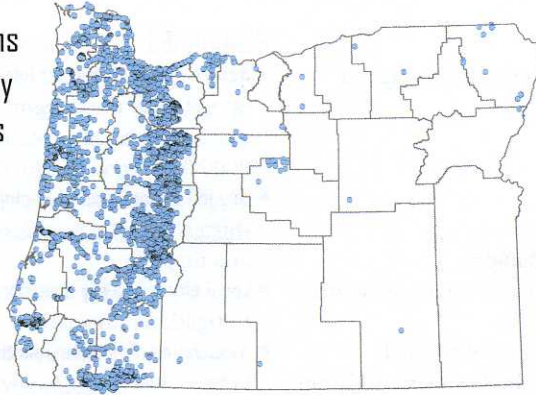


Landslides affect thousands of Oregonians every year. Protect yourself and property by knowing landslide types, their triggers and warning signs, how you can help prevent landslides, and how to react when one happens.

9,500 landslides were reported in Oregon in winter 1996-97 ▶



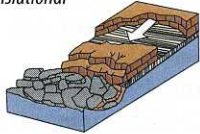
Common landslide triggers in Oregon

- intense rainfall
- rapid snowmelt
- freeze/thaw cycles
- earthquakes
- volcanic eruptions
- human
  - changing the natural slope
  - concentrating water
- combinations of the above

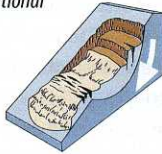
## COMMON LANDSLIDE TYPES

**SLIDES** — downslope movement of soil or rock on a surface of rupture (failure plane or shear-zone). Commonly occurs along an existing plane of weakness or between upper, relatively weak and lower, stronger soil and/or rock. The main modes of slides are translational and rotational.

translational



rotational



## TRIGGERS AND CONDITIONS

Slides are commonly triggered by heavy rain, rapid snow melt, reactivation of an existing landslide, earthquakes, grading/removing material from bottom of slope or adding loads to the top of the slope, or concentrating water onto a slope (for example, from agriculture/landscape irrigation, roof downspouts, or broken water/sewer lines).

Slides generally occur on relatively moderate to steep slopes, especially in weak geologic materials.

## EXAMPLES

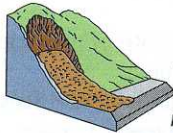


translational slide

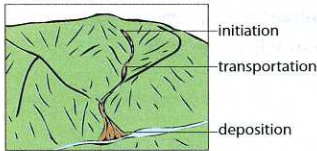


rotational slide

**FLOWS** — mixtures of high concentrations of water and soil, rock, and/or debris that have become a liquefied slurry and commonly move rapidly down slope. The main modes of flows are unchanneled and channelized. Avalanches and lahars are flows.



unchanneled flows—  
left: earth flow;  
right: debris avalanche



channelized flow

Flows are commonly triggered by intense rainfall, rapid snowmelt, or concentrated water on steep, planar or concave slopes. Earth flows are the most common type of unchanneled flow. Avalanches are rapid movement of debris down very steep slopes.

A channelized flow commonly starts on a steep, concave slope as a small landslide, which then enter a channel, pick ups more debris and speed, and deposits in a fan at the outlet of the channel. Debris flows, sometimes referred to as rapidly moving landslides, are the most common type of channelized flow. Lahars are channelized debris flows caused by volcanic eruptions.



debris avalanche (unchanneled flow)



earth flow (unchanneled flow)

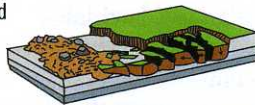


channelized debris flow



lahar aftermath (note the flow height)

**SPREADS** — extension and subsidence of commonly cohesive materials overlying liquefied layers.

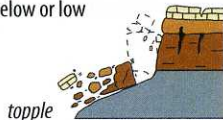


Spreads are commonly triggered by earthquakes, which can cause liquefaction of an underlying layer. Spreads usually occur on very gentle slopes near open bodies of water.

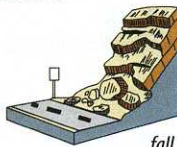


spread

**TOPPLES / FALLS** — near vertical, rapid movements of masses of materials, such as rocks or boulders. Toppling failures are distinguished by forward rotation about some pivotal point, below or low in the mass.



topple



fall

Topples and falls are commonly triggered by freeze-thaw cycles, earthquakes, tree root growth, intense storms, or excavation of material along the toe of a slope or cliff. Topples and falls usually occur in areas with near vertical exposures of soil or rock.



topple



fall

Landslide diagrams modified from USGS Landslide Fact Sheet FS2004-3072. Photos — Translational slide: Johnson Creek, OR (Landslide Technology). Rotational slide: Oregon City, OR, January 2006. Debris avalanche flow: Cape Lookout, OR, June 2005 (Ancil Nance). Earth flow: Portland, OR, January 2006 (Gerrit Huizenga). Channelized debris flow: Dodson, OR, 1996 (Ken Cruikshank, Portland State University). Lahar: Mount St. Helens, WA, 1980 (Lyn Topinka, USGS/Cascades Volcano Observatory). Spread: induced by the Nisqually earthquake, Sunset Lake, Olympia, WA, 2001. Steve Kramer, University of Washington). Fall: Portland, OR (DOGAMI). Topple: I-80 near Portland, OR, January 2006 (DOGAMI).





## Signs of possible landslide problems:

- Structural deformation such as large foundation cracks, misaligned doors and windows, tilted floors, or sagging decks
- Large cracks in driveways, curbs, and roads
- Failing retaining walls
- Arc-shaped cracks in the ground

## What can I do to reduce landslide risk around my home?

- If you are looking for or are building a home, avoid siting the structure in a hazardous location.
- Consult a certified engineering geologist (CEG) or professional geotechnical engineer (PE) if you are considering building on a location with high-risk characteristics.
- Avoid activities that may increase the landslide hazards, especially excavating steep slopes to create a building site or road.
- Control road or driveway water so it flows away from steep slopes and into storm drains or natural drainages where it will not harm you or your neighbors.

## Who should I consult if I have questions about a specific site?

Contact the **Oregon State Board of Examiners for Engineering and Land Surveying** (<http://osbeels.org/>; phone 503-362-2666) or the **Oregon Board of Geologist Examiners** (<http://www.osbge.org/>; phone 503-566-2837) for lists of licensed professional consultants available for site-specific evaluations.

## When are slides most likely to happen?

- Most recent slides and debris flows have occurred after several hours or, in some cases, several days of heavy rain or rapid snowmelt. They may occur after the period of the heaviest rain in a storm.
- Earthquakes can cause landslides; if you are on sloping ground or near a riverbank during an earthquake, be alert for landslides.

## What should I do during dangerous weather?

- During intense, prolonged rainfall, listen for advisories and warnings over local radio or TV or National Oceanic and Atmospheric Administration (NOAA) weather radio. In western Oregon "intense" rainfall is considered 4% of your average annual rainfall in a 12-hour period during the wet season. East of the Cascade Range "intense" rainfall is 2 inches in 4 hours. Debris flows may occur if such rainfall rates continue.
- Be aware that you may not be able to receive local warning broadcasts in canyons. Isolated, very intense rain may occur outside warning areas. You may want to invest in your own rain gauge. Don't assume highways are safe. Be alert when driving, especially at night.
- Watch carefully for collapsed pavement, mud, fallen rock, and other debris. Be particularly careful in areas marked as slide or rockfall areas. Watch for signs with warnings or road closures.
- Plan your evacuation route prior to a big storm. If you have several hours advance notice, drive to a location well away from steep slopes and narrow canyons.
- Once storm intensity has increased, it may be unsafe to leave by vehicle. Stay alert and awake; you may need to evacuate by foot.
- Listen for loud, unusual sounds. If you think there is danger of a landslide, evacuate immediately—don't wait for an official warning.
- Get away from your home if it is in an unsafe area. Be careful but move quickly. Move away from stream channels.



## RESOURCES – Where can I get additional information?

- **Nature of the Northwest Information Center** (<http://www.naturenw.org/>), operated by the Oregon Department of Geology and Mineral Industries, carries earthquake and landslide hazard maps and other reports. 800 NE Oregon St., #5, Portland, OR 97232, phone 503-872-2750.
- **Oregon Department of Geology and Mineral Industries** (<http://www.OregonGeology.com>) maps landslides and issues reports and maps.
- **Local city or county emergency managers or planners** may have landslide mitigation information.
- **Association of Oregon Counties** (<http://www.aocweb.org/>) and the **League of Oregon Cities** (<http://www.orcities.org/>) work with local government and state agencies to coordinate these efforts.
- **Oregon Department of Forestry Debris Flow Warning System** (<http://egov.oregon.gov/ODE/>) provides current forecasts and warnings.
- **Oregon Natural Hazards Workgroup, Partners for Disaster Resistance and Resilience** (<http://www.oregonshowcase.org/>) provides pre-disaster mitigation planning information.
- **Oregon Department of Transportation** maintains highways and issues 24-hour information about road conditions and road closures. For current conditions, call 1-800-977-6368 or visit <http://www.tripcheck.com>.
- **Oregon Department of Land Conservation and Development** (<http://www.oregon.gov/LCD/HAZ/landslides.shtml>) maintains policies that guide local planning for development away from hazardous areas including landslide-prone areas and also maintains the **Oregon Coast Management Program – Coastal Atlas Hazards Map** (<http://www.coastalatlus.net/learn/topics/hazards/landslides/index.asp>).
- **Oregon Department of Consumer and Business Services, Building Codes Division** (<http://www.cbs.state.or.us/bcd/>) provides guidelines for foundations of structures on or adjacent to slopes.
- **USGS National Landslide Information Center** (<http://landslides.usgs.gov/>) has educational information and publications.
- Geology and engineering departments at **Portland State University** (<http://www.pdx.edu>), **Oregon State University, Corvallis** (<http://www.oregonstate.edu>), and **University of Oregon, Eugene** (<http://www.uoregon.edu>) research landslide hazards.

## Other Agencies and Societies

- Oregon Emergency Management, <http://egov.oregon.gov/OOHS/OEM/>
- Federal Emergency Management Agency (FEMA), <http://www.fema.gov/hazards/landslides/>
- USDA Forest Service Pacific Northwest Research Station, <http://www.fs.fed.us/pnw/>
- USDA Natural Resources Conservation Service Soils, <http://soils.usda.gov/>
- Association of Engineering Geologists, Oregon section, <http://www.aegoregon.org/>
- American Society of Civil Engineers, Oregon section, <http://www.asceor.org/>
- Bureau of Land Management, Oregon section, <http://www.blm.gov/or/>

