**

3.1.3 Oregon State Building Codes Division - Landslides

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

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

State building codes do not set standards for lot grading that is not associated with the construction of buildings. However, the state has recognized the Uniform Building Code Appendix Chapter 70 as an appropriate standard for excavation and fill of such properties. Local municipalities have the option of adopting this standard or their own to regulate lot grading in areas other than the building foundation. Many jurisdictions use these standards in conjunction with local planning ordinances. Building codes do not address "off-site" or deep-seated landslide hazards. Local governments can take the initiative to address these hazards.

3.2 Summary: Laws for Landslide Hazards

- ❒ Oregon Statewide Planning Goal 7: Areas Subject to Natural Hazards
- ❒ Senate Bill 12: Addressing Rapidly Moving Landslide Hazards in Oregon
- ❒ Oregon State Building Codes Division

Planning for Natural Hazards: Reviewing your Comprehensive Plan

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

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

- ❒ Does your community's comprehensive plan contain an inventory of landslide hazards, a vulnerability assessment and policies addressing landslide hazards?
- ❒ Has your community's comprehensive plan been updated to reflect the latest information on landslide hazards in your community, the current laws for rapidly moving landslides and the State Building Codes?
- ❒ Does your comprehensive plan have policies and implementing measures to reduce risk to existing and future development in landslide hazard areas?

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

TRG Key

For more information on specific hazards mitigation techniques see Appendix C: Land use Tools and Techniques in the Natural Hazards Technical Resource Guide.

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

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

4.1 How can Your Community Plan for Landslide Hazards?

Landslide Key

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

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

To successfully plan for a landslide hazard, consider the following steps:

- ✓ **Identify the hazard**
  Hazard identification is the first phase of hazard assessment and is part of the foundation for developing plan policies and implementing measures for natural hazards.
- ✓ **Avoid the hazard**
  Restrict development in hazard-prone areas. For landslide-prone areas with high density and potential for severe property damage or loss of life, this option should be followed.
- ✓ **Evaluate site-specific development**
  Communities can require geotechnical reports to evaluate site-specific development in landslide areas. Techniques for evaluating these hazards during the land use and permitting process are described below.
- ✓ **Implement risk reduction measures through land use planning**
  Minimizing development in hazard areas through low density and regulated development can reduce risk of property damage and loss of life. This section provides information on specific land use planning and zoning measures.

✓ **Implement non-regulatory measures**
Additional mitigation strategies and non-regulatory measures can further reduce risk from landslide hazards. These strategies are further explored in this section.

4.2 How is Development in Landslide-Prone Areas Evaluated?

Geotechnical reports can be required for development in locations that may have significant landslide hazards. Geotechnical reports are appropriate for new developments located on known landslides, and for areas where significant excavation may be required to develop the site. Other factors, such as the proposed construction activity may influence the decision to require a site report. For excavations, a combination of hillslope steepness and maximum cut and fill dimensions are generally appropriate criteria for determining when such a report is needed.

Who can Prepare Geotechnical Reports?

Professional Engineers (PE) and Certified Engineering Geologists (CEG) regularly produce geotechnical reports. However, local governments may not be aware of the differences in the types of geotechnical professionals. Such specialists may have a Professional Engineers (PE) stamp or a Certified Engineering Geologist (CEG) stamp, but they must also be competent in the field within which they are practicing.[35]

"Procedures and capability of technical experts qualified to do site specific investigations should be clearly specified. Engineering geological registration and performance guidelines exist and are established by the State Board of Geologist Examiners, but geotechnical engineering certification and procedural guidelines have not yet been established. Qualified technical experts (PEs with geotechnical competency) are available, but not identified by registration."[36]

A *Certified Engineering Geologist* is an Oregon-registered professional geologist who has been trained and tested by the Oregon State Board of Geologist Examiners (OSBGE). An engineering geologist is a person who applies geologic data, principles, and interpretation to naturally occurring materials so that geologic factors affecting planning, design, and construction and maintenance of civil engineering works are properly recognized and utilized ORS 672.505(5).[37] An engineering geologist uses the knowledge of past and potential events to identify and characterize geotechnical problems that could affect the location, design, construction, and maintenance of structures and engineering works.[38] The Oregon Board of Geologist Examiners has adopted guidelines for engineering geologic reports.

A *professional engineer* is an Oregon-registered professional engineer. An engineer is defined as "…a person who has knowledge of mathematics, physical, chemical and other sciences and the principles and methods of engineering analysis and design acquired by engineering education and engineering experience" ORS 672.002(2).[39]

A *geotechnical engineer* is usually a civil engineer who considers the effects of earth materials and geologic processes on structures and

Tip Box

The Three Levels of Hazard Assessment

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

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

engineering works. Geotechnical engineers often use information provided by engineering geologists in analyzing the effects of geologic conditions on proposed structures and in engineered designs to effectively address the geologic conditions. Thus, the geotechnical engineer accomplishes analyses and provides recommendations for geotechnical design, and completes an evaluation of the expected performance of the engineering work.[40]

After a geotechnical review is completed, local governments need to be sure the study has accountability (i.e. the PE or CEG stamp) and competency. Local governments should evaluate the study based on the qualifications of the geotechnical professional. The presence of a State of Oregon Stamp (PE or CEG) alone does not constitute competency. The "Boards" of registration (Oregon Board of Examiners for Engineering and Land Surveying - OSBEELS and the Oregon State Board of Geologist Examiners - OSBGE) can evaluate competency on a case-by-case basis.

There are several ways to ensure the competency of geotechnical studies. Peer review or internal review can help to ensure competency. Local governments can also consider sharing a qualified geotechnical engineer or engineering geologist between agencies to reduce cost, maximize expertise and ensure competency.[41] Private sector specialists can be found in the Yellow Pages.

The Board of Geologist Examiners has adopted guidelines for engineering geologic reports. There are no specific guidelines for Geotechnical Engineering Reports. ODF and DOGAMI plan to work with the Board of Examiners for Engineering and Land Surveying and the Board of Geologist Examiners to develop additional guidelines for rapidly moving landslides.

4.3 What Land Use Tools can be Used to Reduce Risk from Landslide Hazards?

Land use planning and zoning can assist local governments in regulating development and mitigating natural hazards. The following are land use tools communities can use to reduce risk from landslide hazards.

4.3.1 Overlay and Combining Zones

Overlay and combining zones are independent zones that coexist with the base-zoning district. Development is usually regulated in accordance with the uses allowed by the base-zoning district. However, under certain conditions, the requirements of the overlay and combining zones can take precedence over the underlying zoning district. For example, a community could create an overlay-zone for landslide-prone areas and establish special review requirements for development in those areas.[42] Landslide mitigation requirements might include geotechnical reports for development proposals, or structural mitigation measures during construction.

Tip Box

Peer Review

Many of Oregon's local governments require geotechnical reports before they will allow a structure to be located in a landslide or steep slope hazard area. In some cases, local governments require the developer to pay for another engineer to review the geotechnical report. This "peer review" procedure allows the local government to get a "second opinion" regarding the substance of the geotechnical report and the potential risks associated with the proposed development. Marion County is in the process of adopting a new landslide/steep slope overlay zone. The following language regarding peer review is included in the draft ordinance: "All assessments and reports required by this chapter shall be reviewed by a qualified professional or professional firm…of the county's choice prior to acceptance of the development permit application. Such review shall include examination to ensure required elements or guidelines have been completed, report procedures and assumptions are generally accepted and all conclusions and recommendations are supported and reasonable." The proposed ordinance authorizes the county to require the developer to pay the cost of the "peer review."

4.3.2 Incentive Zoning

Incentive zoning requires developers to exceed limitations imposed upon them by regulations, in exchange for specific concessions. For example, if developers avoid developing in landslide-prone areas, the local government might allow them to build on other portions of their land at a higher density than is allowed by the current zoning designation.[43]

4.3.3 Performance Zoning

Performance zoning sets standards that allow for a certain level of impact on the environment from development activities. This technique is usually used in conjunction with traditional zoning. The standards typically address specific environmental conditions, and can include stormwater runoff.[44]

4.3.4 Incorporating Landslide Mitigation Requirements into Subdivision Regulations

Subdivision regulations govern the division of land for sale or development. Additional requirements may be incorporated into these types of regulations. Developers wanting to subdivide a property located in a high landslide-prone area could be required to pay exactions, impact fees or other system development charges.[45] This type of regulation combined with a fee exaction can serve to discourage development in landslide-prone areas. Three mitigation approaches that can be included in subdivision regulations include cluster development, performance bonds and site plans, which are described below.

4.4 What are Additional Methods for Reducing Risk from Landslides?

Some of the techniques listed below are regulatory measures used by local governments. Others are non-regulatory in nature and can be implemented by local government officials, developers and private citizens alike.

4.4.1 Drainage Practices

Ineffective stormwater management and excess runoff can cause erosion and increase the potential for landslides. Drainage can be affected naturally by the geology of an area, but can be exacerbated by the construction of large impervious surfaces (e.g., parking lots). These impervious surfaces impair the natural absorption of water and can adversely concentrate flow onto marginal slopes.[46] Special construction standards can be used to control water runoff, including mulching and seeding disturbed areas, which directs runoff away from potentially hazardous downslope areas.

4.4.2 Soil conservation and Steep Slope Stabilization

Soil conservation and steep slope stabilization are measures that can be implemented by placing restrictions on the grading of hillsides and establishing development limits on landslide-prone slopes. It is possible to reduce erosion and stabilize

slopes using non-invasive structural measures. Activities related to slope stabilization and soil conservation include erosion prevention through regulations that limit development on severe slopes, or through proper site design. These measures can also help avoid costly stabilization work.

4.4.3 Lower Density in Residential Lots

Lower density in landslide-prone areas can result in fewer people and structures being at risk and can also reduce the potential for landslides by reducing the number of cuts and fills for driveways and house pads. Density in hazard areas can also be minimized through the voluntary dedication of land for open space or public parks, which can reduce potential development on those lands.

4.4.4 Development Standards

Development that fits the terrain and does not use extensive excavation and drainage alterations will reduce risk from landslide hazards. Specifying maximum cuts and fills and compaction standards can further reduce risk. Locating the structure on a part of the property not prone to landslides is another strategy to reduce risk of property damage from landslides.

Special hillside development standards applied to slopes calculated to be high risk can reduce cross-slope cuts and fills. These standards include reduced street widths, hammerheads rather than cul-de-sac bulbs and sidewalks on only one side.

4.4.5 Cluster Development

Cluster development is the concentration of structures on one part of a lot to preserve the remainder of the property for open space. Cluster development usually is permitted only under planned unit development procedures. Clustering offers the potential for savings in some areas: the sewer and water lines and streets needed to serve a cluster may be much shorter than those necessary for a traditional subdivision of comparable density.[47] Cluster development provides the opportunity to avoid developing in hazard areas by maximizing development structures on non-hazard areas.

4.4.6 Performance Bonds

Performance bonds are bonds required of a subdivider or developer to ensure that specified improvements will be carried out after approval for the development is given by the local government. Performance bonds are widely used for a broad range of improvements – such as sidewalks, streets, curbs, storm sewers, street lighting, etc. They are one type in a broader category known as surety bonds.[48] Performance bonds can be used to improve drainage practices or implement other mitigation techniques.

Tip Box

Process for Evaluating Development in Landslide-Prone Areas

Communities can use a regulatory process to assist in evaluating development in landslide-prone areas. For example, when a developer submits a site development plan, local planning officials will apply local hazards regulations. If the site is located within the boundary of a known hazard area, the developer can be required by local regulations to retain a professional to evaluate the level of risk and provide recommendations on mitigation measures. This requirement pertains to the proposed structure, to the construction methods, and natural conditions proposed to be altered on and around the site. During the review of the site development plan, planners must rely on detailed technical information and professionals to obtain the most accurate evaluation.

TRG Key

For a brief discussion on Transfer of Development Rights refer to Chapter 3 of the Natural Hazards Technical Resource Guide: the Legal Issues Guide.

4.4.7 Site Plans

A site plan is a large-scale map of a proposed development site. Most zoning and subdivision ordinances require that a site plan accompany any application for a partition, variance, conditional use, zone change, or other quasi-judicial action. The standards for the drafting of such maps are not high, but each drawing should have a consistent scale (described on the plan), a north arrow, and a title or legend, and should show property lines, the locations of buildings, and the presence of roads, streams, and other major features of the landscape.[49] If a landslide hazard is present, you can use the site plan to determine the location of the permitted development and to avoid the hazard area.

4.4.8 Restrictions on Uses and Facilities

There can be restrictions made on the types of uses and facilities that can be built in mapped landslide areas. A city or county may decide that critical facilities or large assembly places such as a college, hospital, convention center, or church should not be allowed in an extreme landslide hazard area.

4.4.9 Prohibition

Where supported by the factual base, a community may decide that the landslide hazard is severe enough that development should be prohibited. There may be legal issues with such prohibitions.

4.4.10 Structural Practices

Structural mitigation practices can include those that deflect landslide movement (typically for debris flows) and those that can physically arrest or control landslide movement. These measures should be required at the time the development is approved by the local government.

4.4.11 Vegetation

Limiting or regulating the amount of vegetation cleared off a hillside lot reduces the risk of increasing the number of landslide-prone areas in a community. Planting vegetation or maintaining slope terraces can also reduce slope-runoff.[50]

4.5 What are Examples of Plan Policies and Ordinances that Regulate Development in Landslide-Prone Areas?

Oregon cities of Bend and Salem provide examples of landslide policies and ordinances used by communities to regulate development in areas of steep slope and landslide-prone areas. For further information on the Salem ordinance refer to Section 5 of this guide.

4.5.1 Bend General Plan[52]

The Bend general plan establishes performance standards for development in steep slope areas. Bend's plan allows the city to reduce minimum residential density where slopes are greater than 20 percent.

TRG Key

Refer to the Legal Issues Guide for further information.

1. The City shall require development on slopes in excess of 10 percent to employ measures to minimize the hillside cuts and fills for streets and driveways.
2. The location and design of streets, structures and other development features on slopes in excess of 10 percent shall give full consideration to the natural contours, drainage patterns, and vegetative features of the site to protect against temporary and long-term erosion.
3. In areas where the natural slope exceeds 20 percent, the city may reduce the minimum residential density (allow larger lots) or alternatively, may require cluster development through the PUD process to preserve the natural topography and vegetation, and improve fire protection.

4.5.2 Salem Ordinance Chapter 68 Section 68.010 Intent and Purpose

The Salem draft ordinance contains a good example of a statement of intent that could be included in a local landslide ordinance. Section (e) clearly indicates the City's position that they cannot completely eliminate the landslide risk in their community.

The intent and purpose of the provisions of this chapter are:

(a) To implement the Geologic Hazards goals and policies of the Scenic and Historic Areas, Natural Resources and Hazards section of the Salem Area Comprehensive Plan;
(b) To review development applications for properties within landslide hazards areas;
(c) To assess the risk that a proposed use or activity will adversely affect the stability and slide susceptibility of an area;
(d) To establish standards and requirements for the use of lands within landslide hazards areas;
(e) To mitigate risk within landslide hazards areas, not to act as a guarantee that the hazard risk will be eliminated, nor as a guarantee that there is a higher risk of hazard at any location. Unless otherwise provided, the landslide hazard regulations are in addition to generally applicable standards provided elsewhere in this code.

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

- **Avoid the hazard** if possible, since risk reduction techniques can be very expensive or may not be feasible in areas prone to rapidly moving landslides or near a very large landslide.
- **Reduce the level of risk** in hazard-prone areas by minimizing development, reducing density, or implementing mitigation measures if developing in hazard-prone locations is unavoidable.
- **Evaluate development** in landslide-prone locations. Evaluation can be required through local government regulations and by understanding the geology of the area. Technical

Sidebar

Hazard Mitigation Grant Project[51]

The City of Rufus along the Columbia River is bisected by Gerking Canyon which drains a watershed largely comprised of dry land wheat fields. Heavy rainfall associated with summer thunderstorms or rapid snowmelt can cause significant runoff that carries water and rocky debris through town impacting roads, bridges, housing and the community well system. To address this hazard, the upland wheat growers constructed a series of catchment basins designed to control runoff before it reaches town by detaining water and soil. Not only are peak runoff flows reduced, soil erosion in the fields is controlled and the detained water is given a chance to percolate into the ground to improve soil moisture. This project involved the Natural Resources Conservation Service, the Sherman County Soil and Water Conservation District, and funding from FEMA's Hazard Mitigation Grant Program.

assistance from state agencies such as DOGAMI and ODF can assist in hazard mapping and assessment. Section 2 provides information on resources and technical assistance for landslide hazard identification.

- ❒ **Require geotechnical investigations** for development in locations that may have significant landslide hazards. Geotechnical reports are commonly used in evaluating development proposals and must be conducted by professional engineers or certified engineering geologists.
- ❒ **Adopt land use policies and enact regulations**, including overlay zones, incentive zoning, performance zoning, and subdivision regulations. Other useful regulatory strategies include excavation and grading standards, stormwater management, hillside development standards, restrictions on the types of uses of landslide-prone areas, density limits, and regulating vegetation on hillside lots.
- ❒ **Consider non-regulatory strategies** such as soil conservation, slope stabilization, and dedication of land for open space useful to a variety of community organizations for reducing risk from landslide hazards.
- ❒ **Provide public outreach** and information sessions for residents and potential residents living in landslide-prone terrain regarding the hazard and steps residents can take to protect themselves.
- ❒ **Assess the level of risk** for rapidly moving "off-site" landslide hazards, as they pose the highest threat to public safety and can cause loss of human life.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

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

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

Section 5:
How are Oregon Communities Addressing Landslide Hazards?

This section describes how several Oregon communities are addressing landslide hazards through a regulatory process. These examples describe development of plan policies, and implementation of the communities' landslide hazard ordinances.

5.1 A Collaborative Planning Approach - Salem & Marion County, Oregon

Salem and Marion County used federal hazard mitigation funding after the 1996 flood and landslide events to reduce risk to life and property through mapping of landslide hazards and development of landslide hazard ordinances.

Background

Salem and Marion County initiated the development of their landslide hazard ordinances in 1996, after heavy rains and flooding resulted in landslide activity. Funding was secured from Federal Emergency Management Agency (FEMA) presidentially declared disaster funds. Funds were provided to the state through the Hazard Mitigation Grant Program, administered by the OSP-Office of Emergency Management (OEM). The city, county, and the Oregon Department of Geology and Mineral Industries (DOGAMI) worked together to produce a landslide hazard study of the South Salem Hills. This project was expanded to include a similar study of the Eola Hills in Polk County after additional grant funds became available.

The study included landslide mapping and characterization of the Salem Hills and Eola Hills project areas coordinated by DOGAMI, the formulation of landslide hazard ordinances by the city and county, and development of a technical reference manual on mitigating geologic hazards in Oregon. The Department of Land Conservation and Development (DLCD) and OEM provided technical support for the study and ordinance development. FEMA funded 75 percent of the study and DOGAMI, Salem, and Marion County contributed the remaining 25 percent of project costs.

The approach taken by city and county staff was a key aspect in developing these ordinances. Collaboration among local government, project participants, and a broad group of stakeholders resulted in a citizen advisory committee. Project staff, together with the citizen advisory committee, agreed upon and adopted a set of principles for the development of the ordinances. With these principles in mind, staff collected, reviewed and summarized for the committee, hillside development ordinances and resource/reference materials from around the country but primarily from the northwest and California. A matrix was developed outlining these resource materials to assist staff and the committee.

Tip Box

Protecting Life and Property in Oregon – Public Education and Response

Oregon residents in landslide-prone areas can obtain additional information on landslides, from the "Oregon Landslide Brochure." Communities can develop an emergency response plan for areas prone to rapidly moving landslides. This plan should include evacuation routes that expose residents to the least hazards. Communities should also consider structural controls along essential evacuation routes, especially if these routes are at high or extreme hazard for rapidly moving landslides. Provisions in the land development code can provide access to landslide hazard areas (such as roads) to ensure emergency vehicle access and resident evacuation. Communities can develop regulations to ensure that homes are not located in the potential paths of rapidly moving landslides.

(The brochure is available by contacting DOGAMI - refer to Section 6 of this guide for contact information.)

TRG Key

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

The Draft Ordinance

The draft Salem ordinance for landslide hazards developed in 2000 requires the preparation and approval of a geological assessment before development occurs in areas identified with a moderate degree of hazard. These areas then undergo a preliminary review of geologic conditions. The ordinance requires staff to determine if a geotechnical report requiring more information and detail than the geological assessment is necessary. This approach ensures adequate review of proposed development on private property where potentially greater risk requires more detailed information to fully identify and address the hazard. Current mapping for landslide susceptibility in Salem covers portions of the Salem Hills and Eola Hills. The city is also incorporating the DOGAMI earthquake hazards maps for the Salem area to further assist in determining the degree of landslide risk for site-specific development. There are no existing city regulations on grading activities, though proposals for this kind of review are being considered.

The citizen advisory committee, city and county public works staff, building inspection staff, and legal counsel reviewed the draft ordinance in spring 2000. The State Board of Geologist Examiners and Engineering and Land Surveying Examiners Board were also asked for input on the draft ordinance. Revisions made the draft more specific to identified hazard areas, simpler to understand, easier to implement, and more clear and objective. The consensus process and collaboration between project staff, the advisory committee, and other interests participating in the study were beneficial to the public hearing process. The advisory committee presented and approved the draft landslide hazard ordinance. Respective city and county decision-makers were considering the draft ordinance at the time of publication of this document.

Landslide Key

Contact the City of Salem and Marion County Community Development Departments for the status of the ordinances. The summary of this section provides information on how to contact these local agencies.

The landslide hazard study resulted in two separate, but similar ordinance proposals. Salem will apply its ordinance to mapped landslide areas within the city limits and the county to mapped geological hazard areas and identified excessive slope areas. A Graduated Response Table, a key element of the Salem landslide ordinance, provides the mechanism that will be used to evaluate future development sites. The table factors the degree of hazard at a site with the level of proposed development activity to determine the extent of geological study needed before development can occur on the site.

The city and county ordinances establish a provision for independent review to ensure compliance with the criteria for a geological assessment or geotechnical report. Geotechnical studies will undergo an independent review process to ensure compliance with the ordinance and ensure that recommended mitigation measures provide for safe development. Prior to development, a declaratory statement indicating the property is within an identified hazard area needs to be recorded on the property deed. Compliance with the ordinance will be required as part of any land use permit and building permit for regulated activities within identified hazard areas.

DRAFT Ordinance – City of Salem - Chapter 68 – Landslide Hazards

(Ordinance under review in May 2000. Final language may be different.)

The following sections of ordinance language are considered ordinance provisions from the Salem Ordinance Chapter 68 Landslide Hazards. For more information or to obtain the draft ordinance in its entirety, contact the Salem Community Development Department.

68.010 INTENT AND PURPOSE

The intent and purpose of the provisions of this chapter are:

a) To implement the Geologic Hazards goals and policies of the Scenic and Historic Areas, Natural Resources and Hazards section of the Salem Area Comprehensive Plan;
b) To review development applications for properties within landslide hazards areas;
c) To assess the risk that a proposed use or activity will adversely affect the stability and slide susceptibility of an area;
d) To establish standards and requirements for the use of lands within landslide hazards areas;
e) To mitigate risk within landslide hazards areas, not to act as a guarantee that the hazard risk will be eliminated, nor as a guarantee that there is a higher risk of hazard at any location. Unless otherwise provided, the landslide hazard regulations are in addition to generally applicable standards provided elsewhere in this code.

68.030 REGULATED ACTIVITIES; PERMIT & APPROVAL REQUIREMENTS; APPLICABILITY

Except as may be exempted under SRC 68.040, no person shall engage in the following regulated activities on geological hazard areas, maps of which are adopted under this chapter, without first obtaining permits or approvals as required by this chapter:

1) Excavations;
2) Fills;
3) Installation or construction of an accessory structure greater than 500 square feet in area;
4) Construction, reconstruction, structural alteration, relocation or enlargement of any building or structure for which permission may be require pursuant to this code;
5) Land division, planned unit development, manufactured dwelling park development;
6) Tree removal on slopes greater than 60 percent.

68.050 MAP ADOPTION: AMENDMENT

The approximate location and extent of geological hazard areas are shown on Landslide Hazard Susceptibility Maps, which shall be adopted by council and shown on the official zoning map of the city. The Landslide Hazard Susceptibility Maps have been developed to indicate the general location of areas of low, moderate, and high susceptibility to landslides, and areas of known landslide hazards. These maps are based on the best

Tip Box

The Salem draft ordinance contains a number of provisions that other communities might consider adopting to address development in their jurisdiction's landslide hazard area:

1. Intent and purpose statement – purpose is clear and tied to the identified risk.
2. Clear statement of where ordinance applies and to what activities.
3. The ordinance is based on mapping of the risk. The factual base clearly supports the implementing measures.
4. The classification criteria provide clear and objective review standards.

available information and may be amended based upon the receipt of corrected, updated or refined data or the revision of studies upon which the maps were initially based.

68.060 CLASSIFICATION CRITERIA AND REVIEW REQUIREMENTS.

The Graduated Response Table 68-1 shall be used by city staff to determine the level of site investigation for various types of regulated activity on property any portion of which is shown on Landslide Hazard Susceptibility Maps. Using a rating system, slope and physiographic conditions at the site are evaluated in relationship to a proposed activity. If a rating meets or exceeds quantified thresholds provided in the table, a geologic assessment or geotechnical report or both shall be provided by the applicant and action specified therein undertaken or insured before any regulated activity may be permitted, approved, or processed. Where any portion of the subject property on which regulated activities are proposed is identified under two slope conditions, or two or more categories, the highest condition or category will apply.

Table 68-1: Graduated Response – Draft July 2000

Graduated Response Table Note:

Select one assigned value from PARTS (I or II, and III and IV) and proceed to PART V.

PART I.

Reference: Public Works Slope Contour Map	Slope Ratings Environmental Constraints Category			
	Low	Moderate	High	Assigned Value
Slope Conditions	1	2	3	
Regulated Slopes Less Than 10%	N.A.	N.A.	N.A.	
Regulated Slopes between 10%-15% but Not Including 15% (N/A to Category 5 on GMS 105)	X			
Regulated Slopes between 15%-25% and Including 25% (N/A to Category 5 on GMS 105		X		
Regulated Slopes over 25% (N/A to Category 5 on GMS 105)			X	
Score				* Points

PART II.

Reference: Geologic Map Series (GMS/105)	Earthquake-Induced Landslide Susceptibility Ratings Environmental Constraints Category			
	Low	Moderate	High	Assigned Value
Physiographic and Geologic Categories	1	2	3	
Property Identified under Categories 1, 2, 3 or 4 on GMS/105 Reports	N.A.	N.A.	N.A.	
Property Identified under Category 5 on GMS/105 Report			X	
Score				** Points

PART III.

Reference: Interpretive Map Series (IMS-5), Interpretive Map Series (IMS-6), Geological Map Series (GMS/105), and Public Works Slope Contour Map	Water-Induced Landslide Susceptibility Ratings Environmental Constraints Category			
	Low	Moderate	High	Assigned Value
Physiographic and Geologic Categories	1	2	3	
Property Identified under Category 1 on IMS-5 & IMS-6 Reports	N.A.	N.A.	N.A.	
Property Identified under Categories 1, 2, 3 or 4 on GMS/105 Reports	N.A.	N.A.	N.A.	
Property Outside GMS/105 and IMS-6 and Greater Than 15%		X		
Property Identified under Categories 2 or 3 on IMS-5 & IMS-6 Reports		X		
Property Identified under Categories 4, 5a, 5b or 6 on IMS-5 & IMS-6 Reports			X	
Score				*** Points

Table 68-1: Graduated Response cont. – Draft July 2000

PART IV.

Type of Activity	Activity Ratings for Potential Site Impact Land Use Category			
	Low	Moderate	High	Assigned Value
	1	2	3	
Installation or Construction of an Accessory Structure Greater Than 500 Square Feet	X			
Single Family, Manufactured Dwelling Building Permit (Structural Expansion/Remodel)	X			
Multiple Family Building Permits (Structural Expansion/Remodel)		X		
Partition		X		
Grading (as Independent Activity)			X	
Subdivision, Planned Unit Development, Manufactured Dwelling Park			X	
Schools, Hospital and Public Building Permits (Structural Expansion/Remodel)			X	
Commercial and Industrial Building Permits (Structural Expansion/Remodel)			X	
Tree Removal on Regulated Slopes Greater than 60% (as Independent Activity)			X	
Score				**** Points
Add scores from PART I or II, and III and IV. Proceed to PART V.				*****Points

PART V.

*See Adopted Requirements for Geologic Assessments and Geotechical Reports in the City of Salem Public Works Design Stadards	Total Risk Assessment Policy Provision	
Category 1- Low Landslide Risk Assessments	Category 2 – Moderate Landslide Risk Assessments	Category 3 – High Landslide Risk Assessments
(4 points or less)	(5-8 points)	(9 points or greater)
No Requirements	Grading Permit, Geologic Assessment* *If the Geologic Assessment indicates landslide hazards on the site, the director of public works or building and safety administrator may specify the requirements of High Landslide Risk Assessments.	Grading Permit, Geotechnical Report* *The director of public works and building and safety administrator may require a qualified independent review of a geotechical report.

5.2 Applying Land Use Tools in Myrtle Creek, Oregon

The Myrtle Creek Zoning ordinances regulate development in steep-slope and landslide-prone areas.

Background

Myrtle Creek's 1990 Comprehensive Plan states that over 300 acres of buildable land within the Myrtle Creek urban growth boundary are designated "Steep Slope Residential." These areas of steep slope are determined suitable for residential development, recognizing that actual development densities will vary according to the degree of the slope. Since hillsides present a potential hazard to life and property from the mass movement of underlying soils, the city developed, and continues to update, its steep slope ordinances. Policies within the comprehensive plan (Chapter 5: Natural Disasters & Chapter 14 Land Use and Urbanization) require a mandatory evaluation of proposed development in areas affected by steep slopes to ensure proper consideration of all potential hazards.

Myrtle Creek has jurisdiction within the city limits and the northern portion of the Urban Growth Area (UGA) (urban growth boundary), while Douglas County (through an Urban Growth Management Agreement) has planning jurisdiction over the southern half of the Myrtle Creek UGA. This southern portion of the UGA is known as Tri City and is an Urban-Unincorporated community. County regulations are enforced through Article IX of the Douglas County Zoning Ordinance.

Local implementation of the Myrtle Creek Zoning Ordinance has shown that the ordinance does a good job of regulating hillside developments. The language in the ordinance is specific enough to make clear and objective interpretations while remaining flexible enough to deal with site-specific issues. The strength of the ordinance is its comprehensiveness.

Myrtle Creek Zoning Ordinance No. 508

The following excerpts of ordinance language are from the Myrtle Creek Zoning Ordinance pertaining to steep slopes and landslides. For more information or to obtain the ordinance in its entirety, contact the Myrtle Creek Planning Office.

Section 1.03.0 Intent

> The intent of these regulations is to provide a means of ensuring that land uses of the community are properly situated in relation to one another; and that development is sufficiently open to provide light, air and privacy; that adequate space is available for each type of development; that density of development in each area is held at a level which can be properly serviced by such governmental facilities as the street, fire protection, school, recreation, and utility systems; and in general, to promote the public health, safety, order, convenience, prosperity and welfare of the people living in the community.

Tip Box

How to Use a Graduated Response Table

The advantage of the graduated response table is that it links development review standards to the degree of risk. For example: Development on slopes of 10-15% would have 1 point; if it is located on an area of relatively low risk of earthquake-induced landslides (category 1,2,3,or 4), the development would be assessed no additional points, a rating of 2 and 3 on the water-induced landslide report would add 3 points. If the activity is a subdivision, an additional 3 points would be assessed for a total of 7 points requiring a grading permit and geologic assessment.

Tip Box

Myrtle Creek

Local governments might want to adopt language like Myrtle Creek's. The ordinance has a clear statement of intent, clear and objective standards for site review, and a requirement to address both the major causes of landslides (e.g., slopes; drainage..) and the effects on surrounding properties. The required elements of a site investigation report are beneficial, and the ordinance includes the following tools to address hazard areas: density limits, open space requirements and performance standards.

Section 5.01.1 Site Review Criteria

The site review will be conducted in accordance with the criteria set forth herein. Any development proposal, which deviates from the established criteria, shall be referred to the Planning Commission for determination. The Planning Commission shall have the power to impose any or all of the supplemental conditions set forth in Section 5.01.2 in making their determination.

(1) Identify areas of potential natural hazards where area protection requirements shall be imposed and which shall include, but are not limited to, the following:

a) Areas of mass movement and areas of greater than 25% slope shall require a written Site Investigation Report (Section 5.02.0) prior to any excavation or change in topography.
b) Areas of potential flooding hazards where the floodplain site criteria of the Flood Hazard Area (SD-FHA) shall apply.
c) Areas of lesser hazard where the imposition of supplemental conditions may be appropriate.

(8) Establish the adequacy of the grading and drainage plan for the collection and transmission of storm and ground water in order that the drainage from the proposed development will not adversely affect adjoining properties of public rights of way.

(9) Consider the effects of slope alteration (cut and fill) on erosion and run-off for surrounding properties and impose restrictions when appropriate.

(11) Establish where the retention of existing vegetation and natural topographic features will be beneficial as a soil stabilizer or is of scenic significance and impose restrictions where appropriate.

Section 5.02.0 Site Investigation Report

A site investigation report shall be submitted as part of the site review process when the proposed development involves identified mass movement hazard areas or areas of greater than 25 % slope. Also, the Planning Commission may require a site investigation report to be submitted for development in other areas of potential natural hazards based on the recommendation of the City Engineer for just cause. The Site Investigation Report provides information on the site of development adjacent land that is likely to be affected by the proposed development. Unless the City Engineer determines that certain specifications are not required, the Report shall include the information described in Subsection (1) through (6) herein, together with appropriate identification of information sources the date of information the methods use in the investigation and approximate man-hours spent on site.

(1) Qualifications To Conduct a Site Investigation Report

The Site Investigation Report shall be prepared by an engineering geologist or an engineer who certifies he is

qualified to evaluate soils for stability or a person or team of persons qualified by experience and training to assemble and analyze physical conditions in flood or slope hazard areas. The person or team shall be employed by the applicant but shall be subject to approval as to qualifications by the City Administrator.

(2) Background Data in Report

The Site Investigation Report shall contain the following information:

a) A general analysis of the local and regional topography and geology including the faults, folds, geologic and engineering geologic units and any soil, rock and structural details important to engineering or geologic interpretations.
b) A history of problems on and adjacent to the site, which may be derived from discussions with local residents and officials and the study of old photographs, reports and newspaper files.
c) The extent of the surface soil formation and its relationship to the vegetation of the site, the activity of the landform and the location of the site.
d) Ground photographs of the site with information showing the scale and date of the photographs and their relationship to the topographic map and profiles. The photographs will include a view of the general area, the site of the proposed development and unusual natural features, which are important to the interpretation of the hazard potential of the site, including all sites of erosion or accretion.

(3) Topography Map
(4) Subsurface Analysis
(5) Development Proposal
(6) Conclusions

The following conclusions should be stated:

a) Whether the intended use of the land is or is not compatible with the conditions.
b) Any existing or potential hazards noted during the investigation.
c) The manner for achieving compliance with the ordinance and other requirements.
d) Mitigating recommendations for specific areas of concern and the degree to which they mitigate the concerns.

Section 5.04.0 Protection Standards for Natural Features

All development shall be preceded by the identification of any environmental or natural feature described in Section 5.04.1 through 5.04.6 below and shall meet the environmental protection standards applicable to each natural resource identified therein. Reference in this Section to “open space” is intended to mean the term as it is defined in Article II.

Section 5.04.1 Steep Slopes

In areas of steep slope, the following standards shall apply:

1) Twelve to less than 16% slope: Nor more than 40% of such areas shall be developed and/or regraded or stripped of vegetation.
2) Sixteen to 25% slope: No more than 30% of such areas shall be developed and/or regraded or stripped of vegetation, with the exception that no more than 20% of such areas may be disturbed in the case of poor soil suitability.
3) More than 25% slope: Not more than 15% of such areas shall be developed and/or regraded or stripped of vegetation, with the exception that no more than 5% of such areas may be disturbed in the case of poor soil suitability.
4) All erodible slopes shall be protected in accordance with the control standards contained in Section 5.04.6.

Section 5.04.3 Ravines and Ravine Buffers

1) At least 98% of all ravines shall remain in permanent open space. At least 80% of all ravine buffers shall remain in permanent open space. No uses or improvements other than those permitted herein shall be permitted in any area consisting of ravines or ravine buffers as defined by this ordinance.
2) Ravines shall not be the site of any land use or development, with the exception that access to other areas may be provided in ravine areas. In this event, an environmental assessment (or Site Investigation Report) shall provide the basis for location of such access. Minimum damage to the area shall be the guide in location of the access. The protected areas of ravine buffers shall be used only for passive recreation.
3) All erodible slopes shall be protected in accordance with the control standards contained in Section 5.04.6.

Section 5.04.6 Soil Erosion and Sedimentation Control

1) SESC Plan
   In order to prevent both soil erosion and sedimentation, a soil erosions and sedimentation control plan shall be required as part of an application for development whenever any land located in a stream, stream channel or body of water is disturbed and whenever a development will involve any clearing, grading, transporting, or other form of disturbing land by removal of earth, including the mining of minerals, sand, and gravel provided that any one of the following descriptions applies to said movement of land:
   a) Excavation, fill, or any combination thereof will exceed 500 cubic yards.
   b) Fill will exceed three feet in vertical depth at its deepest point as measured from the natural ground surface.
   c) Excavation will exceed four feet in vertical depth at its deepest point as measured from the natural ground surface.

d) Excavation, fill, or any combination thereof will exceed an area of 5000 square feet.
e) Plant and/or tree cover is to be removed from an area exceeding 5000 square feet on any parcel of land.

(Note: Specifically exempted from the requirement of a soil erosion and sedimentation control plan are agricultural uses.)

5.3 Summary: Lessons from Oregon Communities Addressing Landslide Hazards

- The development of the **Salem** and **Marion County** Landslide ordinances began with updated inventory information, which included landslide mapping and characterization of the project areas. After adoption by their respective governing bodies, city and county staff will be able to implement the ordinances. For more information on the Salem and Marion County Landslide hazard ordinances, contact:

  Marion County Planning Division
  P.O. Box 14500
  3150 Lancaster Drive NE, Suite B
  Salem, Oregon 97309
  Website: **www.open.org/mcplann**
  (information on the study/ordinance)
  Phone: (503) 588-5038
  Fax: (503) 589-3284

  City of Salem
  555 Liberty St. SE/Room 305
  Salem, OR 97301-3503
  Phone: (503) 588-6211
  Fax: (503) 588-6005

- The **Myrtle Creek Zoning Ordinance** is another good example of regulating development in steep-slope and landslide-prone areas. For more information on the Myrtle Creek Zoning Ordinance, contact:

  City of Myrtle Creek
  P.O. Box 940
  207 Pleasant St.
  Myrtle Creek, OR 97457
  (541) 863-3171

- Communities interested in developing a steep-slope or landslide ordinance can contact DOGAMI and DLCD for additional technical assistance.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

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

- ❒ What plan policies should be added or amended to assist your community in dealing with landslide hazards?
- ❒ Are there communities that face similar landslide threats that have developed ordinances or non-regulatory programs that could be adopted by your community ?
- ❒ Is your comprehensive plan consistent with plans or actions of other jurisdictions and regional plans and policies (such as school, utilities, fire, park, and transportation districts?)

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

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

TRG Key

For more information on public agency coordination refer to the discussion on coordination in Chapter 2: Elements of a Comprehensive Plan.

6.1 State Agency Resources

Oregon Department of Geology and Mineral Industries (DOGAMI)

DOGAMI is an important agency in landslide mitigation activities in the state of Oregon. Some key functions of DOGAMI include development of geologic data for Oregon, producing maps, and acting as a lead regulator for mining and drilling for geological resources. The agency also provides technical assistance to communities and provides public education on geologic hazards. DOGAMI provides data and geologic information to local, state and federal natural resource agencies, industry and other private sector groups.

Contact: DOGAMI
Address: 800 NE Oregon St., Suite 965
Portland, Oregon 97232
Phone: (503) 731-4100
Fax: (503) 731-4066
Website: http://sarvis.dogami.state.or.us/homepage/mission.html
Deputy State Geologist: (503) 731-4100 ext. 228
Earthquake Team Leader: (503) 731-4100 ext. 226
Coastal Team Leader: (541) 574-6642

The Nature of the Northwest Information Center

The Nature of the Northwest Information Center is operated jointly by the Oregon Department of Geology and Mineral Industries and the USDA Forest Service. It offers a selection of maps and publications from state, federal and private agencies.

Contact: The Nature of the Northwest Information Center
Address: 800 NE Oregon Street # 5, Suite 177
Portland, OR 97232
Phone: (503) 872-2750
Fax: (503) 731-4066
Hours: 9am to 5pm Monday through Friday
E-mail: Nature.of.NW@state.or.us
Website: http://www.naturenw.org/

Oregon Department of Forestry

In addition to its other functions, ODF regulates forest operations to reduce the risk of serious bodily injury or death from rapidly moving landslides directly related to forest operations, and assists local governments in the siting review of permanent dwellings on and adjacent to forestlands in further review areas.

Contact: Geotechnical Specialist, Eastern Oregon, Policy Issues
Address: 2600 State Street
Salem, Oregon 97310
Phone: (503) 945-7481
Fax: (503) 945-7490
Website: http://www.odf.state.or.us

Contact: Geotechnical Specialist, Linn and Lane County, Southern Oregon
Address: 1785 NE Airport Road
Roseburg, Oregon 97470-1499
Phone: (541) 440-3412

Contact: Geotechnical Specialist, Northwest Oregon
Address: 801 Gales Creek Road
Forest Grove, Oregon 97116-1199
Phone: (503) 359-7448

Oregon Department of Forestry Debris Flow Warning Page

The ODF debris flow-warning page provides communities with up-to-date access to information regarding potential debris flows. The ODF warning system is triggered by rainfall and monitored in areas that have been determined high hazard for debris flows. As the lead agency, ODF is responsible for forecasting and measuring rainfall from storms that may trigger debris flows. Advisories and warnings are issued as appropriate. Information is broadcast over NOAA weather radio, and on the Law Enforcement Data System. DOGAMI provides additional information on debris flows to the media that convey the information to the interested public. ODOT also provides warnings to motorists during periods determined to be of highest risk for rapidly moving landslides along areas on state highways with a history of being most vulnerable.

Contact: ODF Debris Flow Warning Page
Website: http://www.odf.state.or.us

Sidebar

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

Department of Land Conservation and Development (DLCD)

Oregon's Department of Land Conservation and Development (DLCD) administers a natural hazards program to assist local governments in meeting Statewide Planning Goal 7: Areas Subject to Natural Disasters and Hazards. Activities relating to landslide mitigation include:

- Distribution of model ordinances through which hazards can be mitigated. DLCD advises local governments on which ordinance best meets their needs;
- Review of local land use plan amendments for consistency with state landslide programs and regulations and providing direct technical assistance;
- Provides liaison between pertinent local, state, and federal agencies. DLCD representatives serve on a variety of commissions and ad hoc committees which deal with natural hazards;
- Adopts and amends Statewide Planning Goals and Administrative rules relating to natural hazards.

Contact: Department of Land Conservation and Development
Address: 635 Capitol Street NE, Suite 150
Salem, OR 97301
Phone: (503) 373-0050
Fax: (503) 378-6033
Website: http://www.lcd.state.or.us/

Oregon Department of Consumer and Business Services

The Building Codes Division (BCD) of the Oregon Department of Consumer and Business Services sets statewide standards for design, construction and alteration of buildings that include standards for grading, excavation and fill in the area surrounding the building foundation. The Structural Code also contains requirements for site evaluation of soil and seismic hazard conditions that impact landslides.

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

Oregon Department of Transportation (ODOT)

Under Senate Bill 12, ODOT provides warnings to motorists during periods determined to be of highest risk of rapidly moving landslides along state highways with a history of being most vulnerable to rapidly moving landslides.

Contact: ODOT Transportation Building
Address: 355 Capitol St. NE
Salem, OR 97310
Phone: 888-275-6368
Website: http://www.odot.state.or.us/

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

In relation to Senate Bill 12 and rapidly moving landslide hazards, OEM coordinates state resources for rapid and effective response to landslide-related emergencies. The Oregon Emergency Response System (OERS) of OEM is a key player in the dissemination of debris flow advisories and warnings. OEM chairs the GIHMT, a body which develops landslide hazard mitigation strategies and measures. OEM administers the FEMA Hazard Mitigation Grant Program, which provides a source of funding for implementing hazard mitigation projects. OEM works with other state agencies to develop information for local governments and the public on landslide hazards.

Contact: OEM
Address: 595 Cottage Street NE
Salem, OR 97301
Phone: (503) 378-2911
Fax: (503) 588-1378
OEM State Hazard Mitigation Officer: (503) 378-2911 ext.247
Recovery and Mitigation Specialist: (503) 378-2911 ext.240
Website: http://www.osp.state.or.us/oem/

Department of Geology, Portland State University

Portland State University conducts research and prepares inventories and reports for communities throughout Oregon. Research and projects conducted through the Department of Geology at Portland State University includes an inventory of landslides for the Portland metropolitan region after the 1996 and 1997 floods and a subsequent susceptibility report and planning document for Metro in Portland.

Contact: Portland State University, Department of Geology
Address: 17 Cramer Hall; 1721 SW Broadway
PO Box 751
Portland, OR 97207
Phone: (503) 725-3389
Website: http://www.geol.pdx.edu

6.2 Federal Agency Resources

Federal Emergency Management Agency (FEMA)

FEMA Region 10 serves the northwestern states of Alaska, Idaho, Oregon and Washington. The Federal Regional Center (FRC) for Region 10 is located in Bothell, Washington. FEMA is an agency of the federal government whose purpose is to reduce risks, strengthen support systems, and help people and their communities prepare for and cope with disasters regardless of the cause. FEMA's mission is to "reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based emergency management program of mitigation, preparedness, response and recovery."

Contact: Federal Regional Center, Region 10
Address: 130-228th St. SW
Bothell, WA 98021-9796
Phone: (425) 487-4678
Website: www.fema.gov

Natural Resource Conservation Service (NRCS)

The NRCS produces soil surveys. These may be useful to local governments who are assessing areas with potential development limitations including steep slopes and soil types. The NRCS is "a federal agency that works in partnership with the American people to conserve and sustain our natural resources."[55] Their mission is to "provide leadership in a partnership effort to help people conserve, improve, and sustain our natural resources and environment."[56] They operate many programs dealing with the protection of these resources.

Contact: Natural Resource Conservation Service, Oregon State Branch
Address: 101 S.W. Main Street, Suite 1300
Portland, OR 97204-3221
Phone: (503) 414-3200
Fax: (503) 414-3103
Website: http://www.or.nrcs.usda.gov/Welcome.html

Contact: Federal Natural Resources Conservation Service
Address: 14th and Independence Ave.
Washington, DC 20250
Website: http://www.nrcs.usda.gov/

Sidebar

Project Impact: Building Disaster Resistant Communities

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

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

Project Impact began in October of 1997 when FEMA formed partnerships with seven pilot communities across the country. FEMA offered expertise and technical assistance from the national and regional level and used all the available mechanisms to get the latest technology and mitigation practices into the hands of the local communities. FEMA has enlisted the partnership of all fifty states and U.S. Territories, including nearly 200 Project Impact communities, as well as over 1,100 businesses.[53]

Benton, Deschutes, and Tillamook counties, and Multnomah County with the city of Portland are the Oregon communities currently participating in this initiative to build disaster resistant communities. Application for participation in the program in Oregon is through the OSP-Office of Emergency Management in Salem.[54] For more information about Project Impact visit http://www.fema.gov or (http://www.fema.gov/impact/impact00.htm), or contact the OSP-Office of Emergency Management.

6.3 Recommended Landslide Publications

The following documents provide information on a particular aspect of landslide hazard mitigation. These documents represent the principal resources communities can use to better plan for landslide hazards. They are key tools for reducing the risks associated with landslide-prone areas.

Geologic Hazards: Reducing Oregon's Losses, Special Paper 32. Beaulieu, J.D. and Olmstead, D.O. (1999) Dept. of Geology and Mineral Industries

Characterization of geologic hazards, specific multi-hazard considerations and the interrelationships of geologic hazards, and geologic hazard risk reduction. Outlines the responsibilities and limitations of state agencies including OEM, DLCD, ODF, Building Codes, local agencies, and DOGAMI's coordination role in risk reduction activities. Provides a matrix on strategies to reduce risk and legal considerations.

To obtain this resource contact: DOGAMI (see State Resources for contact information).

Joint Interim Task Force on Landslides and Public Safety - Report to the 70th Legislative Assembly (1998).

Glossary of key terms and relationship to the Statewide Planning Goals – specifically Goal 7. Discussion on forest practices and landslides, best management practices and the authority of ORS 527.630. Discusses non-forest area slides and case studies (West Hills area in Portland) and provides a summary of insurance issues.

To obtain this resource contact: The state library in Salem.

Landslide Loss Reduction: A Guide for State and Local Government Planning. World, Robert L & Jochim, Candace L., FEMA, Colorado Division of Disaster Emergency Services and Colorado Geological Survey

Comprehensive information on landslide related issues. Addresses the benefits of mitigation, planning as a means of loss reduction, local government roles, causes and types of landslides and the relationships between landslides and floods, and landslides and seismic activities. The journal also looks at the planning process, an inventory of landslide costs, and evaluation of mitigation projects and techniques.

To obtain this resource contact: FEMA (see Federal Resources for contact information).

Landslides in Oregon Brochure, Oregon Department of Forestry, Oregon Department of Geology and Mineral Industries, Department of Consumer and Business Services, OSP-Office of Emergency Management

Oregon-specific information on landslides and debris flows. Provides, pictures and graphics, and information on state agencies and their roles in landslide mitigation activities.

To obtain this resource contact: DOGAMI (see State Resources for contact information).

Landslides Investigation and Mitigation, Special Report 247. Turner, Keith A., Schuster, Robert L. (Editors)(1996) Transportation Research Board, National Research Council, National Academy Press, Washington DC.

Mitigating Geologic Hazards in Oregon: A Technical Reference Manual, Special Paper 31. Beaulieu, J.D., and Olmstead, D.O. (1999) Department of Geology and Mineral Industries

To obtain this resource contact: DOGAMI (see State Resources for contact information).

Planning for Hillside Development. Olshansky, Robert B. (1996) American Planning Association Planning Advisory Service Report Number 466

This document describes the history, purpose and functions of hillside development and regulation, the role of planning, and provides excerpts from hillside plans, ordinances and guidelines from communities throughout the U.S.

To obtain this resource: Check your local library or contact the American Planning Association.

Regulation of Hillside Development in the United States. Olshansky, Robert B. (1998) In Environmental Management (Vol. 22, No.3, pp 383-392)

Provides a history of hillside development and the differing views on how and why regulations are developed. Discussion regarding the purpose of hillside regulation including aesthetics, natural phenomena, health, safety and general welfare, natural resources, geologic hazards, fire protection and access.

To obtain this resource: Check your local library.

State of Oregon - Natural Hazards Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) OSP-Office of Emergency Management

To obtain this resource contact: Oregon Emergency Management (see State Agency Resources for contact infor mation).

Unstable Ground: Landslide Policy in the United States. Olshansky, Robert B. and Rogers, J. David (1987) Ecology Law Quarterly pg.939

To obtain this resource: Check your local library.

USGS Landslide Program Brochure. National Landslide Information Center (NLIC), United States Geologic Survey

Good, general information in simple terminology. Information on the importance of landslide studies and a list of databases, outreach and exhibits maintained by the NLIC. The brochure also includes information on types and causes of landslides, falls and flows, features that may indicate catastrophic landslide movement.

To obtain this resource contact:
USGS - MS 966, Box 25046
Denver Federal Center
Denver, CO 80225
Tel. (800) 654-4966
Fax (303) 273-8600
Email: highland@gldvxa.cr.usgs.gov
Web: http://geohazards.cr.usgs.gov/

Database of Slope Failures in Oregon For Three 1996/97 Storm Events. Hofmeister, R.J., (2000) Oregon Department of Geology and Mineral Industries, Special Paper.

To obtain this resource contact: DOGAMI (see State Resources for contact information).

Storm Impacts and Landslides of 1996 Final Report. (1999) Oregon Department of Forestry.

This 145-page technical document contains the findings of a three-year monitoring project to evaluate the effects of the extreme storms that struck Oregon in 1996. This ground-based study sought to determine the accuracy and precision of remote sensing data in identifying landslides, stream channel impacts and landslide-prone areas. The study reports on landslide frequency and channel impacts, particularly as they relate to forest practices. The study also evaluated different timber harvesting, road construction and road drainage practices.

To obtain this resource contact: Oregon Department of Forestry, Forest Practices Section, (503) 945-7470.

6.4 Internet Resources

DOGAMI

http://www.sarvis.dogami.state.or.us
The DOGAMI web page includes information on landslide databases, coastal programs, earthquakes, an oil and gas page, a list of publications and access to the Nature of the Northwest Information Center. There is also a mined-land reclamation section and contact information for the Salem headquarters and other field offices.

Oregon Department of Forestry – Debris Flow

http://www.odf.state.or.us/gis/debris.html
This website provides a listing and access to Geographic Information System maps for counties in Western Oregon that have been mapped by Oregon Department of Forestry for debris flow hazards.

Landslide Web Page - U.S. Geological Survey

http://landslides.usgs.gov/
The landslide web page of the U.S. Geological Survey and the website for the National Landslide Information Center (NLIC) offers compehensive landslide information, as well as indexes to landslide publications available both in hard copy and on-line. The first site describes the National Landslide Hazards Program, lists landslide program publications and current projects, and describes recent landslide events. The NLIC site provides "real-time" monitoring of an active landslide in California, San Francisco Bay area landslide maps, links to landslide information for each state, landslide images, other useful links, a virtual fieldtrip of a Colorado landslide, and access to a new on-line bibliographic database.

Natural Hazards Research and Applications Information Center

http://www.colorado.edu/hazards
Publisher of Natural Hazards Observer newsletter, containing articles on hazards mitigation and listings of other hazard websites.

The International Landslide Research Group

http://ilrg.gndci.pg.cnr.it/
The International Landslide Research Group (ILRG) is an informal group of individuals concerned about mass earth movement and interested in sharing information on landslide research. The ILRG website currently provides all back issues of the group's newsletter, with information about landslide programs, new initiatives, meetings and publications, and the experiences of people engaged in landslide research.

Federal Emergency Management Agency (FEMA)

http://www.fema.gov/pte/prep.htm
The Federal Emergency Management Agency (FEMA) website provides "fact sheets" - including preparedness tips - concerning most natural and technological hazards. A fact sheet on landslides is available at http://www.fema.gov/library/landslif.htm.

Planning for Natural Hazards: Reviewing your Comprehensive Plan

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

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

Landslide Endnotes:

[1] Disasters by Design: A Reassessment of Natural Hazards in the United States Mileti, Dennis S. (1999) Joseph Henry Press, Washington D.C.

[2] USGS Landslide Program Brochure. National Landslide Information Center (NLIC), United States Geologic Survey

[3] State Hazard Mitigation Plan Draft. The Interagency Hazards Mitigation Team, (2000) OSP-Office of Emergency Management

[4] USGS Landslide Program Brochure. National Landslide Information Center (NLIC), United States Geologic Survey

[5] Homeowner's Landslide Guide For Hillside flooding, Debris Flows, Erosion and landslide control. – OEM/FEMA Region 10

[6] Local Government Landslide Guidance. Mills, Keith, (2000)

[7] (ibid.)

[8] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[9] (ibid.)

[10] Debris-Flow Hazards in the San Francisco Bay Region. US Department of the Interior, USGS

[11] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[12] Storm Impacts and Landslides of 1996 Final Report. (1999) Oregon Department of Forestry

[13] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[14] (ibid.)

[15] (ibid.)

[16] (ibid.)

[17] The Citizens' Guide to Geologic Hazard. (1993) American Institute of Professional Geologists

[18] Storm Impacts and Landslides of 1996 Final Report. (1999) Oregon Department of Forestry

[19] Local Government Landslide Guidance. Mills, Keith, (2000)

[20] (ibid.)

[21] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[22] Storm Impacts and Landslides of 1996 Final Report. (1999) Oregon Department of Forestry

[23] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[24] Oregon Natural Resources Conservation Service <ftp://soils.css.orst.edu/pub/webdocs/ssurgo.html> (April 2000)

[25] (ibid.)

[26] (ibid.)

[27] Olmstead, Dennis. Personal Interview. 27 April 2000.

[28] Landslides in Oregon Brochure. ODF, DOGAMI, Department of Consumer and Business Services, Oregon Emergency Management

[29] State Hazard Mitigation Plan Draft. The Interagency Hazards Mitigation Team, (2000) Oregon Emergency Management.

[30] Debris Avalanche Action Plan. March 4, 1997, Governor Kitzhaber

[31] Senate Bill 1211, 1997 Oregon Legislature

[32] ORS 195.250 - 195.275

[33] Senate Bill 12, 1999 Oregon Legislature

[34] (ibid.)

[35] Michael, David (March 2000) Geotechnical Specialist, Oregon Department of Forestry

[36] (ibid.)

[37] (ibid.)

[38] Using Earthquake Hazard Maps, A Guide for Local Governments In the Portland Metropolitan Region. (1998) Spangle Associates, Oregon Department of Geology and Mineral Industries, Open-File Report O-98-4.

[39] Michael, David (March 2000) Geotechnical Specialist, Oregon Department of Forestry

[40] Using Earthquake Hazard Maps, A Guide for Local Governments In the Portland Metropolitan Region. (1998) Spangle Associates, Oregon Department of Geology and Mineral Industries, Open-File Report O-98-4.

[41] Michael, David (March 2000) Geotechnical Specialist, Oregon Department of Forestry

[42] Tools and Techniques for Land-use Planning. Brower, David State of North Carolina

[43] (ibid.)

[44] (ibid.)

[45] (ibid.)

[46] (ibid.)

[47] Land-Use Planning in Oregon. Rohse, Mitch, (1987) Oregon State University Press.

[48] Tools and Techniques for Land-use Planning. Brawer, David State of North Carolina

[49] (ibid.)

[50] (ibid.)

[51] State Hazard Mitigation Plan. The Interagency Hazards Mitigation Team, (2000) Oregon State Police - Office of Emergency Management.

[52] The Bend Area General Plan

[53] Federal Emergency Management Agency. http://www.fema.gov (March 2000)

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

[55] Oregon Natural Resources Conservation Service. <ftp://soils.css.orst.edu/pub/webdocs/ssurgo.html> (April 2000)

[56] (ibid.)