



# ***HOMEOWNER'S GUIDE to LANDSLIDES***

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**RECOGNITION, PREVENTION, CONTROL,  
*and* MITIGATION**

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Laguna Beach, California (2007). Photo credit: USGS [www.usgs.gov](http://www.usgs.gov).

## **If you are in immediate danger:**

- EVACUATE IMMEDIATELY
- Inform your neighbors
- Call the police or fire department
- Call a registered engineering geologist or a geotechnical engineer

## **Warning signs include:**

- House is making noises
- Walls and floors are tilting
- Cracks in house are actively opening
- Cracks in ground are appearing
- Water in drainages becomes irregular or stops

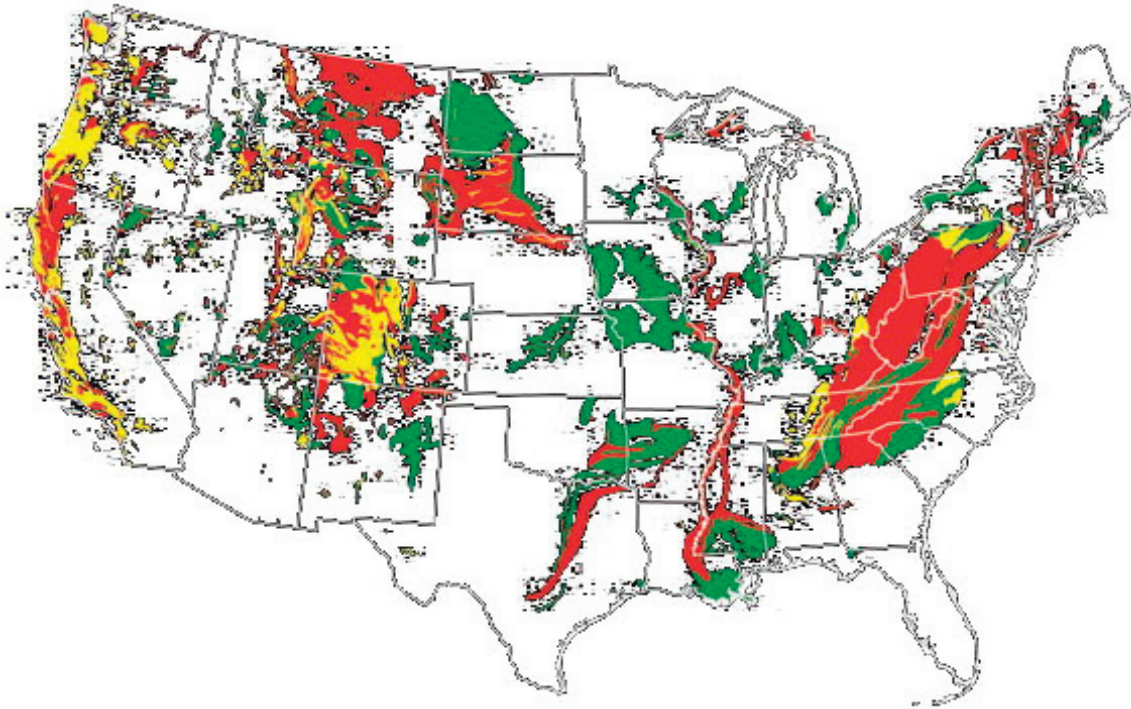
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**Cover:** Kelso, Washington (1998), site of America's second largest landslide disaster involving homes where 60 homes were destroyed. **Photo credit:** Scott Burns.

# I. DEFINITION

Landslides occur when masses of rock, soil, or debris move down a slope under the force of gravity. The term landslide includes a wide range of ground movement such as rockfalls, mud and debris flows, and surface failures called slumps, earthflows, and translational slides. Landslides can occur in a matter of seconds or over the course of weeks and longer.



Landslide potential map - colors represent different levels of activity with red being highest, yellow moderate, green low, and white very low. **Credit:** USGS [www.usgs.gov](http://www.usgs.gov).

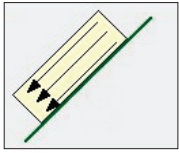
# II. U.S. LANDSLIDE FACTS

- Landslides can occur in all 50 states
- Damages total approximately \$3.5 billion/year
- Landslides cause an average of 25-50 deaths/year
- Landslides reduce real estate value
- Landslides are generally not covered on homeowner's insurance policies



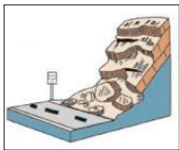
# III. TYPES OF LANDSLIDES

## SLIDES (translational or planar)



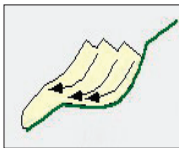
Down-slope movement of soil and/or rock on a plane of weak material can occur on relatively moderate to steep slopes, especially in weak geologic materials.

## ROCKFALLS



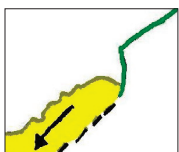
Rapid, near vertical, movement of rocks that involves free-falling, bouncing, and rolling; often occurs in areas with near vertical exposures of rock.

## SLUMPS (rotational)



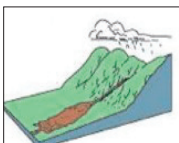
Unconsolidated materials (such as soil and debris) move down-slope in a distinctive rotational motion, usually occurs on moderate to steep slopes.

## EARTH FLOWS



Unchannelized flow of water, soil, rock, and vegetation that moves down-slope, occurs on steep slopes. No failure surface at bottom.

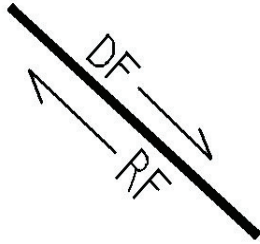
## DEBRIS/ MUD FLOWS



Rapidly moving, channelized slurry flow of water, soil, rock, and vegetation; occurs mainly in drainage channels.

# IV. CAUSES OF LANDSLIDES

**Two forces affecting landslides are:**



- 1) Driving Forces (DF) cause the slope to move
- 2) Resisting Forces (RF) stabilize the slope and prevent movement

When the driving forces exceed the resisting forces, landslides occur. To prevent or mitigate landslides, increase resisting forces or decrease driving forces.

**Factors increasing driving forces:**

- 1) Over-steepened slopes
- 2) Adding water to slope from landscape irrigation, roof downspouts, broken sewer and water lines, and poor stormwater drainage
- 3) Heavy rainfall and/or rapid snowmelt
- 4) Loading extra material at the top of the slope

Earthquakes and heavy precipitation can also trigger landslides on susceptible slopes.

**Factors increasing resisting forces:**

- 1) Removing excess water from slopes
- 2) Adding buttress material at base of a slope
- 3) Building retaining walls

# V. LANDSLIDE RECOGNITION BEFORE YOU BUILD

## SIGNS OF LANDSLIDE POTENTIAL OR ACTIVITY

**Steep slopes** – problems often occur on slopes steeper than 10-15 degrees.

**Suspect landforms** may indicate past ground movement. Landforms such as steep, curved scarps are common at the top of landslides. Hummocky (lumpy and bumpy) ground often indicates a former landslide. Trees that lean in different directions or have bent lower tree trunks (trees with knees) are also indicators.



Suspect landforms include: Scarps, sunken or down-dropped roads, and 'trees with knees'. Top left scarp **photo credit:** USGS [www.usgs.gov](http://www.usgs.gov). Middle road and trees top right **photo credits:** Scott Burns.

**To learn where landslides have occurred** in your area contact local officials, state geologic surveys, departments of natural resources, or university geosciences departments. ***Slopes where landslides have occurred in the past have a higher likelihood of movement in the future.***

## WHEN YOU BUILD

Buildings should be located away from high risk areas such as steep slopes, rivers and streams (perennial or ephemeral), and fans at the mouth of mountain channels.

**Consult a** certified or licensed engineering geologist (**CEG** or **LEG**) or a registered/licensed geologist (**RG**) or a professional geotechnical engineer (**PE**) **if** you plan on building on a location that is a **high risk** area.

### **AREAS PRONE TO LANDSLIDES INCLUDE:**

- Areas where previous landslides have occurred
- Steep natural slopes particularly in weak geologic materials
- Canyons and areas in or around drainages
- Developed hillsides where landscapes are irrigated
- Below cliffs or hills with outcrops of fractured rocks
- Steep slopes where surface runoff is directed onto the slope
- Areas where wildfires or human modification have removed vegetation from the slopes



# VI. MONITORING YOUR HOUSE AND SURROUNDING PROPERTY

## SIGNS OF LANDSLIDE ACTIVITY

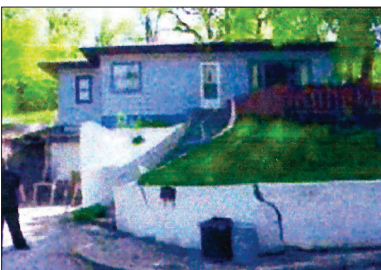
### STRUCTURES:



House cracks. **Photo credit:** Scott Burns.

- Newly cracked pavement, foundation, support walls, sidewalks
- Tilted or cracked chimney
- Doors or windows that stick or jam for the first time
- Outside walls, walkways, or stairs start pulling away from the house
- Soil moves away from the foundation
- Plumbing or gas lines develop leaks

### PROPERTY:



Foundation cracks. **Photo credit:** FEMA [www.fema.gov](http://www.fema.gov).

- Bulging ground at base of slope
- Leaning fence posts or retaining walls
- Springs, seeps, or saturated soil in areas that have been typically dry
- Cracks in the ground
- Tilted trees or utility poles



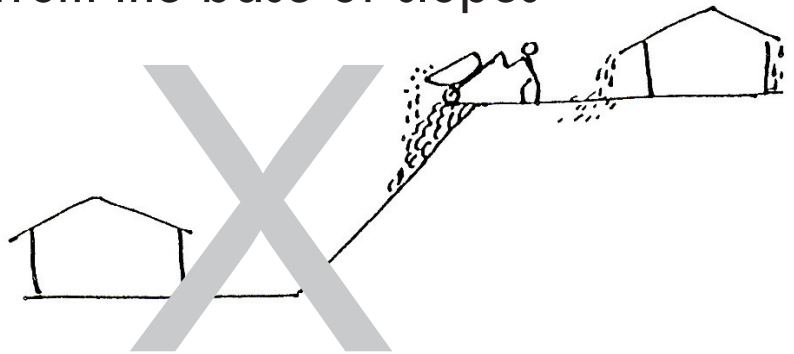
Street and ground cracks. **Photo credit:** Scott Burns.

*If you have some of the above signs, your land may be slowly creeping. It may be an old landslide that has started to reactivate. Call a registered/licensed professional.*

# VII. REDUCE THE LIKELIHOOD OF A LANDSLIDE

- Minimize irrigation on slopes
- Make sure water and sewer lines do not leak
- Avoid removing material from the base of slopes

- **Avoid adding material or excess water to the top of slopes**



- Drain water from surface runoff, down-spouts, and driveways well away from slopes and into storm drains or natural drainages
- Plant ground cover with deep roots on slopes
- Build retaining walls at the base of the slope
- In debris/mud flow prone areas, in valley bottoms or on fans at the mouths of canyons, contact qualified professionals to determine how to best build channels and/or deflection walls to direct the flow around buildings (keeping in mind your neighbors)



Retaining wall at bottom of a slope.  
Photo credit: Scott Burns.

# VIII. QUICK GUIDE TO ASSESS LANDSLIDE POTENTIAL

- Have there been landslides in the area in the past?
- Is the house or site on or near a steep slope?
- Is there a cliff nearby?
- Is the ground cracked?
- Are there any old scarps on the slope?
- Is there a spring, seep or ponding water close by?
- Is there a drainage channel nearby?
- Are there any tilted or leaning trees, fences, or utility poles nearby?
- Do the trees have bent tree trunks?
- Is there any sign of cracking, or patched cracks in the walls or foundations
- Is the driveway or sidewalk cracked, patched, or down-dropped?
- Are any retaining walls cracked, tilted or off-set?
- Have any structures such as concrete steps moved away from the house?

**If you have any of these signs your house could be susceptible to a landslide.**

# IX. ADDITIONAL INFORMATION

Federal Emergency Management Agency (FEMA) [www.fema.gov](http://www.fema.gov)  
1-800-621-FEMA (3362)

United States Geological Survey (USGS) [www.usgs.gov](http://www.usgs.gov)

National Landslide Info Center <http://landslides.usgs.gov>  
1-800-654-4666

## **Important local phone numbers and agencies:**

(Oregon) Nature of the Northwest Information Center: carries landslide hazard maps and other reports <http://www.naturenw.org> (503) 872-2750

Oregon Department of Geology and Mineral Industries (DOGAMI): maps landslides and issues reports [www.oregongeology.com](http://www.oregongeology.com) (971) 673-1555

Oregon Department of Forestry Debris flow Warning System: provides current forecasts and warnings <http://egov.oregon.gov/ODF>

Oregon: to check licensing for engineers (Oregon State Board of Examiners for Engineering and Land Surveying): <http://osbeels.org/>  
(503) 566-2837

Oregon: to get lists of licensed geologists (Oregon State Board of Geology Examiners) [www.oregon.gov/OSBGE/registrants](http://www.oregon.gov/OSBGE/registrants) (503) 566-2837

Washington State Department of Natural Resources: landslide information [www.dnr.wa.gov/geology/hazards/lslides.htm](http://www.dnr.wa.gov/geology/hazards/lslides.htm)

Washington State Department of Natural Resources: general information inquiries (360) 902-1000

Washington State Department of Licensing: to check professional license status [www.dol.wa.gov/business/checkstatus.html](http://www.dol.wa.gov/business/checkstatus.html)